MECHANICAL TESTING OF GEAR LUBRICANTS.

By J. R. HUGHES, B.Eng., G.I.Mech.E., and R. TOURRET, B.Sc.(Eng.), G.I.Mech.E.

(*Concluded from page* 203.)

THE THORNTON CAM-SCUFFING RIG.

IT has been mentioned that gear-lubricant test rigs suffer from the disadvantage that test gears of uniform quality are sometimes difficult to obtain. The cam-scuffing rig is a simulation-type test rig in which the cylindrical surfaces of two eccentrically-mounted discs (" cams ") slide during part of their revolution against two flat surfaces (" tappets "), loaded by air pressure. This mechanism was designed to simulate gear operation while using test-pieces which would be easier to obtain than the gears used in the gear rigs, and the finish of which could be more closely controlled. The contact conditions, a combination of sliding and rolling, are similar to those encountered in spur gears, as also is the type of scuff mark obtained on failure. The kinematics of this type of mechanism are considered in the appendix on page 258.

The rig is built on a trestle foundation, as shown in Fig. 10, herewith, under which is the driving motor, of 6 h.p. continuous rating, and on which is the test chamber. The motor drives a subsidiary shaft which, in turn, drives the main shaft in the main housing through a flexible coupling. This main housing (Fig. 11) has flanges on each side to which are attached the tappet-and-plunger assemblies. These are small air chambers, fed from compressed air bottles, in which the tappet and plunger are free to move. When the air is admitted to the chambers, each plunger is forced towards the extremity of the assembly, and its tappet comes into contact with the rotating cam. The length of the contact arc depends upon the pre-setting of the chamber by means of the knurled sealing ring.

The purpose of the plunger is to ensure that the tappet is held in correct alignment; it is fitted with six narrow piston rings to maintain airtightness. The plunger and tappet clearances have to be accurately maintained to ensure a suitable compromise between plunger-sticking and excessive air loss. The plunger is drilled to take thermocouple leads from the tappet, if required. The tappet and the cam, Figs. 12 and 13, respectively on page 258, must have their contacting surfaces held within close limits of hardness and surface finish; in this case, 800 to 900 Vickers Hardness Number and 4 to 8 micro-inches, measured on the average meter of the Talysurf surface meter, were found to be satisfactory. Early tests demonstrated that such close limits were essential.

The test oil is led, at controlled pressure and temperature, to two jets directed on to the contacting surfaces of the tappet and cam. Two sets of test-pieces are used simultaneously, with the two cams mounted co-axially but out of phase by 180 deg. and separated by a distance piece, the plunger and tappet assemblies being suitably offset. The main casting has an observation window in the face and another in the top of the housing, the latter being fitted with a quick-release device to enable close inspection to be made of the test-pieces.

The tappet was originally pinned in place to prevent rotation, but, owing to the inevitable slight manufacturing errors, the scuff marks often did not conform to the ideal of the square patch, as shown in Fig. 14(*a*), but were one-sided, as in Fig. 14(*b*), on page 258. The pin was then omitted, but " criss-cross " scuff marks were obtained (Fig. 14(*c*)) owing to the haphazard rotation of the tappet; these can be seen in Fig. 9. The final modification was to grind the tappet face at an angle, so that the slight self-aligning property due to the face inclination would turn and maintain the tappet in the correct position. After several trials, an angle of 1 deg. to the original plane (or 89 deg. to the centre-line of the tappet) was found to be satisfactory.

TEST TECHNIQUE.

After the insertion in the test rig of fresh cams and tappets, previously checked for conformity to specification, the oil pump is started and the test oil heated to the required temperature. The driving motor is then started and the air pressure brought up to the required value as rapidly as possible. After a run of one minute at this pressure, the rig is stopped and the cams are observed by releasing the top observation window. If scuffing has not occurred, the rig is restarted (one minute after the finish of the previous run) for the next run, with the air pressure increased by the correct increment. This procedure is followed until both cams are scuffed. After a test, the oil system is flushed out with heated light mineral oil followed by petroleum spirit to guard against the possibility of carrying over traces of additive and influencing the next test.

The standard test conditions are summarised below.

Cam hardness	800 to 900 V.H.N.
Cam rotational speed	1,250 r.p.m.
Cam surface finish	4 to 8 micro-in., ground.
Cam material	Case-hardened mild steel.
Load, initial	30 lb. per square inch.
Load, rate of increase	5 lb. per square inch every minute.
Oil flow	Half Imperial pint per minute per jet.
Oil delivery temperature ..	80 deg. C.
Tappet face angle	1 deg.
Tappet hardness	800 to 900 V.H.N.
Tappet surface finish	4 to 8 micro-in., specular-ground.
Tappet material	Case-hardened mild steel.
Tappet travel	0·031 in.
Test and rest period	1 minute.

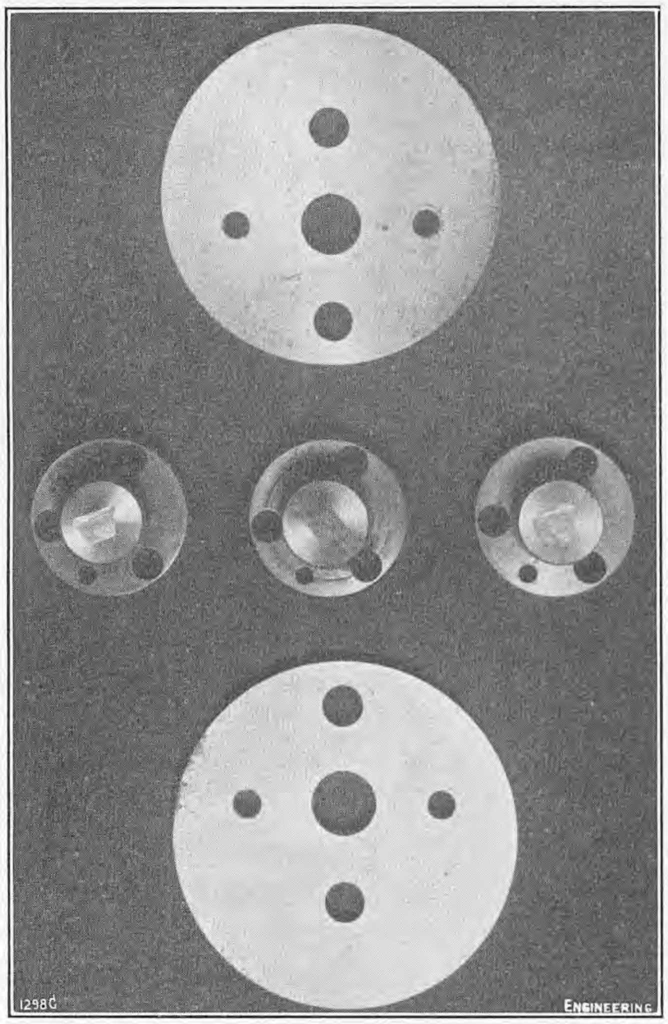


FIG. 9. CAMS AND TAPPETS.

Fig. 10. CAM-SCUFFING RIG.

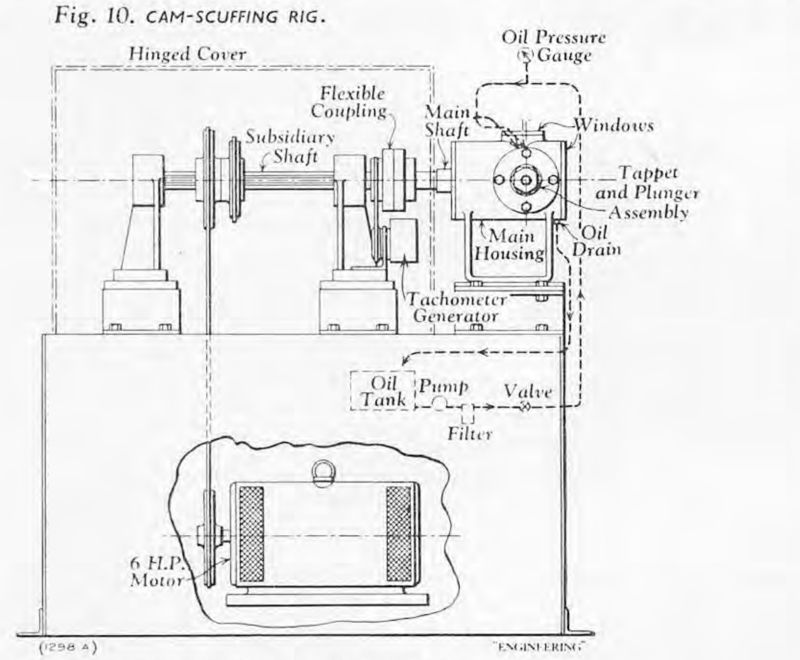
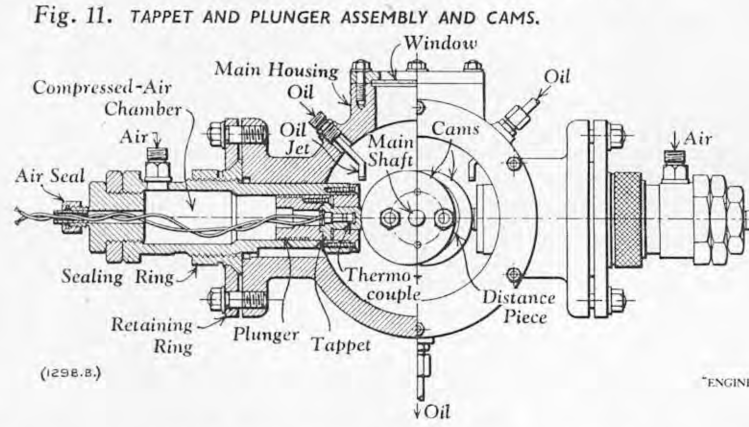


Fig. 11. TAPPET AND PLUNGER ASSEMBLY AND CAMS.



MECHANICAL TESTING OF GEAR LUBRICANTS.

Fig. 12.

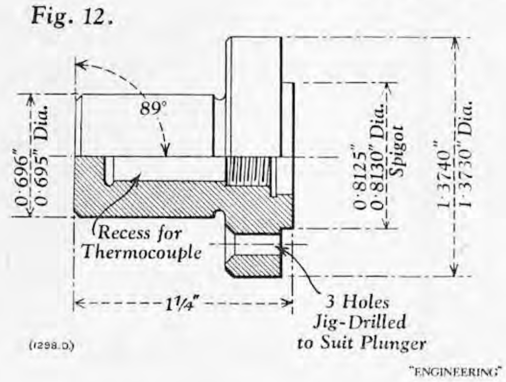


Fig. 13.

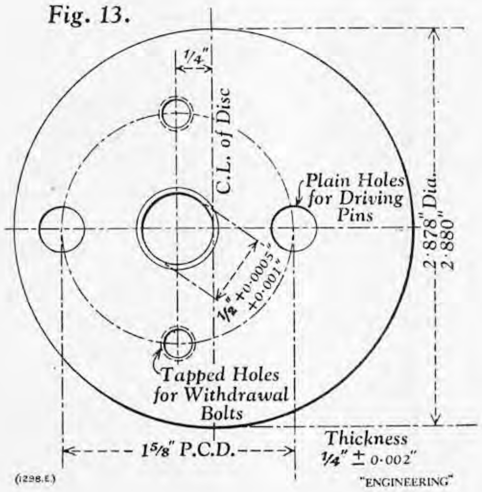
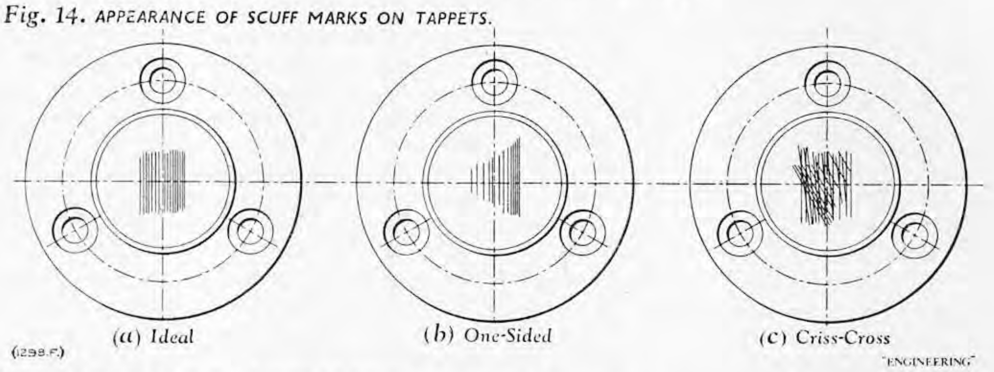


Fig. 14. APPEARANCE OF SCUFF MARKS ON TAPPETS.



(a) Ideal (b) One-Sided (c) Criss-Cross

Fig. 15. TESTS TO SHOW RANGE OF RESULTS OBTAINABLE FROM CAM-SCUFFING RIG.

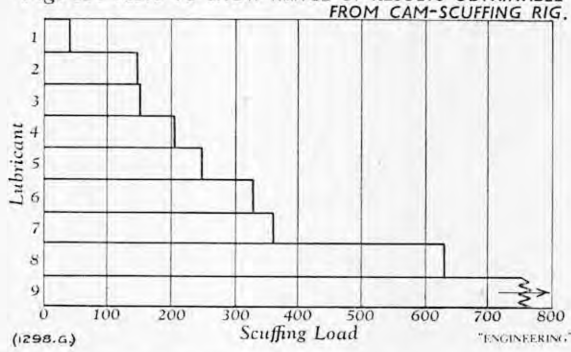
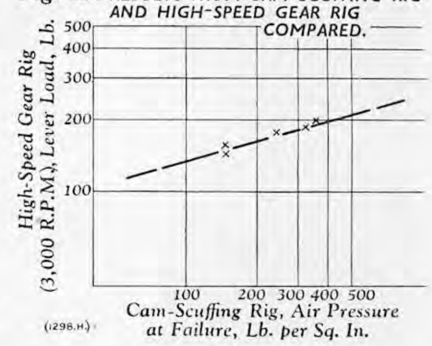


Fig. 16. RESULTS FROM CAM-SCUFFING RIG AND HIGH-SPEED GEAR RIG COMPARED.



A test programme was completed, using oils of which the performance was known to vary widely; the results are given in Fig. 15, herewith. The values given for the scuffing load are the average air pressure at failure, in lb. per square inch, for four or more tests. The tests were intermingled to confirm that there was no carry-over effect when changing lubricants. The air pressure was limited, by the capacity of the compressed-air equipment available, to 750 lb. per square inch, which was insufficient to cause scuffing with lubricant No. 9. The repeatability of the results was very good; for example, probable limits of accuracy for 95 per cent. significance level for the results on lubricant No. 3 are 148 ± 16.

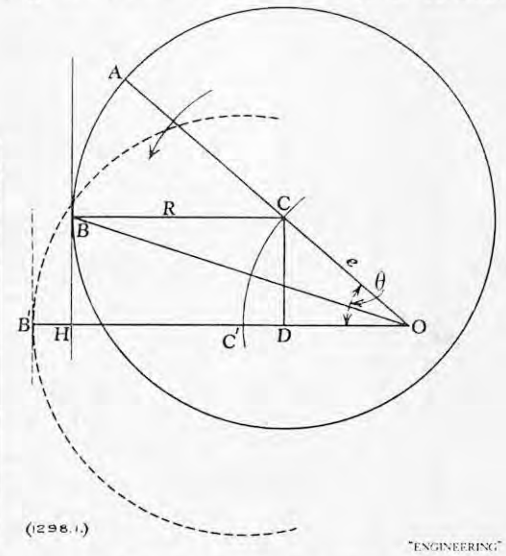
It was apparent, on plotting scuffing load against the other variables for lubricant 3, for which most results were available, that no correlation existed within the narrow ranges of hardness and finish, and hence that neither of these variables had a predominant effect. Therefore, the repeatability could not be further improved by stricter control of hardness and of surface finish (see Figs. 12 and 13).

The rig is thus shown to be capable of distinguishing between different oils, results ranging from 36 lb. per square inch with lubricant No. 1 through 148 lb. per square inch with lubricant No. 3 to over 750 lb. per square inch with lubricant No. 9. This open scale, considered in conjunction with the close confidence limits, amply demonstrates the possibilities of this rig as a test unit. There was no significant difference in the results obtained from the two sides of the test rig, showing that the different oil-feed directions, with and against the direction of rotation, had no effect.

Comparison of Results.

Having shown that the cam-scuffing rig, a simulation-type rig, gives repeatable results differing according to lubricant, it remains to establish how these results relate to gear performance. The test figures are therefore compared in Fig. 16, on this page, with some given by the high-speed gear rig,

Fig. 17. KINEMATICS OF CAM AND TAPPET CONTACT.



running under conditions which give a tip sliding speed similar to that of the cam-scuffing rig. These show reasonable correlation. To give a general idea of the relative merits of the two types of rig, the principal features and possibilities of the cam-scuffing rig are compared with those of gear rigs in Table III, herewith.

TABLE III.—*Comparision of Cam Scuffing Rig and Gear Rig.*

Feature.		Cam-Scuffing Rig.	Spur-Gear Rigs.
Rig performance	Differentiation between oils.	Good.	Good.
	Repeatability of results.	Good.	Good.
Rig conditions	Sliding velocity.	Constant (a) (b).	Varying from negative value through zero to positive value.
	Rolling velocity ratio.	Almost constant (a)	Varying across tooth face.
Range of test specimens	Material.	Almost unlimited.	Almost unlimited.
	Type of surface finish.	Unlimited.	Not very easy to vary.
	Ease of measuring surface finish.	Good.	Difficult; not normally measured.
	Surface hardness.	Easy to vary.	Not very easy to vary.
	Ease of manufacture.	Can be made in ordinary machine shop.	Requires specialist machine shop, accustomed to gear manufacture.

Notes.—(a) For given size of cam; (b) increased by increase in the speed of the rig.

The cam-scuffing rig has several practical advantages over gear rigs, notably in the wider choice of test materials and in the comparative ease of production of the test-pieces. On the other hand, the test conditions are not strictly equivalent to gear operation, because the sliding velocity is constant throughout the contact instead of varying over a wide range and also the rolling-velocity ratio changes to a much smaller extent. While the sliding velocity may be increased by increasing the rotational speed of the cam, the rolling-velocity ratio is independent of the angular velocity of the cam and, therefore, cannot be varied, except to a small extent, by dimensional changes in the cam.

The results given show that these two rigs effectively distinguish between different lubricants in the manner intended, that is, in their ability to delay the onset of scuffing. It may be thought that simulation rigs will eventually replace gear rigs. However, in spite of the cost of test-pieces and difficulty in obtaining gears of the very high accuracy required for test work, it is not intended that the simulation-type test rig should ever entirely supersede the machine using actual gears. As knowledge on the subject of gear lubrication increases, it may be possible to perform an increasing proportion of test work on the simpler simulation rigs, but this would always be in conjunction with works on gear rigs.

Appendix.—Kinematics of the Cam-Scuffing Rig Mechanism.

Consider a circular cam of centre C and radius R rotating with angular velocity ω about the point O (i.e., eccentricity $O\,C = e$) (Fig. 17). Let the cam make contact with a plane tappet B H at the point B and let O H be the perpendicular from the centre of rotation O to the plane of the tappet face, such that the angle $C\,O\,H = \theta$. Then, velocity of point of contact B in the direction B H (i.e., parallel to the face of the tappet) = velocity of centre of circle, C, parallel to $B\,H = O\,C\,\omega \cos\theta$.

Also, velocity of point on periphery of cam at B in direction $B\,H = O\,B\omega \cos B\,O\,H = O\,H\omega = (O\,C \cos\theta + C\,B)\,\omega$.

Whence, rolling-velocity ratio at contact

$$= \frac{(O\,C \cos\theta + C\,B)\,\omega}{O\,C\,\omega \cos\theta} = 1 + \frac{C\,B}{O\,C \cos\theta}$$

$$= 1 + \frac{R}{e \cos\theta}, \quad (1)$$

and sliding velocity at contact

$$= (O\,C \cos\theta + C\,B)\,\omega - O\,C\,\omega \cos\theta$$
$$= C\,B\,\omega = R\,\omega \quad . \quad (2)$$

The maximum displacement of the tappet B H occurs when B C coincides with the straight line O H, perpendicular to B H. Let B′ be the point of contact in this position and let C′ be the corresponding position of C. Let C D be the perpendicular from C to O H. Then, the displacement of the tappet

$$= H\,B' = C'\,D = O\,C\,(1 - \cos\theta)$$
$$= e\,(1 - \cos\theta) \quad . \quad (3)$$

Produce O C to meet the circumference of the circle in A. Then, at the maximum displacement of the tappet, the point A occupies position B′, and if, at initial contact, $\theta = \theta_i$, the complete arc of contact on the cam

$$= 2\,A\,B = 2\,R\,\theta_i \quad . \quad . \quad (4)$$

Length of contact on tappet

$$= 2\,B\,H = 2\,O\,C \sin\theta_i = 2e \sin\theta_i \quad . \quad (5)$$

Duration of contact

$$= \frac{2\,\theta_i}{\omega} \quad . \quad . \quad . \quad (6)$$

Substituting numerical values for the cams and tappets used in the cam-scuffing rig, namely, radius, $R = 1{\cdot}439$ in., eccentricity, $e = 0{\cdot}250$ in., travel, $t = 0{\cdot}031$ in., and angular velocity, $\omega = 7{,}854$ radians per minute (1,250 r.p.m.). Then

Sliding velocity ... ... = 942 ft. per minute.
Rolling-velocity ratio at first contact ... ... = 7·57
Rolling-velocity ratio at maximum displacement = 6·76
Arc of contact on cam ... = 1·448 in.
Length of contact on tappet ... ... = 0·240 in.
Duration of contact ... = 0·0077 sec.

The lengths of contact calculated above agree with measurements of scuff marks on cams and tappets.

LITERATURE.

Electrical Measuring Instruments. Part 1. *General Principles and Electrical Indicating Instruments.*

By DR. C. V. DRYSDALE and A. C. JOLLEY. Second edition, revised by DR. G. F. TAGG. Chapman and Hall, Limited, 37, Essex-street, Strand, London, W.C.2. [Price 75s. net.]

THE two volumes of the first edition of " Drysdale and Jolley " were generally recognised all over the world as the indispensable standard work on instrument design. Dr. Tagg has now undertaken the arduous task of re-editing this work. Some of the introductory sections have been revised and enlarged, and graphs and other matter, forming the particular work of the editor, have been added, supplying the designer with useful tools in dimensioning and critically analysing optimum design features. The section on the " figure of merit " of pivot-supported moving coils is to be commended. The question arises, however, whether the gap of more than 25 years between the first and second editions has been sufficiently closed. The general impression which a cursory inspection of the illustrations will convey to the reader is that this may not be so, as most of them appear to be obsolete. A closer survey shows the unexpected result that more than a hundred illustrations have been replaced by more recent concepts; but this figure should have been doubled at least to bring the work up to date. Figures 1·5, 6·21 and 10·16 are either upside down, incomplete or horizontal instead of vertical.

The text itself is even more open to criticism. The general layout of the work follows closely the original edition, presenting general principles and indicating instruments in the first volume. Therefore, the volume under review should attract mainly research workers and students. Copying complete paragraphs from the first edition without any revision misleads the reader in many respects. For instance, the introductory remarks on filar suspensions are in contradiction to recent developments. This type of moving-coil support has been successfully applied for nearly 40 years in one of the best known recording instruments of the self-balancing type. The few lines on the standard cell (page 12) are inadequate; it forms an important part in potentiometric instruments. Furthermore, the research worker will miss a section on the sensitivity limit of instruments in general, and, in particular, with regard to Brownian movement. No reference is made to potentiometric circuits, electronic instruments, or to such innovations as projected moving scales or light-beam pointers.

The first volume has no bibliography; yet a bibliography is a most important tool to the research worker and student, affording both guidance and stimulus for further investigations. Some 16 references are included in the text, but only two are more recent than 1930. No mention is made of recent publications by well-known authorities, which partly accounts for the shortcomings of the new edition. The footnote on page 187 is missing; and many names of authors and inventors, as given in the text, will leave the reader at a loss where to find the original references. The second volume may remedy some of these deficiencies, and assist to bring this essential work up to date.

The World's Oilfields: The Eastern Hemisphere.

Edited by Professor V. C. ILLING, F.R.S. Oxford University Press (Geoffrey Cumberlege), Amen House, Warwick-square, London, E.C.4. [Price in U.K., 52s. 6d.]

THIS book, which is Vol. VI, Part I, of *The Science of Petroleum*, represents an instalment, and a substantial one, of the post-war resumption by the Oxford University Press of a publishing venture of prime importance, undertaken some years before the war. The four main volumes appeared in 1938 and contained about 400 articles by experts from the main centres of petroleum technology, the aim being (in the words of the publishers) " to bring together the scientific data on the science and technology of petroleum which previously were to be found only in innumerable scattered journals and the archives of industrial companies." This purpose was substantially achieved by those four prewar volumes (which are still available) but it was appreciated that supplementary volumes would be needed to keep the original survey more or less abreast of subsequent progress in exploration, producing and refining practice, and research. The present volume is the first part of the revision of the original Vol. I, and comprises descriptions of the more important oil-producing or oil-containing areas in the Eastern Hemisphere, contributed by more than 30 geologists under the editorship of Professor V. C. Illing, who occupies the chair of oil technology in the Imperial College of Science.

The text is divided into four sections dealing, respectively, with Europe, the Middle East, the Far East and Australasia, and Africa. Of these, the second and fourth are the shortest; the second, because the oilfields of the Middle East, though incomparably the richest of all those discussed, are relatively concentrated and could be treated in only five chapters, and the fourth because, regarding Africa, there is nothing of much significance to report. Russia has been omitted, as no recent information could be obtained from the U.S.S.R.; and, though Poland is included, the information given is not very up to date, for the same reason. Regarding the Far East and Australasia, much of the survey consists of reports of unsuccessful explorations of sites which proved to be either barren or not significantly productive; this applies particularly to Australia itself. In Europe, on the other hand, there is evidence of considerably more oil than the non-expert reader would be likely to expect; and, rather unexpectedly, a table listing the aggregate productions of oil from 13 European countries shows that the United Kingdom has made a contribution which is by no means negligible—639,000 metric tons—though, naturally, this is trivial by comparison with Roumania's total output, which is nearly 170 million tons to the end of 1950. Roumania heads the list in Europe, with Poland second (38 million tons) and Germany and Austria in the third and fourth places, with 15 millions and 10 millions, respectively. The European area in which the greatest expansion is taking place at present is along the border between Holland and Germany.

Broadly considered, the book is one to appeal to the geologist rather than the engineer, and is a work for reference rather than straightforward reading. It is well provided with maps and geological cross-sections, supplemented by some striking photographs of surface formations in oil-bearing regions; and there is an excellent index. Three further parts of Vol. VI are in preparation, as well as Part III of Vol. V, which will deal with " Refinery Products of Petroleum."

Higher Industrial Production with Electricity.

British Electrical Development Association, 2, Savoy-hill, London, W.C.2. [Price 8s. 6d.; by post, 9s.]

MANY sufferers from power cuts, in recent years, have commented rather critically on the continued existence of the British Electrical Development Association, the initial and, at that time, most-publicised function of which was to encourage the wider use of electricity; but the Association has another purpose, in no way diminished in force by post-war economic circumstances, namely, to promote the most efficient use of electricity, and efficiency, in this case, obviously means overall efficiency in the industrial sense and not merely efficiency of generation and distribution. This, presumably, is the motive behind the " Electricity and Productivity Series " of manuals prepared by the Association, of which the volume under review is the first, serving by way of introduction to the series. The seven volumes which are to follow will be of a more specialised character, dealing, respectively, with lighting, electric motors and controls, materials handling, resistance heating, induction and dielectric heating, electric trucks, and " Process Integration and Instrumentation."

It is emphasised in the preface that higher production " does not necessarily involve a great increase in the amount of electricity used " (though this seems to be at variance with the advocacy of some electrical plant, such as large electric furnaces for metal-melting) " but rather the more widespread and intelligent application of electrical methods." The examples of such applications which are cited and illustrated, however, are well chosen to support the arguments put forward, and many of them are backed by figures of performance which will be studied with interest by industrialists. Not all of the statistics are taken from United Kingdom sources and the weight to be attached to them must take into account the availability of current supplies on the scale necessary; but it is reasonable to expect that there will not always be a shortage of electrical generating capacity in this country, and, in many of the applications recommended, the use of electricity is in substitution for other means of obtaining heat and power. Most proposed industrial developments have to be considered on their individual merits, and the non-technical presentation of the case for electricity, as put forward in this general review, should be a useful guide in formulating policies.

THE BITUMINOUS SANDS OF ALBERTA.

By A. A. Peebles.

(*Concluded from page 231.*)

The Provincial Government of Alberta have established a small pilot plant at Bitumont, on the Athabasca River. The plant is designed for, and is operated to, a capacity of over 500 barrels per day, and is entirely self-contained. Apart from the bituminous sand quarry and the central processing plants, including separation, dehydration and distillation units, it has also a power plant, machine shop, laboratory, living quarters for personnel, a river wharf and an air strip. The work at Bitumont has demonstrated that the hot-water separation process can be carried out continuously and is capable of being placed on a routine operating basis on a large scale. The successful operation of the plant has made it possible to estimate with reasonable accuracy both the capital and operating costs that would be involved in comparatively large units.

After separation, the crude bitumen is never entirely free from solids and water; up to 40 per cent. of water may be present in a relatively stable mixture. The solids constitute a serious hazard if the material is to be processed in a pipe-still, and, if present in any quantity, preclude pipe-still operation. Such material can be effectively handled, however, in plants that use the solid fluidising technique. As this process can be applied to charging stock containing both mineral matter and water, and allows continuous operation, its value is apparent. It can also be applied directly to the bituminous sand in a fluidised solids bed, thus eliminating the separation process.

This direct distillation of the bituminous sand has been investigated by a pilot plant designed by the National Research Council of Canada, on the lines shown diagrammatically in Fig. 5, herewith. When gas is passed upwards through a bed of finely divided particles at sufficient velocity, the whole bed becomes violently agitated and is then said to be fluidised. From laboratory tests it was learned that, when lumps of bituminous sand were fed directly into a fluidised bed, heated to 930 deg. F., the oil distilled off immediately. The bituminous sand lumps then broke down into individual grains of free-flowing sand, which become thoroughly mixed with the bed. Some coke was formed, and this appeared as a thin closely-adherent black film, coating the surface of the sand particles. The oil formed was brown instead of black, and it was much less viscous than the bitumen in the feed, indicating that considerable cracking had taken place. The formation of process gas also indicated cracking. Good yields of oil were obtained.

The pilot plant consists of a still burner, together with the necessary controls and measuring equipment. Bituminous sand is fed continuously from a hopper by means of a worm into the top of the still, which contains a heated bed of fluidised sand. The oil flashes off and is carried by the fluidising gas through a hot cyclone, where the dust is removed, and thence to an electric precipitator and condenser to remove the oil. The gasoline is then removed by an activated charcoal scrubber, and is later recovered. As the oil distils off, the residual sand breaks down into free-flowing particles coated with coke. This sand is withdrawn continuously down the still standpipe into the burner, where the combustion of the coke is used to heat the sand. Sufficient of this hot burnt sand can be recycled to the still to supply the heat necessary for distillation. Bed depth and temperature are controlled automatically.

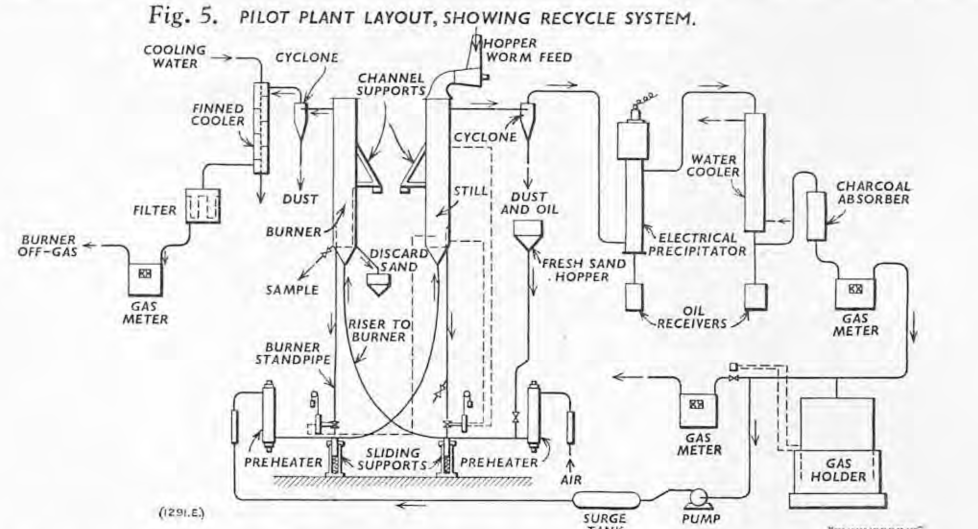
Treatment of the bituminous sand at the Bitumont plant of the Alberta Provincial Government involves three operations, namely, primary water separation to yield a bitumin containing about 33 per cent. water and 7 per cent. solid matter; dilution with a light oil followed by flash dehydration to remove the water; and distillation to recover the light oil and produce a bitumen of high viscosity. The possibility that the fluidised solids method might prove satisfactory for the treatment of wet bitumen, such as that produced by the water separation procedure, has been investigated by the National Research Council. The plant already described was modified to make it possible to pump wet crude bitumen directly into the bottom of the still. The steam and oil vapour which formed when the feed made contact with the hot sand of the still bed served as the fluidising gas. By this process, a maximum oil yield of 88 per cent. by volume was obtained at a temperature of 983 deg. F.

The bitumen obtained from the sands contains, on an average, 5 per cent. of sulphur and the distillate about 4 per cent. This must be reduced before marketing. The process of hydrogenation, as used generally in the oil industry, requires about 1,000 cub. ft. of hydrogen per barrel of the distillate to reduce the sulphur content to 0·25 per cent., and this operation will also remove most of the mineral matter. The bituminous sands in the square mile of the field investigated by the Federal Government contain an estimated 1,500,000 tons of sulphur, of which some 60 per cent. is recoverable in elemental form. With an output of 20,000 barrels per day, the daily recovery of sulphur would be about 140 tons at a cost of about 8·50 dols. per ton, starting with the hydrogen sulphide. Should the time come when the field is developed on a large scale, the marketing of the enormous quantities of this by-product might prove a problem, in spite of the large amounts of sulphur used in the Canadian pulp-paper industry.

To develop the field commercially and on a profitable basis, a pipeline from the field to Edmonton, with three pumping stations, would be necessary. This would cost about 5,000,000 dols., and would impose a tariff on the distillate of about 28 cents per barrel. This project, together with the establishment of hydrogenation and hydrogen manufacturing plants, might be undertaken by the Alberta Provincial Government when prospective development of the field justifies the capital expenditure.

Estimates, based on a project having an output of 20,000 barrels per day and data obtained from the pilot plant, place the total cost of the product at 3·10 dols. per barrel, delivered at the Great Lakes terminal of the Canadian pipeline. This figure includes all operating and associated field costs, administration, depreciation of plant and equipment, and a charge of 1·02 dols. for pipeline tariffs, and does not include interest on investment capital. The value of the product at the Great Lakes terminal would be at least 3·50 dols. per barrel.

Fig. 5. PILOT PLANT LAYOUT, SHOWING RECYCLE SYSTEM.



The price trends of crude and furnace oils have been steadily upwards over the past 20 years, and have risen steeply since 1945. Figures relating to production and consumption over the period in question indicate that the price increase will probably be maintained for the foreseeable future. Statistics prepared by the United States Bureau of Mines show that domestic oil production is approaching its peak, which will proably be reached in 1955, failing new and extensive discoveries, and will then decrease almost to vanishing point by the end of the century. On the other hand, the demand will increase continuously, and it is estimated that, by 1975, consumption will exceed production from presently-known sources by 3,500 to 4,500 million barrels per year. It is also almost certain that large-scale exploitation of the Alberta bituminous sands will develop, from experience gained, methods whereby production costs may be reduced. The estimate of 40 cents per barrel profit may be regarded, therefore, as conservative, and likely to increase materially in the future.

The estimated capital expenditure necessary to establish a plant of the capacity under consideration is 2,000,000 dols. for initial mining equipment, 29,600,000 dols. for processing plants, and 12,000,000 dols. for ancillary equipment; a total of approximately 43,000,000 dols. On the basis of 20,000 barrels per day for 300 working days a year, at 40 cents profit per barrel, the dividend would be from 5 to 6 per cent. on the capital invested. Over large areas of the field, a plant of this capacity could operate for 15 or 20 years before transportation costs from mine to plant commenced to show any significant increment.

The field is owned by the Alberta Provincial Government. Renewable leases for 21 years may be obtained for the nominal rental of 1·00 dol. per acre, plus a royalty of 10 per cent. on all oil extracted. The effect of the rental charges upon the cost per barrel of the product would be quite negligible. The same cannot be said in respect to the royalties. These would increase the cost per barrel to a point at which the profit would be too small, under present market conditions, to make the commercial exploitation of the field an attractive investment. It would appear that, to realise on this tremendous asset, the Government will have to revise their demands drastically in this respect. South-west of Fort McMurray, a rich and extensive oilfield is being developed. This is a normal oil-well field, and its exploitation has tended to distract attention from the possibilities of the bituminous sands for the time being, but this incalculable reserve of oil is available for tapping when the time comes. Its development would have an enormous influence on the economy of Alberta and might even assume strategic importance to the Western Powers as other sources dry up or, possibly, are lost as a result of political action.

ITALIAN PASSENGER LINER "GIULIO CESARE."

