

## 180-B.H.P. DIESEL CRAWLER TRACTOR.

ALTHOUGH the Vickers VR-180 tractor was first introduced to the public as long ago as November, 1950, and prototype models have been shown at various exhibitions since, details of its design and construction were only released a few days ago. This course was chosen by the makers, Messrs. Vickers-Armstrongs Limited, Vickers House, Broadway, London, S.W.1, not with the idea of covering the machine with a cloak of secrecy, but to

distributed throughout the world by Messrs. Jack Olding and Company, Limited, Hatfield, Hertfordshire, who will also be responsible for servicing arrangements and the supply of spare parts.

The time expended on prolonged testing has been well spent and the resulting machine possesses many novel features. It is illustrated in Figs. 1 and 2, below, in the drawing reproduced in Fig. 3, on page 258, which shows a longitudinal section through the complete machine, and in Fig. 4. In Figs. 1 and 2, it is shown at work with an overhead cable-operated scraper and dozer, respectively, both equipments having been designed and manu-

which is fitted with removable wet-type liners. A nitride-hardened crankshaft is used, and this is supported in the crankcase by seven main bearings, the middle bearing being designed to take the axial loads. Aluminium pistons are fitted; they are joined to the crankshaft by forged-steel connecting rods, all big-end and main crankshaft bearings being of the pre-finished thin-shell type.

In accordance with usual practice, overhead inlet and exhaust valves are employed and these are operated by push rods and rocking levers in the normal manner. Twin cast-iron cylinder heads, each of which covers three cylinder bores, are fitted

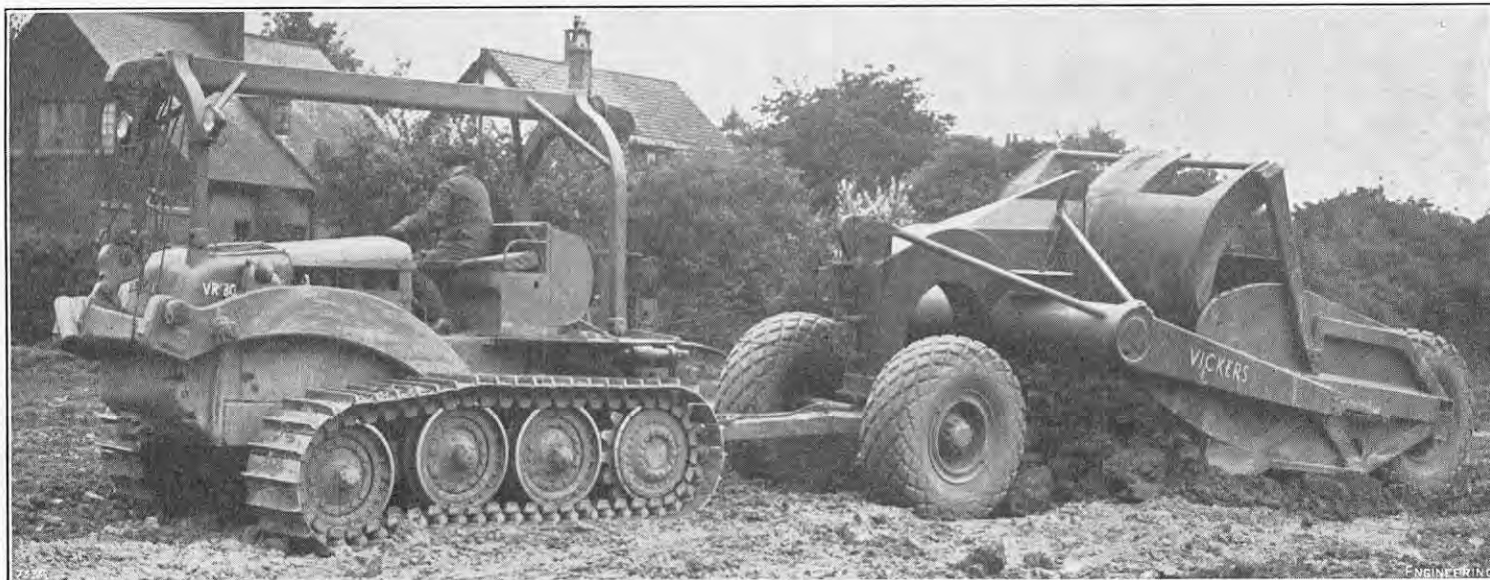


FIG. 1. TRACTOR HAULING SCRAPER OPERATED BY OVERHEAD CABLE.



FIG. 2. TRACTOR AT WORK WITH BULLDOZING ATTACHMENT.

ensure that it was right in every respect before full details were published. With this end in view, prototype and pre-production machines have been subjected to a long programme of tests which involved operating in the most arduous conditions, both at home and abroad. Some machines, for example, have been employed in open-cast coal mines and at the end of last year two pre-production models were dispatched to Australia where, it is understood, they will be employed on the Snowy River hydro-electric project. The tractors will be made at the Scotswood works, Newcastle, of Messrs. Vickers-Armstrongs, part of which is being specially laid out for this purpose, and production is due to begin at the end of next month. Together with their ancillary equipment, they will be dis-

factured by Messrs. Vickers-Armstrongs specifically for use with the VR-180. The power unit is a Rolls-Royce C6SFL six-cylinder in-line supercharged Diesel engine having a bore and stroke of 5.125 in. and 6 in., respectively, and developing 180 belt horse-power at 1,800 r.p.m., the maximum governed speed. The manufacture of Diesel engines was, of course, taken up by Rolls-Royce, Limited, comparatively recently but, like the tractors to which they are fitted, they have a long history of development behind them and incorporate many interesting features. A photograph of the type of unit fitted to the VR-180 tractor is reproduced in Fig. 5, on page 259. Basically, it follows standard Diesel-engine practice, the crankcase and cylinder block being formed by a single iron casting

and they accommodate the fuel injectors in addition to the inlet and exhaust valves. A gear train arranged at the front of the engine transmits the drive to the camshaft, which is situated at the left-hand side of the crankcase. This gear train also drives the fuel-injection pump and the supercharger and, through twin V-belts, the dynamo and coolant pump. An innovation deserving mention is the provision of lugs on the pulley driving the dynamo and pump; these are designed to accept a tommy bar so that the engine can be turned by hand when carrying out adjustments. A separate pulley is fitted to the front end of the crankshaft for driving the fan, the pulley incorporating a viscous-oil type torsional-vibration damper. A drive for a tachometer is provided at the right-hand side of the timing case and provision is made for driving the hydraulic pump used in connection with the implements. As will be seen from the illustration, the supercharger is mounted on the left-hand side of the engine; it is lubricated by the engine main low-pressure system and draws in air through banks of cleaners arranged above the engine.

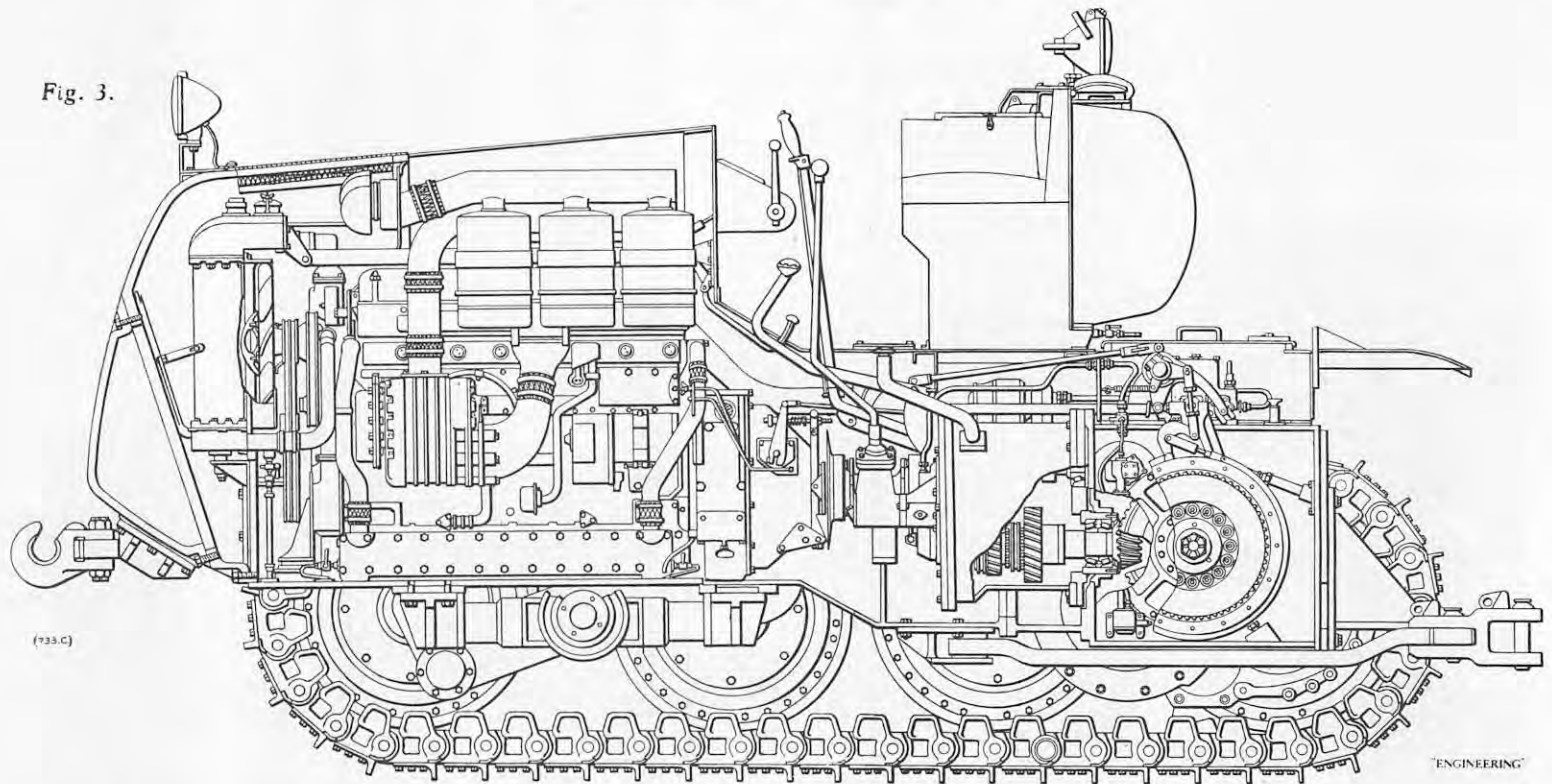
A dry-sump lubrication system is employed so that an adequate supply of oil reaches the main bearings, etc., regardless of the angle at which the tractor is working. Three oil pumps are used, two of which act as scavengers while the third delivers the oil, first through a heat exchanger and then through a triple full-flow filter to the main oil gallery. This supplies the main bearings, the oil passing through drilled ways in the crankshaft and connecting rods to the big-end and little-end bearings. A tapping from the main supply conveys oil at a lower pressure to the camshaft bearings, timing gears, supercharger, etc. The oil cooler is bolted to the left-hand side of the sump and can be seen in Fig. 5, just below the supercharger; it can also be seen in Fig. 8, on Plate XII, which shows the complete sump assembly removed from the engine.

The fuel system is quite straightforward, embodying a lift pump, a self-cleaning edge-type filter, a bank of fabric filters and, of course, the main injection pump. The lift pump is integral with the injection pump and incorporates a hand priming lever for charging and bleeding the system after overhaul. An excess-fuel device for easy starting is

## 180-B.H.P. DIESEL CRAWLER TRACTOR.

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Fig. 3.



provided and the injection pump is fitted with an all-speed governor which, as previously mentioned, limits the engine to a maximum of 1,800 r.p.m. The fabric fuel filters and the full-flow lubricating-oil filters are mounted in accessible positions and—a small point perhaps, but worthy of note—are arranged so that the elements are changed from the bottom, thereby reducing the risk of dirt entering the two systems. The coolant is circulated through the engine and oil cooler by a centrifugal pump situated at the forward end of the leading cylinder head and, as already indicated, driven by twin V-belts from a pulley on the timing case. A thermostat is built into the pump to control the operating temperature of the engine within close limits. The radiator is situated at the forward end of the tractor but the cooling air is drawn in by the fan through horizontal screens located at the forward end of the top engine cowling thereby ensuring that the air is drawn from a zone where it is likely to be most free from dust. It is directed to the front of the radiator through suitable ducts and is discharged through horizontal louvres let into the side panels of the engine cowling. The cooling system operates under a slight pressure and is protected by relief valves. The radiator is shown in position in Fig. 9, Plate XII.

The transmission assembly and the track, together with its associated running gear, have been designed so that higher maximum speeds than are customary with heavy tractors can be achieved. The tractor can travel at approximately 10 miles an hour in top gear. A standard 18-in. dry-plate clutch is used to transmit the drive from the engine to the gearbox, the clutch assembly being located in a bell housing bolted to the rear of the engine and a flexible coupling interposed between the clutch output shaft and the gearbox. The gearbox is designed to give six forward speeds and three reverse speeds, the maximum road speeds in the various ratios being: 2.18 miles an hour in first gear; 3.25 miles an hour in second; 3.76 miles an hour in third; 5.60 miles an hour in fourth; 6.53 miles an hour in fifth; and 9.73 miles an hour in sixth, or top, gear. The three reverse speeds obtainable are 2.66 miles an hour; 4.58 miles an hour; and 7.98 miles an hour. The gearbox is of unorthodox design and actually consists of two boxes built into a single unit. There are four separate shafts, two of which are arranged side by side above the other two shafts, also side

by side, the axes of the four shafts being disposed at the corners of a square when viewed from the ends. This form of construction will, possibly, be apparent from a study of Fig. 11, on Plate XII, which shows the gearbox without its covers and removed from the tractor. The upper two shafts provide high-ratio, low-ratio and reverse while the lower set of gears gives three relative speeds in each particular ratio. Constant-mesh helical gear-wheels are used throughout, including reverse, and the different ratios are brought into use by sliding dog clutches; gear-changing, as a consequence, can be accomplished when the tractor is moving, an important advantage on a machine of this class and one that leads to easier control in conjunction with higher average speeds. Although there are six speeds, the change from bottom gear to top gear can, if required, be achieved with only three movements of the gear lever.