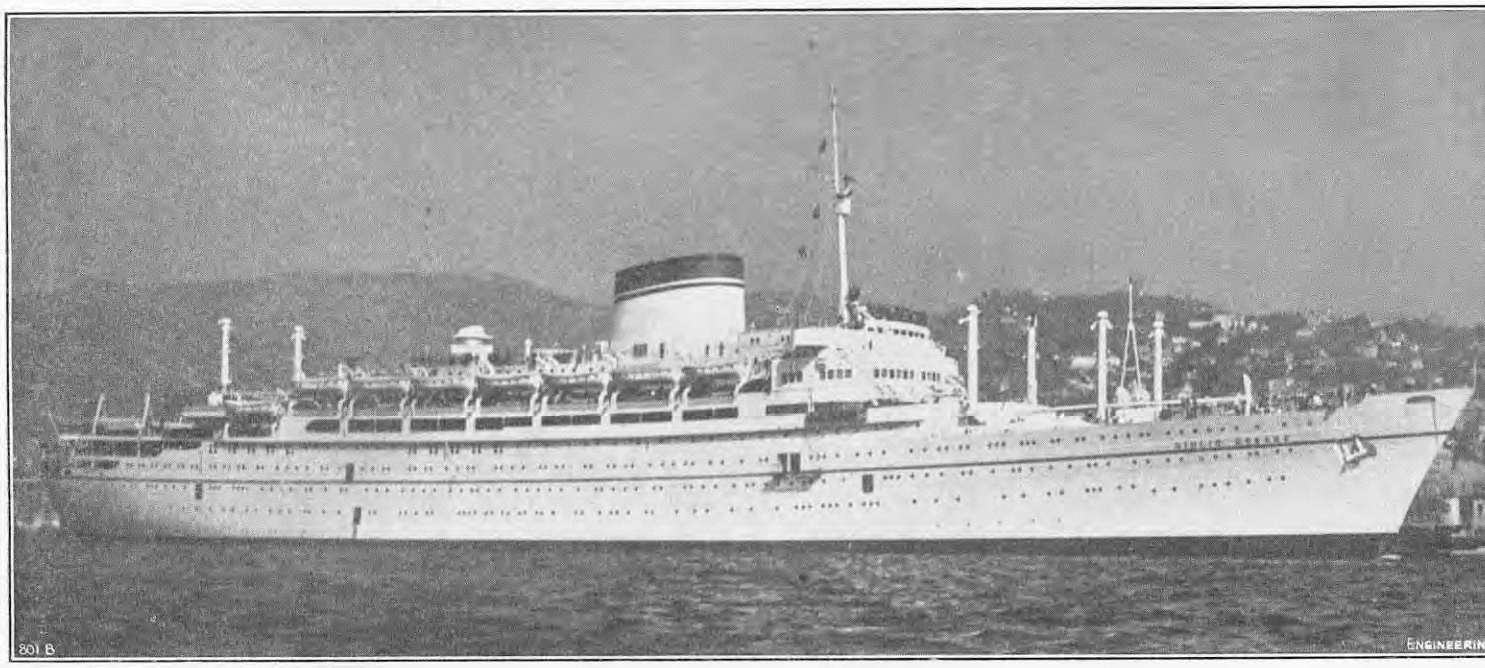


FIG. 1. VESSEL ON TRIALS.

POST-WAR ITALIAN LINERS: I.—"GIULIO CESARE."

BEFORE the war, Italy maintained very close connections with the United States (especially New York) and with South America, particularly Argentina, and Italian transatlantic shipping lines were prominent in both services. This was particularly true of the Società Anonima di Navigazione Italia, of Genoa, whose large fleet included the turbine liners Rex (51,000 tons gross), Conte di Savoia (48,500 tons), and Roma (approximately 30,000 tons), and the motorship Augustus, of about the same tonnage as the Roma. During the war, the company's fleet suffered severely, so that a considerable programme of new construction was necessary to restore the firm to its former position among the shipping companies maintaining first-class passenger services across the Atlantic. In pursuance of this policy, two large motorships, the Augustus and Giulio Cesare, have been added to the fleet; and, more recently, the turbine liner Andrea Doria, which is to be followed shortly by a sister ship, the Cristoforo Colombo. The Augustus, a vessel of 27,700 tons, was built at the San Marco shipyard at Trieste, and her sister ship, the Giulio Cesare, by the Cantieri Riuniti dell' Adriatico, at Monfalcone. The Andrea Doria was completed in January by the Società Anonima Ansaldo, at Genoa, who are also building the Cristoforo Colombo, to be launched later this year.

The Giulio Cesare, which was the earlier of the two motorships, is illustrated in Fig. 1, herewith. She has a length overall of 208 m. (682 ft. 6 in.), and, between perpendiculars, of 188 m. (617 ft. 6 in.); a moulded breadth of 26·6 m. (87 ft. 3 in.), and a depth, to the bridge deck, of 15 m. (49 ft. 3 in.). Her gross tonnage is 27,700, and the designed service speed is 21 knots, though her twin-screw Fiat engines, which develop a normal 26,000 h.p., are capable of propelling the vessel at a considerably higher speed; over 23 knots was attained on the trials. She has been built, under survey, to meet the highest classification requirements of Lloyd's Register of Shipping, the Registro Italiano, and the United States Bureau of Shipping. Electric-arc welding was extensively used in the construction of the hull.

As will be seen from Fig. 1, the vessel has an attractively well-proportioned appearance, the design of the superstructure being such that, while it provides ample passenger accommodation above the hull, there is none of the apparent top-heaviness which has spoiled the lines of so many modern large passenger ships. Arrangement drawings of the profile and some of the nine decks are reproduced in Figs. 3 to 7, on Plate V. Accommodation is provided for 118 first-class passengers, 196 second-class, and 788 third-class—a total of 1,102; but these proportions can be varied over fairly wide limits, and the total number can be increased considerably, if necessary, by fitting additional berths. The total complement of officers and crew is 530. There are nine decks for the use of passengers, these comprising the sun deck, sports deck, boat deck, promenade deck, upper deck, vestibule deck (on which the passengers are embarked), and A, B and C decks. Most of the cabins are located on the upper and vestibule decks and on A and B decks, and the public rooms in the superstructure.

PASSENGER ACCOMMODATION.

The public rooms provided for the first-class passengers comprise the dining saloon, a lounge, a ball-room, writing and reading rooms, and a large observation lounge beneath the bridge, on the boat deck; the reading and writing rooms, and a bar, adjoin this lounge. The ballroom is on the promenade deck, at the forward end of the superstructure. Aft of it, on the same deck, is the first-class lounge, immediately forward of the funnel casing; and the spaces on either side of the casing are devoted to a bar on the port side and a small lounge on the starboard side. Abaft the casing are the second-class lounge and smokeroom. At the after end of the superstructure, on this deck, there is a chapel, in which are held religious services for the three classes of passengers.

The underwater form of the Giulio Cesare is the result of an extensive series of experiments, with both towed and self-propelled models, in the Rome Tank; and the dimensions, eventual form, and other particulars of the vessel were described by General E. De Vito, the consulting naval architect to the Ansaldo Company, in his paper on "Six Recent Atlantic Liners," presented on September 26, 1952, at Genoa, at the joint meeting of the Institution of Naval Architects and the Associazione di Technica Navale (ATENA). General De Vito gave the gross tonnage as 27,226, the load displacement at 26,880 tons, and the block coefficient as 0·624. (It may be remarked that a figure somewhat different was quoted in the Italian journal, *La Marina Italiana*, when the ship went into service, the coefficient of fineness being there given as 0·608, the prismatic coefficient as 0·637, and the immersed midship section as 0·955.) The speed-length ratio, $\frac{V}{\sqrt{L}}$, is 0·84. As Fig. 1 shows, she has a well-raked stem and a semi-cruiser stern. The middle body has been given a considerable "tumble-home," the greatest breadth being actually below the load water-line. The rudder is partly balanced. The vessel has a bulbous bow. The hull structure incorporates a considerable proportion of high-tensile steel and also some 80 tons of aluminium, mainly in the superstructure. Prefabrication was extensively employed in the construction of the hull, some of the portions so fabricated weighing as much as 24 tons, though most of them were lighter.

The hull is subdivided by eleven transverse bulkheads. Below C deck—the lowest passenger deck—the compartments thus formed, from forward, are the chain locker; Nos. 1, 2 and 3 holds; the 'thwartship fuel tanks; the auxiliary engine room; the main engine room; the insulated store-rooms, with the refrigerating plant below; No. 4 hold; the baggage compartment; fresh-water tanks; and the afterpeak tank. No. 3 hold is insulated. Hydraulically-operated watertight doors, supplied by the Società Alessandro Calzoni, of Bologna, are fitted in four bulkheads, namely, the bulkhead between the main and auxiliary engine rooms, the after engine-room bulkhead, the after bulkhead of the refrigerating-machinery space, and, in the shaft tunnel, at frame 40, to give access to the gland compartment. These and other safety provisions in the design and equipment of the ship are in accordance with the requirements of the classification societies mentioned above, and of the London Convention on Safety of Life at Sea, of 1948. Fresh water and ballast are carried mainly in the double bottom, the total capacities being 330 metric tons of drinking water, 2,860 tons of fresh water for washing purposes, etc., 40 tons of feedwater for the waste-heat boilers, and 1,317 tons of salt-water ballast. The fuel tanks can contain 2,664 metric tons of heavy oil for the main engines and 721 tons of Diesel oil for the auxiliary engines; and about 150 tons of lubricating oil are carried in double-bottom tanks, separated from the adjacent tanks by cofferdams.

As mentioned above, the Giulio Cesare has accommodation for 1,102 passengers and a complement of 530. The first-class and second-class passengers are accommodated generally amidship, with the first class forward and the second class aft of the mid-length of the ship, though provision is made to combine the accommodation for the two classes if the vessel is employed in cruising. The first-class cabins are on the upper deck and the boat deck. The locations of the first-class public rooms can be seen by reference to the arrangement drawings reproduced on Plate V. The third-class passengers are normally accommodated forward and aft on B and C decks, the communication from the various cabins to the third-class public rooms being by an alleyway on A deck; but there are also a number of cabins aft on A deck which can be used for either second-class or third-class passengers, according to the needs of the traffic. Each of the three classes has a separate swimming pool, and a gymnasium is provided for each of the first and second classes. For each class, also, there is provision for showing cinema films in one of the public rooms.

The accommodation for the officers is in the superstructure, on the sports deck, the deck officers being forward and the engineers aft. The crew's quarters are disposed in various parts of the ship, some on the vestibule deck, but most on A and B decks. The engine-room complement are on B deck, on each side of the main and auxiliary engine-room casings.

MACHINERY.

As previously stated, the main propelling machinery consists of two double-acting two-stroke engines, each with 12 cylinders, 650 mm. bore and 960 mm. stroke; they were constructed by the Stabilimento Grandi Motori Fiat at Turin. They were ordered originally, before the war, for re-engining the old liners Augustus and Roma, but were not completed before those ships were lost. On the trials of the Giulio Cesare, they showed a consumption of 0·408 lb. of fuel per shaft horse-power per hour, corresponding to about 115 tons per day for the two sets. At the normal revolutions of 160 per minute, corresponding to a ship speed of 21 knots, each engine develops 13,000 h.p., but the design provides for a maximum of 195 r.p.m., at which the horse-power developed by each engine is 20,000. The tops of the engines, installed in the ship, are shown in Fig. 2, on this page. The cylinder castings are of steel, with cast-iron liners. The cylinders are cooled by fresh water and the pistons by oil. The scavenging air-pumps are of the double-acting tandem type and are located in the auxiliary engine-room. They are driven by six-cylinder Diesel engines, 450 mm. bore and 740 mm. stroke, of the same general design as the five engines which drive the electric generators, except that the latter engines have five cylinders only. The scavenge-pump engines run at 170 r.p.m., and are of 1,250 b.h.p. each. The generator engines deliver 1,200 b.h.p. each at 200 r.p.m. Two of the generating sets are situated in the main engine-room, in the port and starboard wings, respectively. Of the other three, one is placed on the centre-line of the auxiliary engine-room, between the two scavenge-air sets, and the others in the wings. Each of the Diesel-driven generating sets has an output of 750 kW at 220 volts.

Each main engine discharges its exhaust gases to a Lamont vertical waste-heat boiler, the steam from which drives a turbo-generating set, consisting of a Brown Boveri turbine of 700 shaft horse-power and a 450-kW generator. The steam pressure is 100 lb. per square inch. There are also two oil-fired Clarkson thimble-tube boilers, working at the same

ITALIAN LINER "GIULIO CESARE."

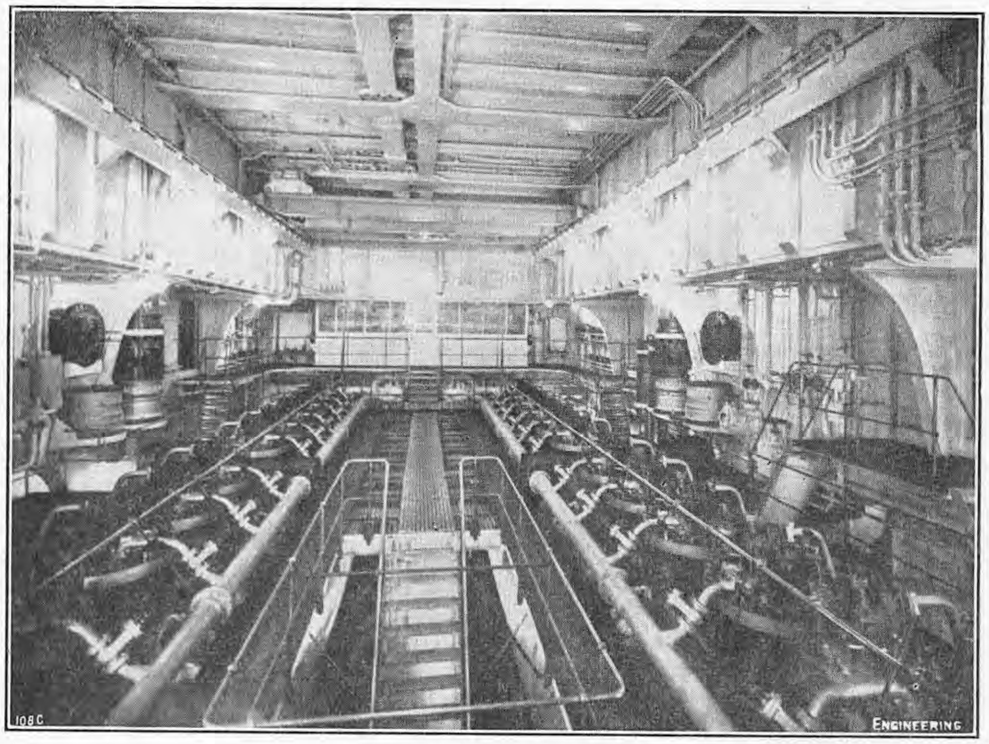


FIG. 2. MAIN ENGINE ROOM.

pressure, for duty in harbour. In addition to the two Diesel-driven scavenge pumps, there is a standby electrically-driven scavenge blower, supplied by Brown Boveri, Limited, running at about 2,000 r.p.m. and driven by a motor of 820 h.p. The emergency Diesel-driven generator, which has a capacity of 100 kW, is housed in the funnel casing, on the sun deck. The engine driving this generator is a 170-h.p. eight-cylinder four-stroke Deutz, running at 1,500 r.p.m.

The other auxiliaries include an evaporating and distilling plant capable of producing 50 tons of distilled water per day, and the usual equipment of independent fire and bilge, ballast, general-service and sanitary pumps, etc., some being of the plunger type and some centrifugal. All are electrically-driven and were supplied by the Termomeccanica Italiana firm, of La Spezia. Among them may be mentioned two ballast pumps, with a capacity of 200 tons an hour each, and a fire pump of similar capacity; two fresh-water pumps, one of the plunger type, with a capacity of 150 tons an hour, and the other centrifugal, delivering 100 tons an hour; a centrifugal emergency bilge pump of 180 tons an hour; a vertical centrifugal pump, delivering 200 tons an hour, which can be used for either sanitary or ballast duties; a 200-ton vertical centrifugal pump to supply washing water, but which can be used also as a fire pump; four vertical-spindle centrifugal pumps, each with a capacity of 150 tons an hour, for general-service and sanitary purposes; and two centrifugal pumps for supplying drinking water, which can deliver 15 tons an hour each.

An important feature of the provision for the comfort of passengers is the air-conditioning plant, supplied by the firm of Aeromeccanica Ascoli, of Milan. The whole of the passenger accommodation and of the crew's quarters is air-conditioned, 40 sets, requiring together about 1,000 h.p., being provided, distributed throughout the ship. The equipment is capable of maintaining throughout the accommodation steady conditions of 18 deg. C. and 50 per cent. humidity.

The steering gear is electro-hydraulic and was constructed at Monfalcone by the Officine dei C.R.D.A., under licence from Messrs. John Hastie and Company, of Greenock. It is capable of moving the rudder over from hard-over to hard-over —a total angle of 70 deg.—in 30 seconds, when the ship is travelling at full speed.

For cargo-working, there are 20 electric winches, four to each hatch. Four of the winches have a lifting capacity of 5 tons each and are driven by 50-h.p. motors. The remainder are of 3 tons capacity, with 34-h.p. motors. All were supplied by the Società San Giorgio, of Genoa.

NAVIGATING AND LIFE-SAVING EQUIPMENT.

Nineteen lifeboats are carried, and also a motor launch for general harbour duties. Two of the lifeboats, holding 75 persons each, are motor-propelled. The remaining boats are of the Fleming hand-propelled type, 14 of them holding 99 persons each and the other three 66 persons. They are all constructed of a light alloy, Peraluman 35, made by the Società Lavorazione Leghe Leggere, of Venice, and were built under licence by the Officine dei C.R.D.A., of Monfalcone, who also supplied the Welin-Maclachlan davits. The motor boats are propelled by Thornycroft six-cylinder Diesel engines of 45 h.p. and are fitted with Marconi radio transmitters.

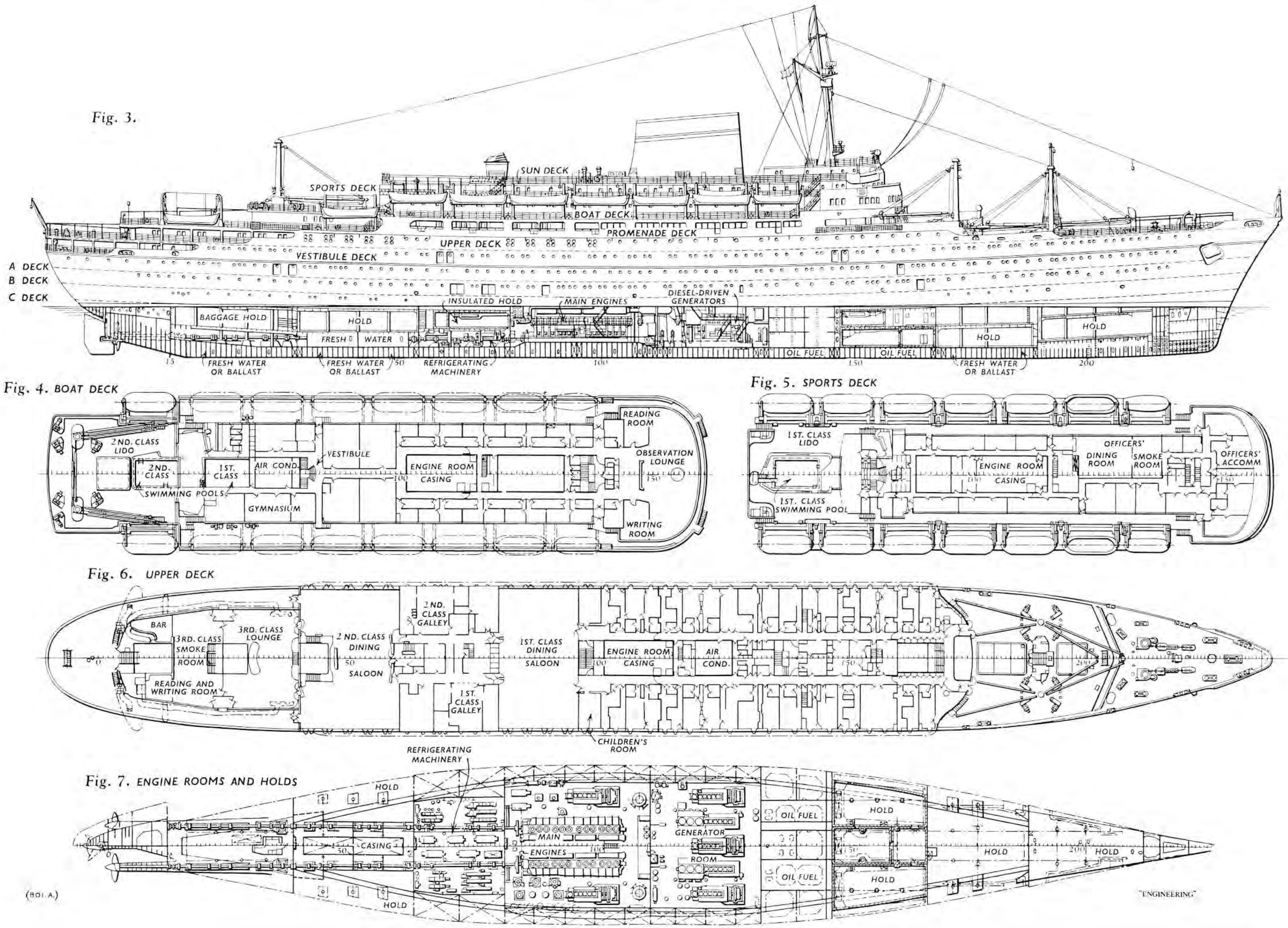
The navigating equipment includes a Sperry Gyropilot; Marconi radiotelegraph and radiotelephone apparatus; and radar instruments supplied by the Raytheon Manufacturing Company, of Waltham, Massachusetts. Messrs. Kelvin and Hughes, Limited, London, have provided their Pneumercator draught indicators, one forward and one aft, and also the Walker "Trident" log for measuring the ship's speed. The main-engine telegraphs are of the Chadburn type. For fire detection there is an extensive Lux-Rich installation of smoke indicators in conjunction with a CO_2 fire-extinguishing plant on the Kidde system; and Grinell sprinklers are fitted in the passenger accommodation, crew's quarters, alleyways, etc.

THE DUKE OF EDINBURGH TO OPEN STEEL WORKS.—The extension to the steel works of John Summers and Sons, Ltd., at Shotton, near Chester, is to be opened by H.R.H. The Duke of Edinburgh on April 29. The Duke is to be installed as Chancellor of Edinburgh University at a ceremony on November 4.

(To face page 262.)

ITALIAN MOTOR LINER "GIULIO CESARE."

(*For Description, see Page* 261.)



THE ENGINEERING OUTLOOK.

V.—The Locomotive and Rolling Stock Industries.

The effects of the policy of restricting capital investment are to be seen nowhere more clearly than on the British railways. Rolling-stock replacement programmes since the war have had to be cut to the barest minimum; in 1952, when balance of payment difficulties again emphasised the need for economy, and re-armament production put a heavy strain on steel supplies, particularly heavy sacrifices were required of the railways. The restriction in steel supplies made it necessary to fix a scale of priorities for investment. Track replacement was of the highest urgency, and therefore received first priority for steel; since it was planned to relay 1,750 miles, the rolling-stock programmes had to be severely restricted. The wagon construction programme was cut by nearly 40 per cent., the locomotive programme by a half, and the carriage-building programme originally planned for 1952 had to be cancelled altogether. The private manufacturers of rolling stock, working for the export market, have not been much more fortunate in their steel supplies than the railway workshops; output was considerably reduced in 1952 and production programmes were set back many months. The export figures for 1952, it is true, are higher than those for 1951 for all classes of rolling stock with the exception of carriages, but since the export statistics reflect the level of work in progress on the shop floor many months previously, the low level of output for 1952 will be reflected in the export statistics for the current year. Order books are still very full; most manufacturers have enough work on hand to keep them fully occupied, even if they could achieve full capacity for at least 18 months. Competition, however, is now very strong in the sellers' market overseas, and if British manufacturers are to maintain full order books they will require every possible assistance from the Government in obtaining sufficient steel to enable them to quote reasonable deliveries and firm prices. Their competitive ability would also be greatly strengthened if they were able to quote as favourable credit terms as can some of their foreign competitors.

FIGS. 1 TO 4, UNITED KINGDOM PRODUCTION OF LOCOMOTIVES.

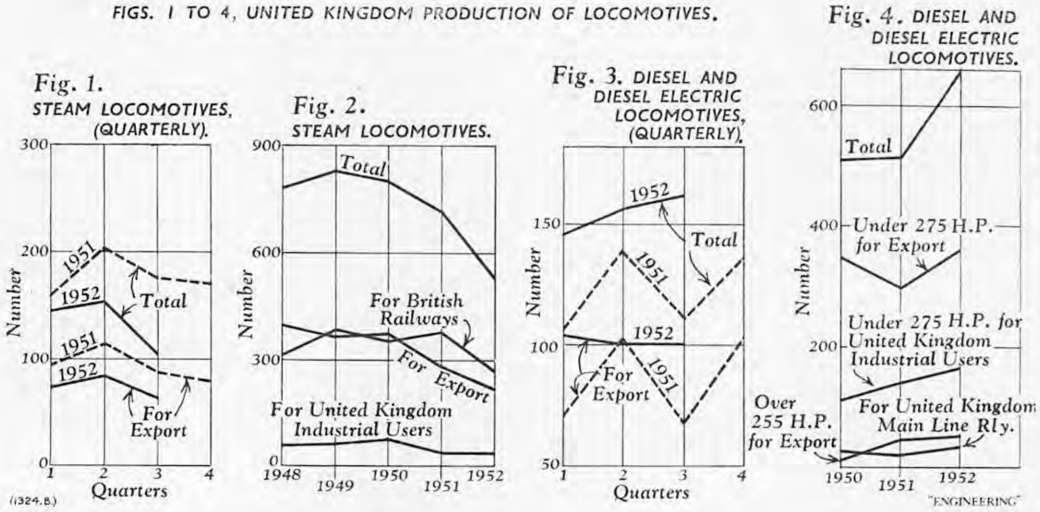


TABLE I.—United Kingdom: Exports of Locomotives and Parts.

—	Number.			Value (£1,000).		
	1950.	1951.	1952.	1950.	1951.	1952.
Complete Locomotives—						
British West Africa	38	58	31	407	745	220
Union of South Africa	100	148	161	218	359	696
Southern Rhodesia	35	19	6	906	17	112
British East Africa	70	71	96	230	217	602
India	235	171	193	3,346	2,330	1,992
Australia	114	204	111	1,867	3,835	3,275
Other Commonwealth Countries and the Irish Republic	71	109	166	274	824	1,640
Egypt	33	12	28	401	26	446
Argentine Republic	15	12	4	332	415	142
Other Foreign Countries	218	168	249	1,397	769	3,246
Steam	354	350	360	7,496	7,173	8,048
Other	575	622	685	1,882	2,364	4,323
Total	929	972	1,045	9,378	9,537	12,371
Railcars	409	153	169	1,465	1,179	1,192
Parts—*						
British West Africa	—	—	—	322	218	227
Union of South Africa	—	—	—	372	423	696
India	—	—	—	913	1,600	1,576
Australia	—	—	—	221	325	435
Other Commonwealth Countries and the Irish Republic	—	—	—	733	610	768
Foreign Countries	—	—	—	993	1,341	1,824
Boilers	—	—	—	464	660	753
Others	—	—	—	3,091	3,857	4,773
Total	—	—	—	3,555	4,517	5,526

* Except internal-combustion engines, axles, tyres and wheels.

Difficulties of Private Locomotive Builders.

The trend of locomotive exports is shown in Table I, herewith, taken from the *Trade and Navigation Accounts*. Deliveries for export, however, shown in Figs. 1 to 5, give a better picture of the performance of the private locomotive builders, who continue to export about 90 per cent. of their output. The number of steam locomotives produced in 1952 was only 389 compared with 484 in 1951, and, if steel supplies improve, there is a prospect of an increase in output. It is ironic that the locomotive builders should be so seriously hampered by the steel shortage, when, for many other engineering industries, steel supplies are more than ample. Capacity for the production of the plates and other types of steel used by shipbuilders and locomotive builders has not, however, expanded in proportion to that for the grades and types of steel used by, say, the motor industry. While, moreover, the demand for motor vehicles has been declining recently, the volume of orders which shipbuilders and locomotive builders have on hand would justify a substantial increase in the present level of output. As exporters, the locomotive builders have obtained a very high priority rating from the Ministry of Supply for steel supplies, but this has been of little avail in producing the required deliveries from the steelmakers. Continental steel plate is available, and some has been obtained, but the prices asked are so high that imports cannot offer a solution to the present difficulties.

The shortage of steel, which has prevented them from quoting speedy enough delivery, has already lost the locomotive builders valuable orders. Even where delivery has been acceptable, inability to quote firm prices for the distant and uncertain future has been a serious handicap. The quality of British locomotives cannot be excelled and the prices charged are lower than any in the world; for many customers, however, quick delivery is of overriding importance. Last year, and again this month, the South African Minister of Transport complained of the delays in the delivery of rolling stock ordered in the United Kingdom, and said that, in future, South Africa would be better advised to pay higher prices for quicker delivery of rolling stock from other countries. This South African criticism was not entirely justified; delivery of locomotives on order in that country was made within a very short period after the Minister's speech. By the end of 1952, 161 locomotives had been delivered to the Union of South Africa. Work was started some time ago on the 90 condensing locomotives on order with the North British Locomotive Company, and delivery of the first will be made early in 1953. These locomotives, the largest non-articulated types ever made in the United Kingdom, are 170 ft. long and 230 tons in weight. The condensing equipment, which will enable them to operate over long distances in areas where water supplies are inadequate, has been developed by the German firm of Henschel und Sohn, who are collaborating with the North British Locomotive Company in fitting it.

German manufacturers already have a much more direct interest in the South African market. The Krupp company secured a good footing when, in 1950, they received an order for 100 shunting locomotives by quoting a price 250,000*l.* under the lowest British tender. German manufacturers, however, are no longer in a position to underquote the British; their labour costs are somewhat less, but their steel costs are substantially higher and their efficiency is certainly not greater. Moreover, bank credit can be obtained in Germany only at the prohibitive rate of 11 per cent.; but German manufacturers have been able to make capital out of their ability to give prompt delivery, and this has even given them entry into an important British colonial market. After the Vulcan Foundry had negotiated a contract for 30 locomotives for Nigeria, it was stipulated that delivery was required within a much shorter period than had been arranged. The Nigerian delivery requirements could be met only by placing orders for 15 of the locomotives on the Continent; in this instance Henschel und Sohn will act as sub-contractors to the Vulcan Foundry.

The Germans are extremely interested in the Indian market. Like the British locomotive builders, they are co-operating with the Indians in setting up locomotive-building shops in India. Good progress has been reported from the Tata works, which are being operated with the assistance of the Krauss Maffei company. An output of 28 locomotives was achieved in 1952 from the Chittaranjan works, which the Indian Government are setting up with the aid of the Locomotive Manufacturers' Association of Great Britain; in 1953, an output of 52 locomotives is scheduled, and by the end of 1954, when the technical aid agreement expires, it is expected that the greater part of the requirements of the Indian railways for steam locomotives will be met from their own industry. Meanwhile, under the agreement, British builders have been assured of a large volume of orders for locomotives and parts, but this is conditional upon satisfactory progress being made at Chittaranjan. In 1952, the L.M.A., seriously handicapped by the shortage of steel, have had no easy task in maintaining uniformity of progress, and, in extreme urgency, some steel has had to be obtained from Continental Europe.

The technical-aid agreement does not restrict Indian purchasing entirely to the United Kingdom, and recently an important order was lost through the inability of British manufacturers to quote firm prices in present conditions. Mr. A. K. Chanda, Financial Commissioner of the Indian Railways, announced in September, after a three months' tour of Europe, that orders to the value of 9*l*. millions for rolling stock (wagons and coaches as well as locomotives) had been placed on the Continent, mainly in Belgium, but also in Italy, Germany and Austria. Deliveries on the contracts, which were all on a firm-price basis, were expected within 18 months. There are still, however, substantial orders on hand from India in the United Kingdom. Delivery is now almost completed of the 100 metre-gauge locomotives ordered from the North British Locomotive Company, one of which was specially finished as an Indian Government exhibit at the Indian Railway Centenary Exhibition, to be held shortly at New Delhi.

OTHER EXPORT MARKETS.

India, for many years the largest single market for British locomotives, now takes second place to Australia. As will be seen from Table I, the value of the locomotives obtained from Britain in 1952 was only about half as much as in 1950. This downward trend, which is offset only slightly by the increase in exports of spares, must almost certainly continue. The need for increased railway transport facilities in India is undoubtedly great, but even if there had been no large growth in the local manufacture of rolling stock, the Indian import demand might have been severely limited by financial difficulties. The amount of capital which can be allocated for investment in the railways (about 60*l*. millions per annum) is barely sufficient for essential replacements.

The upward trend of locomotive exports to Australia may be expected to continue. The financial difficulties which that country has lately experienced has affected imports of railway rolling stock. Undoubtedly, those difficulties have been aggravated by misdirected investment in manufacturing industry; curtailment of this investment should lead to a healthier development of the country's primary resources, which should result in increased demand for transport equipment. A recent order from Australia, valued at 3·5*l*. millions, was for 50 Beyer-Garratt articulated locomotives, 108 ft. in length and 255 tons in weight. These locomotives, which are fitted with mechanical stoking equipment, are for operation on the steep gradients of the New South Wales Railways.

The South American markets, always of great importance, have done little business lately with British locomotive builders. The main difficulty appears to be finance. A recent order for 20 steam locomotives for Chile went to Japan. The British tender was lower than the Japanese, but the Japanese could grant an extended credit for six years, which was more than the British tenderers could arrange. Exports to Southern Rhodesia and East Africa showed substantial increases in 1952, and a high level of demand is to be expected from that area for a long time to come, as railway development still falls far short of the needs of the expanding economy. Work recently began on the construction of 400 new miles of track to link the Rhodesias with the sea at Lourenço Marques. The development programme announced by the Advisory Committee of the East African Railways in December visualises an expenditure of 50*l*. millions. Orders for rolling stock, which comprise 201 locomotives, 267 carriages and 2,941 wagons, amount to 19*l*. millions.

Though there are still some healthy and growing markets, the possibility of a major and permanent decline in the overseas demand for steam locomotives in, say, five to ten years' time, must be faced. If the situation became acute, it is possible that the Government might arrange for British Railways to support the private builders by giving them home orders, but history is far from encouraging in this respect. British Railways will almost certainly give first priority to their own workshops; if these are working below capacity, the assistance given to private builders is likely to be small. Fortunately, however, there is a growing demand for Diesel and Diesel-electric locomotives, and these are now being constructed in quantity, generally in co-operation with the large electrical companies. The steps taken by the private builders of steam locomotives to diversify production, however, have taken them outside the locomotive field altogether. The North British Locomotive Company have been making machine tools for some time, as well as excavators, under licence from the United States. Beyer Peacock and Company have acquired (for 160,000*l*.) the business of Dening and Company (1937), Limited, makers of agricultural machinery, which is now operating as a wholly-owned subsidiary of Richard Garrett Engineering Works, Limited, under the name of Denings of Chard, Limited.

Beyer Peacock and Company, in association with Metropolitan-Vickers Electrical Company, and Vulcan Foundry in association with the English Electric Company, have both made considerable progress with Diesel, Diesel-electric and electric traction, and have important orders in hand. The former group are manufacturing 48 Diesel-electric locomotives of 1,100 h.p., weighing 76 tons each, for the Western Australian Government; the Vulcan Foundry and the English Electric Company have been delivering 60 electric locomotives (the most powerful yet made in Britain) to the Spanish National Railways. The Brush Electrical Engineering Company, who recently erected new workshops for the manufacture of main-line locomotives, delivered in November the first of 25 Diesel-electric locomotives ordered by the Government of Ceylon. The value of the order for these 87-ton locomotives, of 1,000 h.p., exceeds 1*l*. million. The North British Locomotive Company have had remarkable success with their Diesel-hydraulic locomotive. Large orders are in hand at present, including main-line as well as shunting and special-purpose types. The North British Locomotive Company are confident that the Voith system of hydraulic turbo-transmission has solved the long-standing difficulty of providing a sufficiently flexible coupling between the Diesel engine and the driving wheels, so that, as a result, the advantages of the straight Diesel—low maintenance costs and easy control—can be fully realised.

Considerable progress has been made by private locomotive builders in the development of the gas turbine. The 3,000-h.p. locomotive (No. 18100) built by Metropolitan-Vickers Electrical Company in association with Beyer-Peacock, Limited, is now in regular passenger service on the London-Plymouth and London-Swindon routes, and has completed 60,000 miles running.* The North British Locomotive Company are co-operating with C. A. Parsons and Company in the construction of a coal-burning gas-turbine locomotive. Messrs. Parsons, who have already undertaken successful tests in the burning of pulverised coal in a 500-h.p. experimental gas-turbine plant, obtained the support of the Ministry of Fuel and Power in the project. After consultation with the Railway Executive, the Ministry placed an order for an open-cycle external-combustion gas-turbine locomotive, to burn coal and develop a maximum of 1,600 h.p. The project is still at a very early stage of development, but, if successful, may revolutionise rail haulage; over long distances, the saving in fuel may be more than half, compared with steam locomotives. Work is also being carried out on the coal-fired gas turbine in Canada. The Canadian Government have contributed 100,000 dollars to an experimental project at McGill University. A pilot plant has been erected, and the co-operation of the railways has been sought for the manufacture of a prototype locomotive, the running costs of which, it is hoped, will be half those of a similar Diesel locomotive.

MARKETS FOR DIESEL LOCOMOTIVES.

The export markets for Diesel and Diesel-electric locomotives are likely to continue to expand, and British manufacturers should be able to increase their share of the business. As in the case of steam locomotives, they have recently lost some valuable orders through inability to give sufficiently early delivery, but difficulties on this score should be merely transient. A more permanent problem is presented by the threat of foreign competition, particularly from the United States. British builders, with virtually no home market behind them, cannot hope to realise the economies of volume production open to their American competitors. Steam locomotives are fast disappearing in the United States; Diesel-electric traction has grown so rapidly that the generating capacity of the locomotives now in service is 18 million kW, compared with 2 million kW ten years ago. In addition to meeting a heavy home demand, American builders of Diesel and Diesel-electric locomotives are exporting about 50 engines a month. Only one major railway in the United States, the Norfolk and Western, now relies exclusively on steam traction. This railway, it was announced in the middle of 1952, was to test the world's largest single-unit locomotive. Powered by a coal-fired steam-turbine coupled to an electric generator, it is said to develop 4,500 h.p. Following the visit of a Productivity Team to the United States in 1950, British makers of Diesel locomotives have adopted such American techniques as they found applicable and superior to their own. In some markets, they have the advantage that they can supply "custom-built" locomotives to meet special conditions; in general, however, they may find it difficult to keep costs and prices at a level which will compete with the Americans. Monetary difficulties in many markets still shield them from the full force of American competition, but these could be rectified by judicious overseas investment by the United States.

Even in present conditions, the currency difficulties are not insuperable. The General Electric Company of the United States, who have set up an Australian subsidiary, are in a position not only to exploit the largest British market for Diesel and Diesel-electric locomotives, but also to make their products available for sterling in the markets of the world. An order for Australian-made Diesel-electric locomotives has already been received from Pakistan. The process of manufacture in Australia excludes the engines, and at present comprises little more than the assembly of parts imported from the United States. British manufacturers have lost much ground in the Pakistan market of late and, since the war, have secured less than 50 per cent. of that country's orders for rolling stock. No doubt, slow delivery has hampered British manufacturers, but meanwhile much valuable goodwill has been lost to competitors. Orders for nine locomotives were placed in 1952 with the American Locomotive Company, and, in 1951, orders for 23 were placed in Japan and France.

The use of Diesel locomotives for shunting has been growing fairly rapidly, though there are still fewer than 200 operating in the British marshalling yards. The five-year programme under which it is intended to increase the number of Diesel shunters in service by 750 is, however, only just beginning, and, in 1953, a first instalment of 57 Diesel-electric and 12 Diesel-mechanical locomotives is proposed. Electrical components and equipment have been ordered from private builders, but otherwise the construction programme is entirely in the hands of the railway workshops. The use of Diesel locomotives for main-line work in this country is still at a fairly early stage, but towards the end of 1952 the Railway Executive announced that they are to incur an expenditure of 500,000*l*. as a first step towards the introduction of multiple-unit Diesel trains for passenger traffic. The new Diesel trains, which will operate in the first instance in the West Riding of Yorkshire, will comprise two coaches, accommodating 16 first-class and 124 third-class passengers. They will be driven by two 125-h.p. 'bus engines; contracts for 16 of these have already been placed with Leyland Motors, Limited. Six or seven Diesel locomotives are already working on long-distance hauls, but it will be a long time yet before steam is effectively challenged in this sphere.

The Report of the Committee on National Policy for the Use of Fuel and Power Resources (the Ridley Report) of September, 1952, has come down heavily in favour of a rapid extension in the use of

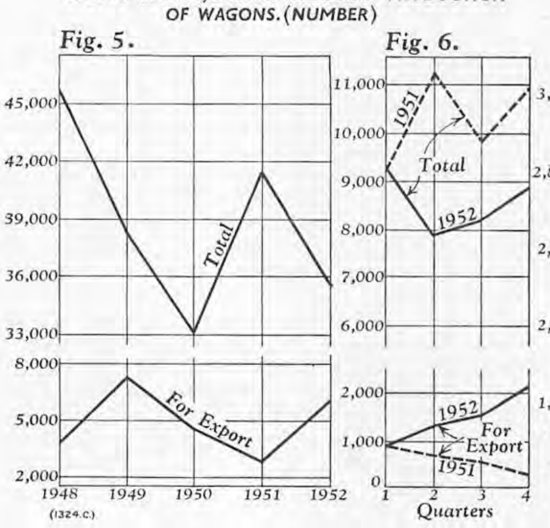
* See page 247, *ante*.

Diesel and electric traction. In the opinion of the Committee, the plans of the Railway Executive "do not go far enough; the fuel resources of the country should not continue to be subject to waste on the present scale in rail transport." According to the Committee, Diesel traction, and, where the traffic is suitable, electric traction, give an operating efficiency more than double that of the present steam locomotive. The objection that increased dependence on imported fuel oil would be undesirable for strategic reasons they have not examined thoroughly, as being outside their terms of reference, but they point out that, in any case, the country is already heavily dependent on oil in war-time for the fighting Services and for other forms of transport. A change in locomotive power which would make a significant difference to fuel consumption on the railways would require a substantial capital outlay, but it would be spread over a fairly long period, and doubtless it is desirable, as the Committee believe, that the Railway Executive "should place greater emphasis in their immediate and longer-term investment plans on the need to make a substantial improvement in fuel efficiency."

The case for steam locomotives is by no means closed; much has been done to increase their efficiency and, in particular, there is evidence of a greatly improved standard of achievement in the new standardised locomotives of British Railways. The Class 7 Pacifics, the largest of the new locomotives, are officially reported to have "exceeded all hopes." It is thought that, while hitherto no locomotive has obtained a run of 100,000 miles before returning to the repair shops, the new locomotives should be able to achieve 120,000 miles regularly without overhaul.

The question of steam or Diesel is undoubtedly of major importance to British Railways at present; such are their replacement needs, however, that the really vital issue is that investment programmes should be sufficiently adequate to prevent a serious deterioration in rail services. This, in turn, requires that sufficient steel shall be made available to provide as many locomotives, steam or Diesel, as the railway workshops are capable of turning out.

FIGS. 5 AND 6, UNITED KINGDOM PRODUCTION OF WAGONS. (NUMBER)



FIGS. 7 AND 8, UNITED KINGDOM PRODUCTION OF PASSENGER CARRIAGES. (NUMBER)

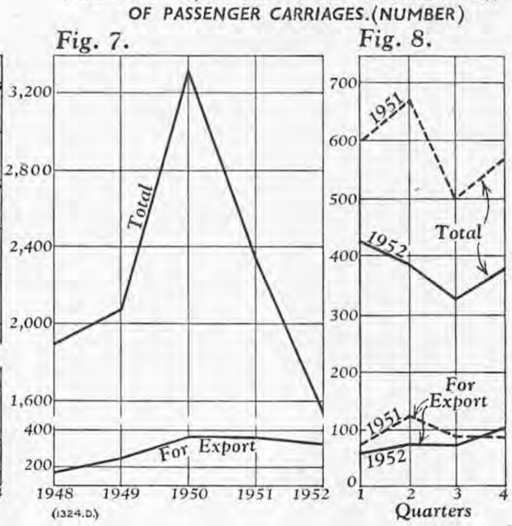


TABLE II.—UNITED KINGDOM: EXPORTS OF RAILWAY WAGONS AND PARTS.

—	Weight, Tons.			Value (£1,000).		
	1950.	1951.	1952.	1950.	1951.	1952.
Wagons and Trucks—						
British West Africa	7,276	2,406	1,249	901	370	164
Union of South Africa	12,183	639	557	802	57	56
Southern Rhodesia	10,419	850	12,197	947	89	1,077
British East Africa	8,421	7,004	2,872	940	809	373
India	6,576	4,151	2,041	668	418	267
Australia	12,436	14,094	22,380	1,254	1,748	2,812
New Zealand	2,481	3,002	10,359	238	317	1,099
Other Commonwealth Countries and the Irish Republic	6,652	4,228	6,191	645	405	700
Egypt	439	329	199	41	32	30
Argentine Republic	7,964	2,553	8,849	832	295	971
Other Foreign Countries	9,888	5,410	2,697	1,080	584	381
Exceeding 3 ft. Gauge—						
Complete	48,809	25,664	38,778	5,107	3,049	4,208
Parts, except axles, tyres and wheels ..	27,415	13,612	24,610	2,529	1,619	3,076
Not Exceeding 3 ft. Gauge—						
Complete	7,580	4,518	5,183	622	358	520
Parts, except axles, tyres and wheels ..	931	872	1,020	90	98	126
Total	84,735	44,666	69,591	8,348	5,124	7,930
Axles, tyres and wheels for rail vehicles—						
Wheels and axles, exported in complete sets	23,348	16,781	20,463	1,414	1,125	1,483
Other	67,744	64,101	57,699	3,317	3,357	3,548
Total	91,092	80,882	78,162	4,731	4,482	5,031
Grand Total	175,827	125,548	147,753	13,079	9,606	12,961

TABLE III.—UNITED KINGDOM: EXPORTS OF RAILWAY CARRIAGES AND PARTS.

—	Weight, Tons.			Value (£1,000).		
	1950.	1951.	1952.	1950.	1951.	1952.
Railway Carriages—						
British West Africa	997	484	214	283	192	111
Union of South Africa	6,101	3,667	249	2,336	1,284	129
Southern Rhodesia	848	2,600	1,802	278	923	591
New Zealand	1,055	246	7	433	103	3
Other Commonwealth Countries and the Irish Republic	1,236	3,741	6,172	297	1,774	2,460
Egypt	1,203	544	1,572	303	134	462
Other Foreign Countries	1,236	714	1,747	427	270	916
Complete carriages	8,215	10,659	9,711	2,731	4,173	3,747
Parts, except axles, tyres, wheels and motors	4,461	1,337	2,052	1,626	507	925
Total	12,676	11,996	11,763	4,357	4,680	4,672

PROSPECTS OF THE WAGON BUILDERS.

Like the locomotive builders, wagon builders have orders on hand which will keep them fully occupied for two years. They, too, had to work well below capacity in 1952 through shortages of steel, and valuable orders were lost through inability to give quick enough delivery or to quote firm prices. In some cases, firm-price tenders by Continental competitors have been countered by offers which set a ceiling to the amount which would be charged to offset any rise in costs while work was in progress; this, however, is not very satisfactory, and, in times of rising costs, can be hazardous. The trend of exports is shown in Table II, herewith, taken from the *Trade and Navigation Accounts*. The downward trend to India is not likely to be arrested. Production in that country is expanding and, as mentioned above, large orders were recently placed with European manufacturers. The number of wagons due for replacement on Indian Railways is estimated at 48,000, and increasing industrial production makes it desirable that there should be a substantial increase in the operating stock; nevertheless, such is the country's financial situation that the railways will be unable to acquire more than 9,000 wagons a year over the next five years, which is substantially less than enough to meet replacement requirements. The growth of local manufacture also precludes any increase in exports to South Africa, until recently one of the largest markets for British wagons. In 1952, delivery was made against large orders received from Australia and New Zealand, and, while these markets may be expected to take considerable numbers of British wagons, purchases are likely to be somewhat reduced in future.

A few markets, notably Southern Rhodesia and British East Africa, are expanding, but, on the whole, the world market is contracting, and competition is strong. Despite recent losses, however, British manufacturers should more than hold their own. Order books on the Continent are now almost as large as in Britain, and the European builders' advantage of being able to give more prompt delivery has been largely lost. The danger that excess capacity in Europe would lead to cut-throat competition in times of recession has diminished somewhat. Economic integration under the Schuman Plan is expected to extend to the pooling of rail transport resources. France and Germany, under a convention of 1951, are already working successfully a scheme for pooling 100,000 wagons. The extension of pooling arrangements will require a certain degree of standardisation in the rolling stock used by participating countries, and this, in turn, should make for rationalisation of the European wagon-building industry. The separate States are certainly not likely to be concerned about keeping alive national rolling-stock industries merely in the interests of self-sufficiency. The production of wagons, and the quantities exported, are shown in Figs. 6 and 7, herewith.

The private British wagon-builders have a considerable advantage compared with the locomotive builders, in that they have a substantial home market behind them. Home orders, however, have always been on an annual contract basis and the established builders have long complained that this has not given them sufficient stability for satisfactory planning of production. The Railway Executive have at last revised their policy, and, after negotiations with the Wagon Building Association, contracts for 80,000 16-ton all-steel mineral wagons were placed in October. Orders placed with seven companies, for 57,490 wagons, were valued at 23·5*l*. millions. One of the largest, placed with the Metropolitan-Cammell Carriage and Wagon Company, was for 13,000 wagons; another, placed with the Cambrian Wagon and Engineering Company (controlled by the Powell Duffryn group) for 10,500 wagons, was valued at 5·25*l*. millions and will mean doubling the capacity of the works. Tees-side

Bridge and Engineering Works, Limited, who have an average output of 40 wagons a week, received an order for 9,740, which alone assures them of five years of continuous employment. These orders make very heavy demands on the capacity of the established builders, and, in view of the steel shortage, it may not be easy to maintain deliveries to schedule. To relieve some of the stress, the Railway Executive, with the assent of the Wagon Builders Association, have placed orders with the Pressed Steel Company, Limited, who are not members of the industry. It has, however, caused some surprise that the Pressed Steel Company, who had not been a party to the earlier negotiations, have been put on an equal footing with the established members through being given a five-year contract.

According to some wagon builders, the prices which have been negotiated by the Railway Executive are so low that they themselves will derive no direct financial advantage from the economies which will accrue from long-term production planning. The indirect benefits, however, may be considerable. A continuous high level of employment may do much to raise productivity in the industry, and the firm background of home orders should enable manufacturers to quote more actively competitive prices in the export markets. The degree of continuity which British wagon-builders now enjoy is no greater than that which foreign national railways have long accorded to the British industry's European competitors.

Low Priority for Passenger Carriages.

Wagon building has received a priority second only to track maintenance in the investment programmes of British Railways, and, within the limits of the steel supply, the output of wagons should increase substantially in 1953 and in 1954. The need for new passenger rolling-stock on British Railways is hardly less than that for wagons, but carriage building comes far down on the priority list. In 1952, the output of carriages was about one-third lower than in 1951, which, in turn, was about one-third lower than in 1950; the trend is graphically illustrated in Figs. 8 and 9, on page 265. Because of the steel shortage, British Railways have been able to do little more in 1952 than to overtake arrears of building left over from the 1951 programme. The trend towards steel construction, as in the new standard carriages, has accentuated the difficulties, but the advantages of steel are so overwhelming as to rule out a return to timber construction. Exports of carriages fell off considerably in 1952 (see Table III, on page 265, taken from the *Trade and Navigation Accounts*) and, since conditions are much the same as for wagons, no improvement may be expected in 1953.

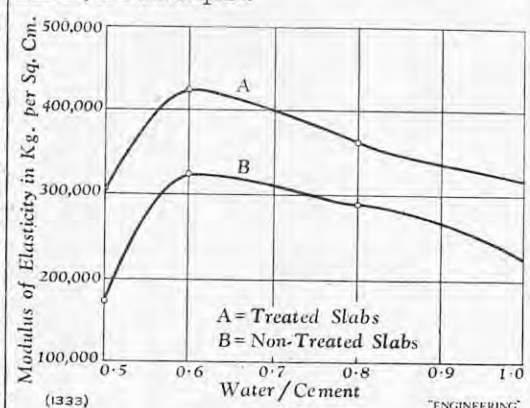
For the rolling-stock industry as a whole, the dominating concern of the immediate future is the shortage of steel, and it may be many months before there is any substantial improvement. The marketing difficulties which were encountered overseas in 1952 derived partly from the inability to obtain steel to meet delivery requirements. The disappearance of the steel shortage will not, however, automatically solve the problem of sales. Every effort will have to be made during the next two years, when order books are still full, to achieve a more stable state of affairs, which will enable manufacturers to quote keen and firm prices without incurring undue risks. The manufacturers themselves can do much to create such a condition, but they will need every support from the Government in arranging export credits and steel priorities. British Railways have shown themselves sympathetic to the needs of the private wagon-builders in 1952, and continuing co-operation from them—extended, if necessary, to the locomotive builders—should go far towards helping the rolling-stock industry to remain vigorous and to maintain its much-needed earnings of foreign currency.

Coryton Refinery.—The Vacuum Oil Co., Caxton House, London, S.W.1, has announced that the refinery at Coryton, flooded on the night of January 21 only a few hours after first coming "on stream," has again been brought into production. Four thousand men worked for 21 days to repair the damage and to bring the refinery back to working order.

VACUUM CONCRETE.

The word "vacuum," when applied to concrete, is somewhat misleading, since it signifies not a concrete mixed or poured in a vacuum, as might be imagined, but a normal concrete mixed in the usual way, and to the surface of which a suction process has been applied while the concrete is still fresh and before setting has commenced. "Vacuum," therefore, represents a stage in the placing of concrete coming immediately after pouring and before the shuttering is removed. The treatment consists simply of creating a negative pressure on one face, by means of a "vacuum mat" which is laid on the surface and is then exhausted by means of a vacuum pump.

The results are as far-reaching as the process is simple, since the resulting concrete has no slump whatever; thus, in many cases, shuttering can be removed immediately. Moreover, the strength is increased, or, conversely, the cement content can be considerably reduced. In a paper entitled "Introduction to the Vacuum Concrete Processes," read recently by Monsieur I. Leviant before a joint meeting in London of the Institution of Structural Engineers and the British Section of the Société des Ingénieurs Civils de France, he said that the expression "vacuum concrete" was coined by an American journalist following the demonstration at Yale University of a process to remove excess water from fresh and newly-placed concrete by means of a vacuum—a process introduced by Mr. Karl P. Billner, of Philadelphia.



According to the chemistry of cement, a given quantity of cement requires a precise quantity of water to set up the hydration process to form a colloid of optimum strength. It is this colloid which is the "cement" that holds together the aggregate, sand, and inorganic particles of concrete. Any excess water causes a weakening of the colloid, delays the time required for strength to be attained, and also reduces the ultimate strength of the concrete. On the other hand, since workability and ease of pouring have to be borne in mind, far more water than the chemistry of the subject demands is invariably used in the mixing of concrete. In practice, therefore, concrete is weaker than it need be, or conversely, more cement is used than is chemically necessary to give the desired strength. Thus a process which permits excess water to be removed quickly and cheaply from an easily-worked concrete mix has obvious advantages.

To explain the process, Mr. Leviant said it was necessary to look upon a mass of fresh concrete as if it were a flexible skeleton built up from particles between which a colloid was forming and water also existed in excess of chemical requirements. This "skeleton" of a mass of concrete is able to support a negative pressure between one face and an air-tight "mat" incorporating a fine screen to serve as a strainer, so that atmospheric or positive pressure acting on the other faces causes the skeleton to collapse and compact towards the face being treated, at the same time expelling all water which cannot be expelled by virtue of capillary action between particles. Since a high vacuum can be obtained almost immediately, the load due to atmospheric pressure rises quickly to several hundred pounds per square foot, and the immediate result is a dense and homogeneous concrete with absolutely no slump. The equipment consists of a vacuum pump driven by a petrol engine or electric motor of about 10 h.p., with the vacuum mats, connected to the pump through hose. The time taken to remove excess water by this method varies, with the size of the work and with the excess water content, from a few minutes to about half an hour. In the matter of time, however, it is important to note that the process cannot be overdone; the cement/water ratio cannot be reduced below the minimum figure of 0·30, due to capillary action between the inorganic particles resisting further expulsion.

The results of comparative tests for compressive strength, carried out on 6 in. by 12 in. cylinders, showed that the strength of treated concrete was as much after seven days as that of untreated concrete after 28 days. The results of another series of tests, in which the cement content was varied, indicated that treated concrete with a cement content of 210 kg. per cubic metre was as strong after 80 days as untreated concrete containing 300 kg. of cement per cubic metre after the same time had elapsed. The graph herewith, reproduced from Mr. Leviant's paper, shows how the modulus of elasticity of a series of 10-cm. slabs varies with the water/cement ratio. It will be observed that a ratio of 0·6 gives the optimum modulus for a concrete containing 300 kg. of cement per cubic metre. Other tests have been carried out by various authorities; all, apparently, with the same general result—that the properties of vacuum concrete are much superior to those of comparable untreated concrete. Other advantages naturally follow. The fact that there is no slump makes for a greater output of pre-cast items with fewer forms, and in certain cases, forms can also be much lighter than they would otherwise be. In the case of certain pressure pipes, cast in Italy, about 4 ft. in diameter and 16 ft. in length, one form has been found to be sufficient for five casts per day, each pour being followed by 27 minutes of treatment, after which the shuttering is immediately struck.

FILM ON WASTE-HEAT RECOVERY FROM DIESEL ENGINES.

An excellent film has recently been produced by Shell-Mex and B.P. Limited, Shell-Mex House, Strand, London, W.C.2, to show how the overall thermal efficiency of a Diesel-engine driven electric-generator set may be raised to as high as 81 per cent. by recovering waste heat from the cooling water and exhaust gases. The film, which is entitled "The Diesel Generator as a Composite Heat and Power Unit," first explains briefly how heat is commonly disposed of and how it may be conserved by passing the cooling water through a heat exchanger and the exhaust gases through a waste-heat boiler. Five examples of recent heat-recovery installations are then illustrated and described in detail.

These include a country house with its own generating plant using one small engine which, on its average winter load, supplies 300 gallons of water at 140 deg. F. each day. The other examples are of larger installations and include a film studio in which waste heat from the engines in the power house is used for space heating; a department store in London where three Diesel-engine generating sets, each of 250 kW, supply 800 gallons of hot water per hour for various purposes; a tannery in which hot water at 130 deg. F., used for processing the hides, is provided by Diesel-driven generating sets; and, finally, a large weaving mill in which waste-heat recovery supplies up to one half of the total heat requirements for space heating, processing and air conditioning. The film, which was made by the Merlin Film Company, Limited, is of particular interest to engineers and others concerned with the efficient utilisation of fuel, but does not require great technical knowledge to appreciate it. It is now included in the Shell-Mex and B.P. film library and can be supplied on loan in the 16-mm. and 35-mm. sizes with sound track. Showing takes about 40 minutes.

Report of Council of Industrial Design.—The seventh annual report of the Council of Industrial Design, that for 1951-52, is now available from H.M. Stationery Office at the price of 1s. 7½d., post free.

HIGH TOP-PRESSURE BLAST-FURNACE OPERATION.*

By I. LOCKERBIE.

IN the previous papers,† two main aspects of high top-pressure operation were discussed. The first dealt with the problem of coke consumption. It was considered, but never proved, that high top pressure would affect some saving in coke per ton of pig iron and advantage was taken of a period when ore was scarce to put this to the test. The results were inconclusive. The second paper analysed the results obtained when the furnace was pressed for production. It was stated that, in this instance, top pressure allowed the blowing rate to be increased considerably beyond the limit that could be expected under normal blowing conditions, while still maintaining smooth stock descent, economic coke rates and reasonable flue dust losses. In this second paper, the work of two furnaces of similar dimensions at the Clyde Iron Works of Colvilles Limited, was assessed—No. 1 furnace on normal operation and No. 2 furnace on high top-pressure operation. The data which follow are set out along the same lines and cover a period of 23 weeks from the week ending January 26 to the week ending July 12, 1952. Two periods, each of one week, have been omitted from the reckoning since on both these occasions the pressure was reduced owing to a shortage of coke. In the time that has elapsed since the publication of the second paper, pig-iron production has continued to be the factor governing the operation of the furnaces, and in pursuance of this policy, the blowing rates were increased to the limit set by the flue-dust production and the overall economy of the plant.

OPERATING DATA.

During the period under review, a total blowing time of 3,864 hours, No. 1 furnace was off blast for 74·4 hours, and No. 2 for 70·2 hours, or 1·8 per cent. This lost time includes all repairs, whether for routine maintenance or operational causes, and illustrates clearly that high top pressure has in no way interfered with production. For routine cleaning of the septum sprays, normal blowing was reverted to for very short periods, around 2 or 3 hours per week, but on many of these occasions the wind volume was maintained as for pressure blowing. This, of course, depended upon the condition of the furnace and was never attempted if the movement tended to be irregular. Naturally, blowing at higher than normal pressures requires a greater steam consumption, and the consumption of steam when on top pressure is about 26·5 per cent. greater than that for normal pressure blowing.

Both furnaces have been charged with the same ores in very similar proportions. A little screening has been done whenever possible but in recent times the percentage of fines in many ores has tended to increase. Since the capacity of the sinter plant may be taken as constant, it follows that the furnaces have had to take an increased quota of fine material, resulting in higher flue dust losses and also higher blowing pressures. It has been noticeable that under such conditions the furnaces are much more sensitive to blast volume in respect of steady movement, although high top pressure does appear to minimise this effect. The charging cycles on both furnaces have been kept constant, No. 1 charging C-C-O-O, large bell dumping every 5th skip, and No. 2 furnace C-O-C-O reversing every second charge to O-C-O-C, large bell dumping every 5th skip. One charge consists of 16 skips, eight of coke and eight of ore, each coke skip weighing 3,000 lb. Both furnaces have operated on identical tuyere sizes, the total area being 270 sq. in. As stated above, the furnaces have been pressed for production and it is only natural to expect that the dust losses would rise accordingly. This has, in fact, occurred, although again it has been shown that, in spite of the much increased wind volume, dust production in No. 2 furnace (average 1·05 cwt. per ton) is less than that in No. 1 (average 1·37 cwt. per ton).

The weekly average $CO : CO_2$ ratios are given in Table III. The average results from a previous paper are also given in Table I. These figures show that in spite of the increased driving rate, the top gas analysis has shown very little change. One fact, however, is clear; No. 2 furnace has consistently produced a better gas, even when blown at comparatively high wind rates. It will be seen in Table II that the burdens are fairly similar in most respects and hence it may be assumed that the burden characteristics are similar. The slag volumes bear a close resemblance, the physical nature of the ores charged and the metallurgical load can be considered as being nearly related. This simplifies the task of assessing the performance of the two furnaces a little.

TABLE I.

Period.	Coke Used per Week, tons.		$CO : CO_2$ Ratio.	
	No. 1.	No. 2.	No. 1.	No. 2.
Week ending August 12 to week ending December 30, 1950	3,040	2,990	2·59	2·46
Week ending September 8, 1951, to week ending January 19, 1952..	3,205	3,322	2·98	2·74
Week ending January 26 to week ending July 12, 1952	3,266	3,525	2·93	2·73

TABLE II.

Burden.	Week Ending January 26 to Week Ending July 12, 1952, Per cent.	
	No. 1.	No. 2.
English ore	12·29	13·19
Swedish ore	23·50	22·64
Wabana ore	9·70	9·84
Mediterranean ore	9·17	9·48
Oued Zem ore	8·78	8·16
Sinter	16·22	16·48
Scrap	0·48	0·55
Liberian ore	1·60	1·38
Cinder, etc.	1·21	0·96
Acid slag..	0·12	0·18
Basic slag	5·26	6·67
Ferro-manganese slag	1·38	1·01
Limestone	10·29	9·46
	100·00	100·00

Two assessments of performance are made: a comparison of the results of No. 2 furnace relative to those of No. 1, and a direct comparison of results from each furnace.

Table III shows the weekly tonnage, coke rates, $CO : CO_2$ ratios and slag volumes for each furnace. Table IV shows the work done expressed in the average figures obtained for the period. Over the 23 weeks No. 2 furnace production was higher than No. 1 on all but two occasions, the coke rate was lower on 17 occasions and the slag volume lower on only five occasions. Referring to the table of averages, No. 2 furnace coke rate was 0·48 cwt. less, although the slag volume was 0·1 cwt. higher. The coke burned was 260 tons more, and as a result of this higher coke-burning capacity and lower coke rate, the furnace produced on an average, 408 tons of pig iron more per week. In Table IV No. 2 furnace slag volume has been corrected to No. 1 furnace slag volume, using as a factor 0·37 cwt. coke per 1 cwt. of slag; then, assuming the coke-burning capacity to be the same, the coke rate on No. 2 drops 0·04 cwt. per ton and consequently the output increases to 4,095 tons.

In the last paper results were published of the work done by both furnaces under normal blowing conditions when it was considered that the optimum rate of working had been achieved from the point of view of production, coke rate and flue-dust losses. The summary of these results is given in Table IV. From these it can be seen that No. 1 furnace slag volume has increased by 1·49 cwt. and No. 2 slag volume by 1·69 cwt., while the coke rates have increased by 0·71 cwt. and 0·96 cwt., respectively. The increase in driving rate for No. 1 is 230 tons coke per week or 7·6 per cent., and for No. 2,

TABLE III.

Weeks, 1952.	Output, Tons per Week.				Coke Rate, Cwt. per Ton.				Slag volume, Cwt. per Ton.				$CO : CO_2$ Ratio.		Top Pressure. Lb. per sq. in.
	No. 1.	No. 2.	+	−	No. 1.	No. 2.	+	−	No. 1.	No. 2.	+	−	No. 1.	No. 2.	
Jan. 26 ..	3,575	3,969	394		17·98	17·02		0·96	13·29	12·80		0·49	3·59	3·07	5
Feb. 9 ..	3,560	4,178	618		18·35	18·13		0·22	13·07	12·05		1·02	2·70	2·93	5½
16 ..	3,358	3,954	576		19·42	18·27		1·15	14·74	11·85		2·89	3·62	2·98	6
23 ..	3,304	4,226	922		19·90	17·70		2·20	12·31	11·44		0·87	3·75	2·90	6
Mar. 1 ..	3,868	4,211	343		17·70	18·18	0·48		10·85	12·73	1·88		2·87	3·11	6
15 ..	3,695	4,194	499		17·25	17·34	0·09		11·91	12·47	0·56		2·56	3·01	6
22 ..	3,384	4,142	758		18·02	17·61		0·41	11·92	12·93	0·01		2·88	2·75	6
29 ..	3,592	4,017	425		18·68	17·93		0·75	11·55	11·99	0·44		2·75	2·96	6
April 5 ..	3,725	4,254	529		17·42	16·90		0·52	9·82	10·49	0·67		3·08	2·50	6
12 ..	4,136	4,135		1	16·76	16·62		0·14	10·14	10·80	0·66		3·27	2·63	6
19 ..	3,846	4,306	460		17·66	16·89		0·77	9·91	10·63	0·72		3·01	2·87	6
26 ..	3,756	4,109	353		17·27	17·47	0·20		8·76	9·23	0·47		3·48	3·03	6
May 3 ..	3,882	4,121	239		17·25	17·20		0·05	10·26	10·59	0·33		2·90	2·73	6
10 ..	3,922	4,220	298		17·18	17·00		0·18	10·00	10·12	0·12		3·17	2·76	6
17 ..	3,789	4,177	388		17·05	17·36	0·31		9·93	10·04	0·11		2·96	2·89	5
24 ..	3,743	3,876	133		17·97	17·48		0·49	10·53	10·60	0·07		2·89	2·56	4
31 ..	3,587	3,909	322		16·96	17·42		0·54	10·65	10·75	0·10		2·77	2·42	4
June 7 ..	3,741	4,120	379		17·46	16·83		0·63	11·43	11·25		0·18	2·65	2·32	4
14 ..	3,690	4,212	522		17·69	16·68		1·01	11·78	12·05	0·27		2·49	2·24	4
21 ..	3,642	4,077	435		17·39	16·95		0·44	12·11	12·60	0·49		2·42	2·42	5½
28 ..	3,841	3,730		111	17·34	16·98		0·36	13·40	13·50	0·10		2·55	2·61	5
July 5 ..	3,596	3,997	401		17·41	17·66	0·25		13·80	14·30	0·50		2·67	2·54	5
12 ..	3,681	3,942	261		17·24	17·29	0·05		12·95	13·50	0·55		2·32	2·65	5
Average, tons	3,682	4,090			17·72	17·28			11·50	11·60			2·93	2·73	
Coke used, tons	3,270	3,530													

TABLE IV.—SUMMARY OF RESULTS.

23 weeks operation.	No. 1 Furnace.					No. 2 Furnace.				
	Slag Volume, cwt. per ton.	Coke Rate, cwt. per ton.	Coke Used, tons.	Output, tons.	$CO : CO_2$ Ratio.	Slag Volume, cwt. per ton.	Coke Rate, cwt. per ton.	Coke Used, tons.	Output, tons.	$CO : CO_2$ Ratio.
No. 1 furnace, normal operation ..	11·50	17·72	3,270	3,682	2·93	—	—	—	—	—
No. 2 furnace, high top pressure ..	—	—	—	—	—	11·60	17·28	3,530	4,090	2·73
No. 2, corrected to No. 1 slag volume	—	—	—	—	—	11·50	17·24	3,530	4,095	—
21 weeks normal blowing	10·01	17·01	3,040	3,577	—	9·81	16·28	2,990	3,669	2·46
No. 2 corrected to No. 1 slag volume	—	—	—	—	—	10·01	16·35	2,990	3,660	—

* Paper entitled "Further Information on High Top Pressure," read before the West of Scotland Iron and Steel Institute, Glasgow, on Friday, February 20, 1953. Abridged.

† *Jl. W. Scot. Iron and Steel Inst.*, vol. 58, page 172 (1950-51); and vol. 59, page 173 (1951-52), and ENGINEERING, vol. 171, pages 575 and 607 (1951).

540 tons of coke or 18·0 per cent. Adjusting the increase in coke rate for increase in slag volume there remains 0·16 cwt. coke for No. 1 furnace and 0·34 cwt. for No. 2 furnace, which may be attributed to the lower stock retention time and consequent poorer top gas. This is a small price to pay for the 18 per cent. increase in the driving rate of No. 2 furnace, especially when it is considered that the flue-dust losses have been kept at a reasonable figure.

CONCLUSIONS.

Smooth, even gas ascent through a steadily descending stock column allows maximum gas/solid contact, so essential in obtaining favourable coke rates. Both have a great influence on the flue-dust losses since any tendency to ragged movement-results in uneven linear gas velocities with consequent high dusting. In effect, as has been stressed on innumerable occasions, smooth working is essential and the maximum speed of driving must be dictated by the character of the materials charged and the limits set upon economy. There can be little doubt, on consideration of the foregoing results, that high top pressure has enabled the furnace to operate at higher than normal wind rates, while still maintaining this steady movement. With the aid of top pressure it has been possible to increase the coke burning capacity by 18 per cent. as against $7\frac{1}{2}$ per cent. increase on the normal pressure furnace. These results were obtained with some loss of efficiency, as must be expected, but clearly the greatly increased production on top pressure far outweighs such considerations. One of the main features of the practice has been the control of flue-dust production. It seems likely that, in the future, ores will tend to become small in size; indeed, it is apparent now, and control over top-gas velocity will be a vital necessity unless large-scale screening and sintering is undertaken.

SMALL MARINE DIESEL ENGINE.

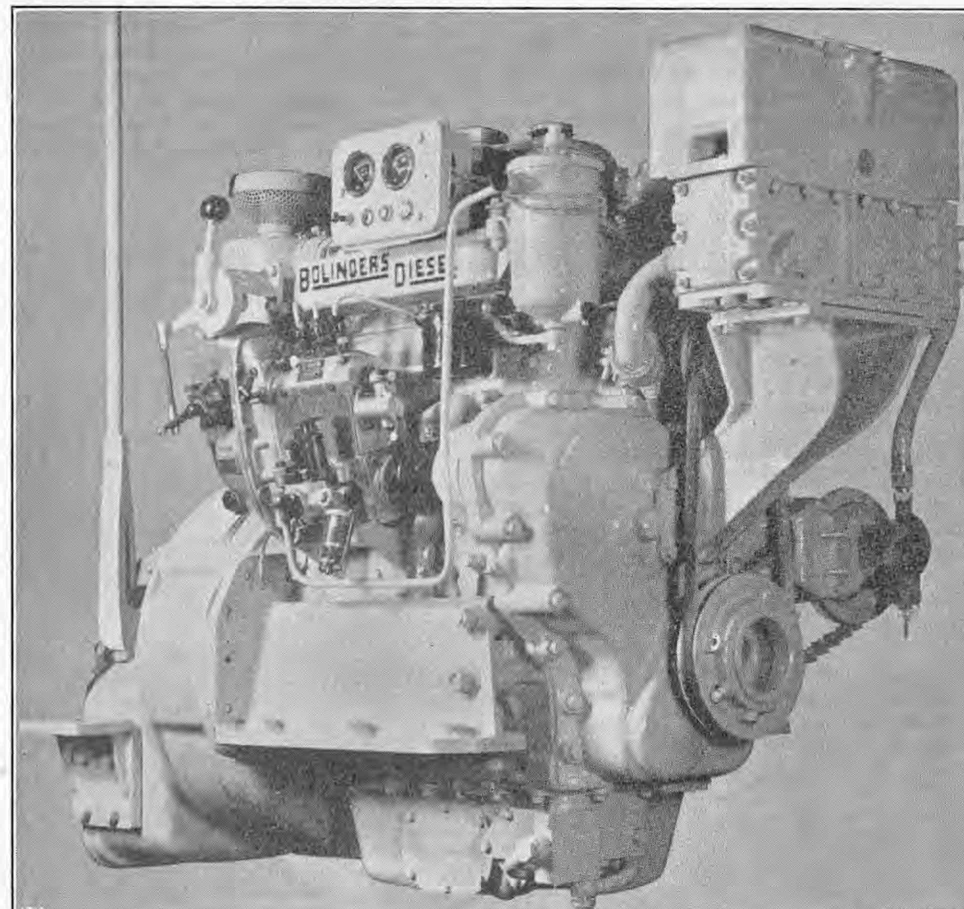
Two Diesel engines of the cold-starting type made for industrial, automotive, and marine purposes have been added to the range of engines produced by the Bolinders Company, Limited, Coronation House, 4, Lloyd's-avenue, London, E.C.3. They are three-cylinder and four-cylinder engines, known as the 1053-BR and 1054-BR, with outputs of 33 brake horse-power normal rating, and 36 brake horse-power intermittent rating, and 44 brake horse-power normal rating and 48 brake horse-power intermittent rating, respectively. The engines are designed to use components common to each other wherever possible, and the makers are planning to produce a one-cylinder and a two-cylinder engine, which will also utilise the same standard components. The engines are of the four-stroke water-cooled type, with overhead valves and a direct-injection fuel system. They have a bore of 4·12 in. (104·7 mm.) and a stroke of 5·12 in. (130 mm.), and the compression ratio is 16·5 to 1. Rotation is in an anti-clockwise direction when viewed at the flywheel end, and the engine speed is 1,500 r.p.m. at the maximum rating.

The engine described here is the 1053-BR, fitted for marine use and shown in the illustration on this page. It is arranged with a heat exchanger mounted on a cast bracket, which is bolted through the front of the timing casing, and placed above the heat exchanger is the header tank for the fresh water used in the engine cooling system. This water is circulated by a centrifugal pump, V-belt driven from the crankshaft. A thermostat is incorporated in the engine cooling circuit to give main and by-pass flow. On the far side of the engine are two self-priming rotary pumps, driven by an adjustable laminated V-belt from the crankshaft. The pumps are coupled to the ends of the same shaft, the bilge pump being driven through a clutch. The other pump circulates sea water through the heat exchanger.

The cylinder and crankcase are cast in one, with an engine mounting bracket on each side. Embodied in this casting are three bearings for the gear-driven camshaft, and four main bearings for the crankshaft.

SMALL MARINE DIESEL ENGINE.

BOLINDERS COMPANY, LTD., LONDON.



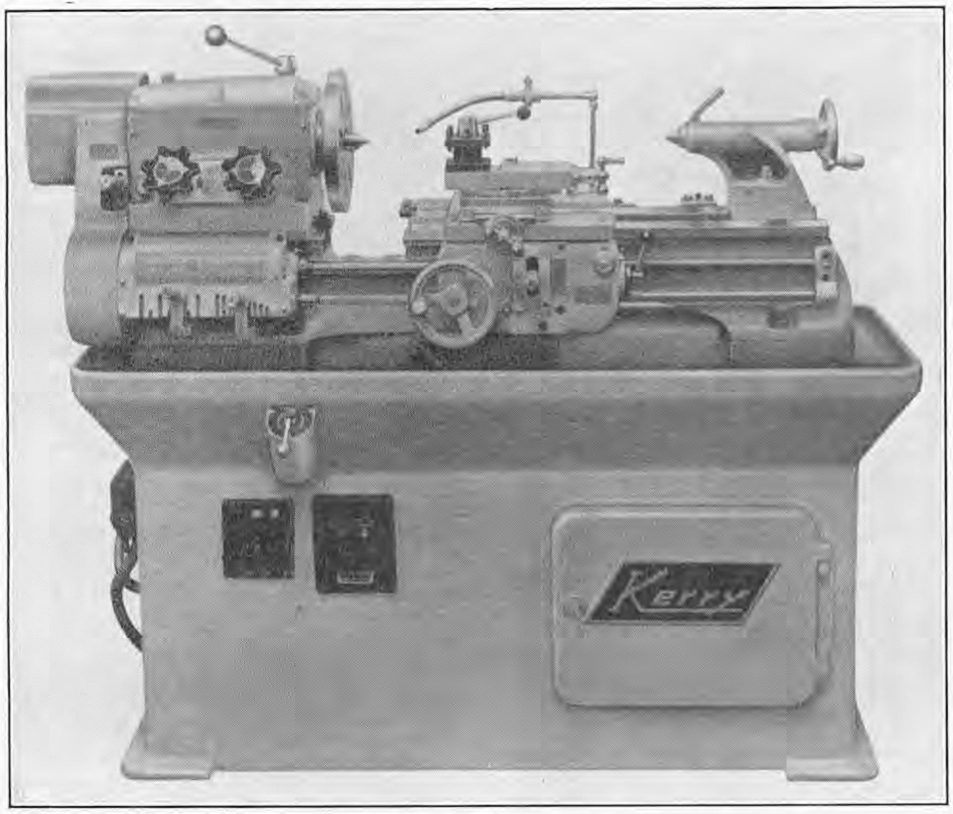
The crankshaft is made from chromium-manganese steel, and is hardened and tempered by induction heating before grinding. The camshaft is a steel forging with integral cams case-hardened and ground. Thin-wall bearings of the copper-lead lined steel-shell type are fitted in both the main bearings and in the big ends of the forged-steel connecting rods. The aluminium-alloy pistons have a toroidal-shaped bowl top, and are fitted with three compression rings, two oil-scraper rings, and a fully-floating gudgeon pin; the top compression ring is plated with hard chromium to give good wearing qualities. The removable wet cylinder liners, which locate on a spigot at one end, have sealing rings at the top and bottom. The cylinder head, which is a molybdenum-iron casting, carries the overhead valve gear and is fitted with renewable valve-seat inserts. The valves are made from heat-resisting alloy steel, Stellite-faced, and are operated from the camshaft by cast-iron tappets and push rods. The cylinder head is cast and has a breather to prevent condensation and corrosion of the valve gear.