The drive from the gearbox, or change-speed section, of the transmission to the right-hand

and left-hand track-driving sprockets is identical, many of the parts being interchangeable. Steering is accomplished by means of combined clutches and brakes in the usual manner, the drive being transmitted from the gearbox to the clutch shaft through a spiral-bevel crown-wheel and pinion assembly. Multi-plate steering clutches are used, each clutch incorporating 16 friction surfaces. The drive is transferred from the input to the output side by serrated, or "toothed," fabric discs which are held in contact with the pressure plates by a series of coiled springs. These, together with the serrated fabric discs, can be seen from the photograph of one of the clutch assemblies reproduced in Fig. 10, on Plate XII, where it is shown removed from the tractor and from which it will be noted that there are 15 coiled springs. The clutches are operated by an automatic hydraulic-servo system controlled by the steering levers, oil for this purpose being supplied under pressure by a seven-cylinder pump driven from the gearbox. It will be appre-

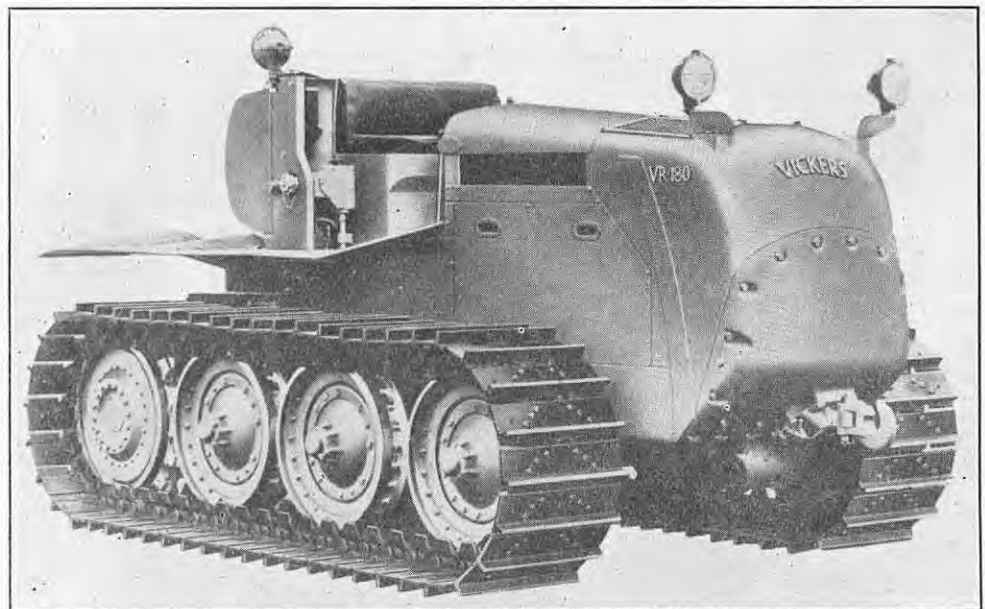


FIG. 4. STANDARD VR-180 TRACTOR.

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(For Description, see Page 257.)

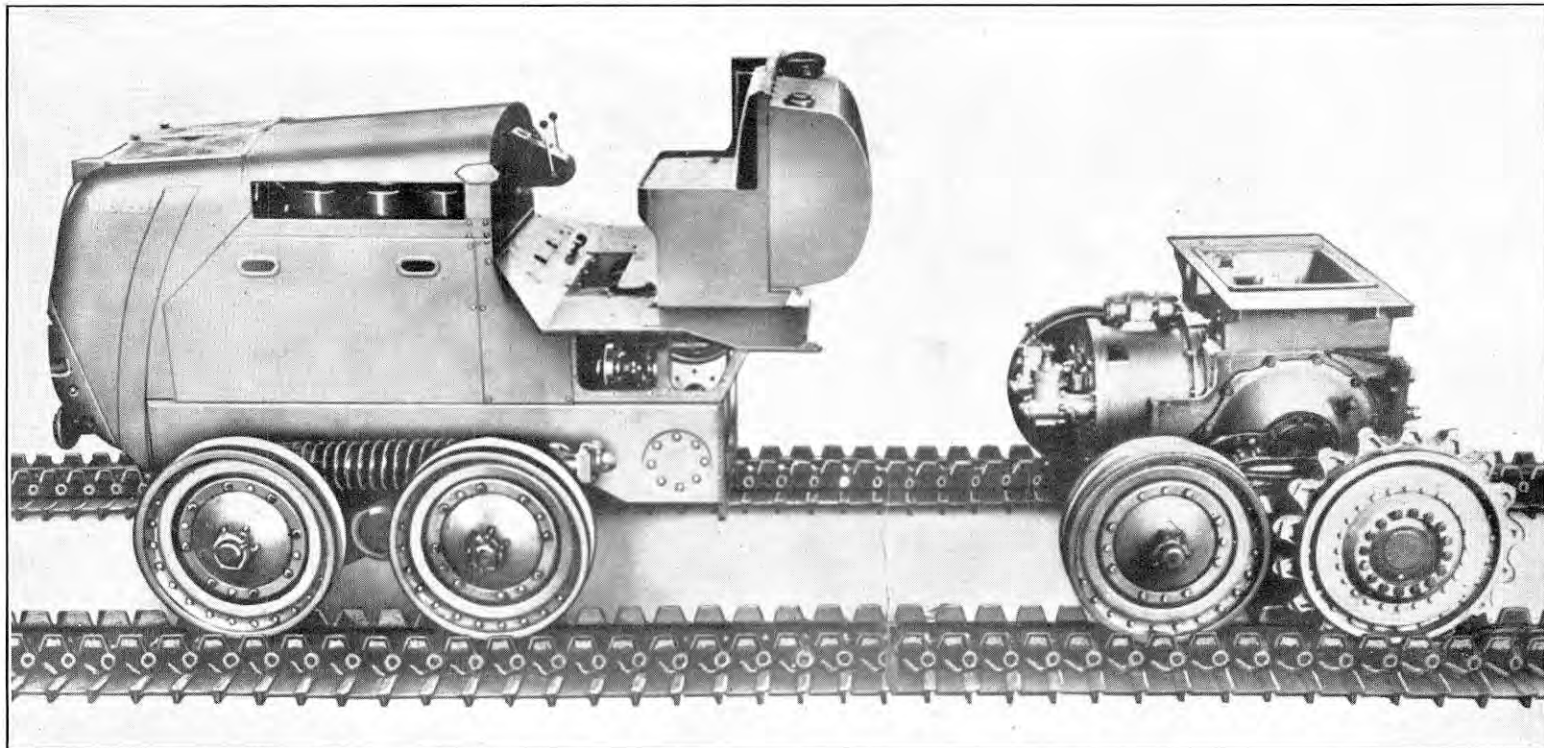


FIG. 7. FRONT AND REAR MAJOR ASSEMBLIES SEPARATED.

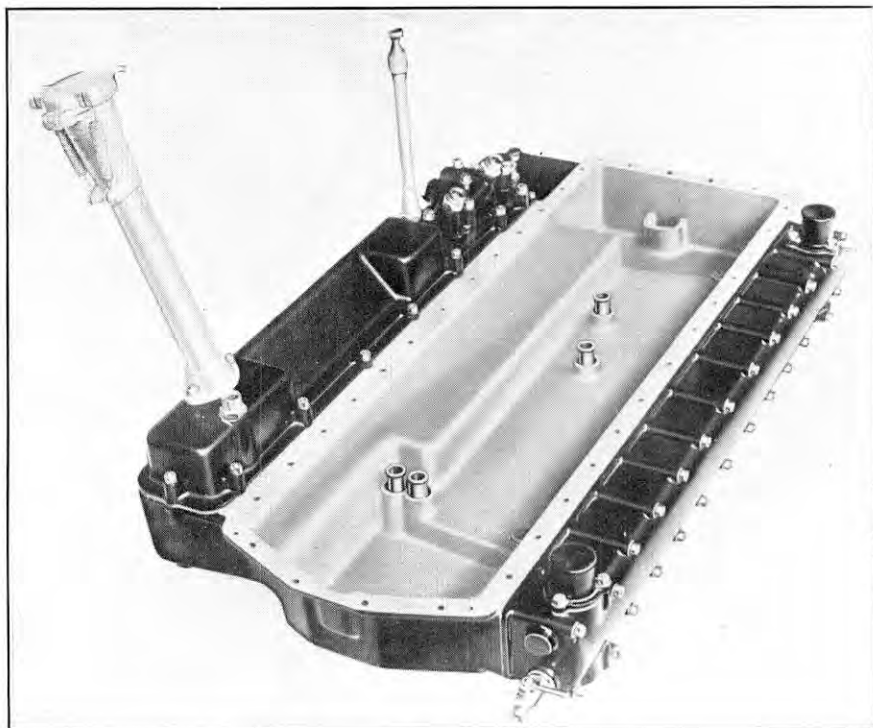


FIG. 8. ENGINE SUMP AND OIL COOLER.

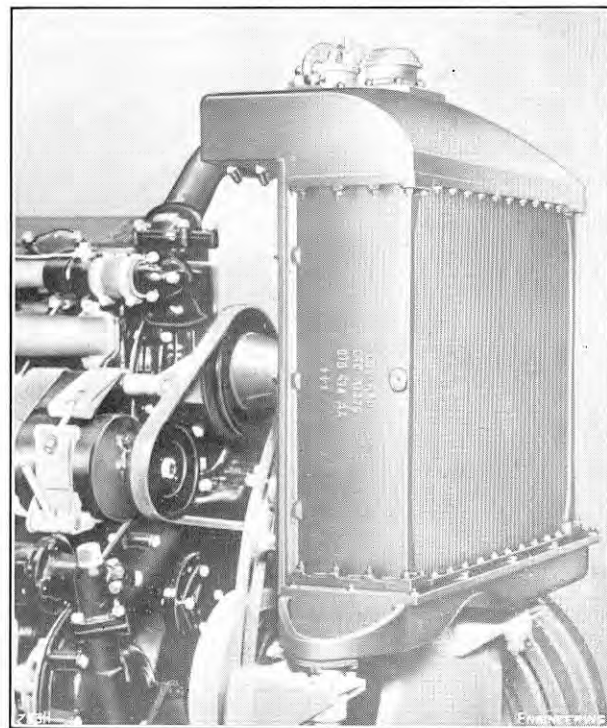


FIG. 9. RADIATOR ASSEMBLY.

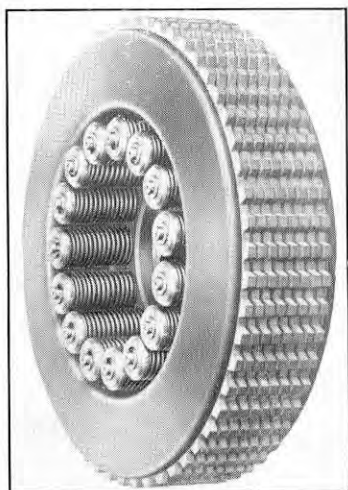


FIG. 10. STEERING CLUTCH.

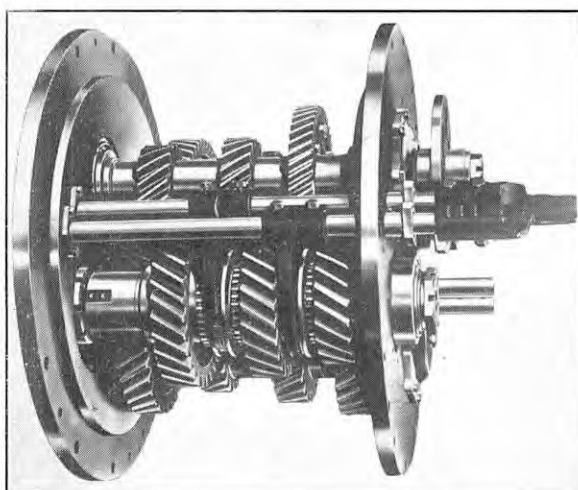


FIG. 11. GEARBOX PARTLY DISMANTLED.

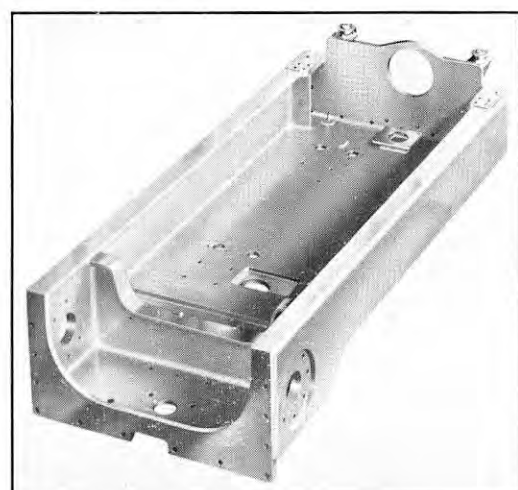


FIG. 12. TRACTOR HULL.

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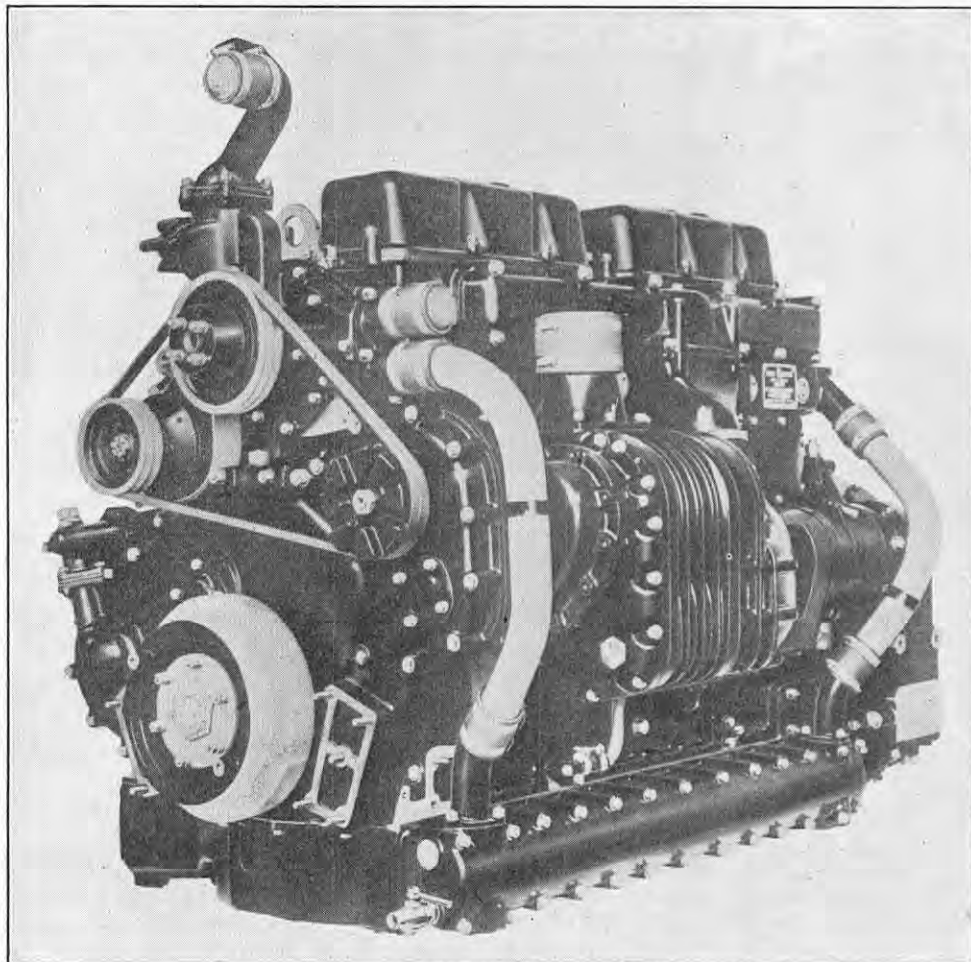


FIG. 5. 180-B.H.P. ROLLS-ROYCE DIESEL ENGINE.