A Bosch-type direct-injection fuel system is used. It draws gas oil through a preliminary filter to the feeder pump and passes it through two twin filters, placed in series, to the injection pump, which has a centrifugal governor with variable speed adjustment between 500 r.p.m. and 1,500 r.p.m. The fuel injectors have multi-hole nozzles spray directly into the cylinder head, and there is an oil-washed air filter on the inlet manifold. The exhaust manifold, on the opposite side to the intake manifold, is cooled by waste water from the heat exchanger. The main, big-end, and gudgeon-pin bearings, timing gear, camshaft and valve gear are pressure lubricated from a gear-type pump placed at sump level. It delivers oil, which is cleaned by a full-flow filter, from a wet sump of 1·76 gallons capacity, and a hand-operated pump is fitted to assist in draining oil from the engine. There is a 12-volt electric starter motor of 4 h.p. mounted on the flywheel housing, and a belt-driven generator with a built-in automatic voltage regulator for battery charging, which gives an output of 130 watts at 12 volts, can be fitted. An overhead hand-starting shaft and decompression gear are also fitted. The timing gear is at the front end of the engine and is driven direct through gears. At the rear, a gearbox giving a reduction of 1·5 to 1 or 3 to 1, and incorporating a reversing gear, is fitted directly to the flanged cover of the flywheel housing, and the drive is transmitted through a dry-plate friction clutch. The gears have silent-running helical teeth, hardened and ground, and the gearbox has a heavy-duty ball thrust-bearing. The control handle to the gearbox can be placed on either side. Full engine power can be used when running astern. Mounted on the top of the engine block is an instrument panel with an ammeter, oil-pressure gauge, and starter button, and a handle throttle lever is placed just above the fuel pump. Six cast-iron bearers are provided for securing the engine to a bed, two on the gearbox and four on the engine, and the maximum angle for mounting is 10 deg. The three-bladed propeller and tailshaft are of manganese bronze. Rotation of the stern gear is clockwise when viewed from aft, i.e., it is suitable for a right-hand propeller.

LIGHT-ALLOY VEHICLE BODIES.—The Northern Aluminium Co., Ltd., have published the second booklet in the series entitled "Light Alloy Bodies for Road Haulage." The sub-title of Book II is "Flat Platform and Dropside Designs," and it is intended for use in conjunction with Book I, "Materials and General Practice." It provides information on recommended design details together with illustrative sketches. The first half of the booklet deals with the layout of a flat platform lorry with corrugated floor and headboard. Details of underframe stools are given together, the crossbearers and suitable positions for riveting are indicated. The second half of the booklet deals with a dropside lorry which is an extension of the first design. Corner pillars are shown in detail as are the hinges and hinge pillars and internal corner cleats and fastening plates are suggested. The sides and tailboard are of single skin construction. The overall dimensions are given by symbols, and a schedule of parts is given together with simple formulæ from which the quantity of material needed for a body of a selected size can be calculated.

$5\frac{1}{2}$-IN. CENTRE LATHE.

KERRY'S (ENGINEERING) CO., LTD., LONDON.



$5\frac{1}{2}$-IN. CENTRE LATHE.

THE Kerry $5\frac{1}{2}$-in. "G.C." lathe illustrated on this page has a gap bed giving 4 in. clearance from the faceplate and a swing of 17 in. The swing over the bed is 11 in., and the lathe is available with a straight or gap bed to admit 23 in. or 40 in. between centres. It is made by Kerry's (Engineering) Company, Limited, Grange-road, Leyton, London, E.10. The bed has four slideways of the V and flat type. There are eight spindle speeds, from 39 to 1,500 r.p.m., and change from one to the other is obtained by setting the dials on the headstock. The drive is transmitted through a Coventry Matrix dry-plate clutch mounted in the headstock pulley, which runs at a speed of 650 r.p.m. and is operated by a lever that also controls the brake. The headstock spindle is of nickel-chromium steel and is mounted in an adjustable Timken taper-roller bearing at the front and an adjustable phosphor-bronze bearing at the rear. All the gears are machine-cut from nickel-chromium steel and run in an oil bath. The spindle has a bore of 1 in., and is bored No. 4 Morse taper. For collet work an adaptor is required. The faceplate is 10 in. in diameter and the maximum collet size that can be used is $\frac{11}{16}$ in.

The feed-box is of the tumbler type and 62 English thread pitches can be selected by the two tumblers; for the full range of metric pitches, three change gears must be used. The top slide of the compound slide rest is graduated to 180 deg. The travel of the carriage on the standard bed is $21\frac{1}{4}$ in. and the compound slide has a travel of $3\frac{1}{4}$ in. The cross and longitudinal traverses have manual and automatic feed which, in the latter case, is engaged by a lever in the centre of the apron. A dial indicator is built into the apron to enable the correct pick-up to be made on the leadscrew when screwcutting, and an interlock is fitted between the screwcutting and feed controls. A separate feed shaft, for sliding and surfacing, gives seven feeds varying from 0·000375 in. to 0·024 in. in a geometrical progression when using inch change gearing, and when the metric change wheels are used 28 different feeds are obtainable. These changes are provided by the left-hand tumbler arm on the feed-box. The right-hand tumbler can be disengaged when making sliding and surfacing cuts, thus disengaging the leadscrew from all drive. The tailstock has side adjustment for taper turning. The barrel is bored No. 3 Morse taper and is graduated along its surface. The motor is normally of 1 h.p., with a speed of 1,420 r.p.m., using a 400/440 volt three-phase supply. It is mounted on the rear of the base casting and is adjustable for belt tensioning.

RECONDITIONING WHEEL SETS FOR LONDON TRANSPORT RAILWAYS.

LONDON TRANSPORT maintain more than 17,000 wheel and axle assemblies—or wheel sets—and in the course of a year they recondition about 10,000 sets in the wheel shop at Acton Works. In addition to the wear on tyres, etc., the principal defects which have to be dealt with are cracks in tyres, flaking of the surfaces of tyres, fractures of the retaining lip in the Gibson-ring type of fastening, fatigue of axles and wheel spokes, hot boxes, inner races of axlebox roller bearings working loose, electrical burning of wheels and axles, and faulty meshing of gears and pinions on driven axles due to wear. Fig. 1, on page 272, shows a wheel set for the new tube rolling-stock. The motor is suspended on the axle by roller bearings, and the axle runs in slip-on type roller-bearing axleboxes. The wheel diameter is 31 in. Figs. 2 to 5 illustrate various defects.

Some London Transport cars travel more than 80,000 miles a year. Sets are most frequently withdrawn from service because of wear to the running surfaces of the wheels, and they are made serviceable by machining these surfaces. Tyre wear varies in nature and degree on different types of rolling stock, and motored wheels suffer more than trailing wheels, since they carry greater weights and sustain a higher proportion of the braking. This effect is heightened when cast-iron blocks are used on the former and non-metallic blocks on the latter, for cast-iron blocks bear on tyre flanges as well as treads. Wheels braked by non-metallic blocks normally require re-profiling because their treads have worn, leaving deep flanges, but wheels braked by cast-iron blocks usually have to be withdrawn because their flanges have worn away and become sharp.

Heat generated during braking, aided by work-hardening of the tyre as it rolls along the track, may cause the surface to crack. Sometimes flakes of metal will tear away from this cracked surface during braking, as shown in Fig. 2, giving rise to the characteristic bumping noise usually associated with flat spots caused by skidding. Occasionally, also, flakes tear away from the tread during machining. Serious tyre fractures are extremely rare, but small fractures, often not sufficiently important to warrant action, sometimes develop around the lip which grips the retaining ring. Wheel centres have a long life, and during many years of use under alternating stress the steel is subjected to fatigue, so that fractures sometimes develop in the spokes. Careful inspection is, therefore, imperative.

All London Transport's older railway cars run on plain white-metal bearings, lubricated by oil-soaked woollen packing. The bearings are changed and the boxes repacked at six-monthly intervals or when wheel sets are changed. Careful attention to packing has reduced the incidence of hot boxes to a very low figure; when they do occur, however, it is still necessary to machine the journal surfaces of axles, or even on occasions to scrap the axles. Regrinding is also carried out to compensate for normal wear of the journals. On more modern cars, roller bearings are used, giving higher rolling efficiency and reliability. However, defects still occur. The inner ring of the bearing is a press fit on the axle journal, and if its grip is insufficient the ring may rotate on the journal. If this is not detected in time, overheating and serious wear may occur, necessitating scrapping of the axle. A case of this is shown in Fig. 5. The probability of this defect arising has been much reduced by the use of a special tool for testing the tightness of rings. The tool consists of a hydraulic jack, mounted horizontally on a trolley, and fitted with a three-claw extractor which embraces the inner race on the journal. A proof load of 35 cwt. is applied by means of a hand pump; if the race moves under this load it is replaced by one of a better fit. End thrust of the axle is taken on a non-metallic wearing pad carried in the axlebox lid.

Wear takes place also between wheel sets and driving motors. With nose suspension of the motors, which is normal on multiple-unit electric stock, the motors "float" in the bogie frame, one side being supported on the frame and the other on the middle portion of the axle by means of suspension bearings. Older classes of rolling stock employ white-metal suspension bearings, which inevitably cause some wear of the axle journal. Normal wear occurs in a tapered form which must be corrected periodically by regrinding the journals, and by replacing the plates, welded to the wheel bosses, which act as thrust bearings to prevent lateral movement of the motor on the axle. The wear of white-metal from the bearings brings with it another source of wear: it allows the distance between the gearwheel and pinion centres to increase. Some "cushioning" of the gears has had to be provided, therefore, by using a particularly viscous material instead of a more normal lubricant. Because of the disadvantages of white-metal suspension bearings, all rolling stock built since 1935 has been fitted with roller-bearing suspension units, as shown in Fig. 1. The unit consists of a steel tube encasing the axle and supported on it by a pair of narrow roller bearings at the ends of the tube. This tube can thereby remain stationary while the axle revolves inside it, and the motor case can be clamped directly to the tube.

Fatigue fractures in axles start as tiny cracks which may, in time, so increase in magnitude that the axle breaks. An ultrasonic crack detector is now in regular use. The older method of magnetic axle testing, necessitating removal of the wheels from an axle, is now avoided except as a valuable check on axles which are already without wheels or have had wheels removed because a crack has been detected in the ultrasonic test.

Damage may also be caused by abnormal events such as derailments and, on an electrified railway, electrical burning of wheels and axles caused by fusing resulting from a short-circuit or breakdown of insulation. Burning is treated with particular care and the damaged parts scrapped, for even a spot of burnt metal will in time almost certainly lead to a fracture.

NOTES FROM THE INDUSTRIAL CENTRES.

SCOTLAND.

INCREASED PIG-IRON PRODUCTION.—The average metal charge in Scottish steel-melting furnaces is now based on almost equal proportions of pig iron and scrap, instead of the 30 per cent. pig iron and 70 per cent. scrap formerly usual. Pig-iron production is being well maintained from the nine Scottish furnaces in blast, and with scrap deliveries from home sources on a good scale, steel output is approaching capacity.

SHORTAGES OF STEEL PLATES.—Mr. Randal G. Kincaid, chairman of John G. Kincaid & Co., Ltd. Greenock, speaking on February 18 after the launch of the oil tanker Nicolas by the Blythswood Shipbuilding Co., Ltd., Scotstoun, Glasgow, complained that three steel-plate mills had been closed down in Scotland and two in England, in the past 20 years or so, and that nothing had been done to replace them. There was a great deal of misunderstanding concerning the delivery of steel, he continued. The position in regard to plates was no better than it was five months ago.

JIG, TOOL AND GAUGE PRODUCTION IN SCOTLAND.—"The field of precision mechanical engineering is one that holds great promise, and we are actively engaged in formulating a scheme for the extension of one of the most highly-skilled sections—the production of jigs, tools, fixtures, and gauges," said Lord Bilsland, President of the Scottish Council (Development and Industry), in Glasgow on February 17, on the occasion of the Council's annual appeal for funds. There was the additional advantage in this case, he added, that there was a substantial local need which could not be satisfied by existing facilities.

TWO SHIPS FOR GOVERNMENT OF BURMA.—It has been reported from Rangoon that the two 1,050-ton passenger and cargo vessels which Fleming and Ferguson, Ltd., Paisley, contracted last November to build for the Government of Burma will cost 782,000*l*. The vessels are for coastal service and will have a steaming radius of 2,000 miles and a speed of 14½ knots. The propelling machinery will consist of triple-expansion engines supplied with steam by oil-burning boilers.

CLEVELAND AND THE NORTHERN COUNTIES.

TRADE OF THE TYNE.—Reviewing the year 1952 at a meeting of the Tyne Improvement Commission, Mr. Leslie Mann, chairman of the Finance and General Purposes Committee, said that the trade of the Tyne was in a healthy state. During 1952, 9,251,371 tons of coal and coke had been shipped, which were 574,257 tons more than in 1951. A feature in recent years had been the increasing home demand for coal, which was reflected in the growing coastal shipments. There had been also an increase in the use of oil for bunkers. During 1952, 301,300 tons of coal bunkers had been supplied, against 528,300 tons in 1942. Bunker oil supplied on the Tyne in 1952 amounted to 198,000 tons, against 55,500 tons in 1942.

INSTITUTION OF PRODUCTION ENGINEERS.—Speaking on February 20 at the annual dinner, at Newcastle on-Tyne, of the North-Eastern Section of the Institution of Production Engineers, Dr. C. I. C. Bosanquet, Rector of King's College, Newcastle, said that the iron and coal plan for Europe was an experiment of great significance. It contained the germ of something of even greater promise—a United Europe. Sir C. M. Weir, President of the Institution and head of the United Kingdom Delegation to the High Authority of the European Coal and Steel Community, said the organisation was engaged at present on two basic products only, but it had no intention of finishing there. This was the first time that six nations, inhabited by 155,000,000 people, had transferred their authority to a supra-national body in respect of the major basic products of their economy.

WORK OF NORTH-EAST ENGINEERING BUREAU.—The annual report of the North-East Engineering Bureau, Newcastle-on-Tyne, referred to increasing competition from Germany and Japan and stated that, if the North-East was to compete successfully, urgent consideration would have to be given to every quotation. About half the orders not secured by the North-East in 1952 had been lost because prices were too high. Some large firms were no longer working above capacity and hence the amount of work sub-contracted was much less. It was not expected that trade in 1953 would improve to any great extent. The report stated that, in 1952, the Bureau had received inquiries for work valued at 2,154,000*l*., members of the Bureau had tendered for work worth 1,250,000*l*. and the orders actually received had totalled 204,800*l*. The Bureau, to which 125 North-East firms subscribe, is to extend its area to Cumberland and Westmorland.

STEEL PIPES FOR FLOODED AREAS.—The South Durham Steel & Iron Co., Ltd., Malleable Works, Stockton-on-Tees, have expeditiously carried out an order for 1,000 metres of 24-in. pipe needed to help to clear flood waters in Holland. The order was carried out in little more than a day, and the pipes were loaded at Middlesbrough for Rotterdam. The Cargo Fleet Iron Co., Ltd., Middlesbrough, have orders for more than 2,000 tons of pipes for the flooded areas.

EXTENSIONS ON TEAM-VALLEY TRADING ESTATE.—Plans have been approved for factory extensions on the Team-Valley Trading Estate, Gateshead, for Hugh Wood & Co., mining-machinery manufacturers; Square Grip Reinforcement Co., Ltd., makers of steel reinforcement for concrete; Fusarc, Ltd., welding-equipment makers; H. Leverton & Co., Ltd., agricultural-plant suppliers; and Armstrong Cork Co., Ltd., flooring manufacturers.

WARDLEY COAL-WASHING PLANT.—A new coal-washing plant, costing about 750,000*l*., is expected to be completed within six months at Wardley Colliery, Co. Durham. The plant, of the froth flotation type, will clean about 200 tons of coal an hour, and will handle coal from Wardley and other neighbouring collieries.

LAID-UP TONNAGE IN RIVER TYNE.—The Tyne Improvement Commission have reported that at the end of December, five ships, comprising 14,350 tons, were laid up in the Tyne, compared with four, making together 5,667 tons, at the end of December and one of 1,252 tons in January last year.

LANCASHIRE AND SOUTH YORKSHIRE.

BRIDGE AND BY-PASS ROAD PROPOSALS IN LANCASHIRE.—The Minister of Transport, the Rt. Hon. Alan Lennox-Boyd, M.P., received an all-party delegation of Lancashire Members of Parliament at the House of Commons on February 18 to discuss the building of by-pass roads round Lancaster and Preston and a high-level bridge over the Manchester Ship Canal at Barton. The delegation put before the Minister the reasons why the Members of Parliament, the County Council and the Lancashire Industrial Development Association had been pressing to have these road improvements started. The Minister recognised the need for the by-passes to relieve the traffic in Preston and Lancaster and also the need for a new bridge at Barton, and hoped to be able to acquaint himself on the spot with the road difficulties in other parts of the county, including Preston and Lancaster.

DEARER COAL AND STEEL PRICES.—It is estimated in Sheffield that the rise of 5*s*. 6*d*. per ton in coal will necessitate an increase of 10*s*. per ton in steel. Sheffield receives, by rail each week, about 210,000 tons of coal. Prominent steel and engineering concerns believe that the new price will cost them individually some 35,000*l*. a year. Smaller concerns, in the lighter trades, believe that the indirect effects through higher gas, electricity and transport charges will hit them more than the direct increase in their coal bills.

MODERNISATION AT SHEFFIELD WORKS.—At the works of the Sheffield Forge and Rolling Mills Co., Ltd., the first week's working of modernised equipment and the re-housing of one of the company's rolling mills has resulted in an increase of 30 per cent. in output. Steam power has been replaced by a 400-h.p. variable-speed motor.

RAILWAY ROLLING STOCK FOR PERU.—Cravens Railway Carriage and Wagon Co., Ltd., Darnall, Sheffield, have despatched the first of 22 carriages which are being built for the Peruvian Central and Southern Railways. Aluminium alloys have been used to achieve the lightness necessary on the steep gradients in Peru, reducing the weight to about half that of an ordinary British coach.

SUSPENSION OF WORK ON NEW FACTORY.—The Standard Motor Co., Ltd., have announced that work on the erection of their new factory at Kirkby, Liverpool has been suspended. They state that the work has not been abandoned, but an adjustment in a Ministry of Supply contract for jet engines has brought about the possibility of concentrating activities at Coventry, and the Kirkby project has been suspended while the matter is investigated.

THE MIDLANDS.

INCREASE IN SHORT-TIME WORKING.—There has been an increase in short-time working in some factories in the Midlands. Those principally affected are in the motor-vehicle and cycle trades in the Coventry and Birmingham areas, but the effect has spread to several firms in the Black Country who are engaged in sub-contract work. It is particularly noticeable in the foundries producing caastings for the motor trade. The total number of persons in all trades on short-time in the Midlands at the end of January was 22,485. There is still, however, a considerable demand for skilled labour in most branches of engineering, and the iron and steel works have more orders than they can execute.

BIRMINGHAM ENGINEERING CENTRE.—Mr. C. J. Grazebrook, President of the Birmingham Exchange, has now made public some further details of the Exchange's plans for an Engineering Centre. The main hall of the Exchange, in Stephenson-place, Birmingham, 2, is to be converted at a cost of between 15,000*l*. and 18,000*l*. to serve as the exhibition hall. A licence has been granted, and completion is expected by the end of the year. The project is being financed by the Exchange.

DEVELOPMENT IN THE IRON AND STEEL INDUSTRY.—Sir Charles Bruce-Gardner, vice-chairman of the Steel Company of Wales, Ltd., speaking at the annual dinner of the Staffordshire Iron and Steel Institute in Wolverhampton on February 20, said that a total of about 5,000,000*l*. is to be spent in Staffordshire in the next five years. This is small, compared with the overall sum being spent on modernisation of the British iron and steel industry, but, as Sir Charles pointed out, most of the Staffordshire iron and steel plants are comparatively small in size. A large part of the sum mentioned is for the new blast furnace and improvements to the steel plant at the works of Stewarts and Lloyds, Ltd., Bilston.

ELECTRICITY SUPPLY CHANGE.—The Midlands Electricity Board have announced that the electricity supply in certain areas of Dudley, Worcestershire, will be changed from direct to alternating current during the coming summer. The area is one of several remaining in the Black Country where the supply is non-standard. Under the control of the Midlands Electricity Board, the position is being rectified gradually.

THE RIVER SEVERN LANDSLIP.—The Finance and Executive Committee of the Severn River Board have reported that, though the investigations into the slow landslip at Jackfield, Shropshire, are not yet complete, it is not considered that old mine workings are the cause. The river Severn flows through a deep gorge at Jackfield, and both banks are unstable. The investigations have shown so far that, though there is not likely to be a large-scale movement which would cause blockage of the river, slipping of the banks will continue.

SOUTH-WEST ENGLAND AND SOUTH WALES.

NEW SCHEME FOR THE GUEST KEEN BALDWINS CARDIFF WORKS.—Plans to increase the production and efficiency of the Cardiff works of Guest Keen Baldwins Iron & Steel Co., Ltd., estimated to cost more than 5,250,000*l*., have been announced by the company. The scheme includes the erection of a modern coke-oven plant costing 1,750,000*l*.; the installation of the latest type of dock-side crane equipment for the rapid discharge of raw materials; and plant for the treatment and preparation of iron ore. Details of the scheme were submitted to a meeting of the Cardiff Corporation Public-Works and Town-Planning Committee, who recommended that permission be granted to proceed with the proposed coke ovens. Mr. L. R. P. Pugh, secretary of the company, said that the works, which had existed on the site since 1890, had been rebuilt between 1930 and 1935 and were still regarded as one of the most efficient and economical in the country. They were producing more than 500,000 tons of steel annually and 9,000,000 cub. ft. of gas daily.

CAMPAIGN TO STIMULATE COAL OUTPUT.—A fresh campaign to stimulate coal output was opened jointly by the National Coal Board and the National Union of Mineworkers in South Wales on February 20, following upon the settlement of the miners' wage claim. The team which visited South Wales included Sir Hubert Houldsworth, chairman, Sir Andrew Bryan and Mr. Ebby Edwards for the Coal Board, and Sir William Lawther, President, Mr. W. E. Jones, vice-president, and Mr. Arthur Horner, secretary, for the union.

COLLIERY DEVELOPMENTS IN WEST WALES.—The sinking of pits at Cwmgorse, a new pit in the Dulais Valley, a new large modern drift in the Vale of Neath, and the re-opening of Wernos Colliery, Ammanford, are included in the National Coal Board development plans for West Wales. It is hoped to begin the sinking of new Cwmgorse shafts to a depth of 750 yards at the end of the year.

NOTICES OF MEETINGS.

It is requested that particulars for insertion in this column shall reach the Editor not later than Tuesday morning in the week preceding the date of the meeting.

SOCIETY OF ENGINEERS.—Monday, March 2, 5.30 p.m., Geological Society's Apartments, Burlington House, Piccadilly, W.1. "Developments in the Recovery of By-Products from Coke-Oven Gases," by Mr. C. L. Boucher and Mr. D. Bagley.

ROYAL SOCIETY OF ARTS.—Monday, March 2, 6 p.m., John Adam-street, Adelphi, W.C.2. "The Safety Factor in Construction.—II," by Professor F. C. Thompson. Wednesday, March 4, 2.30 p.m., "The Assessment of Suitability for Employment," by Dr. C. B. Frisby.

INSTITUTION OF ELECTRICAL ENGINEERS.—*South Midland Centre:* Monday, March 2, 6 p.m., James Watt Memorial Institute, Birmingham. "Review of Electricity Applied to Mining," by Mr. B. L. Metcalf. *Mersey and North Wales Centre:* Monday, March 2, 6.30 p.m., Royal Institution, Colquitt-street, Liverpool. Discussion on "Economies in Wiring Practice," opened by Mr. Forbes Jackson, Mr. P. McKearney and Mr. A. V. Milton. *District Meeting:* Monday, March 2, 6.30 p.m., Crown and Anchor Hotel, Ipswich. "Electrical Equipment of Battery Road Vehicles," by Mr. W. D. Sheers. *Measurements and Radio Sections:* Tuesday, March 3, 5.30 p.m., Victoria-embankment, W.C.2. (i) "The Study of a Magnetic Inverter for Amplification of Low-Input-Power Direct-Current Signals," by Dr. E. H. Frost-Smith; and (ii) "The Parallel-T Direct-Current Amplifier," by Mr. P. S. T. Buckerfield. *North-Western Centre:* Tuesday, March 3, 7 p.m., Engineers' Club, Manchester. Annual Lecture, held in co-operation with Manchester University. "Industry and the Common Law," by Professor W. Mansfield Cooper. *Southern Centre:* Wednesday, March 4, 6.30 p.m., The University, Southampton. "Electronic Telephone Exchanges," by Mr. T. H. Flowers. *Institution:* Thursday, March 5, 5.30 p.m., Victoria-embankment, W.C.2. Joint Meeting with the INSTITUTION OF MECHANICAL ENGINEERS. "Design Features of Certain British Power Stations," by Mr. S. D. Whetman and Mr. A. E. Powell. *London Students' Section:* Friday, March 6, 7 p.m., Victoria-embankment, W.C.2. Joint Meeting with the *Association of London Students* of the INSTITUTION OF CIVIL ENGINEERS and the *London Graduates' Section* of the INSTITUTION OF MECHANICAL ENGINEERS. "Industrial Health Hazards," by Mr. B. J. Sherwood.

INSTITUTION OF THE RUBBER INDUSTRY.—*Newcastle Section:* Monday, March 2, 7 p.m., Neville Hall, Newcastle-upon-Tyne. "Some Engineering Aspects of Belt Conveying," by Mr. J. J. Hickey.

INSTITUTE OF MARINE ENGINEERS.—Monday, March 2, 7 p.m., South-East Essex Technical College, Dagenham. "Photo-Elasticity," by Dr. J. Ward.

INSTITUTE OF ROAD TRANSPORT ENGINEERS.—*Scottish Centre:* Monday, March 2, 7.30 p.m., North British Hotel, Edinburgh. "Transport Law and the Engineer," by Mr. T. P. Rankin. *Eastern Centre:* Tuesday, March 3, 7 p.m., Marshall's Airport, Cambridge. "Palletisation and the Fork-Lift Truck," by Mr. E. Wood. *North Western Centre:* Tuesday, March 3, 7.30 p.m., Station and Victoria Hotel, Preston. "The Running Maintenance of Compression Ignition-Engined Commercial Vehicles," by Mr. T. Charlesworth.

INSTITUTE OF BRITISH FOUNDRYMEN.—*Sheffield Branch:* Monday, March 2, 7.30 p.m., College of Commerce and Technology, Pond-street, Sheffield. "Economic Utilisation of Non-Ferrous Metals," by Mr. F. Hudson.

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS. —*Leeds Branch:* Monday, March 2, 7.30 p.m., Great Northern Hotel, Leeds. "From Nebula to Man," by Mr. W. L. Whittle. *West London Branch:* Tuesday, March 3, 7.30 p.m., 134, King-street, Hammersmith, W.6. "Floodlighting of Sports Arenas," by Mr. A. C. Holden. *South London Branch:* Thursday, March 5, 8 p.m., Café Royal, North End, Croydon. "Electrical Installations," by Mr. W. F. Parker.

ROYAL INSTITUTION.—Tuesday, March 3, 5.15 p.m., 21, Albemarle-street, W.1. "The Behaviour of Engineering Structures.—III," by Professor A. J. S. Pippard. Thursday, March 5, 5.15 p.m., "X-Ray Optics.—I," by Professor Sir Lawrence Bragg, F.R.S. Friday, March 6, 9 p.m., "The Pressure of Radiation," by Professor R. V. Jones.

INSTITUTION OF CIVIL ENGINEERS.—*Airport Engineering Division:* Tuesday, March 3, 5.30 p.m., Great George-street, S.W.1. "Methods of Soil Stabilisation and Their Application to the Construction of Airfield Pavements," by Mr. D. J. Maclean and Mr. P. J. M. Robinson. *Midlands Association:* Tuesday, March 3, 6.30 p.m., Offices of the East Midlands Gas Board, Lower Parliament-street, Nottingham. "The Nottingham Flood-Protection Scheme," by Mr. W. H. Haile. *Hull and East Riding Branch:* Friday, March 6, 6.15 p.m., Guildhall, Hull. "Examination, Assessment, Repair, Maintenance and Renewal of Old Railway Bridges," by Mr. A. Dean.

INSTITUTION OF MECHANICAL ENGINEERS.—*South Wales Branch:* Tuesday, March 3, 6 p.m., South Wales Institute of Engineers, Park-place, Cardiff. Thomas Lowe Gray Lecture on "Welding in Marine Engineering," by Mr. H. N. Pemberton. *Midland Branch:* Tuesday, March 3, 6.30 p.m., College of Technology and Arts, Eastlands, Rugby. "Water-Turbine Governors," by Mr. N. G. Dennis. *North-Western Branch:* Thursday, March 5, 6.45 p.m., Engineers' Club, Manchester. "Accounting Machines and Systems," by Mr. F. Pilling. *Institution:* Friday, March 6, 10.30 a.m., 2.30 p.m. and 5.30 p.m., Storey's-gate, St. James's Park, S.W.1. Seven papers from Pametrada. For programme, see page 278. AUTOMOBILE DIVISION.—*Coventry Centre:* Tuesday, March 3, 7.15 p.m., Craven Arms Hotel, Coventry. Annual General Meeting.

INSTITUTION OF STRUCTURAL ENGINEERS.—*Northern Ireland Branch:* Tuesday, March 3, 6.45 p.m., College of Technology, Belfast. "Recent Developments in Prefabricated-Concrete Structures," by Mr. J. C. Malcolmson. *Western Counties Branch:* Thursday, March 5, 5.30 p.m., The University, University-road, Bristol. "Plymouth 'B' Power Station," by Mr. L. Richardson.

SHEFFIELD METALLURGICAL ASSOCIATION.—Tuesday, March 3, 7 p.m., Grand Hotel, Sheffield. "Technological Education in Relation to the Iron and Steel Industry," by Mr. D. R. O. Thomas.

INCORPORATED PLANT ENGINEERS.—*South Wales Branch:* Tuesday, March 3, 7.15 p.m., South Wales Institute of Engineers, Park-place, Cardiff. Discussion on "Gland Packing versus Mechanical Seals." *Peterborough Branch:* Thursday, March 5, 7.30 p.m., Offices of the Eastern Gas Board, Church-street, Peterborough. Discussion on "Modern Refrigeration."

INSTITUTION OF ENGINEERING INSPECTION.—*Coventry Branch:* Tuesday, March 3, 7.30 p.m., Technical College, Coventry. "The Atom in Engineering," by Dr. H. C. Smith. *South-Western Branch:* Tuesday, March 3, 7.30 p.m., Grand Hotel, Bristol. "Precision Engineering Measurement," by Mr. W. H. Foster. *Birmingham Branch:* Wednesday, March 4, 7.30 p.m., Chamber of Commerce, 95, New-street, Birmingham. "Heat Treatment of High-Temperature Materials," by Mr. T. E. Cound. *Institution:* Thursday, March 5, 6 p.m., Royal Society of Arts, John Adam-street, W.C.2. "Manufacture, Inspection and Erection of Oil-Refinery Equipment," by Mr. A. W. Mason.

NEWCOMEN SOCIETY.—Wednesday, March 4, 5.30 p.m., Science Museum, South Kensington, S.W.7. "The Preservation of Historic Machinery and Its Problems," by Mr. A. Stowers.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—Wednesday, March 4, 6 p.m., Institution of Mechanical Engineers, Storey's-gate, St. James's Park, S.W.1. Annual General Meeting and Presidential Address. *East Midlands Branch:* Wednesday, March 4, 6.30 p.m., College of Arts and Crafts, Nottingham. "Problems and Experiences," by Mr. J. W. Johnson.

JUNIOR INSTITUTION OF ENGINEERS.—*Midland Section:* Wednesday, March 4, 7 p.m., James Watt Memorial Institute, Birmingham. "The Air and Its Future," by Air Commodore F. R. Banks. *Institution:* Friday, March 6, 7 p.m., Townsend House, Greycoat-place, S.W.1. Film Evening.

INSTITUTION OF PRODUCTION ENGINEERS.—*Coventry Section:* Wednesday, March 4, 7 p.m., Church House, Church-street, Rugby. "Manufacture of Components from Powdered Metals," by Dr. W. D. Jones. *Nottingham Section:* Wednesday, March 4, 7 p.m., Victoria Station Hotel, Nottingham. Annual General Meeting. *Edinburgh Section:* Wednesday, March 4, 7.30 p.m., North British Station Hotel, Edinburgh. "A Designer's Notebook," by Mr. J. A. Horne. *London Section:* Thursday, March 5, 7 p.m., Old Ship Assembly Rooms, Brighton. "Measurements in Gear Manufacture," by Mr. R. D. B. Stone. *Glasgow Section:* Thursday, March 5, 7.30 p.m., 39, Elmbank-crescent, Glasgow. Annual Meeting. Discussion on "Radial Drilling."

INSTITUTE OF WELDING.—*Manchester Branch:* Wednesday, March 4, 7.15 p.m., College of Technology, Manchester. "Pressure Welding," by Mr. A. B. Sowter and Mr. R. K. Hilton. *North-Eastern (Tyneside) Branch:* Thursday, March 5, 7 p.m., Mining Institute, Newcastle-upon-Tyne. "Welding in Heavy Machinery," by Mr. E. C. Houghton.

ROYAL SOCIETY.—Thursday, March 5, 4.30 p.m., Burlington House, Piccadilly, W.1. Wilkins Lecture on "Sir Humphry Davy, Bt., P.R.S.," by Sir Harold Hartley, F.R.S.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—Thursday, March 5, 5.30 p.m., Institution of Mechanical Engineers, Storey's-gate, St. James's Park, S.W.1. Sir Seymour Biscoe Tritton Lecture on "Efficiency in Locomotives," by Mr. F. Q. den Hollander.

INSTITUTE OF FUEL.—*South Wales Section:* Friday, March 6, 6 p.m., Royal Institution, Swansea. "Blast-Furnace Practice," by Dr. H. L. Saunders.

PERSONAL.

MR. J. S. GILLIES, M.B.E., outside manager to William Doxford & Sons, Ltd., Sunderland, has retired at the age of 70.

MR. W. WIDDAS, senior district Inspector of Mines, East Midland Division, has been appointed divisional Inspector of Mines for Scotland, in place of MR. H. R. HOUSTON, who has been promoted Deputy Chief Inspector of Mines for Great Britain.

MR. G. B. ALVEY has been elected a director of Mather & Platt Ltd., Park Works, Manchester, 10. He will continue to be responsible for the work of the electrical department.

MR. C. H. FLURSCHEIM, B.A., M.I.E.E., chief engineer, switchgear department, Metropolitan-Vickers Electrical Co. Ltd., Manchester, 17, has been appointed assistant chief electrical engineer, in addition to his present duties.

MR. JAMES NAPIER, engineer manager of the Crieff group of the Scottish Gas Board, is retiring on March 31. In 1917, Mr. Napier succeeded his father, who served with the Crieff Gas & Light Co. for 40 years. MR. J. S. EDNIE, of Blairgowrie, is to be the new manager at Crieff.

MR. JOHN GRIFFITHS has been installed as President of the South Wales Institute of Engineers, Cardiff.

MR. W. V. WRIGHT is now general manager of the Land Boiler Division of John Brown & Co., Ltd.

MR. G. G. SAVILL and MR. L. R. JOHNSTON have been appointed to the board of directors of C.A.V. Ltd., Acton, London, W.3.

MR. F. R. LIVOCK, T.D., B.Sc.(Eng.), M.I.E.E., A.M.I.Mech.E., has been appointed controller, education and personnel services, the General Electric Co. Ltd., Magnet House, Kingsway, London, W.C.2. MR. G. B. L. CHIVERS, B.Sc., A.K.C., has been appointed staff manager of the firm's sales organisation.

MR. THOMAS COOKE, honorary secretary, and MR. F. S. LEGG, honorary treasurer, of the Leeds Association of Engineers, have relinquished these positions on account of ill-health after occupying them for many years. Mr. Cooke is to be made an honorary life member, and MR. R. TURNER, Park-square, Leeds, has been appointed acting secretary.

MR. FRANK GREENSHIELDS, A.M.I.E.E., is leaving for Australia to-day to take up duties at the Sydney branch of Johnson & Phillips Ltd., Charlton, London, S.E.7.

MR. C. A. SMEED, L.R.I.B.A., civil engineer and architect, Eastern Division, British Electricity Authority, retired on February 7.

MR. W. E. PATTMAN has been appointed purchasing manager to Bakelite Ltd., 12, Grosvenor-gardens London, S.W.1. MR. J. M. LASSEN is to be sales manager of the firm's Vybak P.V.C. materials.

MR. H. BLAIR, who has been employed at the Bankfoot Coke Works, Crook, County Durham, for 30 years and became senior foreman in 1946, has been made assistant manager at Horden Coke Works.

MR. R. C. HARROWER has been appointed assistant manager of the Birkenhead works of the Vacuum Oil Co. Ltd., Caxton House, London, S.W.1.

THE HARLAND ENGINEERING CO., LTD., have opened a Midlands area office at Worcester Chambers, 81, Worcester-street, Wolverhampton. (Telephone: Wolverhampton 25482.)

RUBERY, OWEN AND CO., LTD., Darlaston, South Staffordshire, have acquired a Scottish office at 11, Royal-crescent, Sauchiehall-street, Glasgow, for themselves and their associated companies.

THE POWER-GAS CORPORATION LTD., Stockton-on-Tees, have concluded an arrangement with CHEMIEBAU DR. A. ZIEREN G.m.b.H., Nieder-Marsberg, Germany, whereby they will manufacture a complete range of sulphuric-acid plant and associated equipment to Chemiebau designs.

SIR W. G. ARMSTRONG WHITWORTH & CO. (IRONFOUNDERS) LTD., Close Works, Gateshead-on-Tyne, 8, have completed arrangements whereby they will manufacture the wide range of machinery of the OIL WELL SUPPLY DIVISION of the UNITED STATES STEEL CORPORATION, under a licence from their subsidiary, OIL WELL SUPPLY CO. LTD., 5, Queen-street, London, E.C.4. The latter company will act as the sole selling organisation for Oilwell products.

PETER STUBS LTD., Warrington, have appointed MR. JAMES YOUNG, 53, Ardenlee-avenue, Belfast, as their representative for Ireland.

GENT & CO. LTD., Faraday Works, Leicester, have established a depot at 3A, Berkeley-place, Clifton, Bristol, 8. (Telephone: Bristol 25655.) It will be under the direction of J. W. EQUIPMENT LTD.

MUSGRAVE AND CO. LTD., St. Ann's Works, Belfast, have now removed their London office from Commerce House, Newman-street, W.1, to more commodious premises at 2, Howard-street, Strand, W.C.2. (Telephone: TEMple Bar 2061-2.)

RECONDITIONING WHEEL SETS FOR LONDON TRANSPORT RAILWAYS.

(*For Description, see Page* 269.)

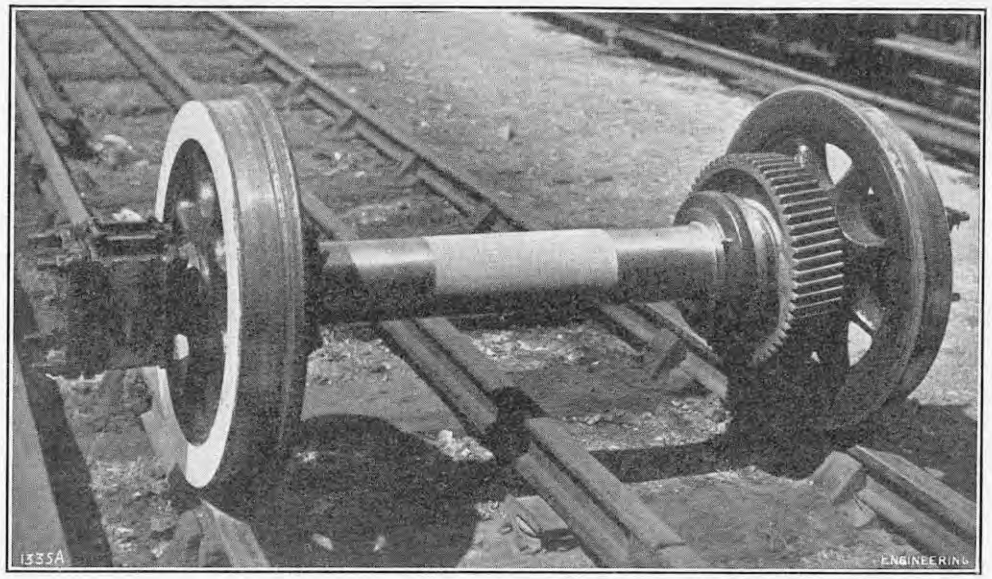


FIG. 1. WHEEL SET WITH ROLLER-BEARING MOTOR-SUSPENSION UNIT AND AXLEBOXES.

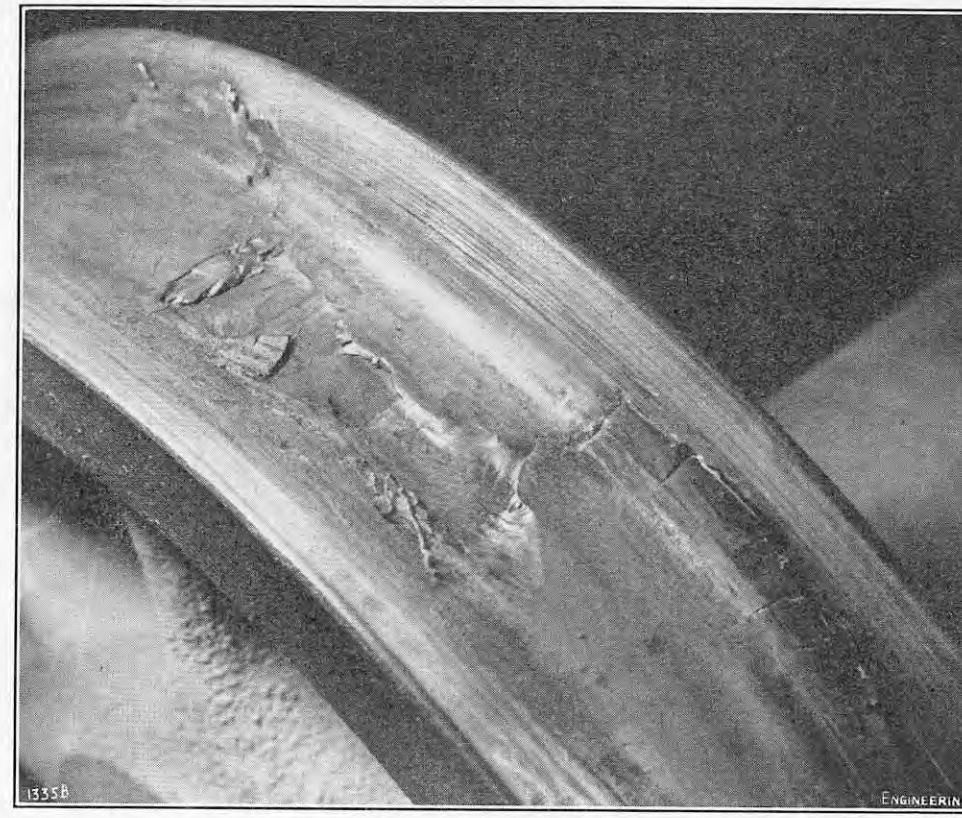


FIG. 2. FLAKING ON A TYRE TREAD.

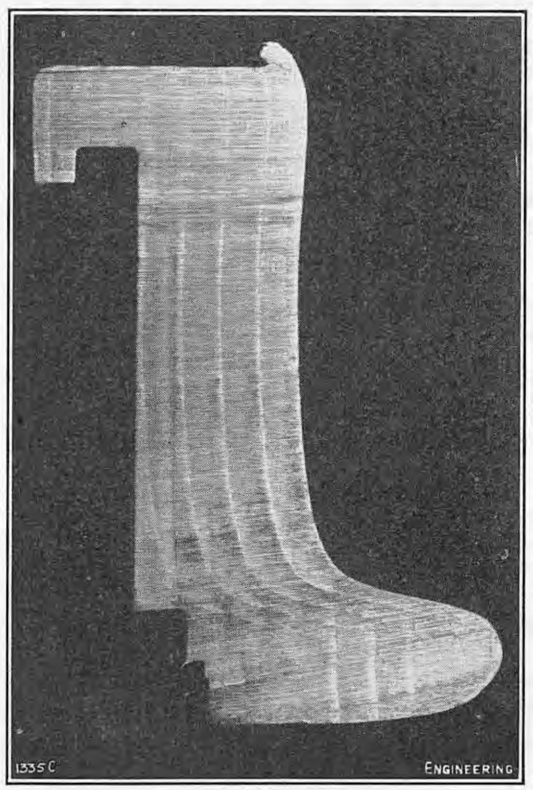


FIG. 3. WORN TYRE.

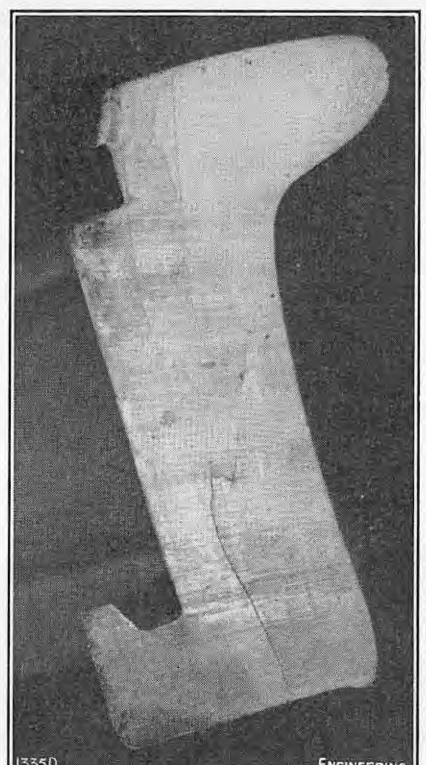


FIG. 4. FRACTURED TYRE.

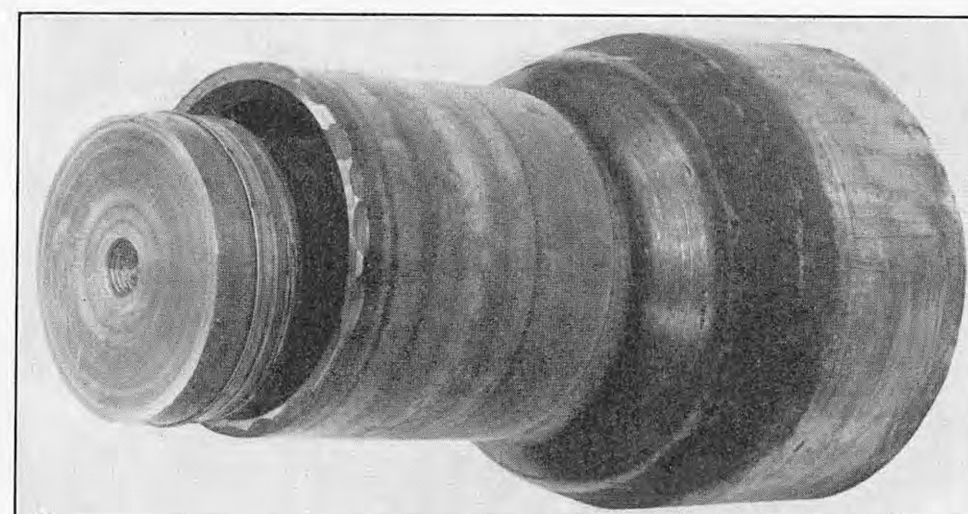


FIG. 5. DAMAGE DUE TO INSUFFICIENT GRIP BETWEEN BEARING RACE AND JOURNAL.

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ENGINEERING

FRIDAY, FEBRUARY 27, 1953.

VOL. 175. No. 4544.

THE BRITISH MERCANTILE MARINE.

A MONTH ago, in summarising (on page 116, *ante*) the comparative statistics of the world's principal merchant shipping fleets as presented in the Appendix to Lloyd's Register Book, we drew attention to the fact that, while the total tonnage of British Commonwealth shipping had increased during the previous accounting year by 163,000 tons, considerably larger proportional increases were shown by the mercantile fleets of Japan, Italy, Germany, Liberia, France and Sweden. When it is borne in mind that the world increase, in terms of gross tonnage, over the total of a year before was 2,935,000 tons and that the largest fleet of all, that of the United States, actually showed a decrease of 87,000 tons, it is obvious that the influences at work, whatever they may be, are important enough to be worth studying. When, in addition, it is realised that the tramp tonnage of the United Kingdom, in the same period, has decreased by more than 400,000 tons, and that tramps, after all, are the class on which the national economy depends for the transport of most essential foodstuffs and raw materials, apart from oil, questions of security as well as day-to-day economics clearly present problems of some concern.

It has been a commonplace for some years that the shipyards of the United Kingdom have had fuller order books than they have had ever before in times of peace; though that state of affairs has been due partly to inadequate or irregular supplies of steel, so that many ships have remained longer in the builders' hands than they would have done otherwise. It is undoubtedly true, also, that the great increase in aggregate world tonnage compared with, say, the period before the war has not brought a corresponding increase in effective capacity for transport, partly because so much of the increase has been tanker tonnage which can be used for one purpose only and usually in one direction only, but partly, also, because of needlessly prolonged delays in port. Concurrently—and this is a point not usually considered in assessments of relative or absolute shipping strength—there has been a vast increase in the population of the world, which, presumably, intensifies the demand for cargo space, though to what extent it is not easy to estimate. In fact, any attempt to build up a true picture of the trends in the construction and operation of ships must take into account so many factors that even the mind of a skilled actuary could hardly find it easy. It is difficult enough for the experienced shipowner, though, as a rule, he is concerned only with a few routes or trades.

One of the most valuable periodical commentaries upon this extraordinarily complex department of world commerce is the annual report of the Chamber of Shipping of the United Kingdom; and if, in recent years, these reports appear to exhibit a tendency towards repetition, especially when dealing with the grievances of shipowners, the reason is simply that, despite all their efforts and protests, these grievances regrettably persist. Moreover, there is some reason to fear that, just as some of them are so frequently voiced that readers of local newspapers in shipbuilding districts expect, as a matter of course, that every launch will be followed by a speech bewailing the hard lot of owner or builder, and turn their attention to something more topically interesting, so those in higher places—notably Chancellors of the Exchequer—appear to have become inured to these recurrent hard-luck stories and may well be tempted to leave the remedy to their successors to deal with. Only once do we recall that any Government was moved to take positive action to increase the ability of British shipping to compete in world markets, and that was between the wars, when the "scrap and build" policy was evolved in the attempt to lower the average age and increase the average efficiency of the shipping trading under the Red Ensign.

The unpalatable fact remains, however, that prolonged taxation on a scale that can only be described as predatory has produced a situation that ought to arouse grave disquiet in the minds of the Government, and of the nation as a whole; and no reader of the somewhat gloomy comments of the Chamber of Shipping would be justified in dismissing them as merely a *malaise* peculiar to shipowners and shipbuilders as a class. Unfortunately, they are only too well justified; and, though the operations of the various rate-fixing conferences in different shipping trades must do something to avoid undesirable undercutting, they can only affect a few of the adverse influences with which the present-day shipowner has to contend. They can do nothing, for example, to ameliorate the effects that must follow the recent decision to raise the price of coal. Only 15 per cent. of the world's merchant shipping now depends on coal as fuel, as compared with 45 per cent. in 1939 and 97 per cent. in 1914; but the cost of coal enters largely into the cost of steel, of men's wages, and of electric current and other shipyard services, not to mention the day-to-day overheads of shipowner and shipbuilder alike. Its influence on the first cost and operating cost of a ship is none the less real because it now appears in the books under some other heading.

The net result of all these economic difficulties, over most of which neither owner nor builder has any effective control, is that, as the Chamber of Shipping report states, the cost of building and fitting out a ship to-day is about four times the pre-war figure; and as delivery may be expected to take at least three years, "any tramp owner—even if he has the money to build—might be forgiven if he finds it difficult to predict the probable level of freights in three years' time, and therefore the chance of reasonably remunerative employment for his very expensive ship by the time she is delivered. . . . At a time when the commercial uncertainties of the future, the burden of taxation, and shipbuilding costs are greater than ever before, it is not difficult to appreciate a hesitation on the part of owners of dry-cargo fleets to commit their diminishing resources to the unknown." The situation was put even more succinctly by the President of the Chamber, Lord Runciman, in his speech at the annual dinner of the Chamber in October of last year, when he remarked that if, by some catastrophe of Nature, the whole of the British merchant ships were lost and had to be replaced at current prices, "the bill would be nothing less than £2,000 millions and would probably be a great deal more"; and when Lord Runciman referred to "current prices," they were the prices of five or six months ago. It is a reasonable assumption that to-day's prices would be higher, if only because of the increased cost of coal.

The conception of a mass renewal of British shipping may be fanciful, but it is not so very far removed from the actual needs as might appear at first sight. According to the latest volume (1953) of the Appendix to Lloyd's Register Book, of the 18,623,654 gross tons of shipping owned in Great Britain and Northern Ireland at June 30, 1952, 2,666,304 tons were over 25 years old, 1,283,980 tons were between 20 and 25 years old, and 1,492,891 tons were between 15 and 20 years old; a total of 5,443,175 tons. In other words, some 30 per cent. of the British tonnage is either due and overdue for replacement, or (at the present rates of building) should be the subject of plans for the immediate ordering of replacement tonnage; and, if the whole of the British shipyards were empty of work at the present moment, the placing of those contracts would represent approximately three years of full employment. Taking Lord Runciman's estimate for the replacement cost of an entire new fleet, the owners (or their financial backers) would be faced with the task of finding, at a guess, some 750*l*. millions; and we doubt whether even the most perfervid ranters about the alleged profit-making of shipowners would believe them to be capable of doing that, under present conditions of taxation.

Without going into an elaborate analysis of the types of ships under construction for different national flags, it is difficult to say whether the proportion of dry-cargo tonnage building for British owners differs materially from the proportion intended for registration in other countries; but the general impression conveyed by a broad survey is that, over the past year or so, the percentage of dry-cargo ships intended for the British flag has been less than the corresponding figures for the foreign fleets which are showing the most rapid increases in their total tonnage, though latterly the proportions of new tanker tonnage building for foreign ownership have become larger. It may be, therefore, that, while the influences at work may differ in different countries, the results are broadly the same and that a shortage of dry-cargo ships, not necessarily temporary, may develop in a few years through over-concentration on tankers. Whether this is so or not, however, the problem of maintaining an adequate and efficient British mercantile fleet remains one of immediate urgency, which it is to be hoped may be recognised when the next official "Economic Survey" is undertaken.

BROWN COAL.

ESTIMATES of probable, or possible, reserves of any mineral buried in the earth are apt to vary greatly over the years. This is partly due, no doubt, to the accumulation of new evidence and the opening up of new country. Although always of doubtful accuracy, overall estimates for countries or continents do, however, give an indication of the relative order of magnitude of the resources of different territories, but this is not to say that they are any guide to the relative extents to which such resources are being utilised. In a recent book,* Dr. H. Herman, quoting the 1948 *Statistical Year Book of the World Power Conference*, gives the probable reserves of brown coal and lignite in North America as 936 thousand million tons. Compared with this huge total, the probable reserves in Germany, according to an "official inventory" made in 1934-35, are 56,758,000 tons. This figure refers to brown coal capable of being mined and may not mean quite the same thing as the American figure, but brown coal has been worked to such a small extent in North America that the extent to which the reserves are worth commercial exploitation is probably not known.

This enormous wealth of brown coal and lignite in North America is almost untouched; in the period from 1927 to 1944, the annual production was only 4 million tons, rising to 7 millions in 1945 to 1947. In Germany, with its much smaller reserves, the average annual production over the period 1927 to 1947 was 174 million tons; the figures for individual years naturally varied considerably in the war period. The small extent to which brown coal and lignite have been utilised in America is sufficiently explained by the very large and easily worked deposits of bituminous coals and anthracite in the United States and the rich water-power resources of Canada. The total reserves of hard coal in North America are estimated at 2,081 thousand million tons. By contrast, the extensive exploitation of brown coal in Germany is to be explained by the fact that it is available in great quantity, especially in the eastern part of the country where hard coal deposits are lacking and that, to a large extent, it is easily won; open-cut working is extensively practised. The great extension of the German brown-coal industry is also partly to be explained by the heavy demand for fuel which arose during the 1914-18 war. In justice, it must be said that it is also due to the scientific and technical ability which has been displayed in its utilisation.

The position of the German brown-coal industry in relation to that of the rest of the world is illustrated by the fact that, in 1942, the output of brown coal was 240 million tons, whereas that of all other countries combined was only 63 million tons. The German output decreased in the post-war period, but is now rapidly rising. In these circumstances, any country contemplating the exploitation of its brown-coal resources will naturally pay much attention to German methods and experience. Dr. Herman is consultant to the State Electricity Commission of Victoria, the body responsible for the development of the brown-coal industry in Australia, and it is stated that the primary purpose of his book is to act as a work of reference for those engaged in the utilisation of the brown-coal deposits in the State of Victoria. This modest claim is far from giving an adequate idea of this authoritative volume, which deals in detail with every aspect of its subject, from the winning of brown coal to its utilisation as fuel in a gas-turbine locomotive. The source of most of the material in the book is Germany, but the information about the way in which selected German experience has been utilised in Australian developments is likely to be of interest and service in a wider field than that covered by the deposits in the State of Victoria.

Compared with those of Europe or America, the brown-coal reserves of Australia are small. According to World Power Conference figures, the 936 thousand million tons in North America compares with only 39 thousand million in Australia. The same disproportion, however, applies to hard coal, the relative figures being 2,081 and 14 thousand million tons; so it is natural that advantage should be taken of brown coal as an alternative fuel. Actually, the combined production of this mineral in Australia and New Zealand is greater than that in the whole of North America. There are known reserves of brown coal in South Australia, lying within some 50 to 80 miles of Adelaide, but the main deposits are situated in Victoria and it is in that State that the main developments have taken place. There are deposits at Altona, close to Melbourne, and at Bacchus Marsh, some 30 miles to the west, but the main development has been at and near Yallourn, 100 miles east of the city. This has been the work of the State Electricity Commission, under whose auspices the deposits have been worked, particularly for supply to the well-known Yallourn power station. The John Thompson water-tube boilers of this plant, with their Seyboth stepped grates and the special pre-drying shaft to reduce the moisture content of the coal, which could be as high as between 50 and 60 per cent., were described in *Proc. I. Mech., E.*, vol. 148, page 161 (1942).

The coal is won in open cuts and the book describes the cutting and transport arrangements in detail, with comparative information about German and American procedure. It is, however, particularly on the subject of briquetting brown coal that this book will be of value to many users; some 280 pages are devoted to this subject. The State Electricity Commission operates a briquetting plant at Yallourn and a further works is being constructed at Morwell. Dr. Herman states that the methods to be used in this new factory are based on German practice and on experience gained at Yallourn. Much weight must be given to this latter consideration as the whole development of briquetting in Victoria obviously owes much, or most, to Dr. Herman, who, before his retirement, was in charge of briquetting and research. This section of the book constitutes a complete treatise on its subject, every aspect being dealt with, especially the difficulties encountered.

If brown coal is to be marketed, briquetting will, in general, be necessary, but the coal can be, and is, used directly under boilers. It is understood that this procedure is extensively practised in Russia but, naturally, no information about present procedure is available from that country. This negative state of affairs does not apply to German and Australian practice, for full information about methods of firing and boiler furnace arrangements is given in the book. Similarly, full descriptions are given about procedures for the generation of gas from brown coal; a plant is to be installed at Morwell, on the Yallourn coalfield, for the production of town gas. The section of the book dealing with the firing of locomotives with brown-coal dust reviews the whole of the work done on this subject in Germany and Australia. It is stated that this practice in Germany has never proceeded farther than small local utilisation, but Australian development has reached a stage at which it has been decided to convert 28 locomotives to burn this fuel. The locomotive section of this important book ends with the suggestion that the low ash content of much Victorian brown coal should make it a promising fuel for possible coal-fired gas-turbine locomotives.

* *Brown Coal, with Special Reference to the State of Victoria, Commonwealth of Australia.* By H. Herman, B.C.E., M.M.E., D.Sc. Published by the State Electricity Commission of Victoria, and distributed by the Tait Book Co., Ltd., 349, Collins-street, Melbourne. [Price 84*s*., postage 4*s*.]

NOTES.

NEW INFANTRY WEAPONS.

THE production of new designs of weapons, vehicles and bridging equipment forms the chief section of technical interest in the *Memorandum of the Secretary of State for War, Relating to the Army Estimates* 1953-54 (H.M. Stationery Office, price 9*d*. net). A new scout car and a new armoured wheeled personnel carrier are to be in full production this year, and issues to the Army are to begin. Adequate supplies of Centurion tanks are stated to be available for the Active Army, and it is proposed to issue Centurion tanks to part of the Territorial Army this year for training. Meanwhile, efforts are being continued to develop the tank still further as a weapon of war. A new assault floating bridge and a new heavy assault ferry have been developed, and a start is to be made on equipping the Army with them this year. The study and design of guided weapons have continued; they show great promise and will be vastly superior to the present orthodox types of weapons. Experience of American body armour in Korea has been sufficiently encouraging to justify production being commenced in this country. A range of "radiac" instruments for detecting the presence of radioactive matter has been developed and production will be started this year. In connection with the re-armament of the infantry, much progress has been made, especially in anti-tank weapons. A complete family of new weapons has been evolved and they are being made and issued to infantry units. The smallest member of the family is the anti-tank grenade projected from the standard service rifle. Though this grenade weighs only 21 oz., its destructive capacity is equal to that of the most powerful infantry anti-tank guns used in the last war. Any soldier can be taught quickly how to use it. In infantry platoons the American 3·5-in. rocket launcher has been adopted and is now in full production in the United Kingdom, complete with its ammunition. This, also, is a light weapon, and although comparatively short-ranged, it is extremely powerful. At battalion level a new anti-tank gun has been designed to replace the existing one. It is a recoilless weapon and is probably the most powerful used by any infantry in the world to-day. It is lighter and more easily manœuvred than existing guns; full production is already under way and the re-equipment of the Regular Army will start this year. In the small-arms field, joint British, Canadian and Belgian development should shortly produce a cartridge acceptable to all the North Atlantic Treaty Organisation countries, together with a rifle on the general lines of the 0·280. The Secretary of State hopes that a decision on this important problem will be reached during the year. Meanwhile, the Patchett machine carbine has been designed and is undergoing wide-scale troop trials. It is intended as a replacement for the Sten gun and so far it has passed all its trials extremely well.

THE INSTITUTION OF MECHANICAL ENGINEERS.

The Council nomination and retiring lists were read, and the prizes for the previous session were awarded, at a meeting of the Institution of Mechanical Engineers held on Friday, February 20. The nominations were, as President, Mr. A. Roebuck; as vice-presidents, Dr. R. W. Bailey, D.Sc. (Eng.), Wh.Sc., F.R.S., and Sir Ewart Smith, M.A.; as members of Council, Mr. H. Desmond Carter, Mr. P. T. Fletcher, B.Sc. (Eng.), Dr. D. F. Galloway, Ph.D., B.Sc. (Eng.), Wh.Sc., Professor E. Giffen, D.Sc., Ph.D., M.Sc., Sir Kenneth Hague, Mr. S. J. Harley, B.Sc. (Eng.), Air-Marshal R. O. Jones, C.B., A.F.C., B.A., Mr. J. H. Pitchford, M.A., and Mr. R. A. Riddles, C.B.E.; and as members of Council but associate members of the Institution, Mr. P. E. Ford, B.Sc. (Eng.), and Mr. R. Stewartson, M.A. The James Clayton Prize of 1,610*l*. was divided equally between Mr. H. Hillier and Professor H. W. Swift, the former for his contributions to marine engineering, particularly in the field of auxiliary machinery, and the latter for his contributions to mechanical engineering in the fields of education, lubrication, and experimental research. The George Stephenson Prize was awarded posthumously to the late Mr. W. S. Graff-Baker, for his paper on "Considerations on Bogie Design, with Particular Reference to Electric Railways." The other awards were the Dugald Clerk Prize to Mr. D. Downs and Mr. R. W. Wheeler for their paper on "Recent Developments in 'Knock' Research"; the Water Arbitration Prize to Dr. A. E. Johnson for his paper on "Creep Under Complex Stress Systems at Elevated Temperatures"; the Starley Premium to Mr. Donald Bastow for his paper on "Independent Rear Suspension"; two Herbert Akroyd Stuart Prizes, one to Mr. John Lamb for his paper on "Explosions in Enclosed Crankcases of Reciprocating Engines," and the other to Mr. J. R. P. Smith for his paper on "Use of Heavy Fuels for Medium-Sized Marine and Stationary Diesel Engines"; the Thomas Lowe Gray Prize to Mr. A. Holmes Fletcher for his paper on "The Marine Gas-Turbine from the Viewpoint of an Aeronautical Engineer"; the T. Bernard Hall Prize to Mr. B. Grinsted for his paper on "Nodal Pattern Analysis"; the Engineering Applied to Agriculture Award to Mr. G. A. Wauchope and Mr. H. P. Humphreys for their paper on "The Design of Large Pumping Installations for Low and Medium Heads"; the Joseph Whitworth Prize to Dr. S. Y. Chung and Professor H. W. Swift for their paper on "Cup Drawing from a Flat Blank"; the Ludwig Mond Prize to Dr. C. N. Davies for his paper on "The Separation of Airborne Dust and Particles"; Institution Prizes to Professor R. N. Arnold and Dr. L. Maunder for their paper on "The Motion due to Slow Precession of a Gyroscope Driven and Supported by a Hooke's Joint," to Mr. W. C. F. Hessenberg and Mr. R. B. Sims for their paper on "Principles of Continuous Gauge Control in Sheet and Strip Rolling," to Mr. R. Pennington for his paper on "Centrifugal Pumps in Steam Power Stations," to Dr. D. Williams for his paper on "The Mathematical Theory of the Snaking of Two-Wheeled Trailers, with Practical Rules and Devices for Preventing Snaking," and to Mr. R. A. Wilson-Jones for his paper on "Steering and Stability of Single-Track Vehicles"; Graduates' Prizes to Mr. G. C. Jain, Mr. T. L. R. S. Dickin, Mr. H. A. Slyper, Mr. J. W. Bassett, Mr. C. H. Radforth, and Mr. P. W. Rowland; and the Hele-Shaw Medal and Prize (England and Wales) to Mr. D. J. White. The prizes were presented by the President, Sir David Pye, F.R.S., who was supported by the chairman of the Applied Mechanics Group, Dr. D. Clayton, as the paper presented for discussion at the meeting was that on "An Investigation of Fretting Corrosion," by Dr. K. H. R. Wright.

PRECAST CONCRETE CONSTRUCTION.

"A bold step forward" was how Professor A. L. L. Baker described the use of precast reinforced concrete for the framework of the turbine house and switch-house annexe in the construction of a major power station for the British Electricity Authority. Professor Baker was opening the discussion on a paper entitled "The Application of Precast Concrete to the Construction of Acton Lane 'B' Power Station," by Mr. J. A. Derrington, B.Sc. (Eng.), A.M.I.C.E., and Mr. A. G. S. Lance, who introduced their paper with the aid of three slides and a film, to a meeting of the Works Construction Division of the Institution of Civil Engineers on Tuesday, February 24. A description of the station has already been given in ENGINEERING, vol. 173, page 77 (1952). Although not the largest structure in reinforced concrete, Acton "B" is probably unique in being such a large structure in which concrete members were first precast and then erected by derrick cranes in precisely the manner, and at a comparable speed, that would have been used had the framework been of steel. The turbine house was 300 ft. long by 64 ft. wide by roughly 60 ft. high, and the design for the reinforced-concrete members was completed in ten weeks; the actual erection was begun five weeks later and was completed within another seven weeks. The columns, beams and roof section were all cast on the basement floors of the turbine house and the boiler house close to their final location. Apart from the speed of the construction achieved, the station was said to show that concrete members of the size used—the principal columns each weighed 33 tons and main roof beams 27 tons—could be precast with the same accuracy as constructional steelwork, say, to the nearest $\frac{1}{16}$ in. The chairman, Mr. David M. Watson, drew attention to the greater ease and the probable increase in accuracy of placing the reinforcement and to the probable improvement in the quality of the concrete, when the members were precast on the floor rather than being fabricated *in situ*, possibly 60 ft. above ground. These points were confirmed by Mr. Brian Colquhoun, who also spoke of the close collaboration that had obtained between himself, as the consultant, and the contractors, Sir Robert McAlpine and Sons, Limited, who conceived the scheme of replacing the unobtainable steel by precast concrete. In introducing the paper, Mr. Derrington had noted that the design problems had been "tedious," rather than "difficult," but he instanced the saving that could be made in the steel content by careful detailing. As an example, he quoted the case of the principal columns which, in the first design drawings, originally contained 105 cwt. of reinforcement, but, by paying attention to the laps required and the location of the stirrups, it had been possible to save 11 cwt., so reducing the steel content of each column to 94 cwt. In the opinion of all the speakers, the authors were thought to have advanced substantially the knowledge available on the expedient of using precast concrete for large structures and to have materially enhanced the possibility of the method being adopted in similar circumstances in the future.

SAFETY IN ENGINEERING CONSTRUCTION.

On Monday, February 23, at the Royal Society of Arts, Mr. G. A. Gardner, O.B.E., M.I.Struct.E., delivered a lecture on "The Safety Factor in Construction"; the first lecture of a course of two, the second of which will be given on March 2 by Professor F. C. Thompson, B.Met. As chief structural engineer in the Ministry of Works, Mr. Gardner is in a position not only to set the standard of structural efficiency in a large Government department, but also to exert considerable influence on general practice, and he used this occasion to justify the apparently high factors of safety which have been traditionally the practice among engineers bearing heavy responsibilities. Laymen, he said—and, indeed, laymen in high places—were fond of telling engineers that they built too strongly; that structures would, in fact, carry three or four times the loads which they were required to bear. He devoted much of his lecture, therefore, to showing that the so-called factor of safety based on stress was no more than notional, if not entirely mythical. Taking first the very rough approximations which had to be made in the design of the simplest elements of construction—the beam and the strut—by engineers working for a living, as opposed to academic theorists, he went on to discuss the more complicated types of structure and referred briefly to other factors, such as variations in material properties, and tolerances and allowances in manufacture and erection. The plastic theory of design, he suggested, would contribute to the development of a system of design based on load factors rather than stress factors of safety; but, in his opinion, no substantial economy could be made, in comparison with present practice, without an extensive programme of comprehensive tests on representative structures.

INTERNATIONAL RESEARCH ON FLAME RADIATION.

Introducing a discussion before the Institute of Fuel in London, on February 24, on the work of the Flame Radiation Research Joint Committee, which followed the exhibition of a number of films of flame form and propagation, Professor O. A. Saunders, chairman of the British Committee, said that the aim of the investigations at Ijmuiden, Holland, was to improve the efficiency of industrial furnaces. Results obtained to date by the team of British, French, Dutch and Swedish scientists, had led to a better understanding of heat-transfer processes. This applied particularly to heat transfer by flame radiation, which was mainly due to suspended carbon particles. Knowledge was lacking of the number and size of the particles, and their rate of formation. The problem was a complex one, and could not be studied satisfactorily in the laboratory; investigations were needed on a scale approaching that of the furnaces actually used in industry. Such investigations had been carried out at Ijmuiden over the past four years. Mr. M. W. Thring, superintendent of research to the Committee, said that the earlier experiments were of two types, namely, performance trials and combustion-mechanism trials. In the performance trials, comparison was made of the effects on flame radiation of pairs of "external" variables, these being oil and creosote pitch; rate of fuel energy input, 76 and 106 therms per hour; air and steam as atomising agents; an increase of 20 per cent. in the quantity of atomising agents; and an increase of 25 per cent. in the quantity of combustion air. In the combustion-mechanism trials, the object was to measure in great detail the conditions inside the flame, with a view to finding an explanation of the results of the performance trials. For example, the structure and distribution of the soot particles in flames had been studied by means of the electron microscope. In the second series of experiments (the burner trials), the effect on the flame characteristics of using various types of burner was studied. At first, the experiments were confined to oil fuel, but later comparison was made between coke-oven gas and oil as fuel. It was shown that, in the early part of the flame, the radiation from coke-oven gas was much lower than for oil; that, in both cases, the most important effect on flame radiation was that of jet momentum; and that the emissivity of the flame depended on the square of the soot concentration, if the soot was formed by two molecules meeting. The next stage would be to apply the knowledge of the effect of jet momentum on flame length, and the relative effects of air and steam as atomising agents, to improving burner design. Studies would be made also of the radiation from pulverised-fuel flames in water-tube boilers.

LETTER TO THE EDITOR.

EXTENDED SURFACES FOR HEAT EXCHANGERS.

TO THE EDITOR OF ENGINEERING.

SIR,—May I reply to the three interesting points raised by Mr. H. Hampson on page 116 of your issue of January 23? He asks for further information on the Sunrod heat exchangers which were described on page 745 of your issue of December 12, 1952.

Regarding the possibility of corrosion occurring at the junction of the copper elements and the steel tubes, no instances of corrosion due to the dissimilar metals surrounded by flue gas have been found during the two and a half years that Sunrod units have been in service. As for the strength of the welds, we have found that after a number of heating cycles the strength actually improves as the welding stresses are normalised.

With regard to Figs. 8 and 9 of the article, we would like to make it clear that they are for comparison and therefore are for exactly the same conditions, including pressure drops across the separate components. As far as fouling is concerned, the design pressure drop can be maintained over long periods of service, provided that the conditions of service are known and allowances made at the design stage. Indeed, in Sweden there are several waste-heat boilers employing Sunrod surfaces, operating in conjunction with open-hearth steel furnaces, which have been in service for periods in excess of 12 months without manual cleaning and without abnormal increase in draught loss.

Yours faithfully,
W. M. GIBSON.

Sunrod Limited,
1 and 2, Hen and Chickens Court,
184, Fleet-street,
London, E.C.4.
February 19, 1953.

OBITUARY.

MR. H. B. FERGUSSON.

IT is with a keen sense of personal regret that we record the sudden death, on February 20, of Mr. H. B. Fergusson, the senior director of Messrs. G. A. Harvey and Company (London), Limited, and an engineer of exceptional experience in an unusual variety of fields. Mr. Fergusson, who was in his 69th year, had been associated with his firm since 1933, when he joined them as manager of their Heavy Construction Department, and had been largely responsible for the subsequent great expansion of that department and, in particular, of their work in the rapidly developing fields of oil and chemical engineering.

Hugh Boscawen Fergusson was born on March 30, 1884, and was the son of a civil engineer, the late Mr. John Coleman Fergusson, M.I.C.E., whose interests were mainly in the construction of hydro-electric plants and docks. He himself, however, began his engineering career, after a general education at Vancouver, British Columbia, as a student of mining engineering in Germany, where, for three years, he attended the Königliche Bergakademie in Freiburg. He then spent five years, from 1906 to 1910, as a pupil under his father. In 1911, he returned to British Columbia to take up an appointment as resident engineer on the construction of the portion of the Canadian Northern Railway between Yale and Hope, on the Fraser River. This contract was completed in 1912, and he then set up in practice in Vancouver as a consulting engineer, in the firm of Du Cane, Dutches and Fergusson, the senior partner of which, Mr. Charles G. Du Cane, B.A., subsequently established himself in London, as a partner in the firm of Sir John Wolfe Barry and Partners, and became a member of Council of the Institution of Civil Engineers.

The war of 1914-18 brought Fergusson again to Europe, in charge of the railway construction unit of 750 Canadians who worked on the building of the Murmansk Railway, in Russia. This occupied him until 1916, when he was appointed works manager of the Gretna munitions factory then newly completed for the Ministry of Munitions. After the Armistice, in 1918, his excellent command of the German language, allied with his varied engineering experience, led to an appointment as chief technical adviser to the British Military Governor of the occupied territories, with headquarters at Cologne, where he remained for a year.