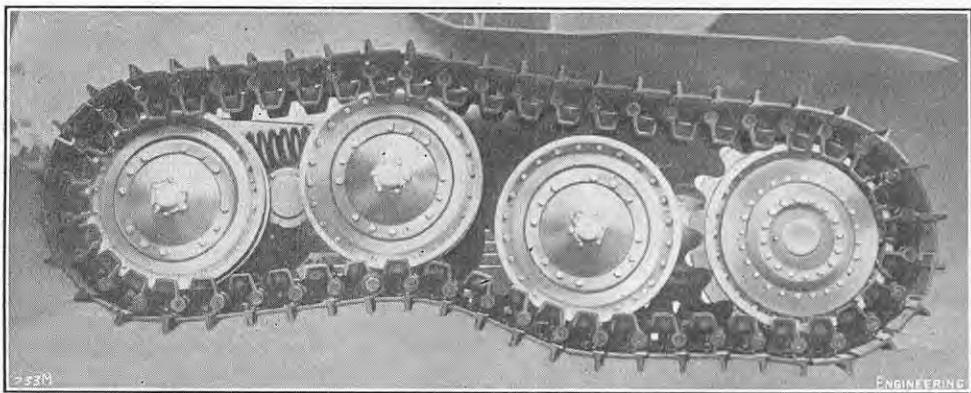


FIG. 6. WHEEL DISPLACEMENT WHEN NEGOTIATING ROUGH GROUND.

ciated that, with this system, it is impossible to release the clutches when the tractor is at rest with the engine stalled—a valuable safety feature. Externally-contracting band brakes operating on the driven portions of the clutches are used and these are applied independently by the steering levers with an over-riding foot control for applying both brakes simultaneously. When each steering lever has been moved far enough to disengage the appropriate steering clutch, a definite resistance is felt which has to be overcome before the brake is applied, this feature being incorporated to reduce unnecessary brake wear. Three-piece brake shoes are used; they can be removed for re-lining, etc., without dismantling the transmission assembly.

Final drive to each track is through spur reduction gearing and a gear train, the latter being arranged inside a casing which forms an integral part of the track-suspension system. The driving sprockets and the track wheels are of large diameter, occupying the full depth between the upper and lower parts of

the track—a factor which adds to the cross-country performance, and, to give smoother riding qualities, they incorporate resilient mountings. This is accomplished by dividing the wheels into two parts, namely, a hub and an outer rim, which are insulated from each other by rubber rings compressed between external flanges on the periphery of the hub and internal flanges formed on the inner periphery of the rim. Two rings are fitted to the track wheels and four rings to the driving sprockets; as a consequence, only one flange is required on each track wheel hub and two on the associated rim, the rubber rings being disposed one at each side of the hub flange. The hubs for the sprocket wheels, on the other hand, have three flanges, the rubber rings being arranged in pairs at each side of the central hub flange and each pair of rings, in turn, separated by the flanges on the rim. It will be appreciated that this arrangement is somewhat similar to a multi-plate clutch permanently in engagement, the hub corresponding to the driving member and

the rim to the driven member. To enable the rings to be installed, the rims of the track wheels and sprocket wheels are divided, the two halves being bolted together to compress the rings, and the outer flanges on the driving-sprocket hubs are removable and are bolted in position.

In addition to dampening the high-frequency vibrations transmitted by the wheels to the frame, or "hull," of the tractor, the rubber rings in the driving sprockets also remove some of the snatch in the drive to the tracks. Observed tests have shown that the rings permit relative movement between the inner and outer sections of the sprocket amounting to as much as  $\frac{3}{8}$  in. when the clutch is engaged and full torque passes through one track. The rings have a long life and, in view of the bolted construction of the rims, sprockets and sprocket hubs, are easily replaced. Taper-roller bearings are fitted to all track wheels and the sprocket hubs; to prevent the ingress of dirt, etc., and the loss of lubricant, double oil seals are provided for each bearing, a dirt trap being arranged between the two seals.

The design of the tracks and their associated running gear is probably the outstanding feature of the tractor. The suspension is fully articulated and enables the machine to surmount large obstacles without losing speed, straining the hull or unduly disturbing the driver. To achieve this, the four wheels at each side are arranged in pairs, the forward pair being supported at the ends of a beam parallel to the longitudinal axis of the tractor and free to pivot about its centre, and the rear pair by the casing containing the final drive gear train which is also free to pivot about its centre. The effectiveness of this arrangement will be clear from Fig. 6, which shows a track negotiating some rough ground. To prevent the imposition of undue wracking strains on the hull, the pivot points for the two front beams are incorporated in the ends of an axle which extends across the front of the tractor and is free to move about a central pivot arranged along the longitudinal axis of the tractor, thereby giving three-point suspension. Correct track tension is maintained by a coiled spring incorporated in each front-beam assembly, the stub axle for each leading wheel being fitted to a swinging link, the lower end of which pivots about the beam while the top end reacts against the thrust of the spring; the tendency is, therefore, for the two wheels to move apart, this tendency being resisted by the track.

To allow the articulated suspension to operate freely, the track is designed so that it can flex in both directions, as shown in Fig. 6. Normally, such a large degree of relative movement between each track component would cause rapid wear of the track pins, so therefore sealed pins operating in small oil baths are used. Special rubber washers, which are compressed during assembly, form the oil seals and it is claimed that, once each unit is filled with oil, no further attention is required until overhaul. To assist in maintenance, removable master pins are provided at three points of each track, thereby ensuring that when it becomes necessary to remove a track, one of the pins is in an accessible position. The gauge of the tracks, measured from centre to centre, is 6 ft. 8 in. and the length of track in contact with the ground 8 ft. 8 in., this dimension being the distance from the drive sprocket centre to the centre of the leading track wheel. The width of the standard track shoe is 24 in. and the area of track in contact with the ground is therefore 4,992 sq. in.

The hull of the tractor, which is illustrated in Fig. 12, on Plate XII, is an exceptionally rigid structure, being built up mainly from  $\frac{3}{8}$ -in. thick steel plate. It is suitably cross-braced and stiffened and, in addition to supporting the engine, it carries the front suspension unit and cooling system and entirely encloses the sump and oil reservoir, making additional protection of these parts unnecessary. The tractor may be considered as two separate groups, namely, front and rear groups, the front group being made up from the hull, engine, front suspension, cooling system, etc., and the rear group from the transmission and rear suspension. These two groups are designed so that, when major overhauls are necessary, they can be moved apart on the tractor wheels, as shown in Fig. 7, on Plate

XII. The transmission unit is joined to the hull by fourteen  $\frac{3}{4}$ -in. diameter bolts and it is claimed that the two units can be separated on the uncoupled tracks, as shown in the illustration, in less than two hours. This method of unit construction permits either unit to be removed for overhaul without the need to move the complete machine to a repair depot. The idea of unit construction has been extended to many of the sub-assemblies, so that maintenance work is reduced to an absolute minimum.

The machine is provided with the usual accessories, the electrical equipment including a 24-volt starter-motor taking current from four 6-volt heavy-duty 185-ampere-hour batteries connected in series. The batteries are charged by a  $5\frac{1}{2}$ -in. dynamo, but, in case they become discharged, an auxiliary starter socket is provided at the side of the driver's seat so that the system can be coupled to another tractor or a spare set of batteries. Cable for this purpose forms part of the standard equipment and, when not in use, watertight screwed caps with captive chains protect the sockets. The lighting system includes two headlamps protected by wire-mesh stone guards, and a spotlight, which is to be mounted at the rear of the driver. The leads to these lamps are provided with adaptors so that, when required, they can be removed easily, the associated sockets on the tractor being rendered weatherproof by screwed caps. With the exception of those for lamps, all cables pass through armoured and sealed conduits.

The drawbar pull of the tractor varies, of course, with the speed, but during manufacturer's tests on pre-production models, the following drawbar pulls were recorded at rated engine speed: first gear, 26,100 lb.; second, 17,000 lb.; third, 14,500 lb.; fourth, 8,240 lb.; fifth, 6,720 lb.; and sixth gear, 3,140 lb. At maximum engine torque, the drawbar pulls are, of course, considerably greater, the calculated figure for first gear being 29,500 lb., and for sixth, or top, gear, 3,600 lb. In view of its power, the overall dimensions of the unit are remarkably small, the length being only 14 ft. 8 $\frac{3}{4}$  in., the height, 7 ft. 2 $\frac{3}{4}$  in., and the width, 8 ft. 8 in. The weight varies according to the equipment but the bare tractor, as shown in Fig. 4, weighs approximately 32,500 lb.

## LITERATURE.

### *Combustion, Flames and Explosions of Gases.*

By BERNARD LEWIS and GUENTHER VON ELBE. The Academic Press, Incorporated, 125, East 23rd-street, New York 10, U.S.A. [Price 13.50 dols.]

A FLAME, as every schoolboy should know, results from the chemical combination of some gaseous substance with oxygen, and this knowledge suffices for most practical purposes. The physicist, however, is not so easily satisfied. He knows that the chance of complete molecules combining directly with their "opposite numbers" is exceedingly small, though they may meet in collision many millions of times per second. In general, a gas reaction appears to be of a complex nature, and has to be brought about by a series of so-called "chain reactions" originated by a comparatively small number of free atoms of one or both of the gases. One of these atoms, on striking a molecule, may take the place of one of a different kind, and the latter, in its turn, will perform a corresponding operation on another molecule, and so on. A collision between two atoms will not result in the formation of a diatomic molecule, because the energy of the collision will instantly blow them apart again unless there happens to be some third molecule involved in the process and capable of absorbing the excess energy. The principles of statistical mechanics enable the number of collisions per second in unit volume of gas to be calculated, but what proportion of them will be effective is another question. Again, the overall rate at which the reaction proceeds may be enhanced by the catalytic effect of surfaces in contact with the gas, or retarded by the breakage of the reaction chains when the carriers come into contact with the surfaces. There is also the effect of the rise of

temperature caused by the reaction which may enable the latter to progress with explosive speed if the heat is allowed to accumulate in the gas.

Since molecular behaviour must always be a matter of inference instead of direct observation, it is not surprising that detailed knowledge of the combustion of gases in general is still very scanty. Nevertheless, much has been done during recent years to arrive at the fundamental facts, and the authors of the present book, who are on the staff of the Explosives and Physical Sciences Division of the United States Bureau of Mines, are to be thanked for having summarised the knowledge obtained for the benefit of those whose interest lies in the theory of combustion phenomena. The volume, which contains about 800 pages, is divided into four parts, of which the first deals with the chemistry and kinetics of the reactions of fuel gases with oxygen. The hydrogen reaction is now thought to be fully understood, and that of carbon monoxide less completely, while the burning of the hydrocarbons, which is much more important from the practical point of view, still requires a great deal more research for its elucidation. Among the phenomena of engineering interest, that of the shock wave produced in engine cylinders by the accelerated combustion of the charge due to its auto-compression after firing, and commonly recognised as "engine knock," is discussed at some length. The critical compression ratios of more than a hundred hydrocarbon fuels are tabulated, as well as the relative merits of over a score of anti-knock substances, of which tetra-ethyl lead is by far the most effective.

The second and longest section is concerned with flame propagation. After explaining the principles of the Schlieren and other methods of flame photography, and the apparatus used for measuring the pressure rise in explosions, the stability of burner flames and the action of electric sparks in initiating combustion are also considered. In the third section, the calculation of explosion pressures, temperatures and flame volumes from data derived from the analysis of band spectra is described, but the reader is supposed to be familiar with the experimental work involved, and to understand, without any explanation, the meaning of such phrases as "The spectrum of the molecule having been ordered and the term scheme obtained . . ." Moreover, other things that he might particularly like to know are more than once stated to be "outside the scope of this book," though references to available sources of information are given. Up to this point, the book has been eminently one for specialists equipped with a thorough knowledge of the chemistry of the hydrocarbons and familiar with statistical and quantum mechanics. Others may find it decidedly difficult to follow, mainly on account of the condensation necessary to cover such an immense field. The remaining and shortest section is the one that will make the most direct appeal to engineers, though they may not find much in it with which they are not already conversant. Industrial furnaces are disposed of in less than four pages, as being outside the scope of the book, and another 20 pages suffice to cover the cycles of the Otto and Diesel engines, the gas turbine and the turbo-jet engine. Discussions of the combustion processes in the piston engines, and of the stabilisation of flames in fuel jets complete the volume, except for appendices containing tables and data required in combustion calculations.

### *Man and the Chemical Elements: from Stone-Age Hearth to the Cyclotron.*

By DR. J. NEWTON FRIEND. Charles Griffin and Company, Limited, 42, Drury-lane, London, W.C.2. [Price 27s. 6d. net.]

THIS book is not easy to classify. A note on the jacket states that "it may be read with profit by the student, with interest by the chemist, and with enjoyment by all." The claim in reference to the student may certainly be admitted and that the author has had students in mind during its compilation is shown by the fact that it contains two footnotes directed to them, one reminding them how to spell fluorspar and the other that data is a plural noun. These notes are presumably reflexes from minor causes of irritation met with in examina-

tion papers. The chemists, as claimed, will read the book with interest, but "all," who may be taken to be general readers, will at times find themselves in deep waters. It is also stated on the jacket that the pages of the book are not "strewn with obscure chemical equations or strange cabalistic-seeming formulæ." They are certainly not so "strewn," but in places Dr. Friend quotes formulæ which the general non-scientific reader will certainly not understand.

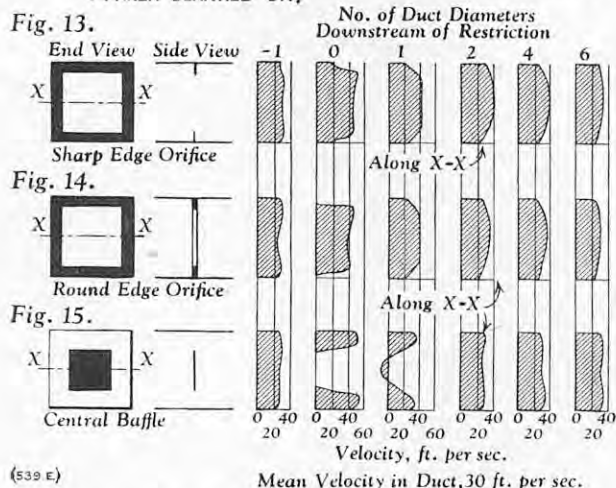
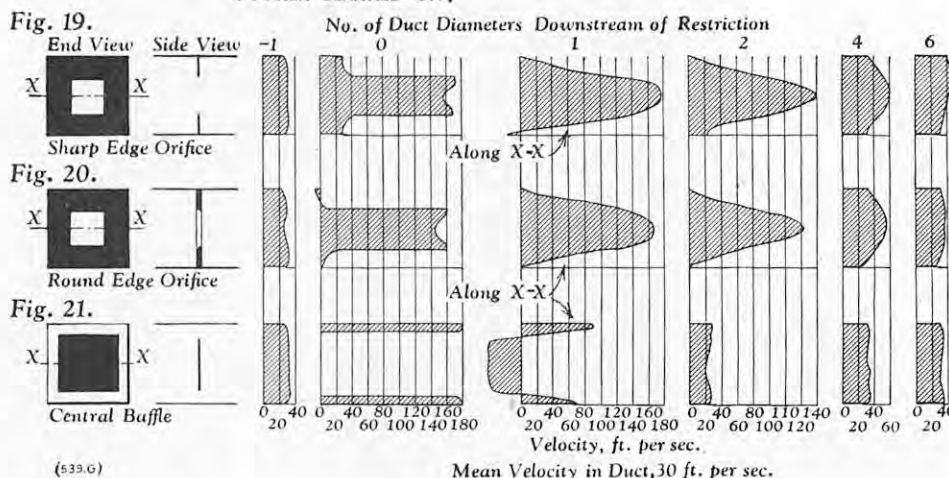
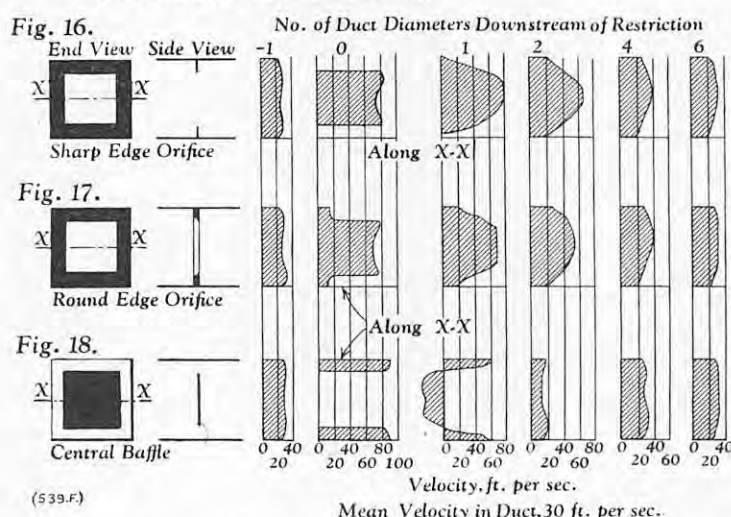
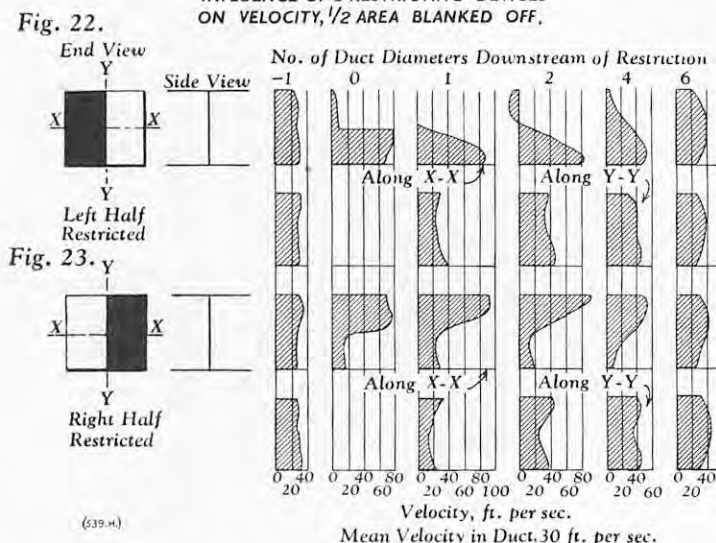
The scheme of the book is to describe, in turn, the discovery, nature and uses of the various elements. By far the greater part of its contents are concerned with discovery and isolation, and although in some cases, as, for instance, in connection with what the author terms "the coinage metals," a good deal is said about their use in practice, in general the manner in which the various elements are employed in modern life is dealt with but briefly. This is reasonable; a dissertation on the various ways in which iron is now used would be likely to be neither interesting nor profitable. The purposes for which it was used in ancient days is, however, another matter. The history of its discovery and separation from its ores is closely bound up with its uses. This applies throughout, and when Dr. Friend records that copper was probably the first metal known to the Egyptians, the statement is naturally based on the evidence of material objects found in tombs.

It is recorded in the preface that "information has been culled from many and varied sources." There is no doubt about the validity of this claim. The number and variety of the references given is remarkable; they range from the works of Pliny and *The Canterbury Tales* to the *Journal of the Institute of Metals*. The mass of information accumulated has been built up into a fascinating story. Numerous incidents are recorded and anecdotes related, many amusing, some undoubtedly apocryphal, but all entertaining. The theoretical scientific matter occupies but a small part of it, and the general reader is likely to find it both attractive and instructive. It should be valuable to students in adding human interest to the sometimes arid matter of their text-books, and in recounting how modern knowledge of the various elements was built up; by its account of various false starts, and now-disproved explanations, it may remind them that even the most positive text-book statement is not necessarily conclusive.

The chapters of the book deal, in turn, with the various groups of elements under such titles as "The Permanent Gases," "The Sulphur Group" and "The Iron Group," etc. In some few cases, the application of metals in practice is dealt with in some detail and in the chapter on "Lead, Tin and Mercury," there is an interesting history of the development of the thermometer. As mentioned earlier, the use of metals in coinage is given considerable attention. Some doubt may be felt about the implication, made on pages 87 and 137, that if coinage metals expanded on solidification, coins might profitably be cast instead of being stamped. This is not the only case in which Dr. Friend tends to repeat himself. On both pages 290 and 297 he refers to the properties of invar in almost identical words, and, incidentally, shows that his subject index is not perfect, as in it neither of these page numbers is given under the word.

LAST "BROWN" POLARISED TRACK RELAY.—On February 9, the signal engineer of London Transport, Mr. R. Dell, presented to Mr. Donald Brown one of the last polarised direct-current track relays which were designed by Mr. Brown's father, the late Mr. H. G. Brown. The system of using two polarised relays to prevent interference between the traction circuit and track circuits was evolved by Mr. H. G. Brown when he was employed on the Elevated Railway in Boston, U.S.A. Mr. Brown, who became managing director of the Westinghouse Brake and Signal Company (the post now held by his son), introduced this system of signalling throughout the District Railway, and later it was adopted for the newly constructed Piccadilly, Bakerloo and Hampstead tube lines. The last Brown direct-current relays were removed from service in the Whitechapel signal cabin on November 17 last, after being in use for 46 years. That presented to Mr. D. Brown was suitably inscribed with its record of service.

## FLUE-DUST SAMPLING.

INFLUENCE OF VARIOUS RESTRICTING DEVICES ON VELOCITY,  
1/4 AREA BLANKED OFF.INFLUENCE OF VARIOUS RESTRICTING DEVICES ON VELOCITY,  
3/4 AREA BLANKED OFF.INFLUENCE OF VARIOUS RESTRICTING DEVICES  
ON VELOCITY, 1/2 AREA BLANKED OFF.INFLUENCE OF 2 RESTRICTING DEVICES  
ON VELOCITY, 1/2 AREA BLANKED OFF.THE COLLECTION OF A  
REPRESENTATIVE FLUE-  
DUST SAMPLE.By A. FITTON, B.Sc., A.M.I.Mech.E., and  
C. P. SAYLES, M.A. (Cantab).

(Concluded from page 230.)

At the time when the experimental work was suspended, 17 restricting devices had been examined. These are briefly described below and are illustrated in Figs. 13 to 31, on this page and on page 262.

## Baffles.

1. Restrictions which blank off a quarter of the area of the duct (Figs. 13 to 15):
  - (i) Square orifice, sharp edge.
  - (ii) Square orifice, round edge.
  - (iii) Central square baffle, sharp edge.
2. Restrictions which blank off half the area of the duct (Figs. 16 to 18):
  - (i) Square orifice, sharp edge.
  - (ii) Square orifice, round edge.
  - (iii) Central square baffle, sharp edge.
3. Restrictions which blank off three-quarters of the area of the duct (Figs. 19 to 21):
  - (i) Square orifice, sharp edge.
  - (ii) Square orifice, round edge.
  - (iii) Central square baffle, sharp edge.
4. Off-set restrictions which blank off half the area of the duct (Figs. 22 to 27):
  - (i) Flat plate in left half of duct, sharp edge
  - (ii) Flat plate in right half of duct, sharp edge.
  - (i) Flat plate in top half of duct, sharp edge.
  - (ii) Flat plate in bottom half of duct, sharp edge.

- (i) Curved plate in bottom half of duct
- (ii) Curved plate in top half of duct.

## Nozzles.

As none of the baffles listed in the preceding paragraphs gave uniform distribution, attention was directed to nozzles. These were a square nozzle which blanked off half the area of the duct (Figs. 28 and 29); and a square nozzle which blanked off two-thirds of the area of the duct (Figs. 30 and 31).

The velocity distributions at sections of the duct are shown in Figs. 13 to 31 for the restricting devices when operating at a mean air velocity in the duct of 30 ft. per second. Additional velocity explorations at a mean velocity of 50 ft. per second were made with the two nozzles and the results are reproduced in Figs. 28 to 31.

In most cases, during the tests with an air velocity of 30 ft. per second, the dust samples were collected at the centre of the duct at each section at the appropriate velocity at that point. In the case of the off-set restricting devices, Figs. 22 to 27, however, dust samples at sections 2, 3 and 4 were collected at positions in the centre line of the aperture and not at the centre of the duct. The main results of these tests are given in Table I, page 262, which also includes the pressure loss in inches w.g., due to each restricting device.

An examination of Table I shows that the restrictions which blank off a quarter of the area of the duct are ineffective for the purpose of obtaining representative samples of dust at a single point. With these, even as far as six duct diameters downstream of the restrictions, the dust sample is seen to be far from representative. At the other extreme, with the devices which blank off three quarters of the area of the duct, the pressure loss is seen to be much greater than could be tolerated in practice.

Of the remainder, the off-set devices which blank off half the area of the duct, though giving great

turbulence, are seen to be unsuitable. On the other hand, the symmetrical devices which blank off half the area of the duct give useful information, particularly those with the central opening. Referring to Table I, it will be noted that, with these restrictions, progressive improvement for conditions of sampling at a single point takes place with reduction of turbulence caused by the restriction, i.e., the round-edge orifice is more effective than the sharp-edge orifice and, in turn, the nozzle is more effective than the round-edge orifice.

For ease of further examination, the results on the four symmetrical devices which blank off half the area of the duct are reproduced in graphical form in Fig. 32, on page 263, which shows the dust concentration at the centre of the duct plotted against the distance of the sampling point from the restricting device. It will be noted that the nozzle type of restriction is outstandingly superior to any of the other devices. Over a length of duct from  $1\frac{1}{2}$  to 6 duct diameters downstream of the nozzle, the maximum divergence from the mean concentration is only 10 per cent. This nozzle has the additional merit that the pressure loss is less than the other devices, the results of which are shown in Fig. 32, being only 0.29 in. w.g. at a mean air velocity of 30 ft. per second. For the same velocity at higher temperatures, it would be even smaller.

Additional tests were made with two nozzles using a mean air velocity of 50 ft. per second; a velocity which is probably higher than that which would have to be dealt with in boiler flues. The results of the tests with the nozzle which blanks off half the area of the duct are also shown in Fig. 32 by a chain-dotted line. The curve drawn through the experimental points is of the same general shape as that for the tests at a velocity of 30 ft. per second; but, for the same divergence of 10 per cent. from the true dust concentration, the length of duct for sampling is confined to the length



## FLUE-DUST SAMPLING.

Fig. 32. INFLUENCE OF TYPE OF RESTRICTION ON DUST CONCENTRATION AT CENTRE OF DUCT.

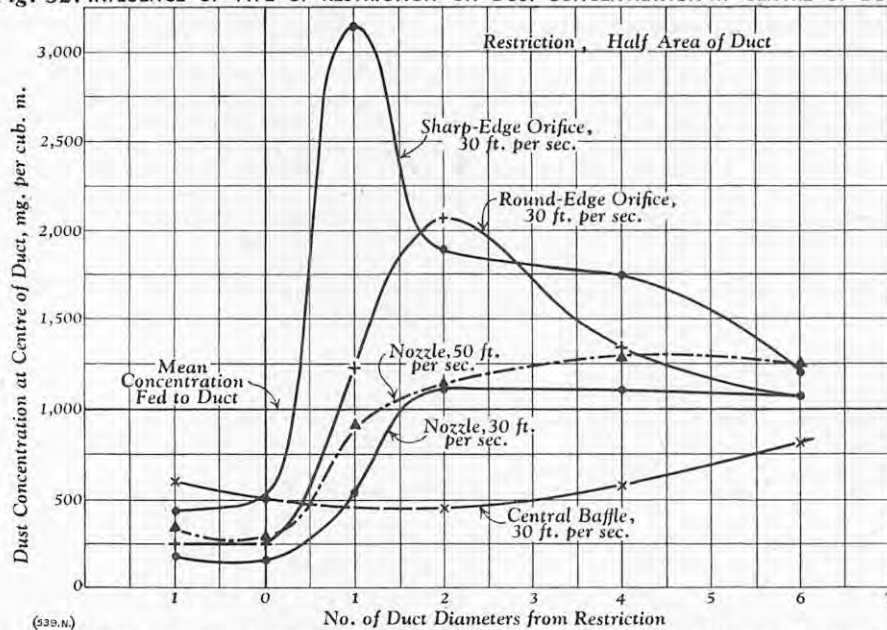
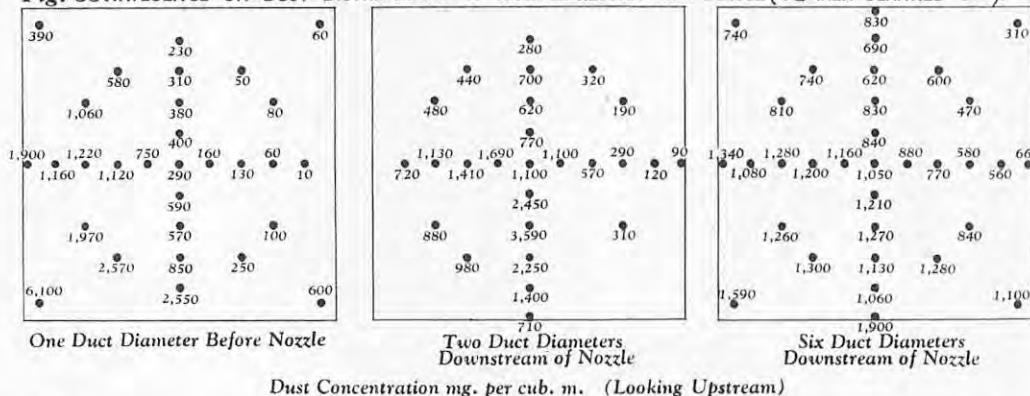
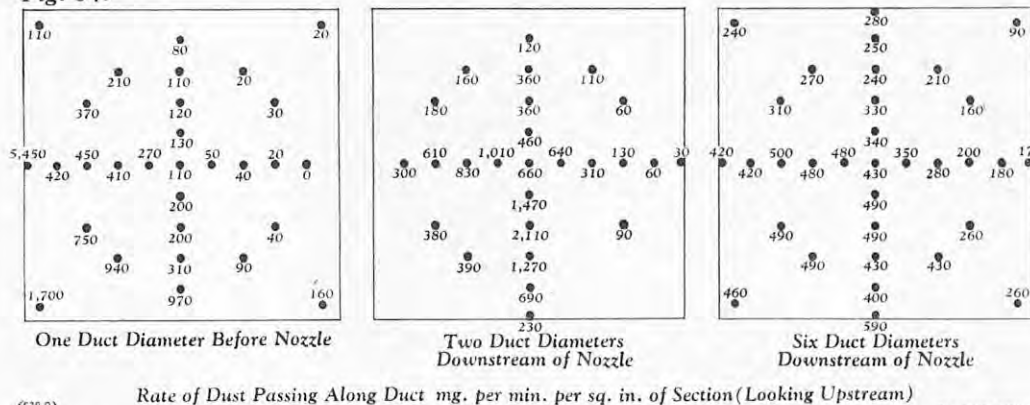
Fig. 33. INFLUENCE ON DUST DISTRIBUTION OF NOZZLE RESTRICTING DEVICE ( $\frac{1}{2}$  AREA BLANKED OFF).