In 1919, through his connection with Du Cane, he became associated with Sir John Wolfe Barry and Partners, on whose behalf he was engaged for six years on railway electrification and the construction of hydro-electric stations in Spain. His next appointment, in 1925, was as chief agent for Sir John Norton-Griffiths, then at the height of his career as a public-works contractor, on railway and other constructional work in South America, where, for three years, he was in charge of the construction of the Trans-Andine Highway from Cucuta to Bogotà, in Colombia. He remained in South America until 1932, when he returned to England to take up his first appointment with Messrs. G. A. Harvey and Company, as previously stated. In that position, and especially since he was made a director in 1938, he soon became known as a specialist in heavy steel construction, more particularly the production of welded fractionating towers and other large steel pressure vessels, in the supply of which he built up one of the largest connections in the country.

Mr. Fergusson was a member of the Institution of Mechanical Engineers, the Institution of Naval Architects and the Canadian Society of Civil Engineers, and a vice-president of the Institute of Welding. He was fluent in German and Spanish and hardly less so in French and Russian, knowledgeable and far-sighted beyond the ordinary, and possessing a fund of engineering anecdote which was an education in itself and made him one of the most companionable of men.

OPERATING EXPERIENCES WITH TWO GAS-TURBINE LOCOMOTIVES.*

By A. W. J. DYMOND, B.Sc., M.I.C.E., M.I.Mech.E.

(*Concluded from page 248.*)

Operation and Utilisation.—It will have been noticed that the Brown, Boveri locomotive has spent comparatively little time on the Paddington-Plymouth run, for which it was primarily intended. The reason for this is three-fold: in the first place the emphasis in the traction-motor design has been on speed and not tractive effort, consequently the capacity of the locomotive to deal with the heaviest trains over the steep gradients in South Devon has been somewhat restricted. The inconclusive trials held in June, 1950, followed by the traction-motor trouble, delayed any decision as to the safe load for these gradients until a thermal indicator could be fitted to indicate the temperature rise in the generator and traction motors, and until further trials could be arranged. These trials took place in May, 1952, and as a result it was decided that a load that is normal for a "King" class locomotive could be hauled with safety provided no stop were made on the gradient. What, in the second place, has an important impact on the use of the engine on any services is the necessity for an adequate link of trained staff—not too large, as they would be likely to lose touch with details between driving turns on the engine, and not too small, since that would restrict flexibility in the use of the locomotive to the few people trained to handle it. This aspect, allied to the early inadequacies of the train-heating boiler, constituted the other main restriction on the use of the engine to Plymouth.

Fuels and Fuelling.—As has been stated, the locomotive uses two fuels, gas oil for starting the turbine, running the Diesel engine and firing the train-heating boiler, and a fairly heavy residual fuel (950 secs. Redwood No. 1 at 100 deg. F.) for normal running of the gas turbine. Fuelling points with both fuels available were in existence at certain depots of the Western Region, the gas oil being on tap for Diesel-electric shunters, and the residual fuel facilities being those originally provided for the coal-oil conversion project for steam locomotives. The existence of these facilities at certain depots—and their absence at others—has obviously a bearing on the points between which the locomotive can operate without refuelling. The gas oil offers no serious problem, but the residual oil, requiring as it does heating in winter, entails handling facilities with heating coils in the tanks and steam tracer pipes on the oil lines. In this sense the use of a residual fuel of high viscosity is a disadvantage from an operating point of view, as fairly costly facilities must be established at every motive power depot at which the locomotive is scheduled to refuel. The motive-power depots at Old Oak Common (London), Swindon and Laira (Plymouth) are fully equipped to deal with both oils, but no other depot on the Western Region now has facilities for dealing with heavy oil. Hence, services are necessarily confined to out-and-home trips without refuelling (as in the case of the Paddington-Bristol run) or trips between the three depots mentioned.

The fuel consumption has remained remarkably constant throughout. In the first 12 months, including initial trials and consequently excessive light-engine miles, the average was 3·03 gallons per mile. In the second 12 months, the figure was also 3·03 gallons per mile, while up to the time of writing, in the third 12 months, it has registered 2·81 gallons per mile. The only critical reading of fuel consumption arises from the series of dynamometer car tests carried out between Paddington and Plymouth in September, 1951, the results of which have been published. In this, the corresponding figure of oil fuel consumed varied from 23·02 lb. per mile to 28·3 lb. per mile. With the specific gravity of the oil at 0·94, this is from 2·47 to 3·00 gallons per mile. As these values are substantially of the same order as the annual

* Paper presented to the Institution of Locomotive Engineers, in London, on February 18, 1953. Abridged.

figures, it is reasonable to assume that the ratio of oil per drawbar horse-power per hour (1·93 to 2·17 lb.) obtained on the tests obtains throughout the operating period. This is the equivalent of an overall work-to-fuel ratio of about 6·7 per cent. Compared with the optimum efficiency at full load of about 16·8 per cent., obtained on the bench tests of the power unit at Baden, this is perhaps surprising. The explanation lies in the average power required of a locomotive being in the vicinity of 50 per cent. or less of full power, combined with the strongly drooping characteristic of the efficiency curve for the gas turbine. In this connection, idling and light-engine running account for far more than their due share of fuel consumption.

It is, however, interesting to relate the fuel consumption per mile to an equivalent coal basis and compare this with normal steam locomotive figures. Taking a gross calorific value for the oil of 18,630 B.Th.U. per lb., with an average specific gravity of 0·882 at 220 deg. F. (i.e., temperature at burner) the equivalent coal at 14,000 B.Th.U. per lb. works out at 35·6 lb. per mile. This is a very favourable figure compared with a general figure of 50-55 lb. of coal per mile for all coal supplied to steam locomotives using varying grades of coal, the average calorific value of which would almost certainly be less than 14,000 B.Th.U. per lb. The difference between the low equivalent coal (35·6 lb.) and the general figure quoted (50-55 lb.) is also in part explained by the elimination of stand-by and lighting-up losses, as well as by the effect of the wider variety of operating conditions in general service which have adverse reactions on fuel figures for all steam locomotives compared with those for the gas turbine on its limited and selected duties.

Lubrication.—Gas-turbine locomotives are claimed to have very low figures for lubricating-oil consumption, and in this connection the following record of the behaviour of the Brown, Boveri locomotive will be of interest. For a weekly service involving 1,750 miles and approximately 50 hours running, the following quantities were used per week for topping up: Diesel-engine sump, 1¼ galls.; compressor exhauster, 1 gall.; traction-motor gears, 1 gall.; traction-motor armature bearings, 2 pints; various grease points, 4½ lb. Every three months in service the main lubricant tank of the turbine required 10 gallons for topping up, while the sump of the Diesel engine and exhauster-compressor in the same time have required some 20-22 gallons for complete changing of the oils in the sumps at the prescribed intervals. Over the period from the commencement in service the consumption of lubricating oils (as distinct from greases) has averaged between 2·5 and 2·8 pints per 100 miles.

Metropolitan-Vickers Locomotive No. 18100.

This locomotive, after having made only one or two short movements under its own power in the works yard at Trafford Park, was towed to Swindon, where it arrived on December 17, 1951. As practically no facilities were available for any serious running tests and adjustments before delivery, some weeks elapsed after its arrival in Swindon before it was deemed ready for operational service. The first period, therefore, was occupied on a number of what might be termed "works trials," both light-engine and with empty stock, the first of these (a light-engine trip) taking place on January 3, 1952, between Swindon and Stoke Gifford (Bristol). The locomotive also ran a series of empty-stock trips between Swindon and Plymouth, and between Paddington and Plymouth, Wolverhampton and Bristol. The outstanding features of these trials were the taking of a train of 17 empty stock (532 tons) to Plymouth from Swindon, via Reading, on March 6 and the restarting trials on the 1-in-42 gradient at Hemerdon on March 9, when 609 tons tare weight (18 coaches) were successfully restarted. At this date, some 3,200 miles had been achieved.

The general behaviour of the locomotive throughout all this preliminary running gave no cause for anxiety. Such adjustments and modifications as were made were solely those likely to arise with a new design being first put into operation. There was some difficulty with hunting in the main control gear, and some time was spent in suppressing it. No major incident intervened, however, before the first passenger-train trip on April 4, when a nine-coach train was taken from Paddington to Bristol and back. Mileage at this date was 4,500. The engine then settled down for staff-training purposes to run a trip to Bristol and back each day over a period of about one month. One day was lost during this period owing to inability to restart the turbine while on the way to take up the day's work. This was due to an electrical fault on the battery starting system. The engine took up its duty on the following day without further difficulty. By the end of May, 15,500 miles had been run with no serious incident.

At the end of the first week in June, an oil pipe feeding one of the main bearings of the turbine fractured, and as the amount of dismantling to correct this was considerable it was decided to anticipate a projected week's stoppage in shops by a few days, and the engine accordingly was withdrawn from service. The intention to withdraw the engine for a week arose from the desire to carry out simultaneously some modifications to the exhaust trunking, the traction motor gear cases, and the main side frames of the bogies. None of these modifications was the result of any serious defect becoming apparent, but each was deemed necessary in the endeavour to secure the maximum degree of reliability in the locomotive when finally passed to the railway for independent operation. It is to be borne in mind that the joint responsibility for the locomotive, which was shared from the outset equally by the Railway Executive and Metropolitan-Vickers, persisted through all the preliminary trials, and during the actual service runs, and, indeed, remains up to the present. In the middle of July, the engine was put to work two trips a day to Bristol and back (some 2,900 miles per week) and by the beginning of August nearly 30,000 miles had been logged. Early in August, the engine was put on the Plymouth run, making the round trip from London to Plymouth and back in one day. It remained on that service up to mid-September, when it was stopped owing to a serious defect in the control circuits, causing a small fire which entailed considerable renewal of the wiring and components of the control gear. During the ensuing stoppage, the bearings at the pinion ends of the traction motors were changed from oil to grease lubrication. This was deemed desirable owing to the oiling system having required fairly considerable replenishment due to persistent loss of lubricant. At the date when the stoppage occurred, the engine had achieved 42,021 miles and completed 1,237 turbine hours.

In the case of the Brown, Boveri machine, it was possible to give some comprehensive comments on maintenance, operation, fuelling, etc. Owing to the much shorter mileage achieved in considerably less time by the Metropolitan-Vickers locomotive, together with the fact that it has been in the hands of the maker's staff (except for driving duties) throughout the whole period since its delivery, similar detailed comment on this locomotive is not yet possible. Such maintenance work as has been necessary has been carried out by the firm's staff, often in conjunction with some slight modifications revealed to be necessary by the current running experience. The picture is thus confused in some degree and no useful purpose is served in endeavouring to generalise. On the question of fuel, no very elaborate storage facilities for refuelling the locomotive are necessary, since the gas oil used is the same as that already available for the Diesel railcars and Diesel-electric shunters. The consumption rate, initially rather high at 3·77 gallons per mile, settled down to 2·97 gallons per mile after adjustment to the idling control consumption. Comparing this consumption of gas oil of a gross calorific value of 19,500 B.Th.U. per lb. with the equivalent coal at 14,000 B.Th.U. per lb. gives an equivalent coal consumption of 34·6 lb. per mile. This figure, subject to the same reservations as that quoted for the Brown, Boveri locomotive, is nevertheless very near to that figure and suggests, in the absence of precise figures from dynamometer tests, that the thermal characteristics of both locomotives are very closely allied. The consumption of lubricants has been quite modest, except in regard to that for the traction-motor gear cases, which were modified after months of running to improve the oil seals, The make-up of main turbine lubricant has been at the rate of 13-14 gallons per month. The utilisation of the locomotive has been in some measure restricted by most of the factors referred to in the case of the Brown, Boveri machine, with one important exception. The excellent tractive performance with heavy trains on the South Devon banks has made possible the employment of the engine on services to this area without the reservations applicable to the Swiss engine. Up to the time of writing, no considerable experience had been obtained with the train-heating boiler; consequently, the restriction on the use of the engine imposed on the Brown, Boveri engine did not apply. The engine has been stabled at Old Oak Common throughout.

Some Generalisations.

For locomotives of such a novel type, handled, with assistance in part from the builders' staffs, by the normal railway personnel, the general experience has been distinctly encouraging. As the narrative has revealed, there have, of course, been incidents involving withdrawal from service. In addition, there have been many hours, at night and at week-ends, of arduous work, particularly in the initial stages, correcting trivial defects or mal-adjustments. Such is to be expected of a new design of any accepted principle. No more than this has been necessary with either of these gas-turbine locomotives, with the exception, of course, of the major incidents which have been recorded. On the road, the engines have put up some very impressive performances, which may be exemplified by the comparison of the Brown, Boveri dynamometer car record with that of a King-class engine on the West of England route. The climb from Cowley Bridge (Exeter), at which a permanent speed restriction of 50 m.p.h. must be observed, to the summit of Whiteball, is about 18½ miles. The Brown, Boveri engine, working most of the time below maximum power, was nevertheless able to breast the summit at 18-20 m.p.h. faster than the "King." Similarly, the climb up from Athelney to Somerton, of about 8 miles of 1 in 264, reduced the "King" speed from 70 to 52 m.p.h., while the Brown, Boveri engine, though again not working at maximum power, did not drop its speed below 66 m.p.h., and could have maintained the 70 m.p.h. which was the speed past Athelney, were it not for the necessity to avoid running too far ahead of booked time.

It may be safely stated that the sustained high rate of drawbar horse-power here shown is beyond that normally possible even with the maximum continuous steaming capacity of any steam locomotive in the country. Although no dynamometer-car tests have yet been made with the Metropolitan-Vickers engine, some very fine runs have been recorded on normal or special services. For example, on a special run with a train of 498 tons, passing Taunton at 60 m.p.h., the 107 miles to Reading (passing at about 45 m.p.h.) was covered in 90 minutes, including the climbs to Witham and Savernake summits. Both locomotives on regular service have consistently and frequently made up substantial margins caused by late departures, mostly not of their causing. From the point of view of the driving staff, this makes the locomotives very popular, their complete mastery of the trains being fully appreciated and made use of by the drivers. After the initial period of training, during which the novelty of the engines has perhaps caused the trainee drivers some misgivings, most of those passed to take charge have shown considerable confidence and competency in dealing with the engines. This is most marked, of course, with the Brown, Boveri engine, which has been running many months in sole charge of driver and assistant, with only occasional visits from headquarters inspectors, and practically none from representatives of the builders. No doubt, the same will prove to be true for the Metropolitan-Vickers engine when the firm's staff, who up to now have always ridden with the engine, are finally withdrawn. Given the fact that driving technique for these machines is not a major difficulty, there would be good grounds for assuming that the utmost could be made of the high user potential of each locomotive if a number were in use simultaneously, and the American project for ten such engines, when fully implemented, may be confidently expected to confirm this.

The operating cost, on the usual "per mile" basis for fuel alone, strikes a somewhat disheartening note compared with Diesel and steam locomotives. If the day-to-day maintenance and servicing of a fleet of such locomotives is very slight (as would appear from experience to be extremely likely) and a high utilisation factor is achieved, however, the advantages of being able to provide units of such power within normal space and weight limitations make the overall economic consideration much more favourable. The difficulty with only one or two locomotives is to achieve a high utilisation factor, consequently the actual operating cost affords only a slight criterion on which to base an opinion.

So far as the physical phenomena associated with these engines are concerned, relatively little difficulty has been experienced. The noise, although noticeable enough, is only inconvenient when stationary, and is practically inaudible in the train either stationary or running. Smell has been found to vary with the rate of working, being worse when idling or running light and practically absent when on medium load or more. The use of the residual fuel on the Brown, Boveri engine, with the attendant combustion difficulties, has aggravated the smell problem, but it is hoped that the work at present proceeding on the combustion will eliminate or at least mitigate this. Practically no complaint has arisen on account of smell concerning the Metropolitan-Vickers engine.

The unusual quantity of air being inhaled and exhaled has given rise to doubt as to the effects of this on bridges and other structures. The only indication of anything unusual has been the fairly heavy falling of soot and dirt from tunnel roofs, station verandahs, etc., at the initial passage of the engine. After repeated journeys the falls have been very much reduced, or cease altogether, and an item could almost be claimed on the credit side for cleaning structures for the civil engineer. No trouble has been experienced due to the large intake of air. Experience to date has been, therefore, that no insurmountable disadvantages arise due to noise, smell, nor air displacement. In this connection it would be appropriate to record that, although great care has been taken on the Metropolitan-Vickers engine to filter all air entering the compressor, while no filters at all are provided on the Brown, Boveri engine, little difference in the performance of the machines, due to this variation between them, has been noticed. Both engines inhale air from dust or smoke-laden surroundings—notably in tunnels. In the case of the Brown, Boveri engine, the compressor is periodically washed out. In the case of the Metropolitan-Vickers engine, the filters are periodically cleaned. But no significant falling-off in performance has been noticed in either case.

The radius of action of both locomotives has been, in some measure, restricted by the fuel-tank capacity. This has proved ample for the 225 miles run from Paddington to Plymouth, specified when the projects were first examined, but experience has shown that advantage could have been taken of further short trips at the ends of long runs of up to 250 miles, were it not for the necessity to refuel. So far as the Brown, Boveri engine is concerned, this is of some importance, as the necessity for special heating facilities for the residual oil at motive-power depots makes multiplication of these expensive facilities (for one locomotive only, as in the present case) a very costly provision. In the case of the Metropolitan-Vickers locomotive, arrangements are in hand to increase the tankage on the locomotive and provide, in addition, a fuelling pump on the locomotive so that gas oil can be taken direct from a tank car. In either case it would seem that the omission of the double-ended driving facilities, and the re-arrangement of gear on the frame, could have made possible substantial increased fuel capacity, with great advantage for these experimental machines. An additional virtue would have been greater facility for the provision of gangway connections to the main train, which would be of great advantage in dealing with many features which arise with a novel machine.

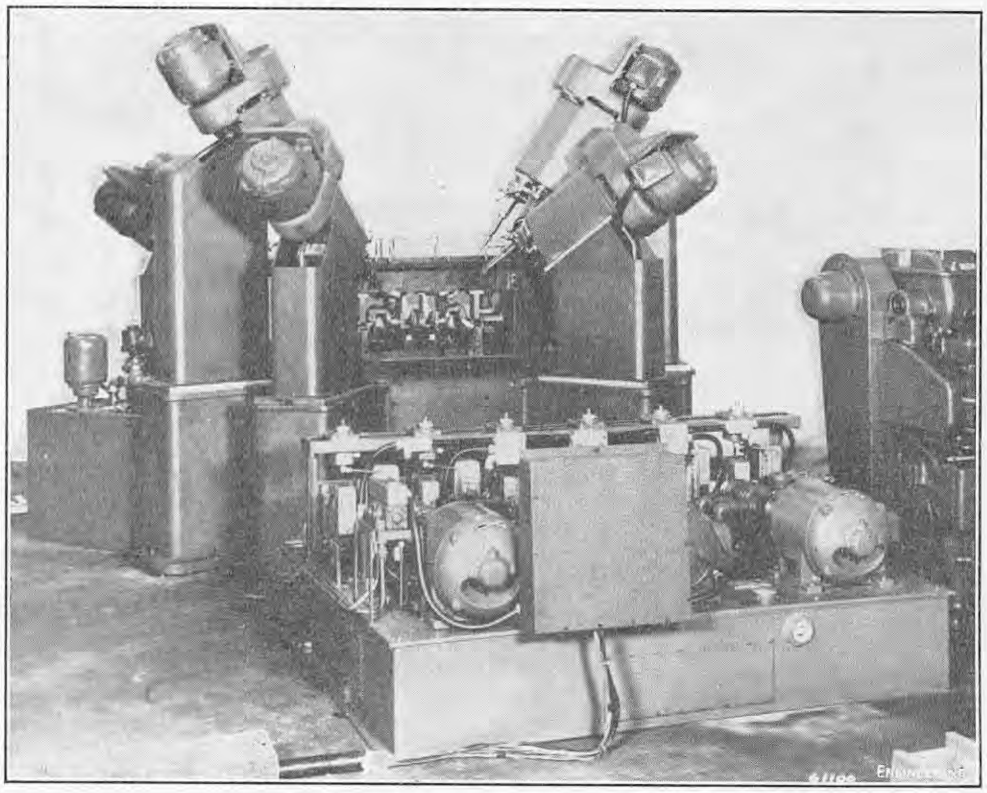
On the question of the train-heating boilers much could be said. Suffice it to remark that the provision of a boiler-tender-cum-baggage-car, particularly if associated with the gangway connection envisaged, would have eliminated or reduced engine days lost solely due to the train-heating boiler. Moreover, the space, not only for the boiler, but also for its attendant water tank, could again have provided additional fuel space. If the locomotive could be fuelled for 20 to 22 hours in traffic a day, which is otherwise well within its capacity, many more revenue-earning miles could be achieved. The importance of this in relation to capital cost does not need emphasis.

On the question of capital cost the author makes no excuse for refraining from quoting figures. Both locomotives are prototypes, with all that that statement implies in relation to cost. The intention was to conduct an experiment on the principle of gas turbines for railway traction. Given that the experiment might show real promise, capital costs of further units developed from that experiment would be markedly influenced by the lessons learned from the prototypes.

There remains the important matter of operating costs—particularly, and mainly, of fuel. This is ground upon which the author treads with trepidation. Certainly it can be said that the initial concepts of the designs are now six or more years old, and in the gas-turbine world six years is a long time, in which efficiencies of compressors and turbines have made advances. Moreover, it is for debate whether to-day a machine would incorporate the two-shaft principle, or whether two complete gas-turbine units each of half the total required output should be provided, to overcome the drooping characteristic of the efficiency-load curve. These are questions best answered by those engaged on gas-turbine development in general. There is also the development of gas generators working on the Diesel principle to consider, bearing in mind the much reduced size of the turbine and much less onerous conditions under which it would operate when working in conjunction with such generators. The possibilities of these and, no doubt, other approaches to the problem, on the vital question, so far as this country is concerned, of coal-burning gas-turbine locomotives, are of great significance. The knowledge that projects working along such lines have emerged, or are emerging, gives additional value to the experiment which is now proceeding on British Railways.

ELECTRONIC TORQUE CONTROL OF DRILLS.

(*For Description, see Opposite Page.*)



ELECTRONIC PREVENTION OF DRILL BREAKAGE.

EXCESSIVE drill breakage on a deep hole drilling operation in aluminium at the Pratt and Whitney engine plant of the Ford Motor Company has led to the development of an electronic control which automatically reverses the drill when the torque exceeds a given amount. The device can be set to operate on as little as 1 per cent. increase in torque load on the drill spindle, though the usual operating range is about 10 per cent., to offset variations in line voltage due to the intermittent operation of other plant having a heavy current consumption.

In the Ford application, $\frac{5}{32}$ in. holes, 4 in. deep, are being drilled in the forged aluminium half-crankcase of the 2,000-h.p. Pratt and Whitney radial aircraft engine. Because of the angularity of the holes and the interferences involved, drills about 10 in. long have to be employed. The end thrust in drilling is normally light and if excessive end thrust occurred the drill would whip and break before any pressure-sensitive device could function. Breakage has usually occurred from an increase in torque as a result of the flutes becoming loaded with chips. Step drilling cannot be successfully used in this particular application because it is impossible to predict how frequently the flutes will become choked in a drill of such small diameter. Much depends upon the condition of the drill point.

The Farmer-Kirkham torque control unit, which is illustrated herewith, has been developed by the H. E. Farmer Engineering Company, of Detroit, Michigan, and operates by the amplification of the torque load variations of the electric motor driving the drill. Its application is through electrical relays, limit switches and hydraulic units controlled by solenoid-operated valves. Standard pumps and control panels are employed in the hydraulic circuit. In the unit shown, each head is automatically controlled through a separate torque-control unit. For each drill head, the normal cycle is as follows. The head is advanced rapidly to just short of the drilling position, at which point it is slowed down to the feed rate by a limit switch. Drilling continues at the feed rate until an excessive torque force is applied to the drill, due to either undue pressure or the accumulation of chips in the flutes. The torque device then operates a relay which, in turn, energises a solenoid-operated hydraulic valve, causing the head to be retracted to its starting position at the rapid traverse rate. At this point, a limit switch is tripped and the head is quickly returned to a point just short of where it ceased drilling, and is slowed to the feed rate. This cycle repeats until the hole is completed

When the head reaches its final position, it makes contact with another limit switch and is returned to its starting position, automatically resetting the feed-starting limit switch on its way back. This switch is mounted on a friction slide and, during drilling, is constantly being pushed forward in step with the advance of the drill. A setscrew adjustment permits the limit switch to be tripped to the feed rate about $\frac{1}{32}$ in. ahead of the point at which the drill-head slide picks up the friction slide on which the limit switch is mounted.

The torque-control unit forms, in essence, an unbalanced Wheatstone-bridge circuit in which the galvanometer is replaced by the grid circuit of a vacuum tube. By placing several tubes in series, variations in grid potential can be made to actuate a relay and, in turn, solenoid valves in the hydraulic system. Two sides of the bridge have fixed resistances, the third has an adjustable rheostat which governs the torque range, and the fourth leg is connected across the leads of the driving motor. For the $\frac{5}{32}$ in. drills mentioned, $\frac{1}{4}$ h.p. motors are used. In effect, the device measures variations in voltage across the motor terminals. As the torque is built up, the rotor tends to slow down, the current increases, the effective resistance and reactance of the motor drop, and the voltage drops. By adjustment of the compensating rheostat, it is possible to actuate the relay with an increase of only 1 in.-oz. torque on the drill spindle. A time-delay relay prevents the torque control from coming into operation until after the feed hydraulic circuit is actuated, thus eliminating the effect of both high starting current and low no-loa d motor characteristics.

In the machine installed at the works of the Ford Motor Company, there are six separate drill heads, arranged to drill 18 radial oil-holes by two indexings after the first set of holes has been drilled. The aluminium forging is clamped on the index table, which is in its lowered position. Pressing the starting button elevates the table, starts the drill motors, and advances auxiliary slides, carrying the drill bushings, up to the work. The drilling cycle is then initiated as indicated above. When the last head has been retracted, the table is indexed automatically through 120 deg. to present the next set of holes.

Each unit has its own hydraulic pump and control panel and each drill is separately motor-driven. One of the pumps is also connected to the elevating and indexing circuit of the work-fixture table. In action, each head follows its own course. Sharp drills may cut three-quarters of the depth before the first pullout, while dull drills begin to pull out almost from the start. This action provides a warning that the drill needs to be replaced with a sharpened one.

Before this unit was installed, these oil holes were being drilled individually in single-spindle sensitive drill presses. Even with manual operation, a number of drills were broken daily. This breakage has been greatly reduced on the automatic machines, and the time of drilling has been reduced from 15 minutes to 4 minutes.

The same principle of torque control is being applied by the H. E. Farmer Engineering Company in the design of a tapping unit which is driven through a reversible motor. When undue stress is applied to the tap, the unit will stop and reverse the motor, backing out the tap to clear the flutes. Tapping and withdrawal continues as controlled by the motor torque until the required depth is reached. It is believed that this type of torque control may be applied to all machine-tool applications as a measure of tool dulling. While the device need not cause retraction of cutting tools where the danger of breakage is negligible, it could be set to operate a signal light to inform the operator that tools must be replaced. The control is being marketed in this country by Gaston E. Marbaix, Limited, Devonshire House, Vicarage-crescent, London, S.W.11.

FORTHCOMING EXHIBITIONS AND CONFERENCES.

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

NORTH OF SCOTLAND HYDRO-ELECTRIC EXHIBITION.—March, at Perth. Arranged by the North of Scotland Hydro-Electric Board, 16, Rothesay-terrace, Edinburgh, 3. (Telephone : Central 1361.)

HANOVER FAIR.—*Light Industries Fair :* Sunday, March 1, to Thursday, March 5, at Hanover. *Heavy Industries Fair :* Sunday, April 26, to Tuesday, May 5, at Hanover, Germany. *Agents :* Schenkers, Ltd., 27, Chancery-lane, London, W.C.2. (Telephone : HOLborn 5595.)

" DAILY MAIL " IDEAL HOME EXHIBITION.—Tuesday, March 3, to Saturday, March 28, at Olympia, London, W.14. Organised by Associated Newspapers, Ltd., New Carmelite House, Carmelite-street, London, E.C.4. (Telephone : CENtral 6000.)

33RD INTERNATIONAL SPRING FAIR.—Sunday, March 15, to Sunday, March 22, at Vienna. Apply to the British-Austrian Chamber of Commerce, 29, Dorset-square, London, N.W.1. (Telephone : PADdington 7646.)

CONFERENCE ON DEEP DRAWING OF METALS AND CONTINUOUS CASTING OF INGOTS.—Monday and Tuesday, March 16 and 17, at the University of Birmingham. Apply to the secretary, Department of Industrial Metallurgy, The University, Edgbaston, Birmingham, 15.

SYMPOSIUM ON ELECTRICAL INSULATING MATERIALS.—Monday, March 16, to Wednesday, March 18, at the Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. Organised by the Measurements Section of the Institution. Applications to be made to the secretary of the Institution at the above address. (Telephone : TEMple Bar 7676.) See also page 243, *ante*.

COURSE ON ELECTRONICS AT HARWELL.—Monday, March 16, to Friday, March 20, at the Isotope School, Harwell. Applications to be made to the Electronics Division, Atomic Energy Research Establishment, Harwell, near Didcot, Berkshire. (Telephone : Abingdon 620.) See also page 237, *ante*.

ENGINEERING CONFERENCE IN AUSTRALIA.—Monday, March 16, to Saturday, March 21, at Melbourne, Victoria. Conference on " Power and Water," organised by the Institution of Engineers, Australia. Further information may be obtained from the honorary conference organiser, the Institution of Engineers, Australia, 55, Collins-place, Melbourne, C.1.

ROYAL NETHERLANDS INDUSTRIES SPRING FAIR.—Tuesday, March 17, to Thursday, March 26, at Utrecht, Holland. *Agent :* Mr. W. Friedhoff, 10, Gloucester-place, London, W.1. (Telephone : WELbeck 9971.)

FRANKFURT INTERNATIONAL MOTOR SHOW.—Thursday, March 19, to Sunday, March 29, at Frankfurt-am-Main. Organised by the Versand der Deutschen Automobilindustrie, Westendstrasse, Frankfurt-am-Main.

FACTORY EQUIPMENT EXHIBITION.—Monday, March 23, to Friday, March 27, at the New Horticultural Hall, Greycoat and Elverton Streets, Westminster, London, S.W.1. Further particulars obtainable from Mr. J. E. Holdsworth, Exhibition Offices, 117, Kingsway, London, W.C.2. (Telephone : HOLborn 1414.)

CONFERENCE ON STATIC ELECTRIFICATION.—Wednesday, Thursday and Friday, March 25, 26 and 27, at Bedford College for Women, Regent's Park, London, N.W.1. Organised by the Institute of Physics. Applications should be addressed to the conference secretary, Mr. N. Clarke, Institute of Physics, 47, Belgrave-square, London, S.W.1. (Telephone : SLOane 9806.) See also our issue of December 12, 1952, page 751.

SECOND NATIONAL ELECTRICAL ENGINEERS' EXHIBITION.—Wednesday, March 25, to Saturday, March 28, at Earl's Court, London, S.W.5. Organised by the Association of Supervising Electrical Engineers. Apply to Mr. P. A. Thorogood, 35, Gibbs-green, Edgware, Middlesex. (Telephone : MILl Hill 3528.)

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

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

FIFTH EMPIRE MINING AND METALLURGICAL CONGRESS.—To be opened on Tuesday, April 21, at Melbourne. Closing date in May not yet fixed. Sessions will be held at centres in Australia and New Zealand. Apply to Miss B. E. Jacka, Australian Institute of Mining and Metallurgy, 399, Little Collins-street, Melbourne, C.I.

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

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

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

GLASS INDUSTRIES EXHIBITION.—Monday, May 11, to Saturday, May 16, in the New Horticultural Hall, Greycoat-street, London, S.W.1. Apply to Mr. G. F. E. Grimaldi, B. and C. D. Exhibitions, Ltd., 194-200, Bishopsgate, London, E.C.2. (Telephone : AVEnue 1444.)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

INTERNATIONAL TEXTILE MACHINERY AND ACCESSORIES EXHIBITION.—Wednesday, October 14, to Saturday, October 24, at Belle Vue, Manchester. Organised by the Textile Recorder Machinery and Accessories Exhibitions, Ltd., Old Colony House, South King-street, Manchester, 2. (Telephone: Blackfriars 7234-6.)

INTERNATIONAL MOTOR SHOW.—Wednesday, October 21, to Saturday, October 31, at Earl's Court, London, S.W.5. Organised by the Society of Motor Manufacturers and Traders, Ltd., 148, Piccadilly, London, W.1. (Telephone: GROsvenor 4040.)

SCOTTISH MOTOR SHOW.—Friday, November 13, to Saturday, November 21, at Kelvin Hall, Glasgow. Apply to the Scottish Motor Trades Association, Ltd., 3, Palmerston-place, Edinburgh, 12. (Telephone: Central 3643.)

LABOUR NOTES.

ENGINEERS, architects, valuers, surveyors and employees from a number of other professions, in the service of Government Departments, were the subject of a wage claim presented by the Institution of Professional Civil Servants to the Treasury on Monday last. The Institution asked for an overall increase of 7 per cent., and based its claim on the rise which has taken place in the index of wage rates of the Ministry of Labour and National Service, since the last salary increase was granted to these civil servants in January, 1952. The demand was only the first of a series of claims which were laid before the Government during the remainder of the week by Civil Service organisations.

On Tuesday, Treasury officials met representatives of the Association of First Division Civil Servants and received particulars of the Association's case for an advance in the remuneration of its members. The Association, which caters for the highest-paid grades in the Service, has a membership of about three thousand. The Civil Service Clerical Association, representing most of the clerical and typing grades, and possessing a correspondingly large membership, presented its claim on Wednesday. Yesterday, it was the turn of the Society of Civil Servants to bring its demands before the Treasury and this union was understood to be in favour of a general revision in the basic rates of its members.

The claims of all these organisations were similar in substance to that of the Institution of Professional Civil Servants. They arose as the result of the ruling by the official side of the Civil Service National Whitley Council that the Treasury was unable to accede to a general wage settlement for the Civil Service, as a whole, based on advances in the Ministry of Labour's index of wage rates. It was mainly due to rises in the level of that index that the Civil Service wage increases in January last year were granted. No decisions were reached at the meetings held during the past week, and it is expected that further meetings will take place in the near future, at which the Government's attitude to the individual claims will be made known.

Undermanagers in the coal-mining industry have been granted substantial increases in their salaries by an award of the industry's National Reference Tribunal, according to an announcement on February 23. The undermanagers' salaries will now range from 900*l*. to 1,200*l*. a year, instead of from 700*l*. to 1,100*l*. a year, and the increases will be payable from July 1, 1952. Rather more than one thousand men are expected to benefit from this award.

Efficiency, and not increased production as such, must be the aim of the forthcoming high-level discussions in the Lancashire coalfield, if they are to receive the support of the rank and file. The Lancashire area executive committee of the National Union of Mineworkers decided at a meeting in Bolton on Monday that the visit of national leaders of the union and representatives of the National Coal Board to Lancashire, which is expected to take place on March 14 and 15, must not be regarded in any sense as a call to drive the men. Conferences to be held on these days, probably at Bolton, are among the first of a series of meetings arranged to be held throughout the coalfields by the industry's joint production campaign committee, in accordance with the terms of the recent wage agreement.

At the close of last Monday's committee meeting, Mr. Edwin Hall, the general secretary of the union's Lancashire area, emphasised that the coming conferences were part of an efficiency campaign and that managements as well as workpeople would be called upon for their help. He said that the committee was adamant in its view that, if the ordinary miners had to accept a full share of responsibility to the industry, which they did willingly, they had the right to be consulted and to receive full co-operation from the managerial side. Unless that were forthcoming, there would be no taking part in any campaign. The conference on the second day would be attended by members of pit consultative committees in Lancashire, chargemen at the coalface and local representatives at every level of the industry.

Pleas for more encouragement for working parties at problem pits were put forward by Mr. Alwyn Machen, the President of the Yorkshire area of the N.U.M., at a local meeting at Barnsley on Monday. He claimed that these working parties, comprising representatives of the union, the National Coal Board, pit deputies, and colliery managements, had been functioning in Yorkshire for some time past and that their efforts had produced satisfactory results. Working parties had dealt with many difficult problems at Silverwood Colliery. All concerned had congratulated the local branch officials on the good work they had done in getting rid of bad practices. Unfortunately, however, progress had been endangered by the attitude of the North-Eastern Divisional Coal Board. They had prevented the working parties from dealing with problems connected with the training and the supply of labour.

Proposals for an industrial code, embodying the Government's main policy for the maintenance of good industrial relations, were discussed at a meeting of the trade-union side of the National Joint Advisory Council of the Ministry of Labour on Tuesday. The code is intended to set up standards respecting security of employment and the provision of incentives to the individual to do his work well and obtain a better job, to which it is hoped all employers will conform, however large or small the firm may be. The code was, on the whole, rather calmly received by the trade-union leaders at that meeting. They appear to have considered that the code contained little that was not already in operation or which could not be enforced fairly easily where the workpeople were organised. There was also comment on the absence of anything designed to discourage the formation of "house unions."

A meeting of the Trades Union Congress General Council took place on Wednesday, when the trade-union attitude to the industrial code and proposals to the Chancellor of the Exchequer respecting the forthcoming Budget were considered. On the question of the code, the General Council appears to have largely endorsed the views of the trade-union side of the National Joint Advisory Council. Later in the day, there was a meeting of the whole Joint Council at which the Minister of Labour, Sir Walter Monckton, presided. In addition to the trade-union representatives, the Joint Council, which was set up to advise the Government on labour questions generally, comprises representatives of the British Employers' Confederation and the Boards of the nationalised industries.

A mass meeting in Birmingham last Monday, stated to have been attended by most of the two thousand vehicle builders on strike at the Longbridge works of the Austin Motor Company, Limited, decided to continue the dispute until the firm "reinstates" the shop steward concerned. He was dismissed, with 700 other workpeople, in September, 1952, owing to redundancy. Reports were received of the steps being taken to obtain financial aid from other members of the National Union of Vehicle Builders in the area. More than three-quarters of the 18,000 persons employed at the factory have been rendered idle by the strike of the vehicle builders.

The Midlands district committee of the Confederation of Shipbuilding and Engineering Unions and representatives from the Longbridge works met in London yesterday to consider the position, especially in regard to the formation of a common policy for all unions having members employed at the works. Members of the United Society of Boilermakers, who have been rendered idle by the stoppage, held a separate meeting in Birmingham last Monday, and decided to give moral support to the strikers in their stand on a "fundamental trade-union principle." Dissatisfaction has been recorded, however, among other sections of the operatives who have been forced into idleness. They contend that their own unions would not have involved them.

FAN-COOLED ALTERNATOR FOR EAST AFRICA.

GENERAL ELECTRIC COMPANY, LIMITED, LONDON.