Fig. 34.



stream of the nozzle, the divergence from the dust concentration at the centre is reduced to 4 per cent.

From consideration of the nozzle as a mixing device, the results show that it reduces the variation of measured dust concentration over a section before the nozzle from 610 : 1 to a variation over a section six duct diameters downstream of the nozzle of 5 : 1. This is a great improvement, but there is obviously margin for further improvement. Taking into consideration all the aspects of the work done, the results indicate that a nozzle which restricts half the area of the duct would enable a reasonably representative sample of dust to be collected at the centre of the duct at a distance some four to six duct diameters downstream of the nozzle.

Though this experimental work was terminated before a final solution to the problem was obtained, it is considered that the knowledge gained may be applied immediately to full-scale plant with advantage. For example, a nozzle could be installed in the boiler flue of a new power station without great difficulty and provision made to examine completely the distribution of gas velocity and dust concentration at a section, say, four diameters downstream

of the nozzle. From an examination of the results obtained, it should be possible to select a point at which the sample collected would be representative of the whole dust. From then onwards, single-point sampling would be adequate for all routine test work, provided that the tests were carried out at the normal load. For other conditions, additional calibrations might be necessary. Further development work could take the form of an investigation into the effect of the shape of the nozzle on the distribution of gas velocity and concentration of dust.

EXHIBITION OF MEASURING EQUIPMENT.—Alfred Herbert, Ltd., are arranging to hold an exhibition of modern measuring equipment in their Glasgow show-rooms at Montrose-avenue, Hillington, Glasgow, S.W.2, from March 10 to 21. The exhibition will be open from 10 a.m. till 6 p.m. on Mondays to Fridays, and from 10 a.m. till 4 p.m. on Saturday, March 15. The equipment will include Sigma automatic, semi-automatic and hand-operated multi-dimension inspection machines, Hilger projectors, Watts Microptic measuring machines, optical dividing heads, and a general range of smaller measuring equipment.

## THE ENGINEERING OUTLOOK.

IX.—THE LIGHT ELECTRICAL INDUSTRY, AND THE ELECTRIC WIRE AND CABLE INDUSTRY.

At the outset, it seemed that 1951 would be a very difficult year for light electrical engineering. The shortage of copper and other raw materials made it unlikely that any sections would be able to increase their output. Some manufacturers, more particularly those producing consumer goods, had reason to fear a falling demand on the home market, especially after the Budget and the doubling of purchase tax, on a wide range of electrical goods, from 33½ per cent. to 66½ per cent. Other manufacturers, mainly those manufacturing wireless equipment and instruments, were faced with the difficult transition to re-armament production; and, for all, the necessity of maintaining exports was as urgent as ever. In the event, conditions proved to be much more favourable than was expected. The production of all the items listed in Tables I and II, on page 264, which are taken from the *Monthly Digest of Statistics*, was higher in 1951 than in 1950. The output of electric irons and vacuum cleaners was 11 per cent. higher, of radio sets 12 per cent. higher, of television sets, electric kettles and washing machines 13 per cent. higher, and of domestic refrigerators 14 per cent. higher. The volume of goods exported was a record.

As will be seen from Table III, taken from the *Trade and Navigation Accounts*, the value of the categories listed, 70.2l. millions in 1951, was 23 per cent. higher than in 1950. Output and export figures, however, present too optimistic a picture. There is always some time-lag before they react to changes in demand, and in this case there are further complications as a result of the seasonal fluctuations in sales of domestic electrical appliances and the increase in purchase tax in April. Before the Budget, sales were increased by anticipatory buying and continued for some time at a high level, while retailers' stocks of goods carrying the lower purchase tax lasted. Then followed the normal summer seasonal drop in sales, and it was not until autumn that the fall in demand was really apparent. This was partly offset by increased exports, but production began to fall off in the winter.

According to some statistics published by the Radio and Television Retailers' Association, the number of radio sets sold per shop per month in 1951 rose to 17.26 in April, compared with 8.90 in April, 1950; but by October, 1951, it had fallen to 9.48, compared with 15.22 in October, 1950. Production in October—200,000 sets—was, nevertheless, still 16,000 sets higher than in October, 1950. In November, however, it had fallen to 156,000 sets, compared with 209,000 sets in November, 1950, though production for export had increased by 19,000 to 50,000 sets. In the radio industry, falling demand is particularly serious, for, if they are to cope successfully with the heavy load of re-armament orders, they must be able to retain their skilled labour. The full extent of the re-armament burden to be borne by the radio industry is not yet accurately known, though a rough estimate of 80l. millions over the three years was made by the Ministry of Supply early in 1951. It will, however, almost certainly be much greater. Orders for 50l. millions had already been placed by the autumn of 1951. The total output of the industry in 1950 was valued at 75l. millions, of which domestic receivers accounted for 42l. millions, exports 18l. millions, defence 6l. millions, industrial users and the mercantile marine 8l. millions, and the Post Office and British Broadcasting Corporation 1l. million. At its peak, re-armament work will account for at least half of the output of the industry, and this means that much of it will have to be undertaken by manufacturers of domestic receivers, who already employ 125,000 persons and produce 56 per cent. of the industry's output.

The Select Committee on Estimates, who reviewed the proposed expenditure on re-armament, realised the dangers of a fall in the demand for domestic receivers and recommended that the Ministry of Supply should accelerate the placing of orders in order "to take up any slack in output." This, however, is not easy to arrange. Much of the defence

work, initially at least, consists of heavy and very intricate equipment, such as large radar installations, which cannot be handled by the factories manufacturing receivers. The subcontract work which these latter can conveniently handle must come later. Much of the defence work takes the form of providing ancillary radio equipment for aircraft, tanks, etc., and, as was explained to the Select Committee, it may take six months from the time of drawing up the original programme of aircraft construction to work out the radio and component requirements. Moreover, the Air Ministry maintain that, in many instances, long delay is justified in the interest of getting into service the very latest equipment available. The Ministry of Supply, in response to the Select Committee's plea for urgent action to improve the "present system of negotiation between the Ministry of Supply and the radio industry," announced in July that a Radio Advisory Council was to be formed and a Director-General of Radio Production appointed. This, it is hoped, will make the transition from civilian to military production as smooth as possible.

The shortage of materials, particularly copper, zinc and nickel, are creating problems almost as acute as the gap in demand. The nickel shortage was perhaps the most serious in 1951; some component manufacturers complained in the summer that they were getting only 10 per cent. of their requirements. The valve manufacturers, who account for most of the nickel consumed by the radio industry and have a capacity of between 25 and 30 million commercial valves a year, which, if necessary, could be increased by 50 per cent., have succeeded, however, in maintaining their output fairly well. Meanwhile, the supply of nickel is slowly improving. The International Materials Conference allocated 33,600 tons for the first quarter of 1951, compared with 31,500 tons for the first quarter of 1950; and it is expected that, by 1953, production will have increased enough to meet most demands. Copper is now considered to be the scarcest of the non-ferrous metals. In the United Kingdom, the shortage is particularly acute, since consumers have now largely exhausted their stocks of scrap as well as primary metal, and new supplies of scrap have been arriving in diminished volume. However, the shortage may not be as permanent as many imagine. Mr. Simon D. Strauss, vice-president of the American Smelting and Refining Company, said recently that the shortage, far from persisting until 1954, as had been maintained, might ease within a few months, and forecasted that any consumer who might be stampeded into planning a permanent change from copper to an inferior metal would eventually regret his decision. The zinc supply position is already considerably easier than a year ago, and it is likely to improve further in 1952.

For the first time since the opening of television services in the United Kingdom, the demand for television receivers flagged in 1951. According to the Radio and Television Retailers' Association the average number of sets sold per shop was lower between June and September, 1951, than between June and September, 1950. In September, 1951, 8.82 sets were sold per shop, compared with 11.77 in September, 1950. The fall, however, was purely temporary: the trend of production has been fairly steadily upwards and, to a very large extent, has compensated for the decline in the production of radio receivers. The value of the output of television receivers is now at least as great as that of radio receivers, and in November, 1950, nearly half as many television sets were produced as radio sets. Production, however, fell short of the 900,000 sets planned for 1951, the output in the first 11 months of the year being at an annual rate of 707,000 sets. The demand for television receivers is bound to continue to grow for a long time yet. The opening of the Holme Moss Station, the most powerful in the world, on October 12, created in the North of England a potential market as great as the London Area. The Kirk o' Shotts transmitter, which is due to come into regular operation in March of this year, will bring television to a further population of 3.5 millions. (By special efforts, it was brought into temporary use, with excellent results, to transmit to Scottish viewers the funeral procession of King George VI.) When

the Wivern station, which is to serve Wales and the West of England, comes into service later in the year, a coverage of 78 per cent. of the population of Britain will have been achieved at a total cost of 5½ millions for providing the five transmitters.

Manufacturers are not longer restricted to the home market; British television receivers have been ordered by Brazil, Germany and Argentina. In Argentina, where the decision to install British rather than American television was, no doubt, greatly influenced by the need to conserve dollars, the Marconi Wireless Telegraph Company are to provide the transmitter and the complete studio centre. E. K. Cole, Limited, are to supply receivers to a value of about 250,000£. Some British television transmitting equipment (manufactured by Pye, Limited) is being sold on the United States

still large problems to solve, and, indeed, much work has still to be done before monochrome television as radiated by the British 405-line system can be used to its full advantage. In the United States, on the other hand, a colour television service was started during 1951. The Federal Communications Commission gave its official approval to the colour system of the Columbia Broadcasting Corporation and that organisation went ahead with plans for the mass output of colour-television receivers. The American commercial developments do not mean, however, that colour television is farther ahead in the United States than in the United Kingdom. Both Pye, Limited, and the B.B.C., at their research station at Kingswood Warren, have demonstrated colour television resembling that of the C.B.S. fairly closely and considered

TABLE I.—UNITED KINGDOM: PRODUCTION OF MISCELLANEOUS ELECTRICAL EQUIPMENT.  
(Monthly Averages or Calendar Months.)

|           | Deliveries of Refrigerating Machinery. |             |             |             |             |             | Electric Lamps, Complete. |             | Electric Washing Machines. |             | Domestic Radio Sets. |             | Electric Cookers. |
|-----------|----------------------------------------|-------------|-------------|-------------|-------------|-------------|---------------------------|-------------|----------------------------|-------------|----------------------|-------------|-------------------|
|           | Domestic.                              |             | Commercial. |             | Industrial. |             |                           |             |                            |             |                      |             |                   |
|           | Total.                                 | For Export. | Total.      | For Export. | Total.      | For Export. | Total.                    | For Export. | Total.                     | For Export. | Total.               | For Export. | Total.            |
|           | Value (£1,000).                        |             |             |             |             |             |                           |             | Number (Thousands).        |             |                      |             |                   |
| 1935 ..   | —                                      | —           | —           | —           | —           | —           | 339                       | 48          | —                          | —           | 154                  | 5           | —                 |
| 1947 ..   | 249                                    | 69          | 503         | 61          | 137         | 73          | 865                       | 97          | —                          | —           | 165                  | 34          | 2.4               |
| 1948 ..   | 450                                    | 235         | 576         | 96          | 161         | 76          | 931                       | 144         | 12.0                       | 4.2         | 136                  | 27          | 7.6               |
| 1949 ..   | 718                                    | 391         | 607         | 124         | 231         | 100         | 892                       | 142         | 24.7                       | 8.2         | 112                  | 26          | 17.6              |
| 1950 ..   | 990                                    | 545         | 677         | 177         | 296         | 109         | 1,101                     | 150         | 44.8                       | 18.9        | 150                  | 31          | 22.9              |
| 1950—     |                                        |             |             |             |             |             |                           |             |                            |             |                      |             |                   |
| Oct. ..   | 1,139                                  | 616         | 559         | 199         | 202         | 80          | 1,381                     | 164         | 49.1                       | 21.8        | 184                  | 45          | 25.6              |
| Nov. ..   | 1,232                                  | 755         | 530         | 199         | 288         | 126         | 1,540                     | 203         | 59.1                       | 26.1        | 209                  | 44          | 27.4              |
| Dec. ..   | 1,193                                  | 811         | 511         | 201         | 196         | 78          | 1,274                     | 152         | 52.1                       | 18.4        | 175                  | 42          | 25.2              |
| 1951—     |                                        |             |             |             |             |             |                           |             |                            |             |                      |             |                   |
| Jan. ..   | 1,332                                  | 741         | 679         | 252         | 326         | 99          | 1,435                     | 153         | 56.0                       | 31.0        | 183                  | 41          | 27.1              |
| Feb. ..   | 1,127                                  | 493         | 705         | 200         | 354         | 103         | 1,314                     | 172         | 51.9                       | 28.2        | 177                  | 33          | 25.8              |
| March ..  | 1,471                                  | 685         | 893         | 316         | 326         | 108         | 1,354                     | 194         | 60.0                       | 34.1        | 186                  | 50          | 27.8              |
| April ..  | 1,311                                  | 800         | 867         | 241         | 397         | 127         | 1,248                     | 189         | 51.3                       | 26.0        | 182                  | 55          | 26.9              |
| May ..    | 1,247                                  | 833         | 900         | 287         | 341         | 65          | 1,259                     | 193         | 57.7                       | 28.1        | 190                  | 54          | 27.7              |
| June ..   | 1,462                                  | 914         | 889         | 286         | 526         | 110         | 1,174                     | 212         | 51.8                       | 33.0        | 190                  | 55          | 27.3              |
| July ..   | 1,275                                  | 904         | 846         | 320         | 308         | 93          | 1,058                     | 220         | 62.7                       | 40.0        | 172                  | 56          | 27.1              |
| August .. | 1,093                                  | 730         | 566         | 232         | 311         | 72          | 1,193                     | 253         | 53.4                       | 34.9        | 144                  | 45          | 22.1              |
| Sept. ..  | 1,106                                  | 793         | 688         | 264         | 351         | 66          | 1,382                     | 223         | 57.6                       | 35.8        | 156                  | 44          | 25.8              |
| Oct. ..   | 1,203                                  | 878         | 631         | 267         | 212         | 81          | —                         | —           | 69.1                       | 36.2        | 200                  | 49          | 28.2              |
| Nov. ..   | 1,038                                  | 735         | 536         | 228         | 338         | 98          | —                         | —           | —                          | —           | 156                  | 50          | 28.9              |
| Dec. ..   | —                                      | —           | —           | —           | —           | —           | —                         | —           | —                          | —           | —                    | —           | 22.9              |

TABLE II.—United Kingdom: Deliveries of Domestic Electrical Appliances (Monthly Averages, Thousands).

|         | Electric Irons. |             | Electric Vacuum Cleaners. |             | Electric Kettles. |             |
|---------|-----------------|-------------|---------------------------|-------------|-------------------|-------------|
|         | Total.          | For Export. | Total.                    | For Export. | Total.            | For Export. |
| 1937 .. | 112             | —           | 42.7                      | 4.5         | 35                | —           |
| 1947 .. | 199             | 72          | 75.8                      | 26.7        | 64.6              | 17.3        |
| 1948 .. | 141             | 38          | 54.3                      | 14.8        | 40.4              | 6.7         |
| 1949 .. | 132             | 33          | 66.9                      | 16.4        | 32.8              | 5.5         |
| 1950 .. | 160             | 49          | 87.9                      | 24.3        | 39.0              | 4.7         |
| 1948—   |                 |             |                           |             |                   |             |
| 3rd Qr. | 130             | 32          | 46.9                      | 11.6        | 31.9              | 5.3         |
| 4th "   | 144             | 36          | 61.8                      | 17.5        | 51.9              | 7.0         |
| 1949—   |                 |             |                           |             |                   |             |
| 1st Qr. | 126             | 31          | 48.6                      | 21.6        | 30.8              | 6.7         |
| 2nd "   | 128             | 39          | 72.9                      | 14.2        | 34.6              | 9.0         |
| 3rd "   | 125             | 26          | 65.8                      | 13.9        | 33.0              | 3.7         |
| 4th "   | 148             | 34          | 80.2                      | 16.0        | 32.8              | 2.6         |
| 1950—   |                 |             |                           |             |                   |             |
| 1st Qr. | 162             | 50          | 81.5                      | 22.4        | 36.3              | 4.2         |
| 2nd "   | 142             | 48          | 88.0                      | 25.3        | 35.4              | 5.5         |
| 3rd "   | 160             | 46          | 88.2                      | 23.3        | 40.9              | 4.9         |
| 4th "   | 175             | 53          | 93.7                      | 26.2        | 43.4              | 4.3         |
| 1951—   |                 |             |                           |             |                   |             |
| 1st Qr. | 181             | 72          | 102.8                     | 34.5        | 52.1              | 6.8         |
| 2nd "   | 190             | 73          | 96.1                      | 36.5        | 57.7              | 11.0        |
| 3rd "   | 173             | 67          | 91.7                      | 40.0        | 43.3              | 10.0        |

market. In 1951, exports of radio and television transmitting equipment, at 5.7½ millions, though 55 per cent. higher than in 1949, were 800,000£ less than in 1950. This, however, is likely to prove only a temporary set-back. The export of radio receivers increased in 1951, when they amounted to 479,000 sets, valued at 5.8½ millions, or nearly twice as many as in 1950.

According to Mr. W. Proctor Wilson, head of the B.B.C. Research Department, there is no ground for the belief that "colour television is just round the corner" in the United Kingdom. There are

to be just as good. The British attitude, however, is that the American commercial exploitation of the "spinning disc" principle is premature; colour television as developed by the C.B.S. is "incompatible," in that it could not be received on existing monochrome sets without considerable modification. It was, however, approved by the Federal Communications Commission because it was simpler, more effective, and more practicable for immediate broadcasting than the rival, less developed, "compatible" system of the Radio Corporation of America. The incompatible system, however, has still to justify itself in the United States. The C.B.S. receivers, which cost over 700 dols. each, proved hard to sell, and the magazine *Business Week* contends that a request by the Government to suspend the production of colour receivers, "to conserve critical materials until such time as these materials are in sufficient supply to warrant production," was not unwelcome.

Another branch of light electrical engineering which is affected both directly and indirectly by re-armament is the manufacture of small electric motors. By 1950, when motors were beginning to be hard to sell, there was every indication that rapid expansion since the war had created surplus capacity in the industry. During 1951, however, the demand revived and a record output was achieved. The production of fractional horse-power motors for the civilian domestic market suffered because manufacturers had to give priority to larger motors, required for re-armament and for export. Nevertheless, the output of fractional horse-power motors in the first ten months of 1951 achieved an annual rate of 8.4½ millions, compared with 6.5½ millions in 1950; and the output for export was at a rate of 2.3½ millions, compared with 1.4½ millions. Mr. Frank V. Brook, chairman and joint managing director of Brook Motors, Limited, said that his firm had increased their production of industrial motors by 30 per cent. and of fractional horse-power motors by 50 per cent. in 1951. A new factory at Barnsley,

which will employ 1,000 people, is expected to be in production in the spring. At the present rate of production, the company, who completed their millionth electric motor in December, should complete another million in five years. Mr. Brook added that it would not be long before they would have made a million fractional horse-power motors.

The production of electric lamps was also higher in 1951 than in 1950; the total output from January to September, 1951, was valued at 11.3% millions, compared with 9.0% millions in the corresponding period of 1950, and the output for export was 1.8% millions, compared with 1.3% millions. This industry has been the subject of inquiry by the Monopolies and Restrictive Practices Commission, who published their report on November 13. It was established that the Electric Lamp Manufacturers' Association, whose members supply about 60 per cent. of both filament and discharge lamps, operated a number of arrangements which restricted competition in the industry, though, as the Commission pointed out, these were not always against the public interest. In any case, the system is much less restrictive than before the war. Except in the case of motor-vehicle lamps, prices and profits, which were unduly high before the war, are now reasonable. Since the exchange of technical information has done much to offset the potential dangers of the price ring, the Commission did not consider that the fixing of common manufacturers' prices should be prohibited, provided that the exchange of technical information extended to all manufacturers within the system of common prices and that the prices were reasonable. It was recommended that components supplied by E.L.M.A. members, other than those covered by patents and those with ready-coiled filaments, should be made equally available to members and non-members at the same price; and that sales quota arrangements should be ended, as well as the collective enforcement of resale price maintenance, "exclusive dealing," and ancillary arrangements regarding prices and payments.

Finally, it was considered that the E.L.M.A. members should be required to give an assurance that they would continue to provide a measure of competition by supplying cheap lamps, but that this should not take the form of unfair competition designed to squeeze independent manufacturers out of business. Mr. H. M. Steel, director of the Scottish Co-operative Wholesale Society, complained in November about the treatment accorded to the S.C.W.S. venture in lamp-making. He is reported in the *Co-operative News* as having said that, before production could start at the Luma factory, the S.C.W.S. had been compelled to sign an agreement which was "obnoxious and detestable in the extreme." In addition, E.L.M.A. had forbidden a municipal corporation, "not 100 miles away from Shieldhall," to buy more than 5 per cent. of their requirements from the Luma factory on pain of losing the rebate. The agreement with E.L.M.A. has now been cancelled and S.C.W.S. are going ahead with plans to produce 10 million electric lamps per annum.

In general, it does not seem the E.L.M.A. have given either manufacturers or the public very much ground for complaint. The attitude of many sections of the electrical industry to the work of the Monopolies Commission is one of approval. Mr. G. Leslie Wates, speaking as chairman of the British Electrical and Allied Manufacturers' Association, in April, made clear his preference for the inquiries of the Commission, which were not law suits or prosecutions, to American anti-trust investigations. The object of the Commission was to discover whether business practices conformed with modern ideas of the public interest, and this, he said, gave a wonderful opportunity "for us to educate the Commission and through them the whole country as to the reasonableness of our well-established customs."

Considerable progress has been made recently with the manufacture of fluorescent lamps. Thorn Electrical Industries, Limited, are making lamps which, they claim, have an average effective life of 5,000 hours, or twice the usually accepted service life. The company, who formed an agreement with Sylvania Electric Products, Incorporated, for the exchange of patents and technical information, claim that they are responsible for 70 per cent.

of the fluorescent lamps exported from the United Kingdom.

Volume 4, Trade O, of the *Final Report on The Census of Production for 1948*, recently made available by H.M. Stationery Office, gives some detailed information about the manufacture of electric lighting accessories and fittings. The total value of sales of the principal products of the trade in 1948 was 20.28% millions, whereas production in 1937 was valued at only 4.16% millions. Of the 152 establishments in the industry, employing 16,500 persons, 59, accounting for 38.1 per cent. of the total net output, were in the London and South-Eastern area. In the Midlands and North Midlands there were 44 establishments, employing 5,200 persons and producing 31.5 per cent. of the total output.

Since the end of the war, sales of electric cookers have made continuous progress and a production of 318,000 domestic cookers of 5 to 12 kW was achieved in 1951, compared with 275,000 in 1950. This was due largely to an increase of over 100 per cent. in the production for export, from 36,000 in 1950 to 74,900 in 1951. Production for the home market, however, was also higher, and even in the latter months of 1951 there was little evidence of falling demand; but it is possible that sales will suffer slightly in the first few months of 1952 as the result of the tightening of credit. The increase in export sales took place largely in the Australian market. In 1951, the total British exports of cooking appliances of all descriptions were valued at 2.5% millions, compared with 1.4% millions in 1950, and the exports of cooking and heating appliances 4.3% millions, compared with 2.6% millions. Exports of cooking and heating appliances to Australia amounted to 1.2% millions, twice as much as in 1951. Credit restrictions imposed to curb inflation in that country, however, have caused sales to fall off, and, as a result, the British output of domestic cookers has suffered. In December, 1951, only 22,900 cookers were produced, compared with 25,200 in December, 1950.

The extent of the export success achieved by the light electrical industry may be seen from Table III,

TABLE III.—United Kingdom: Exports of Light Electrical Goods and Apparatus.  
Value (£1,000.)

|                                                      | 1938. | 1948.  | 1949.  | 1950.  | 1951.  |
|------------------------------------------------------|-------|--------|--------|--------|--------|
| Wireless apparatus:                                  |       |        |        |        |        |
| Domestic radio receiving sets ..                     | 441   | 3,640  | 2,964  | 2,730  | 4,768  |
| Transmitting apparatus ..                            | 341   | 2,732  | 3,151  | 6,406  | 5,712  |
| Valves, complete ..                                  | 495   | 1,948  | 1,868  | 2,668  | 3,734  |
| Telegraph and telephone apparatus ..                 | 2,913 | 12,021 | 15,887 | 17,032 | 15,508 |
| Electric light bulbs, complete ..                    | 593   | 1,693  | 1,643  | 1,499  | 1,902  |
| Electric light appliances and accessories ..         | 583   | 4,986  | 4,594  | 3,395  | 4,409  |
| Batteries, primary, complete ..                      | 163   | 702    | 939    | 1,265  | 2,182  |
| Accumulators ..                                      | 584   | 3,459  | 4,225  | 3,461  | 4,946  |
| Electrical cooking and heating appliances ..         | 368   | 3,052  | 2,488  | 2,559  | 4,257  |
| Electrical instruments, including X-ray apparatus .. | 590   | 5,315  | 4,557  | 3,768  | 5,254  |
| Refrigerating machinery ..                           | 396   | 4,095  | 7,041  | 9,844  | 14,003 |
| Vacuum cleaners ..                                   | 320   | 1,743  | 1,887  | 2,359  | 3,507  |
| Total—Above categories ..                            | 7,787 | 45,386 | 51,244 | 57,076 | 70,182 |

herewith, taken from the *Trade and Navigation Accounts*. The exports in 1951 of the categories listed, which exclude a wide range of miscellaneous items, at 70.2% millions, were 23 per cent. higher than in 1950. The most striking increase was in exports of refrigerating machinery; much of this, again, was accounted for by the Australian market, exports to which in 1951 were valued at 2.1% millions, compared with 1.4% millions in 1950. Exports are, however, spread over a wide range of markets, and this will help to guarantee their maintenance at a high level in 1952. Exports of a few items, notably telephone and telegraph equipment, declined in 1951. This was not unexpected, since manufacturers were complaining in 1950 that most of the export inquiries coming in were from countries requiring long-term credits, which most manufacturers were unable to grant.

At home, the demand is depressed by the necessity

to conserve national investment resources. Sir Alexander Roger, K.C.I.E., chairman of the Automatic Telephone and Electric Company, said in May that his company had facilities for the employment of 1,000 persons if the Post Office were to place more orders. In stressing the need for a larger outlay on the telephone services, he pointed out that the United Kingdom has now sunk to ninth place in the list of telephones per head of population in the various countries, and that whereas, in the United Kingdom, there is a waiting list of 450,000, or 9 per cent. of the total number of subscribers, in the United States, one company alone, the American Telephone and Telegraph Company, added nearly two million telephones to its system in 1950, involving a capital expenditure of 300% millions. There is no doubt that, in 1952, the light electrical-engineering industry will respond well to the Chancellor of the Exchequer's plea to the engineering industries "to do everything they can to push forward overseas orders and thus ensure that a larger proportion of their output goes abroad." The Government, however, must also play their part in seeing that the industry gets a fair share of raw materials, while the British public will often have to deny themselves many goods which go far to improving the amenities of home life.