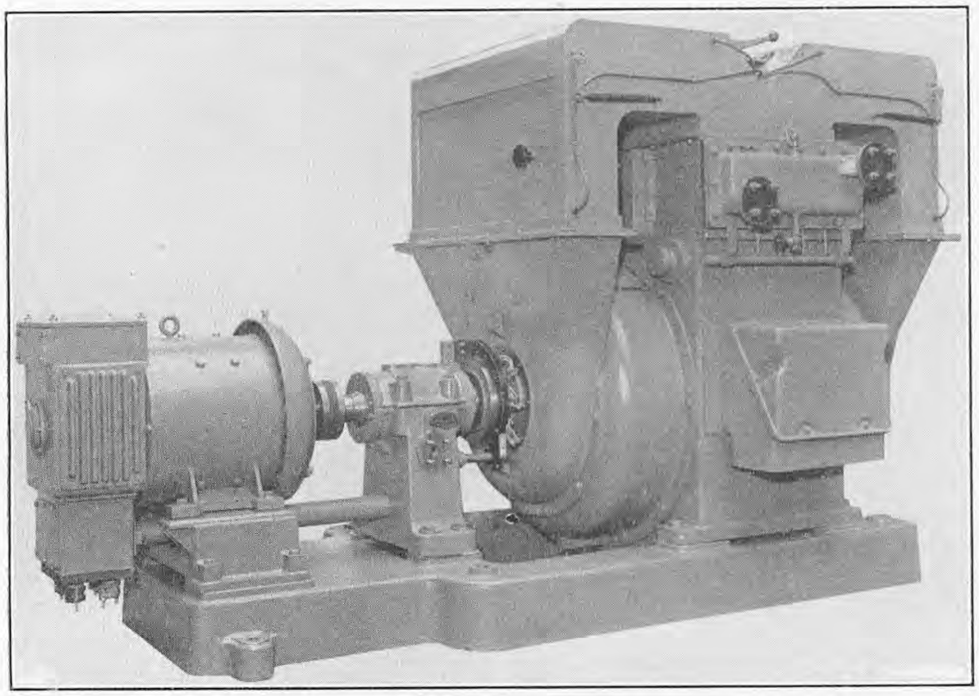


FIG. 1. 750-KW ALTERNATOR AND EXCITER.

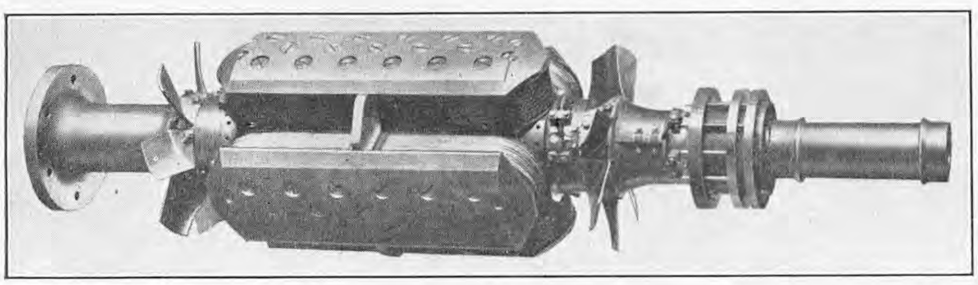
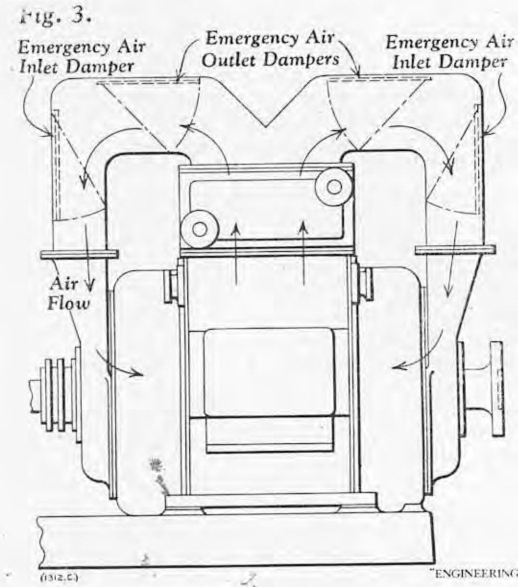


FIG. 2. SALIENT-POLE ROTOR SHOWING AIR-CIRCULATING FANS.

Fig. 3.



ALTERNATOR FOR OPERATING IN HIGH AMBIENT TEMPERATURES.

A TURBO-ALTERNATOR incorporating special cooling arrangements to ensure reliability under exceptionally difficult site conditions has recently been constructed by the General Electric Company, Limited, Magnet House, Kingsway, London, W.C.2, for Sena Sugar Estates, Limited, Chinde, Portuguese East Africa. The alternator has a continuous maximum rating of 750 kW at 1,800 r.p.m. when operating as a closed air-circuit machine in conjunction with a cooler; and 650 kW at the same speed when running without fan cooling and open to atmosphere. It will provide a 440-volt three-phase 60-cycle supply for a sugar factory at Luabo.

Three major difficulties were encountered in the design of the cooling system for this machine. The first of these was the high ambient temperature at Luabo, which averages 90 deg. F. for the first few months of the sugar crop, rising to 100 deg. F. during the latter part of September, with peaks of 120 deg. F. at midday. A further complication was the presence inside the factory of considerable quantities of dust from the crushed sugar cane, or bagasse, which is used as fuel for the main boilers. Finally, the risk of flooding precluded the adoption of a conventional design with the coolers in the foundations of the alternator.

As can be seen in Fig. 1, the machine embodies closed-circuit ventilation with an air cooler mounted above the alternator. With the exception of the cooling system the design follows the company's standard practice for machines of this size. The rotor, which is illustrated in Fig. 2, is of the salient-pole type, with two integral ventilating fans, and is coupled through reduction gearing to the turbine shaft. The rotor shaft, poles and half-coupling are machined from a single steel forging, and the pole shoes and retaining screws are of high-tensile steel. The field coils are manufactured from copper strip wound on edge and are insulated with treated asbestos. The stator windings are star-connected, the neutral connection being made by means of an external link. The alternator is fitted with a single pedestal bearing which is force-lubricated from the oil supply to the turbine bearings. The cooling system adopted for the alternator is shown in elevation in Fig. 3. As will be seen, the fans circulate air over the surface of the rotor, and through the stator core and windings to the cooler mounted on the top of the stator frame. The cool air is then returned to the fans through ducts at each end of the machine and is re-circulated. Water is supplied to the cooler at a temperature not exceeding 86 deg. F., the rate of flow being approximately 40 gallons per minute.

During the sugar season the generating plant must be capable of being run continuously, and provision has, therefore, been made to enable the alternator to function as an open air-circuit machine in the event of a failure in the water supply to the cooler. Operation of an emergency trip lever mounted above the cooler releases spring-loaded dampers in the entry and exit air ducts, and thus opens the cooling circuit to atmosphere. Air is then drawn into the machine through the emergency air inlets in the sides of the ducts, and is expelled through the corresponding outlets above the cooler. When it is possible to return to normal running conditions with closed-circuit cooling, the four dampers are closed by hand.

The exciter, which is directly coupled to the alternator, is a totally-enclosed machine which has a special cooling diaphragm in the end-shield bearing bracket. An internal fan circulates the warm air through internal ducts in the diaphragm, and an external fan directs cool air through external ducts and over the surface of the diaphragm and the frame of the machine, thus providing an extremely efficient cooling system.

STATE AWARDS TO INVENTORS.

THE third report of the Royal Commission on Awards to Inventors, published recently,* deals particularly with claims in connection with radar, the Pluto pipe-line across the English Channel, and degaussing, and also gives some information on the principles adopted by the Commission in deciding on the merits of claims. Thus, for example, the Commission have had to consider a number of cases in which claims have been presented by firms with whom Government orders have been placed, such claims being based on the ground that the equipment supplied or the process of manufacture employed was patented, and the terms of the contract were such as to entitle the firm to ask for some further payment for the use of the patent, additional to the price paid for the articles under contract. The Commission have held that such claims can only succeed where there is clear evidence that it was in the contemplation of the parties at the time of making the contract that some further compensation might be claimed by the contractor in view of the fact that the goods supplied were patented or were the product of a patented process.

The Commission also had to consider cases in which claims had been made for an *ex gratia* award in respect of inventions made by employees of such contracting firms. In those cases in which an invention was made by the employee of the contracting firm in fulfilment of his duty to his employees, and used in carrying out the contract, the Commission have adhered to the principle enunciated by the 1919 Royal Commission that the employee must look to the firm whom he serves, and not to the Crown, for any reward for such services. There were cases, however, where the invention in respect of which the employee claimed was made in circumstances which justified its being fairly regarded as outside the scope of the duty he owed to the contracting firm whose employee he was. Thus, in the case of two claimants, Mr. A. C. Hartley and Mr. Ellis, who had been lent by the contracting firms whose employees they were to work as temporary members of a Government Department on problems connected with the Pluto pipe-line, the Commission held that the special circumstances of their employment entitled them to an award by the Crown.

* *Royal Commission on Awards to Inventors: Third Report.* H.M. Stationery Office, London. [Price 6*d*. net.]

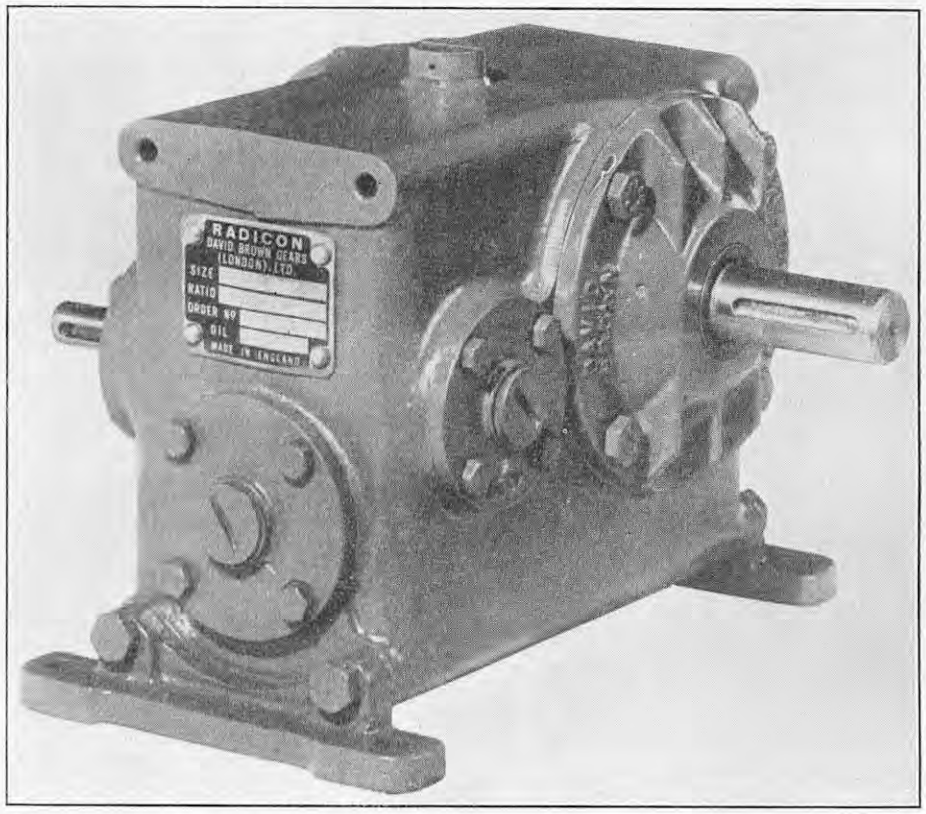
The report covers the period November 9, 1949, to November 8, 1952, during which the Commission disposed of 212 claims; 56 claims were examined by the Investigating Committee, with the result that 13 cases were referred to the Commission for decision, the remainder being found to be devoid of any reasonable ground for reference. Of the 13 claims referred to the Commission, four were recommended for an award. In one class of claims the compensation awarded by the Commission normally takes into account the extent of Crown use up to the date of the hearing. In some cases, however, the Commission have agreed at the request of the claimant and the Crown to award a comprehensive sum to cover future as well as past use of the invention. This course was adopted in the case of a claim presented by Mr. P. M. Otway, a member of the Ministry of Transport, in respect of joints for use in concrete structures, such as concrete roads. Where the Commission had before them two or more claims relating to the same subject it has been their practice to allow each claimant to see, before the hearing, the statement of claim of the other claimant or claimants, and at the hearing to put relevant questions to the claimant through the Commission. During the period under review, the Commission dealt with three important instances in which this procedure was adopted, namely, those concerned with radar, Pluto and degaussing.

Describing in some detail the claims in connection with the invention of radar, the report states that many of the claims by inventors in this field were dealt with and settled departmentally, and awards amounting in all to some 200,000*l.* were made in respect of these claims without reference to the Commission. However, 25 claims in respect of radar inventions were referred to the Commission who, having heard the evidence of each of the claimants, decided to make individual recommendations in all cases. The total amount recommended to be paid was 94,600*l.*, of which 50,000*l.* was awarded to Sir Robert Watson-Watt. The radar inventions dealt with by the Commission were mostly produced by a team of scientific workers under Watson-Watt. In January, 1935, Mr. H. E. Wimperis, Director of Scientific Research at the Air Ministry, invited Watson-Watt to come and see him. Watson-Watt was at that time Superintendent of the Radio Research Department at Slough, and was carrying out investigations with Sir Edward Appleton for the purpose of ascertaining, by means of the reflection of radio waves, the characteristics of the ionosphere. He had also been experimenting to locate the centre of thunderstorms. Wimperis desired to have Watson-Watt's opinion on the practicability of attacking and damaging enemy aircraft by means of radio waves, sometimes referred to as the "death ray." Watson-Watt's reply was that it was not practical but that the approach of an enemy plane might be detected and its position and speed ascertained by a radio echo from the plane. During the week following this interview, Watson-Watt produced a memorandum based upon mathematical calculations worked out with the help of his colleague, Mr. A. F. Wilkins, which suggested, in broad outline, proposals for the use of radar for defensive and offensive purposes.

The report lists the decisions and awards recommended by the Commission during the period. They include, among others, 17,500*l.* (in addition to 63,224*l.* 15*s.* already received) to Mr. M. R. Gundlach and others in respect of periscopes for use in armoured vehicles; 3,000*l.* to Mr. C. S. Bell, in respect of a winged target; 27,500*l.* to Messrs. William Denny and Brothers, Limited, and Brown Brothers and Company, Limited, in respect of ships' stabilisers; 7,000*l.* (in addition to an interim award of 25,000*l.* already made) to Lt.-Col. L. V. S. Blacker in respect of projectiles for the spigot mortar ("Blacker Bombard"), "Hedgehog," "Piat," "Petard," etc.; 3,000*l.* to Professor J. F. Baker in respect of the Morrison shelter; 6,000*l.* to Wing-Commander H. de V. Leigh in respect of the "Leigh light"; 10,000*l.* to Mr. B. N. Wallis in respect of a mine; 5,000*l.* to Mr. R. A. W. A. Lochner in respect of the degaussing of ships; 7,500*l.* to Sir Charles Goodeve in respect of the degaussing of ships; and a number of other awards on the same and other subjects.

DOUBLE-REDUCTION WORM GEAR.

DAVID BROWN GEARS (LONDON), LIMITED, LONDON.



DOUBLE-REDUCTION WORM GEAR.

THE double-reduction speed-reducing gear illustrated herewith is the most recent addition to the standard range of "Radicon" worm reducers made by David Brown Gears (London), Limited, Stonebridge Park Works, North Circular-road, London, N.W.10, and is described as the "$1\frac{5}{8}$" size. It is designed to transmit very small horsepowers at low speeds and has been developed from the $1\frac{1}{8}$-in. and $1\frac{5}{8}$-in. single-reduction gears made by the same firm, in which these dimensions are the distances between centres of the input and output shafts. Many of the component parts are interchangeable with those of the single-reduction gears. Reductions ranging from about 5 : 1 to 60 : 1 are obtainable with each worm gear, so that the overall reductions may range from 65 : 1 to 3,600 : 1 with the standard components. Special units can be supplied with non-standard ratios up to 10,000 : 1. The input speeds can be from 500 to 3,000 revolutions per minute. In the standard units, all the gears are designed for a right-handed rotation of both the input and output shafts, though reducers are available, if required, with gears of the opposite hand.

The casing is of cast iron and has ample cooling surface for the powers and speeds listed. It is oil-tight and dustproof, oil seals being fitted to both shafts. The circular covers which carry the worm-shaft bearings are interchangeable for each gear, so that each worm can be turned end for end, thus giving four arrangements of the driving and driven shafts. As can be seen, the larger covers are ribbed to increase the cooling surface. The worms are of steel, carried in combined thrust and journal bearings. The threads are integral with the shafts, and are case-hardened and afterwards precision-ground. The worm-wheels, of the makers' Taurus bronze, are pressed and keyed on to the intermediate and low-speed shafts, and have accurately generated teeth. Splash lubrication is employed except when the unit is so mounted that one of the shafts (or both) projects downward, in which case grease lubrication is recommended. At normal ratings, the designed torque can be maintained for 26,000 hours, if there is no sustained overloading. When properly lubricated according to the makers' recommendations, and running with a maximum temperature rise of 100 deg. F., the units will carry a momentary overload of 100 per cent. at starting. The cast-iron feet are detachable and are secured by tap bolts to the casing. The facings for their attachment are accurately machined, with jig-drilled holes, to ensure correct mounting; and duplicate facings are provided at the top of the casing, as shown, so that the units can be mounted in alternative positions. Screwed plugs are provided for the oil-filling hole and to act as ventilators, and other plugs are fitted for use as oil-level indicators and for draining.

The overall dimensions of the standard unit, as illustrated, are $7\frac{7}{8}$ in. long by $4\frac{1}{2}$ in. wide over the feet; $7\frac{5}{8}$ in. overall width from shaft end to shaft end, with the shafts projecting on opposite sides of the casing; and $6\frac{1}{16}$ in. high to the top of the filling plug. The weight is 18 lb. in the standard form. If desired, the units can be supplied with shaft-end covers having an integral facing for the attachment of a directly-connected driving motor. Adjustment of the worm and worm-wheel relatively to each other is by means of shims, inserted when the unit is assembled. No subsequent adjustment is normally required in service unless it is desired to reverse the handing of the shaft extensions.

PEASE ANTHONY GAS SCRUBBERS.—The Power-Gas Corporation, Ltd., Stockton-on-Tees, who are the licensees for the Pease Anthony gas scrubbers, inform us that they now have a pilot-plant unit available for experimental purposes. The unit, which is mobile, can handle 500 cub. ft. of gas per minute and is capable of dealing with micron and sub-micron dusts and fumes.

EXTENSION TO COWAL HYDRO-ELECTRIC SCHEME.—A scheme to extend the existing Cowal hydro-electric project has been confirmed by the Secretary of State for Scotland. It was prepared by the North of Scotland Hydro-Electric Board to meet the increasing demand for electricity in the Cowal district of Argyll, and will increase the annual output of the Cowal generating station from 14,000,000 to 18,600,000 kWh. The estimated cost is 350,000*l.* The headwaters of a number of small streams flowing into Loch Riddon will be diverted through a pressure pipe to the existing generating station at the head of Loch Striven. The pipe will be buried where it crosses the flat land at the head of the loch. A white paper on the scheme is available from H.M. Stationery Office, price 2*d.*

POST-WAR PROBLEMS IN ENGINEERING EDUCATION.*

By PROFESSOR L. J. KASTNER, M.A., M.I.Mech.E.

MORE than 11 years have passed since Professor Sir Charles Inglis delivered his presidential address to the Institution of Civil Engineers. The subject of his address was the education of engineers, and since what he said has been widely quoted and often discussed, it may well be asked whether any useful purpose is to be served by surveying the same ground again. To such an objection, if it were raised, I would reply that, in these post-war years, there have been great and continuing changes both in our industrial position and in our outlook on the profession of the engineer; and, in spite of the fact that much has been said and written on the training of engineers since the war ended, the subject remains one of perennial interest.

In the main, what I have to say will deal with the university education of engineers. Like any good salesman making it his business to see that the public are fully informed as to the excellence of his wares, I shall not be modest about the advantages of the kind of education given to budding engineers in our universities.

To begin with, I think it will be useful to outline what I conceive to be the aims and objects of a university education for a young engineer, though I would emphasise that, as in many other fields of human endeavour, the target at which we aim is sometimes missed. Unfortunately, it is a fact that a few of the entries to any engineering school prove incapable of staying the course, and there may even be one or two who succeed in obtaining a degree but later on show themselves to be quite unsuited for the profession they have chosen. On the whole, however, it seems as though professional engineers are not dissatisfied with those examples of the rising generation which reach them via the universities, and though some criticisms and suggestions are made from time to time, the friendly spirit in which these are made encourages me to think that there is a growing interest in the problems involved.

The conception of a university education, in whatever subject, has always had as its basis the belief that formal instruction is less important than the development of the capacity to think, and that intensive specialised training in the techniques of some particular branch of knowledge is fairly certain to stunt intellectual development unless it has been preceded by a thorough grounding in fundamentals. That this is true has been affirmed by many distinguished men, and it is a principle that seems to be entrenched in an impregnable position; but a university education consists in more than the observance of this—it consists also in an understanding that the universities, in the words of Sir Alfred Ewing, " will continue, as ever, to be sanctuaries of the spirit of man, where he may learn to live not by bread alone."

Where the engineering student is concerned, I interpret these noble words to mean that the young man who comes to the university has a golden opportunity of rubbing shoulders with others whose interests are far removed from his own, and of learning to respect points of view which are often fantastically different from any he had imagined possible. Let it not be supposed, however, that this part of a university education can be organised into a regular curriculum, or that Socratic discussions on abstruse problems are necessarily essential in developing the character of an engineer; each individual must judge for himself how best to use the spare time which remains to him at the university after the demands of class work have been met.

Turning now to that part of a young man's education which he gains in the classrooms and laboratories of the engineering department of a university, it is necessary to say something about the degree of technological training, and of specialisation, which may properly be undertaken. In Sir Charles Inglis' address, he had some trenchant things to say about the dangers of too-early specialisation, and he advocated a system (of which I had first-hand experience in my student days) in which the courses provided were to be the same for all engineering students until their last year, when a small degree of specialisation was permitted, depending on the special interests, or perhaps aptitudes, of the student concerned. On the whole, however, though the opposition to premature or exclusive specialisation remains as strong as ever, the general consensus of opinion among professors of engineering in Great Britain (to judge from the organisation of their courses) seems to favour a somewhat greater degree of specialist study than has been the case in the past; and the setting up of separate and distinct departments of civil, mechanical and electrical engineering, each headed by an autonomous professor, in most of the larger universities, is probably significant.

At this point, I would like to say that I am suspicious of the assertion, sometimes made, that no matter of a technological nature should be permitted within the holy ground of an undergraduate course in engineering. Even if the principle behind this assertion were admitted to be valid, which I doubt, I consider that it is virtually impossible to organise engineering studies without some measure of technology being admitted to " leaven the lump " and to make the work real to the student. I would go farther than this and would say that, as far as civil and mechanical engineering are concerned, courses in engineering design embodying a good deal of drawing-office work should be a part of every degree scheme, and I would suggest that every civil or mechanical engineering student should at least be familiar with the appearance of British Standard Specifications before he is allowed to graduate.

There was a time when engineering students at many British universities were required to undergo an organised course of workshop training, and to attain a certain level of proficiency in the use of tools before they were permitted to take their final examinations. In many ways, this was an admirable idea, especially for young mechanical engineers, since skill with hand and machine tools, once acquired, never entirely leaves one, and it helps in a considerable degree to avoid that conflict between the drawing office and the workshop which so often smoulders beneath the surface and sometimes breaks out in internecine war. It is now considered, however, in the overwhelming majority of universities, that a course of practical workshop training is best obtained in industry, either before entering or after leaving the university, both on the grounds that a three-year or four-year university degree scheme in engineering is so crowded with other material that the time for an adequate workshop training cannot be afforded, and also (and this is of great importance) that contacts with workpeople and " the feeling of the factory " can only be obtained in industry itself.

In the factory, valuable lessons can be learned about the true meaning of commerce and industry. Young people are commonly idealistic, and an early implanting of the sordid, but fundamental, idea that a business exists to make money, will avoid misconceptions and mistakes later on. At the present time, there seems to exist a vocal but misguided school of thought which looks upon a successful business almost as if it were something disgraceful, and all profits as if they were immoral, but the young engineer should not allow his balance to be disturbed by ideas of this kind. Ruskin mentions that, on a wall of the church of S. Giacomo de Rialto, in Venice, there appears the inscription: " Around this temple let the merchant's law be just, his weights true and his covenants faithful." Provided that business is carried on in conformity with these ideas, there is certainly no shame in being connected with it.

I have no doubt at all that a short period (perhaps a year) spent in industry before entry to the university can be highly beneficial. It is not uncommon to find young men of 18 or 19 possessing good qualifications in mathematics and fundamental science, but who only have the vaguest ideas as to the nature of a rivet or the purpose of a crank; and repeated experience has not yet succeeded in suppressing the incredulous amazement with which I listen to some candidate for admission to the university who unblushingly admits that he has never visited any engineering works or read any popular books on any branch of engineering. But even this amazement pales before my feelings when, a short time ago, I was told by a budding engineer, who was obviously grossly ignorant of all the opportunities which are offered by the great profession he proposed to join, that he wished to become a civil engineer because his father considered that civil engineering was the only branch of engineering open to a gentleman.

THE RECRUITMENT OF APPLIED SCIENTISTS.

Post-war developments in engineering education may be said to have received a special impetus from the 1945 report of the Special Committee on Higher Technological Education, which contained the warning that the position of Great Britain as a leading industrial nation was being endangered by a failure to secure the fullest possible application of science to industry, and declared that this failure was partly due to deficiencies in education. It stated, further, that the annual intake into the industries of this country of men trained by universities and technical colleges was insufficient both in quality and quantity, and it made suggestions, in general terms, as to how these faults should be remedied. The question of scientific man-power was also referred to in the 1948 report of the Advisory Council on Scientific Policy, who expressed themselves as being satisfied that the output of newly qualified " pure " scientists was likely to meet the anticipated demand, but felt that the position was less reassuring where " applied " scientists were concerned. In this connection, the figures of Tables I, II and III, below, are of interest; they are taken from reports by the

TABLE I.—*Numbers of Full-time Students Enrolled at Universities Having Engineering Departments.*

University.	1938-39.	1946-47.	1950-51.
Birmingham	1,433	2,577	3,306
Bristol	1,005	1,733	2,515
Cambridge	5,931	6,813	7,891
Durham and Newcastle ..	1,709	3,156	4,331
Leeds	1,757	2,612	3,245
Liverpool	2,055	2,780	3,297
London	13,191	15,399	18,412
Manchester	2,108	3,472	4,318
Nottingham	582	1,222	2,112
Oxford	5,023	6,680	7,207
Sheffield	767	1,354	2,024
Southampton	268	575	947
Wales	2,779	4,105	5,133
Aberdeen	1,211	1,757	1,956
Edinburgh	3,205	4,477	5,327
Glasgow	4,175	4,435	5,586
St. Andrews and Dundee ..	928	1,546	1,897

TABLE II.—*Full-time Students,* 1950-51: *Distribution of Various Faculties.*

Faculty.	No. of Students.	Percentage of Total.
Arts	36,788	43·1
Pure Science	17,168	20·1
Medicine	14,201	16·6
Technology	10,591	12·4
Dentistry	2,885	3·4
Agriculture	2,606	3·1
Veterinary Science	1,075	1·3
	85,314	100

TABLE III.—*Percentage of Total Full-time Students Studying Pure Science or Technology* (1950-51).

University.	Pure Science.	Technology.
Birmingham	20·6	21·9
Bristol	28·3	8·9
Cambridge	23·1	9·5
Newcastle	18·5	22·7
Leeds	17·5	20·8
Liverpool	18·4	21·7
London	16·7	9·6
Manchester*	28·3	9·5
Nottingham	30·3	12·8
Oxford	16·6	1·1
Sheffield	20·3	24·1
Southampton	37·2	13·4
Wales	28·7	9·0
Aberdeen	15·3	7·4
Edinburgh	11·1	5·3
Glasgow†	13·8	13·2
St. Andrews and Dundee ..	24·3	6·0

* Not including College of Technology.
† Not including Royal Technical College.

* Address delivered on January 26, 1953, to the South Wales and Monmouthshire Association of the Institution of Civil Engineers. Abridged.

University Grants Committee, which are obtainable from H.M. Stationery Office. Table I shows the growth in the population of the universities since 1938 and, though a moderate fall in numbers at several universities has been reported since the 1950-51 session, there seems no doubt at all that the general increase, relative to pre-war conditions, will be maintained.

Table II gives overall figures relating to the distribution of students in the various faculties and shows that students of technology are considerably less numerous than those of pure science. The percentages of students studying pure science or technology at the various universities are compared in Table III and, while several universities can show a figure better than 20 per cent., others fall much below this. It is possible that national requirements may demand, by one means or another, that the overall percentage of university applied scientists shall rise in the future to 20 per cent. or so; but as yet there seems no real sign of intensive pressure to bring this about.

If we take the "average" university to have some 4,000 full-time students, of whom 400 to 600 are applied scientists, it will be evident that the school of applied science will require buildings and equipment on a considerable scale. Assuming a student-staff ratio of 10 to 1, there will be 40 to 60 members of the teaching staff and a numerous staff of laboratory technicians. Taking into account interest charges, salaries and wages, and maintenance grants for students, it is clear that the cost to the country of producing an applied science graduate is considerable, and the economics of a university education in applied science are deserving of careful scrutiny.

University applied-science departments, on a smaller scale than the "average" ones described, are sometimes said to be uneconomic for present-day conditions, but, though the large department offers obvious advantages for team work in research and, for a given ratio of students to staff, reduces the teaching load which any one member of the staff has to carry, the smaller department, with its smaller classes, preserves a much more intimate contact between pupil and teacher; a contact which, in the case of an initially weak but intelligent and hardworking student, may mean all the difference between success and failure. Nor must it be supposed that the impressive collections of apparatus of the larger departments are necessarily of more value to the undergraduate than the more modest equipment in the smaller schools; there is a definite limit to the amount of laboratory work which can be done in a three-year course and therefore a definite limit to the amount of apparatus on which experience can be gained. Surely we shall not go wrong here by following the old British habit of compromise; both large and small schools of applied science have their advantages and can exist together, provided that the financial support given to the smaller ones is not disproportionately meagre compared with that enjoyed by their larger brothers.

(To be continued.)

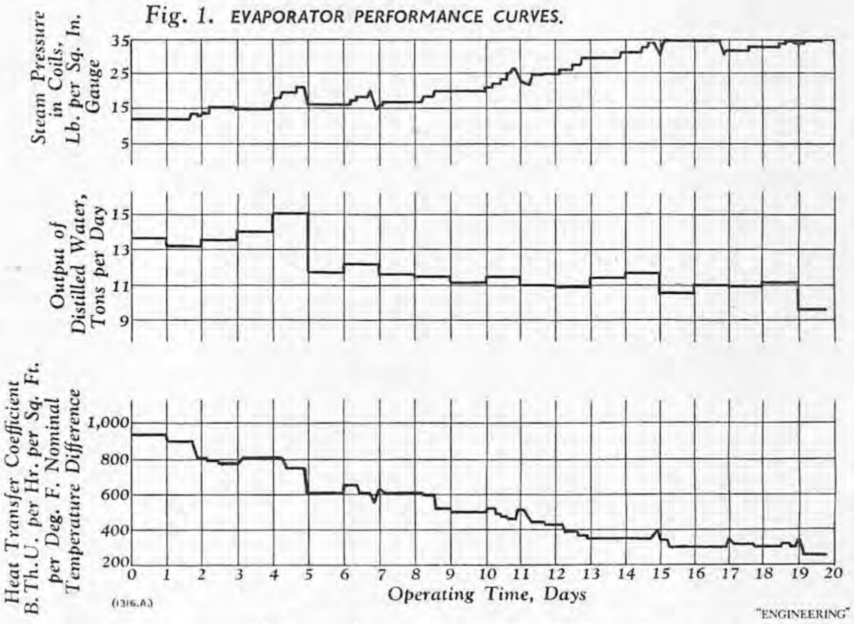
SUMMER SCHOOL AND CONFERENCE ON PLASTIC DEFORMATION OF METALS.—The H. H. Wills Physical Laboratory and the Department of Adult Education of the University of Bristol, in co-operation with the Institute of Physics, will be conducting a short summer school followed by a conference on "The Theory of the Plastic Deformation of Metals, with Special Reference to Creep and to Fatigue," from July 13 to 16, in Bristol. The provisional programme of the summer school, which will be held on July 13 and 14, includes lectures by Professor N. F. Mott, Dr. A. J. Forty and Dr. F. C. Frank. The school is similar in conception to those held in the University of Bristol on this and similar subjects; it is intended mainly for research students at universities and for members of the staffs of Government and industrial laboratories. The particular aim is to see to what extent the observed phenomena can be explained in terms of present theories, and to guide future work. The fee for the summer school is 1*l*. 10*s*., but there will be no fee for the conference. Further particulars and forms of application, to be returned before May 31, can be obtained either from the director of the Department of Adult Education, The University, Bristol, 8, or from the secretary of the Institute of Physics, 47, Belgrave-square, London, S.W.1.

SCALE IN SEA-WATER DISTILLING PLANTS.*

By H. HILLIER, O.B.E., M.I.Mech.E.

THE production of fresh water from sea water is a major requirement in naval and merchant ships; and for many communities, adjacent to the sea, in localities where the natural supply of fresh water is inadequate. In distilling plants producing fresh water from sea water, the heating and evaporation of the sea water result in a very rapid and heavy scale formation—on the heating surfaces of the evaporators in particular—and, to maintain a given output of distilled water, the heating surfaces must be proportioned to allow for it. Scale formation involves frequent withdrawals of the plant from operation for its removal, which is expensive and difficult, and considerably increases maintenance costs. In ships, space is limited and it is desirable that the weight and space occupied by machinery for a given duty should be the minimum.

Fig. 1. EVAPORATOR PERFORMANCE CURVES.



The typical performance of a coil-type evaporator (Fig. 1, herewith) shows how the rate of heat transfer falls rapidly due to the scale formation—the heat-transfer coefficient falling from over 900 to less than 300 B.Th.U. per square foot per hour per degree F. temperature difference, in the short time of 20 days. The evaporator-shell pressure was 0·5 lb. per square inch gauge; the brine-concentration factor was 2·5. In this plant, it was possible to reduce the fall in output by allowing the steam pressure in the coils to rise as the scale increased; but in many cases this is not possible and the fall in output is more severe than is shown. A typical scale formation on a coil-type evaporator tube is shown, in cross-section, in Fig. 2, opposite.

The solids in sea water are indicated by the typical example given in Table I, taken from British Standard 1170 : 1947. There are slight variations in the solid contents of sea water in different parts of the world, but they are not significant in the problem.

TABLE I.—*Solids Contained in a Sample of Sea Water (In Ionic Solution).*

Dissolved Solids.	Lb. per Million Lb. of Water.
Calcium bicarbonate, $Ca(HCO_3)_2$	180
Calcium sulphate, $CaSO_4$	1,220
Magnesium sulphate, $MgSO_4$	1,960
Magnesium chloride, $MgCl_2$	3,300
Sodium chloride, NaCl	25,620
	32,280

It has usually been accepted that the weight of solids contained in sea water makes any form of water treatment to prevent scale formation too cumbersome and costly to be accepted. It was considered, however, that, if a detailed knowledge of its mechanism could be obtained, there might be a better prospect of attacking the problem of preventing the scale formation and that, in the long run, it would be necessary to carry out the investigation with a reasonably large-sized distilling plant.

The facilities available for testing were 20 miles from the sea and this necessitated the transport of large quantities of sea water. A large amount of experience was available in the use of synthetic sea water and it was known that such water gave appreciably different scale formation from that obtained with actual sea water. It was considered necessary, therefore, to use real sea water. All the sea water used was obtained at Troon, Firth of Clyde, and its composition compared closely with that given in British Standard 1170 : 1947. Typical analyses of the Troon water are given in Table II, herewith.

TABLE II.—*Solids Contained in a Sample of Sea Water.*

Dissolved Solids.	Lb. per Million Lb. of Water. Flood Tide.	Ebb Tide.
Calcium bicarbonate, $Ca(HCO_3)_2$ ..	186	183
Calcium sulphate, $CaSO_4$	1,210	1,170
Magnesium sulphate, $MgSO_4$ ..	1,940	2,070
Magnesium chloride, $MgCl_2$ ..	3,260	3,200
Sodium chloride, NaCl	25,700	25,650
	32,296	32,273
Specific gravity at 60 deg. F. ..	1·0256	1·0252
*p*H-value	7·58	7·82

With the usual operating conditions for sea-water evaporating plants, scales are formed from calcium carbonate, $CaCO_3$, known as calcite; magnesium hydroxide, $Mg(OH)_2$, known as brucite; and calcium sulphate scales, $CaSO_4$, which may be anhydrite, hemi-hydrate, or gypsum. The scale formed may be predominantly one or other of these scales or a mixture dependent upon the operating conditions; but, owing to the number of factors involved and the variety of operating conditions, and also to the difficulty of obtaining reliable data under controlled conditions over a long period of time, the factors governing the deposition and incidence of these scales were not understood.

The main factors to be considered were the temperature and pressure at which evaporation takes place, the temperature difference across the heating surface, and the density of the brine in the evaporator. It was decided to use an evaporator provided with four coils, with a separate steam supply to each coil, so that each coil could be operated with a different coil-steam pressure but a common shell pressure and brine density. Sea-water evaporators are commonly operated somewhere in the range of 140 to 220 deg. F. and 2·88 to 17·2 lb. per square, inch absolute. For drinking purposes, it is considered desirable from the medical point of view that,

* Paper presented to the Institution of Mechanical Engineers at a meeting held in London on January 30, 1953. Abridged.

SCALE IN SEA-WATER DISTILLING PLANTS.

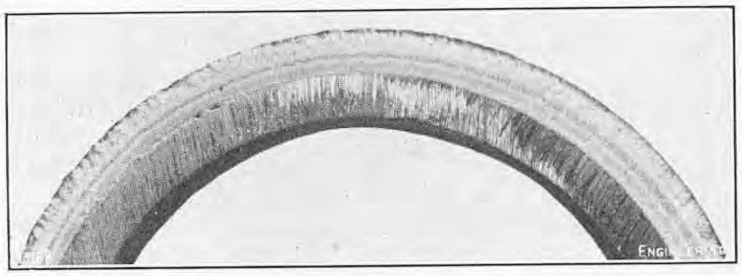


FIG. 2. CROSS-SECTION THROUGH AN EVAPORATOR COIL, SHOWING SCALE FORMATION.