The shortage of non-ferrous metals is of particular concern to manufacturers of electrical wires and cables, but, despite the shortages, they have succeeded in maintaining their output remarkably well. As will be seen from Table IV, herewith,

TABLE IV.—United Kingdom: Production of Insulated Wire and Cable.  
(Monthly Averages.)

|                     |    | Value (£1,000). |             |
|---------------------|----|-----------------|-------------|
|                     |    | Total.          | For Export. |
| 1937 .. .. .        | .. | 2,272           | 366         |
| 1947 .. .. .        | .. | 4,659           | 1,230       |
| 1948 .. .. .        | .. | 5,824           | 2,048       |
| 1949 .. .. .        | .. | 6,484           | 2,119       |
| 1950 .. .. .        | .. | 5,986           | 1,933       |
| 1948—3rd Quarter .. | .. | 5,637           | 2,048       |
| 4th .. .. .         | .. | 6,778           | 2,386       |
| 1949—1st Quarter .. | .. | 6,109           | 1,985       |
| 2nd .. .. .         | .. | 6,492           | 2,290       |
| 3rd .. .. .         | .. | 6,247           | 1,986       |
| 4th .. .. .         | .. | 7,086           | 2,215       |
| 1950—1st Quarter .. | .. | 5,855           | 1,938       |
| 2nd .. .. .         | .. | 5,549           | 1,904       |
| 3rd .. .. .         | .. | 5,477           | 1,706       |
| 4th .. .. .         | .. | 7,064           | 2,183       |
| 1951—1st Quarter .. | .. | 7,167           | 1,797       |
| 2nd .. .. .         | .. | 7,458           | 1,981       |
| 3rd .. .. .         | .. | 6,920           | 2,012       |

taken from the *Monthly Digest of Statistics*, the output in the first three quarters of 1951 was valued at 64.6% millions, 7 per cent. more than in the first three quarters of 1950. The rise in price of copper and other raw materials is sufficient, however, to account for the increase. From Table V, herewith, taken from the *Trade and Navigation Accounts*, it will be seen that, while the value of exports of wires and cables—23.6% millions in 1951—was 4 per cent. higher than in 1950, the volume (109,000 tons) was 30 per cent. lower. The largest fall was in the export of telegraph and telephone cables, and was very largely in the Indian and Australian markets. Cables of this sort lend themselves well to local manufacture in the Dominions. Falling exports are to be expected, therefore, as production facilities are established, but British cablemakers, who, in most cases, have participated in the ventures, will draw large dividends. In India, where Standard Telephones and Cables, Limited, are co-operating with the Government, the output has increased rapidly and is already capable of meeting most of the local demand for telegraph and telephone cables.

The manufacture of paper-insulated cables for use up to quite high pressures is also being undertaken in the Dominions, but for these, as well as many other types of cables, there is still a considerable export market. The Earl of Verulam, chairman of Enfield Cables, Limited, speaking at his company's annual general meeting in June, said that they had booked a larger total of orders during

the year than ever before and had done business with 62 countries. Mr. William Fraser, the chairman of Scottish Cables, Limited, said in August that his company had increased their exports by 50 per cent. in 1950-51. The demand for cables both at home and abroad has undergone considerable change in the past 18 months. Before the outbreak of war in Korea, as was pointed out in May by Sir Alexander Roger, chairman of British Insulated Callender's Cables, Limited, the industry was facing keen competition: most divisions of the company's organisation had overtaken the arrears of orders and were returning to pre-war conditions. By the middle of 1951, all cable makers had full order books—Enfield Cables, Limited, reported that theirs was twice as large as a year earlier—and, though the shortage of raw materials restricts production, manufacturers have again become highly selective in their acceptance of orders.

Of particular interest is the success of Enfield

controlling the load or putting in larger mains or lines, and that is a big job." Plans for remedying the situation are, however, well in hand. A scheme for the 275,000-volt grid to meet requirements up to 1960 has been prepared, and the first stage will be completed by 1955.

The *Final Report of the Census of Production*, Vol. 4, Trade L, gives the latest available detailed statistical information relating to the electric wire and cable industry. Sales of the principal products of the trade in 1948 were valued at 78·46l. millions; in 1937, the value was 29·3l. millions. Sales of telegraph and telephone cables were valued at 13·8l. millions; paper-insulated cables 26·1l. millions; rubber-insulated cables 21·7l. millions; enamel, glass and asbestos-insulated cables 4·8l. millions; and cotton and silk, rayon and nylon-insulated cables 4·4l. millions. The industry is largely concentrated in the North-West of England and in the London and South-Eastern region. Of the

## THE GROWTH OF THE UNIVERSITIES.

THE interim report of the University Grants Committee for the years 1947 to 1951, entitled *University Development* [H.M. Stationery Office, price 1s. net] makes interesting reading. The outstanding feature of the period has been the expansion of the universities to nearly twice their pre-war size, the number of students for the country as a whole having risen from about 50,000 before the war to 85,000 at present, an average increase of 70 per cent. In certain cases, particularly those of the newer universities, the increase is very much greater.

In the immediate post-war period, there was a great influx of students owing to the release of men from the Services, but inflationary pressure of a more lasting kind resulted from the implementation of the recommendations of the Barlow Committee on Scientific Manpower. The doubling of the numbers of graduates in science and technology within a period of 10 years, recommended by this committee in 1946, was, in fact, virtually accomplished by 1947, and, in the same period, the number of Arts students rose by 57 per cent. As regards the quality of the students, the report states that in science and technology there has been only a small increase in the number of outstandingly able persons. On the other hand, students of poor quality who used to gain ready admission to the universities, before the war, no longer find this easy. As a result, the proportions of outstandingly good and outstandingly weak students are lower than formerly, and that of good second-class students is higher. The number of really first-class students reading for Arts degrees is thought to be smaller than before the war—a result of the greater rewards and opportunities offered to science students in after-life.

The growth in teaching staffs has been even more striking and amounts to over 100 per cent. on the 1939 figure. The number of professors has increased by about 40 per cent., but the number of senior lecturers has increased by as much as 170 per cent. Although the report is silent on the point, it is too much to expect that this increase has been accomplished without some falling off in the general standard of tuition. The increase in the number of lecturers may have been necessitated largely by the development of new branches of science, but it seems likely that the number of first-class men available for recruitment to university staffs is, like the number of first-class students, not very different from the pre-war total, and this in spite of the fact that the recent long-overdue increases in salaries have made an academic career considerably more attractive than was formerly the case. The report makes it clear, however, that the large increase in staffs is also part of a deliberate policy of increasing the ratio of staff to students, in order to leave the former with more time for research. While no one would wish to underrate the importance of university research, there may, at times, be a tendency to overlook the fact that the primary function of a university is the same as that of a school, namely, to impart sound instruction. The other benefits which university life confers are incidental. If an undue emphasis on research qualifications were to lead to the recruitment of staff on this basis, rather than on qualities of personality and teaching ability which are often not concomitant with the other, the result could only be to the universities' loss.

On the subject of accommodation, the report points out that, although progress was made with building schemes, it was, in general, much less than had been hoped for. Moreover, the prospects for the immediate future are not bright. As regards future numbers of students, however, it is stated that few universities and colleges are contemplating a substantial increase above the levels already reached. It may well be, however, that the general level is already too high and that a better solution for all concerned—though this view is not expressed in the report—would be to increase the size and number of technical colleges providing vocational instruction up to less than degree standard. The report concludes by expressing the view that the

TABLE V.—UNITED KINGDOM: EXPORTS OF ELECTRIC WIRES AND CABLES.

|                                                               | Tons.   |         |        | Value (£1,000). |        |        |
|---------------------------------------------------------------|---------|---------|--------|-----------------|--------|--------|
|                                                               | 1949.   | 1950.   | 1951.  | 1949.           | 1950.  | 1951.  |
| Telegraph and telephone cables and wires—                     |         |         |        |                 |        |        |
| Submarine .. .. .                                             | 7,317   | 13,392  | 4,338  | 854             | 1,620  | 557    |
| Other .. .. .                                                 | 37,307  | 35,777  | 21,554 | 8,100           | 7,934  | 5,825  |
| Other types of wires and cables—                              |         |         |        |                 |        |        |
| Paper insulated:                                              |         |         |        |                 |        |        |
| To British West Africa .. .. .                                | 1,203   | 779     | 697    | 195             | 137    | 145    |
| „ Union of South Africa .. .. .                               | 7,884   | 3,154   | 3,080  | 1,228           | 555    | 590    |
| „ India .. .. .                                               | 13,290  | 7,494   | 4,939  | 2,075           | 1,227  | 938    |
| „ Malaya .. .. .                                              | 1,169   | 2,547   | 2,139  | 170             | 373    | 391    |
| „ Hong Kong .. .. .                                           | 2,061   | 1,374   | 354    | 353             | 235    | 74     |
| „ Australia .. .. .                                           | 8,308   | 7,252   | 5,344  | 1,376           | 1,226  | 1,046  |
| „ New Zealand .. .. .                                         | 1,443   | 2,423   | 917    | 219             | 413    | 179    |
| „ Other Commonwealth Countries and the Irish Republic .. .. . | 6,778   | 4,184   | 7,622  | 1,116           | 723    | 1,623  |
| „ Norway .. .. .                                              | 1,428   | 1,323   | 1,006  | 235             | 227    | 211    |
| „ Egypt .. .. .                                               | 1,385   | 1,560   | 1,131  | 229             | 233    | 223    |
| „ Other Foreign Countries .. .. .                             | 9,174   | 5,308   | 5,656  | 1,539           | 901    | 1,241  |
| Total .. .. .                                                 | 54,123  | 37,398  | 32,885 | 8,735           | 6,250  | 6,661  |
| Rubber insulated:                                             |         |         |        |                 |        |        |
| To Union of South Africa .. .. .                              | 2,671   | 1,449   | 1,405  | 641             | 400    | 570    |
| „ British East Africa .. .. .                                 | 438     | 816     | 970    | 141             | 253    | 468    |
| „ India .. .. .                                               | 3,706   | 2,323   | 1,394  | 947             | 632    | 465    |
| „ Malaya .. .. .                                              | 1,038   | 733     | 1,288  | 278             | 189    | 496    |
| „ Australia .. .. .                                           | 476     | 576     | 302    | 146             | 181    | 136    |
| „ New Zealand .. .. .                                         | 1,079   | 1,369   | 1,536  | 270             | 361    | 619    |
| „ Other Commonwealth Countries and the Irish Republic .. .. . | 3,699   | 3,434   | 5,137  | 1,006           | 978    | 2,083  |
| „ Foreign Countries .. .. .                                   | 5,904   | 3,967   | 3,852  | 1,452           | 1,050  | 1,517  |
| Total .. .. .                                                 | 19,011  | 14,667  | 15,884 | 4,881           | 4,004  | 6,354  |
| All other:                                                    |         |         |        |                 |        |        |
| Cotton, silk or artificial silk-insulated .. .. .             | 2,570   | 1,548   | 1,528  | 835             | 690    | 695    |
| Enamel, glass or asbestos-insulated .. .. .                   | 2,498   | 2,266   | 2,015  | 996             | 894    | 986    |
| Other .. .. .                                                 | 3,057   | 4,088   | 5,828  | 977             | 1,420  | 2,499  |
| Total .. .. .                                                 | 8,125   | 7,902   | 9,371  | 2,808           | 2,904  | 4,180  |
| Grand Total .. .. .                                           | 125,883 | 109,136 | 84,032 | 25,378          | 22,712 | 23,567 |

Cables, Limited, in expanding sales to Canada. Early in 1951, orders were received from the Ontario Hydro-Electric Power Commission for 115-kV pipeline compression cables and from the Quebec Hydro-Electric Commission for a 120-kV self-contained compression cable to be laid across Montreal harbour. The value of these two orders, for the largest power cables ever to be shipped across the Atlantic in either direction, is a million dollars. British Insulated Callender's Cables, Limited, continue to receive important orders for railway electrification work, an activity which they first undertook in 1912 on an Australian contract; it was announced in April that a contract valued at 3l. millions had been signed for the supply and installation of overhead equipment for railway electrification between Parramatta and Lithgow, N.S.W.

The demand for electrical transmission and distribution cables at home must continue at a high level for many years, even if retarded by the need to restrict capital expenditure. The British Electricity Authority, in their annual report, drew attention to the extensive reinforcement of the main transmission system which is required to meet the ever-growing load. The inadequacy of the grid was clearly brought out in the power failure in September, which affected 2,000 square miles and brought chaos to Liverpool. As the B.E.A. explained, the immediate cause was "a chance in a million," but trouble is always likely to occur while the grid is required to transfer bulk supplies from one part of the country to another on a scale for which it was never designed. Lord Citrine is reported as having said that the only way to prevent the system from becoming overloaded is "either by

84 establishments in the industry in 1948, 22 in the North-Western region, employing 26,830 people, accounted for 40·2 per cent. of the net output; and 34 in the London and South-Eastern Region, employing 25,280 people, produced 38·4 per cent. of the net output.

The electric wire and cable industry is another which has come under the surveillance of the Monopolies Commission. Some manufacturers have complained about the waste of time involved; Sir Alexander Roger, of British Insulated Callender's Cables, said at the annual general meeting that the company had assisted the Commission in every way, at considerable cost of time and money. They could, however, "ill afford this diversion of their effort in these times." Mr. W. J. Terry, chairman and managing director of the London Electric Wire Company and Smiths, Limited, thought it unfortunate that the investigation should take place at such a time, but considered that "while there may be differences of opinion as to what constitutes a monopoly (certainly 30 per cent. of any trade does not do so) no exception whatever can be taken to this examination being made on the grounds of public interest." He also welcomed its thoroughness, maintaining that "the Monopolies Inquiry must necessarily be exhaustive and it must take time to produce a considered opinion because it is in the interest of all parties to receive considered and fair comment."

There is no doubt that the cable makers will require all their energies to surmount the difficulties which are crowding in upon them. Nevertheless, so far as can be foreseen, 1952 promises to be at least as satisfactory a year as 1951.

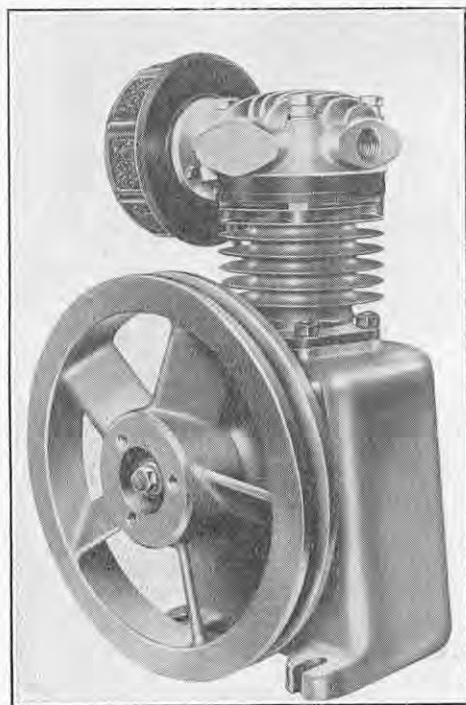
exceptionally large sums which Parliament has provided for the universities during the present quinquennium have been expended judiciously, even if many of the hopes which were entertained at the beginning of the period have remained unfulfilled.