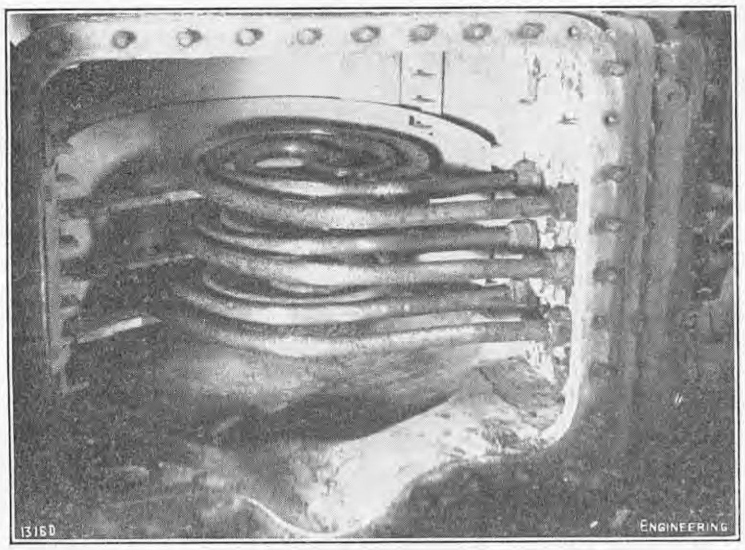


FIG. 4. EVAPORATOR COILS: TOP COIL REMOVED TO SHOW COIL FORMATION.

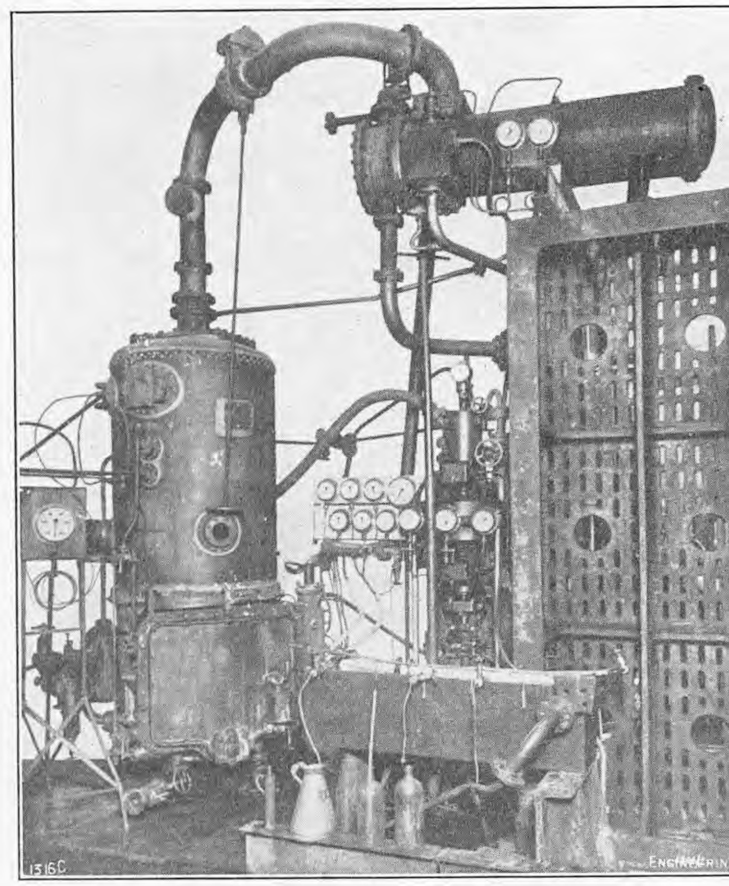
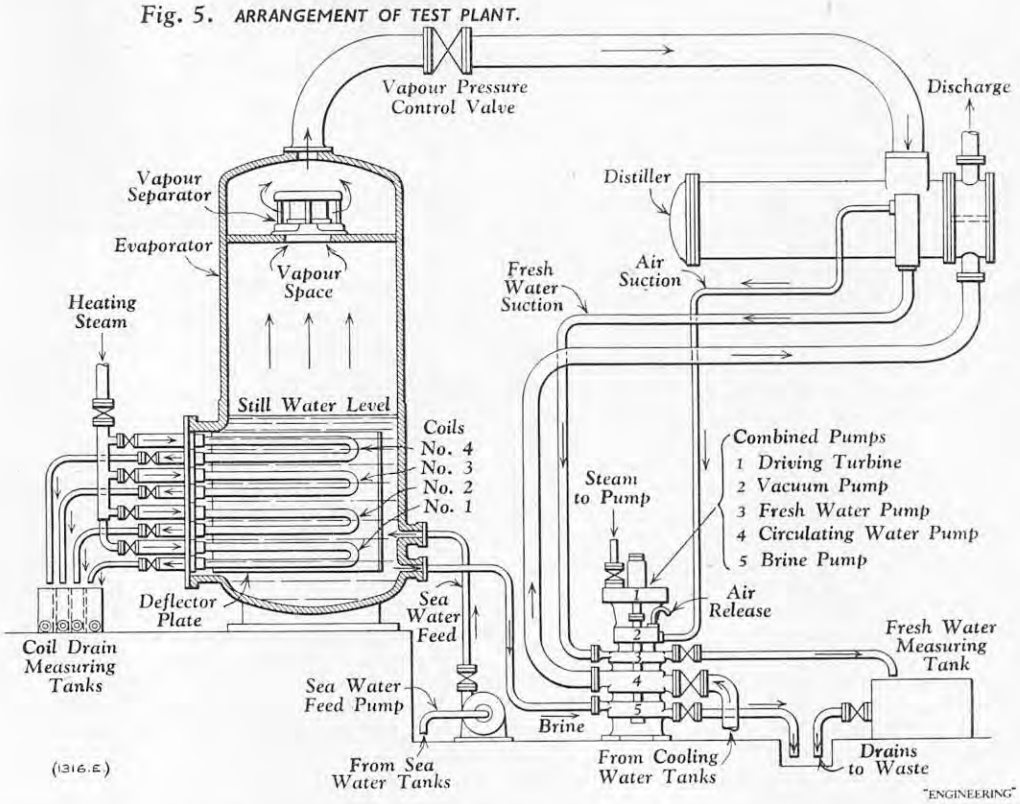


FIG. 3. DISTILLING PLANT USED IN THE TESTS.

Fig. 5. ARRANGEMENT OF TEST PLANT.



to render any bacteria harmless, all the sea water used should be subjected to a temperature of 160 deg. F. or over.

With regard to brine density, it has been a common practice to use a blow-down equal to 50 per cent. of the made water; that is, a brine concentration of 3. One school of thought considers that scale formation can be largely reduced by operating with a blow-down of 200 per cent. of the made water, i.e., a brine concentration of 1·5. It was decided to run at evaporator vapour temperatures of between 140 deg. and 220 deg. F., with brine concentrations between 3 and 1·5, and with temperature differences between 20 deg. and 100 deg. F.

The test plant is shown in Fig. 3, herewith, and is represented diagrammatically in Fig. 5. The steam supply to each coil was separately controlled and the condensate draining from each coil was measured separately. This quantity and the temperature difference were used to determine the rate of heat transfer obtained from each coil. The temperature differences were based on the saturation temperature corresponding to the steam pressure in each coil, recorded by the pressure gauge at the inlet to the coil, and the temperature of the vapour in the evaporator shell. These points should be borne in mind in assessing the possible accuracy of the data. Fig. 4 shows the coils in the evaporator.

(To be continued.)

ADJUSTABLE-WING AIRCRAFT.

SINCE the SB/5, designed and constructed by Short Brothers and Harland, Limited, Queen's Island, Belfast, made its maiden flight at Boscombe Down, Wiltshire, on December 5 last, it has been engaged on test flying as part of a programme of research into problems that arise in the handling of swept-back wing high-speed aircraft. In the past, difficulties have arisen in maintaining full and immediate control of aircraft of this type at low speeds due to a tendency of the airflow to break-away at and around the wing tips, causing some loss of stability and a tendency for the controls not to respond at critical speeds such as take-off and landing. It is understood that these difficulties occur when the sweep-back exceeds 35 deg. This aircraft should be able to cover a wide field of work as it has been designed so that, by fitting alternative components, the wings can be arranged with different degrees of sweep-back from 50 deg. to 69 deg., giving a span from 35 ft. to 26 ft.

The wing is very thin, and adjustment to the sweep-back is made on the ground. The tail-plane can be located at the top of the fin or beneath the fuselage, and its angle of incidence can be varied in flight to any angle up to 10 deg. on either side of the horizontal. The wings are a metal structure with plywood covering on the leading and trailing edges and leading-edge flaps are fitted along the full span. The aircraft is fitted with anti-spin and braking parachutes. Its undercarriage is non-retractable. The power unit is a Rolls-Royce Derwent jet engine. It is intended that the test programme to investigate low-speed handling characteristics shall cover all possible combinations of sweep-back and tail-plane setting. All flying done so far has been with a 50-deg. sweep-back.

THE CASTING OF INGOTS FOR SEAMLESS TUBE MAKING.*

By G. BOWMAN.

MR. N. H. BACON once said that the pit-side was the Cinderella of the melting shop. There could be no doubt, he said, that the casting-pit practice had a very important bearing on the measure of success achieved by the melting shop, and that this section of the open-hearth plant had not received the attention that its importance warranted. While this statement was undoubtedly justified, in recent years, steelmakers have become more alive to the damage which can be done to good steel through faulty casting practice. Also, more technical attention and study has been devoted to this aspect of steelmaking with the object of developing improved techniques. Since the introduction of seamless tube-making, the company with which the author is connected has been very conscious of the importance of casting practice, and has devoted a great deal of time and money to this subject. This work, however, has always been hindered by the lack of a reliable method of assessing ingot quality by a non-destructive test. The assessment has depended to a large extent upon the incidence and type of defects occurring on the rolled or forged product, and, since certain defects can arise from faults in these processes themselves, this method of assessing the value of variations in casting practice has its limitations.

It is considered fair to say that, while steels have a variable tendency to tear during forging, variations in forging practice can result in a varying tendency to tear the steel. To assign the responsibility for certain defects, therefore, is sometimes extremely difficult, if not impossible. If this method of assessment is being used, it is undoubtedly necessary to study the particular forging process involved in conjunction with the steelmaking and casting practice. Although the author and his associates have of necessity used this method of assessment extensively, for the reasons given, the present paper is confined to items of work where the results could be more definitely measured. The work concerns the casting of ingots for seamless tube manufacture by the rotary-forge process, as practised at the Clydesdale steel and tube works of Stewarts and Lloyds, Limited.

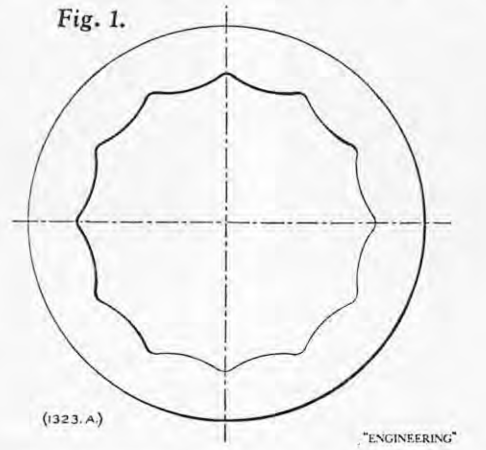
The steel plant has a capacity of approximately 3,250 tons a week, and the entire tonnage is devoted to killed-steel ingots suitable for direct processing in the tube plant. The steels vary in composition from 0·10 per cent. to 0·45 per cent. carbon and from 0·40 per cent. to 1·3 per cent. manganese. The ingots, which are all cast "uphill," are of the round fluted type, and vary in diameter from $7\frac{1}{2}$ in. to $21\frac{1}{2}$ in. The weight in each diameter varies considerably, since the ingots are cast to suit the length of tube ordered, because there is no intermediate rolling process; the overall ingot weight may vary from 5 cwt. to 50 cwt. In view of the absence of any opportunity to dress or de-surface after intermediate rolling, the maintenance of a high quality of cast ingot is essential. When this is considered in conjunction with the wide range of sizes and weights to be dealt with, it will be appreciated that the casting problem involved is somewhat different from that which presents itself in the normal steel plant. Consequently, more than usual attention has been paid to casting practice for many years, and special facilities have been provided in order to maintain the high standard of ingot necessary for this type of tube making.

Casting is carried out in separate buildings at right angles to the melting shop, with the object of avoiding contamination as far as possible. These buildings are provided with sunken casting pits and the ladles are brought from the melting shop in ladle cars, which run over these pits. After each cast, the moulds are transferred to other buildings, where facilities are provided for examination, cleaning and coating. After cooling, each individual ingot is examined carefully, and, when necessary, dressed. In the course of the day-to-day checking of quality, both in tube and steel plants, interesting features of this type of ingot have been observed, and, in certain cases, have led to experiments aimed at improving quality. The object of this paper is to describe some of these features and how they are affected by experimental changes in practice; also, to indicate the conclusions which have been drawn from these experiments. Teeming speed is undoubtedly of paramount importance, and some general comments will be made on its effect before dealing with the more detailed points grouped under the three headings of cracking, cavitation and crusting, and porosity.

TEEMING SPEED.

As has been stated, all the ingots concerned are teemed uphill. The moulds are filled in groups, each group being located on one large bottom plate and fed from a central feeder into which the molten metal is poured from the ladle. Depending on the size of ingot being cast, a 70-ton heat may be spread over anything from six to twelve plates, and the total time of teeming may be as high as 50 minutes. Obviously, if an ordinary clay nozzle were used and the same number of moulds were set on each plate, the variation in teeming speed from the beginning to the end of the cast would be enormous, and the consequences would be disastrous. It is customary to use a composite-type nozzle, the upper portion of which is magnesite and the lower portion fireclay. The internal diameter of the two sections can be varied, but normally the magnesite is $\frac{1}{8}$ in. larger than the fireclay. In this way the variation in rate of discharge from the nozzle is minimised. A wide range of nozzle sizes in $\frac{1}{8}$ in. steps is available so that the teeming speed can be adjusted to suit all ingot diameters. Variations in the rate of discharge from the nozzle can be compensated for, by varying the number of moulds set per plate, and the same method can be used when different diameters of ingot are being cast from the same ladle in order to obtain the most suitable teeming speed for each diameter. This method is used frequently in experimental work for obtaining a few ingots cast at other than the standard speeds.

Fig. 1.



It will be appreciated that, with this practice, the rate of discharge from the nozzle does not bear a constant relationship to the rate at which the metal rises in the moulds. The rate of rise is the important factor; it is measured directly in "inches per minute" and is referred to in these terms. Within reasonable limits, the higher the teeming speed, the better the ingot in all but one respect, namely, the incidence of cracking. This has been proved beyond any doubt and, of course, the effect of teeming speed on ingot cracking is well known. It is easy, therefore, to determine the optimum teeming speed for any size of ingot; it is the maximum speed at which the losses due to cracking remain within economic bounds.

Until a few years ago, the tube-making process necessitated the use of round ingots, which are more prone to cracking than any other shape. Immediately developments in tube-making made this possible, a twelve-sided fluted design was adopted, as seen in Fig. 1, herewith (showing the plan at the base of the mould), and the standard teeming speeds were increased. Apart from one major advantage from increased teeming speeds, to be dealt with later, improvements arise in the following respects: (a) there is less danger of momentary arrests in the rising metal and the resultant lapping or rippling of the ingot skin; (b) there is less tendency for eroded refractory to be trapped in the skin of the ingot; (c) the chill zone is much cleaner and less pronounced; (d) there is less segregation in the columnar zone, due presumably to the greater washing action of the faster flowing metal; and (e) the ladle emptying time is reduced, with a consequent reduction in lining wear. It is inevitable, therefore, that the aim must still be higher teeming speeds and, since cracking is the limiting factor, some consideration has been given to the mechanism causing this defect.

INGOT CRACKING.

The photograph reproduced in Fig. 2 illustrates the type of longitudinal ingot crack involved. It was decided that an attempt should be made to determine when longitudinal ingot cracks occur, whereas existing knowledge was limited to the fact that such cracks are usually visible when an ingot is stripped. The procedure adopted was to

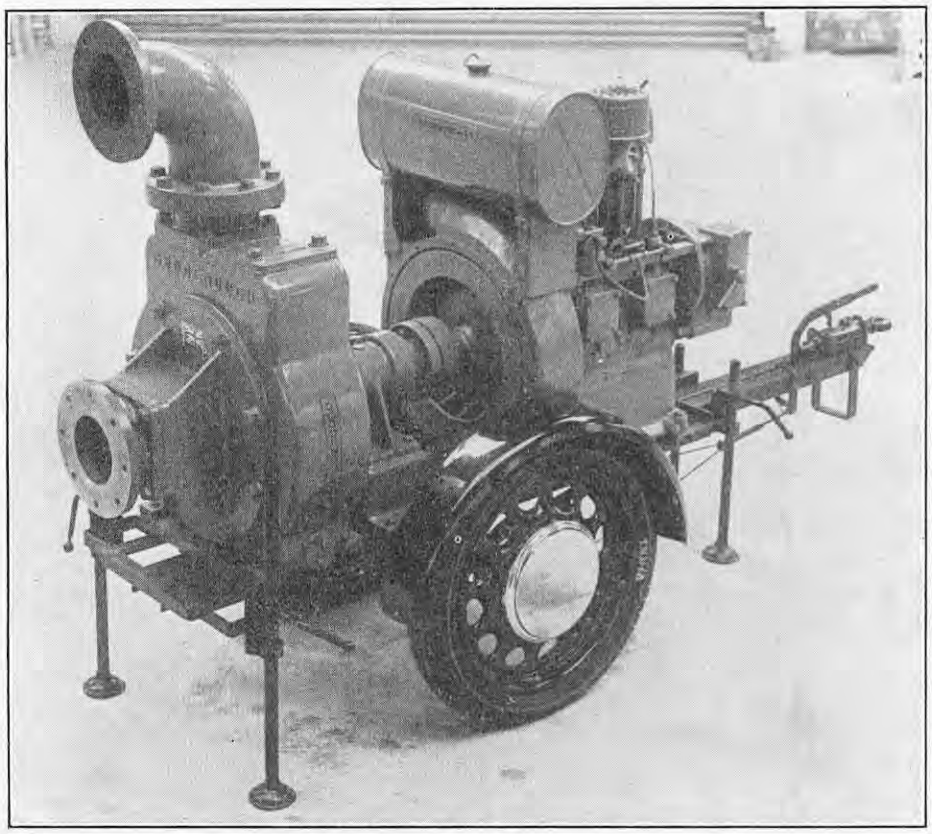
FIG. 2. LONGITUDINAL INGOT CRACK.

fill at about four times the normal teeming speed and to use a round mould, so that there would be a very strong cracking tendency. In addition, a tangential runner entry was used, so that the rising metal swirled. In this way an inverted cone formation was maintained on the surface, thus ensuring that slag and refractory material would be kept away from the mould/steel interface and so avoid entrapment in the chill layer. The diameter of the mould used was $12\frac{3}{4}$ in., and the ingots cast weighed approximately 12 cwt. It was found that the mould could be stripped quite quickly provided the runner entry was not disturbed, otherwise bleeding took place at that point. The time from the finish of teeming to the stripping of the mould was reduced on each succeeding trial, but always the ingot was found to be cracked, even when that time was reduced to as little as 40 seconds. This established one fact not previously known, namely, that the crack occurred almost immediately teeming was completed and the total time taken to fill the mould did not exceed one minute. The following three points were observed in all cases, namely, no bleeding occurred, there was distinct necking at the crack, and the cracks always occurred in a hot longitudinal band between two cooler bands. It was concluded that the cracks were caused by circumferential stresses set up by the contraction of the two cooler bands, which caused the ingot skin in the hot band to neck and ultimately break. Consideration was given to the possible cause of the very uneven cooling, and, when it was found that the mould was $\frac{3}{16}$ in. out of round, it was

* Paper, entitled "Some Practical Notes on Casting of Ingots for Seamless Tubemaking," read before the West of Scotland Iron and Steel Institute, at Glasgow, on Friday, February 20, 1953. Abridged.

SELF-PRIMING TRAILER PUMP.

GOODENOUGH CONTRACTORS' MACHINERY, LIMITED, TWICKENHAM, MIDDLESEX.



thought that this might be causing exaggerated partial contact along the cooler bands. The mould was machined to a true round, but the same phenomenon continued to occur. Numerous methods of combating the uneven cooling were tried, but only two were found practicable, and these were both based on reducing the rate at which the molten metal was chilled. The first was to preheat the mould, the average temperature being increased in each succeeding trial. Only when a temperature of 250 deg. C. was reached was an ingot made free from cracks. This was repeated several times and the results confirmed that cracking could be avoided by the use of hot moulds. The other method used was to line the mould with template paper and so reduce the rate of heat transfer from ingot to mould. Ingots free from cracks were made by this method on several occasions. In all cases, the ingots were stripped between one and two minutes after finishing teeming, and, though there was still evidence of uneven cooling, the temperature difference between different parts of the ingot was much less than when unlined moulds at the normal temperature were used.

These experiments seem to have established the following interesting facts: that ingots of the type used can be stripped almost immediately after filling; that the type of cracking being studied occurs either during filling or immediately afterwards; that, under normal casting conditions, the temperature differences found on the ingot surface are very great; that the cracks occur in the slower cooled bands of the ingot; and that reducing the cooling rate of the ingot skin results in more even cooling and inhibits ingot cracking. It might be suggested that the phenomena observed in these experiments were associated in some way with the swirling of the rising metal which resulted from the use of a tangential entry. While this cannot be confuted from the evidence available, the author does not believe it to have been the case, and considers that it was important to use this method and so to avoid the danger of any entrapped material affecting the cracking tendency. The intervals between finishing filling and stripping were much shorter than might have been expected from a study of the existing literature. It might be that the relatively light ingot used had some influence in this connection and that the mould was stripped before complete separation had taken place. Nevertheless, any remaining partial contact must have been very slight to allow removal of the mould without transverse rupture of the ingot skin.

The results of previous work have always led to the recommendation that the rapid formation of a thick chilled skin should be encouraged in order to resist the bursting effect of the ferrostatic pressure from the still-molten interior, and the localised stresses that might be set up in the later stages of cooling. In the case quoted, however, cracking took place at a very early stage without any sign of bleeding, which suggests that such cracking does not result from internal pressure; in fact, in previous work where bleeding has occurred, it does not necessarily mean that the crack has resulted from internal pressure. Nor is there confirmation that a thick chill zone counteracts localised stresses; it may be that the crack has taken place before the chill zone is completely formed.

Earlier experience led the author to favour the theory that partial contact was the cause of cracking, due to the tension set up between two points where the ingot skin continued to adhere to the mould after the intervening portion had separated. The fact that slower cooling prevented cracking might be claimed to support this theory, if the slower cooling encouraged the ingot to separate from the mould in a more regular manner. It is doubtful, however, whether the ingot skin ever adheres tightly enough to the surface of the mould to set up the necessary tension, unless there are irregularities such as crazy cracking on the mould wall. The author is of the opinion that the type of longitudinal cracking under consideration is entirely due to uneven cooling of the ingot skin immediately after casting, and that the cure must be found through improved methods of controlling this factor. The experiments suggest that this might be achieved by reducing the rate of chilling by some method suitable for production practice.

(To be continued.)

INQUIRY INTO LOSS OF M.S. "PRINCESS VICTORIA."—The formal investigation ordered by the Minister of Transport, the Rt. Hon. Alan Lennox-Boyd, M.P., into the loss of the motor vessel Princess Victoria in the Irish Sea on January 31, 1953, has been fixed for hearing at the Petty Sessions Courts Building, Chichester-street, Belfast, on Monday, March 23, 1953, at 10.30 a.m. The investigation is to be conducted by Mr. J. H. Campbell, Q.C.

6-IN. SELF-PRIMING TRAILER PUMP.

THE portable centrifugal pumping set illustrated herewith, which has been put on the market by Goodenough Contractors' Machinery, Limited, 70-72, London-road, Twickenham, Middlesex, has been designed to meet the need of public-works contractors for a unit of large capacity that can be readily transported to and on the sites of civil-engineering works. It is listed as the 6-in. Model 660 and consists of a single-stage pump driven by a Diesel engine (though a petrol or petrol/paraffin engine can be supplied if desired) mounted on a two-wheeled rubber-tyred trailer. The pump has a maximum capacity of 75,000 gallons an hour, a guaranteed suction lift of 25 ft. without a foot-valve, and a maximum total head of 100 ft. It will handle water containing a high proportion of abrasive matter and up to 25 per cent. of solids, and is equally suitable for pumping liquid mud, sewage sludge, oil, petrol and chemicals, though its primary purpose is the dewatering of excavations and caissons, etc.

The pump body is made in a non-corrosive alloy, lined with a renewable cast-iron volute and has two large drain holes to facilitate cleaning. The open-type impeller is of cast iron, with four vanes, and is screwed on to the spindle, which is of nickel-chrome steel and fitted with renewable carbon seals, running in oil, from which the liquid being pumped is completely excluded. The suction and delivery branches are 6 in. bore, with British Standard flanges. A clack valve is interposed between the suction flange and the pump body, and a 90-deg. bend is provided on the delivery to give a horizontal discharge. The drive from the engine is through a flexible coupling to the impeller spindle, which is carried in oversize ball bearings, grease-lubricated. The pump and engine are so balanced on the trailer that the unit can be moved by one man. Car-type steel wheels are fitted, with 8-in. brake drums, and the brakes are provided with over-run mechanism for towing purposes. Four telescopic jacks, which can be seen in the illustration, support the unit when pumping.

The engine fitted to the unit illustrated is a two-cylinder Armstrong-Siddeley air-cooled Diesel of 20 h.p., and is stated to consume less than a gallon of fuel oil per hour. Alternatively, if a radiator-cooled engine is preferred, the makers offer a choice of either a B.2 Petter engine, developing 18 h.p., or a 2.VSH Ruston engine, of 22 h.p. The total weight of the set shown is 1,300 lb. and it measures 5 ft. 8 in. in height, 6 ft. 6 in. in length, and 3 ft. in width. Each unit is provided with a strainer for the suction hose, and a kit of tools.

COURSE ON CORROSION TESTING.

A SERIES of six evening lectures on "Corrosion Testing" will be delivered at 7 p.m. on Wednesday, March 18, and on Tuesdays, March 24, April 14, 21 and 28, and May 5, in the Department of Applied Chemistry, Northampton Polytechnic, St. John-street, London, E.C.1. The first lecture, on March 18, will deal with "General Principles of Corrosion Testing" and will be by Mr. S. C. Britton, of the Tin Research Institute. The second lecture, on March 24, on the subject of "The Preparation of Specimens," will be by Dr. F. A. Champion, of the British Aluminium Company, Limited. The third lecture, on April 14, entitled "The Atmospheric Corrosion of Uncoated Metals," will be by Mr. J. F. Stanners, of the British Iron and Steel Research Association. The fourth lecture, on April 21, will treat of "The Immersed Corrosion of Uncoated Metals," and will be by Mr. G. H. Botham, of the A.P.V. Company, Limited. The fifth lecture, on April 28, will be concerned with "Tests for the Selection of Protective Coatings," and will be by Mr. S. C. Britton. The sixth and last lecture, on "The Assessment of Corrosion," to be delivered on May 5, will be by Dr. F. A. Champion. The fee for the course is 20s., and enrolment can be effected either at the Polytechnic or by post. Those enrolling by post should supply their name and address, academic qualifications, and the name of their employers and enclose a stamped addressed envelope.

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.

Code of Practice for Telephone and Telegraph Services.—The Council for Codes of Practice for Buildings, Construction and Engineering Services, Lambeth Bridge House, London, S.E.1, have now issued, in final form, Code C.P. No. 327.101 relating to "Telephones and Telegraphs—Public Services" and C.P. No. 327.102 dealing with "Telephone and Telegraphs—Private Services." Both Codes were drawn up by a committee convened on behalf of the Council by the Institution of Electrical Engineers. The Code dealing with public services describes the principal telephone and telegraph systems supplied and/or maintained by the Post Office to provide intercommunication within a building or group of buildings, and between remote buildings via the public telephone or telegraph services or via private circuits supplied by the Post Office. The Code dealing with private services describes telephone and telegraph systems other than those connected to the public system or supplied by the Post Office. [Price 7*s.* 6*d.*, each postage included.]

Commercial Platinum-Resistance Thermometer Elements.—B.S. No. 1904, covering commercial platinum-resistance thermometer elements, has been issued. The publication specifies requirements for elements made of platinum foil, strip or wire and usually contained in a sheath forming a bulb. Tests for stability and behaviour under vibration are dealt with in the specification. [Price 2*s.* 6*d.*]

Filler Rods for Gas Welding.—A first revision of B.S. No. 1453, covering filler rods for gas welding, has now been issued. The specification was first published in 1950 under the title "Steel Filler Rods for the Gas Welding of Mild Steel," and dealt with only one type of rod. It was mainly intended to provide a specification for the type of filler rod used in the gas welding of pipelines. The new edition is much wider in scope than that of 1950, as it covers 31 types of filler rods for steel, cast iron, copper and copper alloys, magnesium alloys and aluminium and aluminium alloys. Each type is defined in terms of chemical composition. The filler rod specified in the 1950 edition is included in the 1952 edition as type A2. [Price 3*s.*, postage included.]

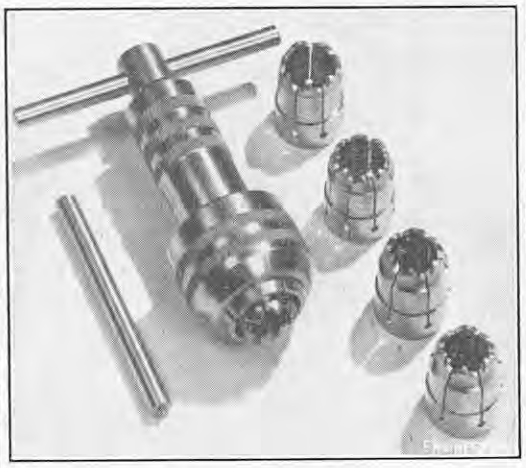
Heavy-Duty Engine Lubricating Oils.—A new specification, B.S. No. 1905, deals with engine lubricating oils (H.D. type). The demand for heavy-duty type engine lubricating oils has arisen because some highly-rated compression-ignition engines will not operate satisfactorily on plain hydrocarbon mineral oil and require lubricants possessing higher detergency and greater stability in resisting oxidation. The compilers state that at present no test method is available, using a British engine, which has been sufficiently examined under controlled conditions to permit its adoption as a British Standard. Consequently, the present specification has been based on U.S. Army Ordnance Specification MIL-O-2104. An engine test is inevitably complicated and it is not possible, at present, for the results to be completely assessed numerically. A special procedure has therefore been adopted. This is that engine tests shall be carried out in a laboratory approved by the Institution, and the laboratory report and other material shall be submitted to a special panel of the Institution, who will determine whether the oil complies with the requirements of the specification. [Price 7*s.* 6*d.*, postage included.]

Oil Circuit-Breakers for Alternating-Current Systems.—A third revision of B.S. No. 116 has recently been issued and the new edition applies to oil circuit-breakers only for single-phase and three-phase systems, except those up to 660 volts, intended for use in electrically-remote parts of a system. Such circuit-breakers are covered by B.S. No. 936. In the new edition of B.S. No. 116, service conditions are defined and standard ratings are listed for rated service voltages up to 275 kV. Clauses concerning construction, testing and performance are inserted and appendices deal with such matters as information to be given with inquiries and orders, the calculation of short-circuit fault-currents, the selection and maintenance of circuit-breakers, methods of test, and information to be given in test reports. [Price 15*s.*, postage included.]

Portable Foam-Type Fire Extinguishers.—Part 2 of B.S. No. 740, covering portable fire extinguishers of the foam type (gas pressure), has now been issued. In this type the foam is expelled by compressed or liquefied gas from a container attached to, or fitted into, the extinguisher. The new publication contains the requirements regarding operation, performance, anti-corrosion treatment, the chemical charge to be used, and the construction of the extinguisher. [Price 6*s.*, postage included.]

EXTRACTOR FOR BALL AND ROLLER BEARINGS.

THE tool shown in the accompanying illustration is a ball-bearing extractor marketed by Civitas Trading Corporation, Limited, Wigmore House, 10, Duke-street, London, W.1. It comprises a hollow body with a self-centring chuck at one end and a threaded thrust pin with a tommy-bar at the other. The nose of the thrust pin is bored out for part of its length to accommodate a single ball, which fits at the bottom of the hole, and the end of either a short or long plain pin. The purpose of the ball is to reduce friction and thereby prevent the rotation of the plain pin when it is being forced against the end of the shaft by the screwing of the thrust pin. A collet fits into the chuck at one end and has teeth that grip the ball groove of the inner race. Collets are made in various sizes, and classified according to the type of bearing for which they are suitable; a different type is necessary for extracting roller bearings.



To remove a ball race, a collet of the appropriate size is sprung on to the inner race between the balls. The body of the extractor which has the thrust pin screwed back as far as necessary to allow a plain pin of the required length to be inserted, is placed in position over the collet, and the chuck tightened so that the teeth grip the bearing. The thrust pin is then screwed up until the plain pin makes contact with the end of the shaft, whereupon the extractor body, collet, and bearing are drawn away from the shaft as the screwing continues.

It is claimed that the gripping of the inner ring does no damage to the bearing. Special extension tubes are made for removing bearings situated at some distance along the shaft.

"BAR AND ANGLE SHEARING MACHINE": ERRATUM.—We regret that, in the above article, which appeared on page 189, *ante*, the name of the suppliers of the Cupo Zanogen steel cutting blades of the machine was incorrectly stated; they are Messrs. W. Fearnehough, Limited, of Garden-street Works, Sheffield, 1.

ELECTRICAL HEAT STORAGE DEVICES.—In reply to a question by Mr. P. Price in the House of Commons on Monday, February 16, the Minister of Fuel and Power (Mr. Geoffrey Lloyd) said there was no need to give a general direction to the British Electricity Authority to revise their tariffs so as to encourage the use of heat-storage devices. He was, however, discussing with the Authority whether alterations in general tariff policy could give further encouragement to off-peak consumption.

THE INSTITUTE OF METALS.—The Council of the Institute of Metals have awarded the 1952 W. H. A. Robertson Medal and a premium of 50 guineas to Mr. J. F. Waight, engineer, West Midlands Gas Board, for his paper on "Gas Equipment for the Thermal Treatment of Non-Ferrous Metals and Alloys," published in the *Journal* of the Institute, vol. 80, page 269 (1952). The Council have made two awards, each of 10 guineas, for essays submitted for the annual Students' Essay Prize Competition. The awards are to Mr. R. D. Stacey for an essay on "Some Experimental Evidence for Dislocations," and Mr. G. Thomas for an essay on "Martensitic Transformations in Non-Ferrous Metals and Alloys."

BOOKS RECEIVED.

Photometry. By DR. JOHN W. T. WALSH. Constable and Company, Limited, 10 and 12, Orange-street, London, W.C.2. [Price 63*s.* net.]

United States National Bureau of Standards. Circular No. 535. *An Annotated Bibliography of Selected References on the Solid-State Reactions of the Uranium Oxides.* By S. M. LANG. The Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., U.S.A. [Price 30 cents.]

Symposium on Determination of Elastic Constants. Presented at the Fifty-fifth Annual Meeting, American Society for Testing Materials, New York, June 25, 1952. American Society for Testing Materials, 1916, Race-street, Philadelphia 3, Pennsylvania, U.S.A. [Price 2 dols.]

Productivity Team Report: Plastics Moulding. Report of a Productivity Team Representing the British Plastics Moulding Industry which Visited the United States of America in 1952. British Productivity Council, 21, Tothill-street, London, S.W.1. [Price 5*s.* 6*d.*]

Notch Bar Testing and its Relation to Welding Construction. Symposium organised by the Institute of Welding in association with the Joint Committee on Materials and their Testing. The Institute of Welding, 2, Buckingham Palace-gardens, London, S.W.1. [Price 25*s.*]

The Welding of Austenitic Corrosion- and Heat-Resisting Steels. British Welding Research Association, 29, Park-crescent, London, W.1. [Price 27*s.* 6*d.*]

Atlas of the World's Resources. Vol. II. *The Mineral Resources of the World.* By PROFESSORS WILLIAM VAN ROYEN and OLIVER BOWLES, in collaboration with ELMER W. PEHRSON. Prentice-Hall Incorporated, 70, Fifth-avenue, New York, U.S.A. [Price 10.75 dols.]; and Constable and Company, Limited, 10, Orange-street, London, W.C.2. [Price 70*s.* net.]

TRADE PUBLICATIONS.

Automatic Boiler Firing.—Copperad Auto Burners, Ltd., Poyle-road, Colnbrook, Buckinghamshire, have sent us a booklet giving particulars of their gravity-feed solid-fuel burner for firing boilers.

Motor Grader and Excavator.—Of two brochures that have been issued by Blaw Knox Ltd., 90-94, Brompton-road, London, S.W.3, one gives information about the BK-50 half cubic yard excavator with shovel or crane attachments, and the other relates to the performance of the BK-12 heavy-duty motor grader and accessories. Both these machines are driven by Diesel engines.

Food and Chemical Plant.—Robert Jenkins & Co., Ltd., Wortley-road, Rotherham, Lancashire, have sent us their catalogue giving details of tanks, pressure vessels, and welded fabrications, together with design graphs and charts.

Mechanical Handling in the Timber Industry.—We have received an illustrated booklet from Steels Engineering Products, Ltd., Crown Works, Sunderland, giving details of their Coles mobile and lorry-mounted cranes, and also of the various tiering and other small trucks for use in the timber industry.

Machine Tools.—F. J. Edwards, Ltd., 359-361, Euston-road, London, N.W.1, have sent us a booklet giving details of the many machine tools and accessories which they make or for which they are agents.

Vibration Insulators.—A pamphlet describing their many different types of rubber insulating mountings has been published by the British Tyre & Rubber Co., Ltd., Herga House, Vincent Square, London, S.W.1.

Industrial Dust Collectors.—Dallow Lambert & Co., Ltd., Spalding-street, Leicester, have issued an illustrated brochure giving particulars of their dust-collection equipment for use in workshops.

Fuel Oil Additives, and Soot Removers.—We have received five leaflets from Xzit (G.B.), Ltd., 175, Piccadilly, London, W.1, which give information on detergent-additives for fuel oil, and scale and soot eradicators for chimneys.

Transformer and Switch Oils.—C. C. Wakefield & Co., Ltd., 46, Grosvenor-street, London, W.1, have issued an illustrated brochure giving full technical particulars of the transformer and switch oils manufactured by them.

Electric-Light Fittings.—Pamphlets dealing with reflectors, floodlights and watertight bulkhead and prismatic fittings for industrial electric lighting have been received from the Wardle Engineering Co., Ltd., Old Trafford, Manchester. 16. Similar pamphlets covering flameproof and glassware fittings have also been received.

Electronic Repeaters.—Details of their electronic repeater which is designed to transmit measurements of level, flow, pressure, temperature and electrical quantities, are given in a pamphlet issued by Messrs. Evershed and Vignoles Ltd., Chiswick, London, W.4.