As regards future developments, the amounts of money to be voted to the universities during the next five years were the subject of a written reply to a member's question by the Chancellor of the Exchequer in the House of Commons on February 22. Mr. Butler said that, for the universities merely to continue as at present without retrenchment, the present annual vote of 16,000,000*l.* must be increased to 20,000,000*l.* next year. Thereafter, the sum would rise in stages to 25,000,000*l.* in the final year (1956-57) of the new quinquennial period. He hoped that the amounts to be provided would allow the universities not only to meet the rising expenditure to which they are already committed, but also, towards the end of the period, to undertake some expansion.

### SINGLE-STAGE LIGHT AIR COMPRESSOR.

THE Hymatic Engineering Company, Limited, Redditch, Worcestershire, recently started production on a new compressor designed to cover a wide range of duties. Known as the 100SAS, the new unit is capable of running at speeds up to 2,000 r.p.m. and can be driven either by a V-belt or coupled directly to the prime mover. It has a displacement of 7.5 cub. ft. per minute at pressures of 80 to 100 lb. per square inch and is suitable, therefore, for use in connection with such diverse duties as spray painting, lime washing, pneumatic greasing, operation of air tools, compressed-air braking, etc.

It is a single-stage unit and, as will be seen from the photograph reproduced below, consists of an air-cooled cylinder mounted on a totally-enclosed crankcase. The cylinder, which has a bore and stroke of 1.97 in. and 2.16 in., respectively, is an aluminium casting, suitably finned cooling and fitted with a cast-iron



liner. Cooling is assisted by a fan formed integrally with the driving pulley and designed so that the air is directed over the cylinder. A light-alloy piston is used and this is fitted with two compression rings and a single oil-control ring. It is joined to the crankshaft by a forged-steel I-section connecting rod, provided with a roller bearing at the big end and a phosphor-bronze bush at the little end. The crankshaft has an integral balance weight and runs in main bearings of the wrapped-bush type. Low-lift disc-type valves are used which, to ensure low air speeds and greater efficiency, are provided with exceptionally large air passages. The construction is such that the suction and delivery valve assembly can be removed as a single unit, thus facilitating maintenance and replacement.

The cylinder walls, piston rings, big-end and little-end bearings, etc., are lubricated by splash from the

crankcase, the level of the oil in the sump being controlled by the height of the filling orifice. Oil consumption is 2.25 c.c. per hour or 1 pint for every 250 hours of running time, the sump holding 1½ pints. The machine weighs 36 lb. and absorbs only 1.34 h.p. at 2,000 r.p.m. when delivering its full capacity at 80 lb. per square inch, and 1 h.p. at 1,500 r.p.m. The equipment supplied with the compressor includes an oil-wetted air-intake filter.

### THE COLOMBO PLAN EXHIBITION, CEYLON.

MANY British firms and organisations are participating in the Colombo Plan Exhibition, which opened in Ceylon on February 23. This exhibition, it will be remembered, is intended to demonstrate the aims of the Colombo Plan and enable the participating countries to illustrate their resources, products and culture. The exhibition site in Victoria Park, Colombo, is larger than that used for the recent South Bank Exhibition in London and British firms are showing in two main sections. The first is the United Kingdom pavilion, the theme of which is how this country can help South-East Asia to solve its problems. The second main section in which British firms are exhibiting is the Trade and Commerce Fair, where firms from all over the world are represented.

In view of the large distance concerned and the difficulties, therefore, of shipping complete equipments to the exhibition site, many firms are making good use of models. Messrs. Ransomes and Rapier, Limited, Watlington Works, Ipswich, for example, are showing a complete range of scale models of their excavators, which range from the Rapier 410 excavator with a capacity of ¾ cubic yard, the smallest of the range, to the W.1400 walking drag-line, the largest in the world. Messrs. Babcock and Wilcox, Limited, Farringdon-street, London, E.C.4, are also showing models, the main exhibit being a model of their integral-furnace type of boiler for power stations and large industrial plants. In addition, their stand makes considerable use of large-scale photographs and drawings illustrating the many other types of industrial boilers in service in the East, including those supplied to the artificial-fertiliser factory at Sindri, India's largest single industrial power station. The display also emphasises the work that has been done by Messrs. Babcock and Wilcox towards the design of special furnaces for burning waste products such as sugar-cane refuse, the husks of coffee, rice and cotton seed, sawdust and leather trimmings.

Messrs. W. G. Bagnall, Limited, Stafford, have been supplying steam locomotives to Ceylon for a number of years and the exhibits on their stand include a model of an industrial type 0-4-0 saddle-tank locomotive. Similarly, the English Electric Company, Limited, Queen's House, Kingsway, London, have supplied a number of Diesel-electric locomotives to Ceylon, and their exhibits in the United Kingdom pavilion include a scale model of a 660-h.p. locomotive of this type. Other exhibits on their stand include a large model showing a typical switching station equipped with 275-kV air-blast circuit breakers and a sectioned single-pole circuit breaker of the same rating. The company has also provided for use by the Board of Trade a sectioned working model of a twin overhead-runner four-jet impulse water-turbine generating set of 40,000 kVA capacity. This exhibit should prove of particular interest as turbines of this type are installed in the Norton Bridge power station of the Lakshapana Development Scheme in Ceylon.

The display staged by the Shell Petroleum Company, Limited, St. Helen's-court, London, E.C.3, consists mainly of photographs which illustrate all phases of the oil industry from exploration and drilling to distribution of the final products. The exhibit of Hunting Aero Surveys, Limited, 6, Elstree-way, Boreham Wood, consists of models, dioramas and photographs illustrating the type of survey work now being carried out in the Far East. Their stand should prove of particular interest as they have recently been appointed advisors to the Ceylon Government on aerial-survey work. Messrs. Ruston and Hornsby, Limited, Lincoln, instead of models, are showing complete examples from their range of Diesel engines, the main exhibits being a four-cylinder horizontal type of engine and one of their YE class of vertical engine. The YE range of engines, it will be recalled, was introduced to meet the demand for heavy-duty units having a low weight-power ratio but capable of being used for such applications as marine propulsion, driving excavators, powering locomotives, etc. These engines are therefore heavier than automotive type units but considerably lighter than the general run of heavy-duty engines.

A selection from their range of earth-moving machinery is being shown by Messrs. E. Boydell and Company, Limited, Old Trafford, Manchester, 16. The selection includes their Muir-Hill model 14B dumper, which is

designed to carry 4½ cubic yards of spoil. This machine is powered by a 4.73-litre Perkins Diesel engine and is provided with a special gearbox, arranged to give four speeds in both directions of travel, a three-point suspension system and four-wheel brakes. In common with several other firms, Messrs. Aveling-Barfords Limited, Grantham, have supplied several machines, for use on many important projects in Ceylon. Their 4½ cubic-yard dumpers, for example, are being used in connection with the Gal Oya Development Scheme and the Colombo Port Improvement Scheme. The firm have also supplied many road rollers which are operated on the Island by the Public Works Department; their "GB" range of rollers has proved particularly popular, not only with the Public Works Department but also on tea estates. The Aveling-Barford exhibit, which is being staged by their distributors in Ceylon, includes, therefore, a type "G B W" road roller, the manufacturer's basic 3½-ton model, and one of a range extending from 2½ tons to 5 tons.

At the end of the Second World War, Messrs. Ransomes, Sims and Jefferies, Limited, Ipswich, developed a special plough for destroying kanks grass, a weed peculiar to India which grows roots to a depth of 3 ft. and offers up to 40 lb. shearing resistance. Known as the Supertrac, the plough has proved most effective in dealing with this weed. It is their main exhibit. Agricultural equipment is also being shown by Messrs. Harry Ferguson, Limited, Coventry, the equipment on view including a representative selection of their mounted-type implements and, of course, a complete tractor. Dairy-farming equipment is represented by a joint exhibit staged by the Anglo-Ceylon and General Estates Company, Limited, in association with Messrs. Gascoignes (Reading), Limited, and the A.P.V. Company, Limited. The stand is in three sections which deal with the value of attested herds, clean-milk production, and bottling and pasteurisation.

Those firms showing machine tools include Messrs. H. W. Kearns and Company, Limited, Broadheath, Altrincham, who are exhibiting their Optimetric horizontal tool-room boring machine, which is capable of performing to a high degree of accuracy surfacing, boring, milling and drilling operations. Many firms, of course, are represented by their Ceylon distributors; Messrs. Wm. McKinnon and Company, Limited, Aberdeen, Messrs. Drake and Fletcher, Limited, Maidstone, and Messrs. R. A. Lister and Company, Limited, Dursley, for example, are represented at the exhibition by Messrs. Harrison's Lister Engineering, Limited, Colombo. These firms are showing rice-production machinery, crop-spraying equipment and small-horse-power engines, respectively. Messrs. Harrison's Lister Engineering are also showing equipment manufactured by Messrs. Frederick Parker, Limited, Leicester, the Lee, Howl Company, Limited, Tipton, and Messrs. H. J. Godwin, Limited, Fairford, Gloucestershire.

### A NATIONAL FUEL POLICY.\*

THE Federation of British Industries advocated the appointment of the Committee on National Fuel Policy because it was hoped that such a committee would lay bare the details of a situation which, they fear, is going from bad to worse; because, in the light of that situation, a policy is required which will guide the plans of fuel suppliers and consumers; and because a plan of action based upon a sound long-term policy is urgently needed now.

Because of shortage, Britain has for years had to slash coal exports. In the ten years before the war, the average coal exports were 42.5 million tons, contrasted with 8.7 million tons in the post-war years. This means that, since the war, Britain has lost on average some 110*l.* to 120*l.* million of foreign exchange a year. Acute hardship is caused to other countries, who would like to buy this coal and, in consequence, Britain is losing imports of valuable raw materials and food. Some three-quarters of American economic aid to Europe during the current United States fiscal year is likely to be spent on American coal.

A population of 50 millions can be supported only by maintaining a high level of production in industry and agriculture. This cannot be done without more coal, or more gas and electricity made from coal. Each industrial worker in the United States has available three times the horse-power available in Britain. To achieve the reduced costs and prices that will accompany greater efficiency means more coal and power. The true demand for coal is bigger than the present "restrained" demands. Gas works, power stations, coal mines, railways, and coke ovens are allowed to consume as much coal as their present plants require; but export demands, domestic con-

\* Summary, by the Federation of British Industries, of the evidence submitted by them to the Committee on National Fuel Policy (the Ridley Committee). Abridged.

sumption and, to a smaller extent, industrial consumption, are held down to a total probably 10 to 20 million tons below the true demands.

According to available evidence on the probable trend of future demand, we estimate that by 1960-65 the total demand will have grown by 73.5 million tons, to 293 million tons. The accompanying table compares the present consumption with the estimated future demand. Comparison with the National Coal Board's *Plan for Coal* shows that, on present trends, a true shortage which is now 10 to 20 million tons, will, by 1960-65, have grown to some 50 million tons. The problem is to formulate a policy and to devise plans to bridge this disparity. Without such a policy and such plans we could look forward only to disaster.

*Present Coal Consumption and Estimated Future Demand.*  
(million tons)

|                                        | 1951<br>Annual<br>Consumption. | 1961-65<br>Estimated<br>Demand. |
|----------------------------------------|--------------------------------|---------------------------------|
| Gas .. .. .                            | 27.4                           | 38                              |
| Electricity .. .. .                    | 35.5                           | 63                              |
| Railways .. .. .                       | 14.3                           | 15                              |
| Coke ovens .. .. .                     | 23.5                           | 26                              |
| Industry .. .. .                       | 45.5                           | 56                              |
| Miners and collieries .. .. .          | 15.6                           | 12                              |
| Domestic .. .. .                       | 32.4                           | 40                              |
| Overseas shipments and bunkers .. .. . | 11.7                           | 30                              |
| Miscellaneous .. .. .                  | 13.6                           | 13                              |
| Total .. .. .                          | 219.5                          | 293                             |

The Committee will, no doubt, realise how intimately coal output is bound up with man-power, including the question of admitting more foreign workers. If the Committee felt that larger capital investment would assist the man-power problem and secure more coal, we hope they would advocate this. We hope the Committee will emphasise the need to give developments in providing alternative sources of fuel—including atomic energy and hydro-electric power—every possible facility. Fuels are now used with too little discrimination. We hope the Committee will not shrink from recommending that the most efficient fuel be chosen for each main use. Economy through fuel efficiency is the only means of bringing demand into step with supply.

The Committee will, no doubt, review the relationship between the capital investment programmes of coal mines, power stations, gas works, oil refineries, and fuel consumers, in order that they may be kept in step. Plans to develop power stations, industry, or export must not outstrip coal supply, nor plans to develop the consumption of electric power outstrip the capacity of the electricity industry. We recommend that the Committee, in reviewing existing programmes should take account of the whole cost of the developments which would correspond with the forecast increases in coal supply. While the *Plan for Coal* indicates the capital investment required to raise mine output, it does not say to what extent there might be a resulting increase in railway developments, for example, in wagons to carry the coal. To sum up, a national fuel policy should guide and direct the development and production of all forms of fuel and power; encourage to the utmost the employment of the different types of fuel and power in those uses for which they are most suitable; promote the most efficient use of fuel and power; and ensure that developments involving the use of fuel and power are in step with their prospective supply.

Much more should be done to promote industrial fuel efficiency. The main obstacle to improvements is shortage of capital owing to the combined effect of high taxation and rising replacement cost of plant. Alternative methods for encouraging replacement of obsolete equipment are Government loans repayable over a long period free of interest or at a low rate; or immediate taxation relief by treating approved expenditure as revenue expenses for taxation purposes.

Valuable heat is being lost through faulty thermal insulation or entire lack of it. Thorough insulation must be encouraged to the utmost. Proposals made on the financing of new equipment apply with equal force to insulation. Present educational and training facilities for all who deal with fuel and power in industry should be reviewed and if necessary expanded. The Committee should consider whether, in, say, five years time, boiler operatives should not be obliged to hold certificates of competence. While an estimate of the saving that might be achieved by greater fuel efficiency is purely speculative, a target of ten million tons should be adopted as the economy to be achieved by 1965. In other words, by this saving, industrial expansion could continue at the present rate for 15 years with the same ultimate rate of coal consumption.

Our main concern under the heading of electricity generation and use is to ensure sufficient supplies of electric power in the years ahead and to be rid of peak-load problems. In the building of large power stations,

## SURFACE-HARDENING MACHINE.

SURFARD LIMITED, LONDON.

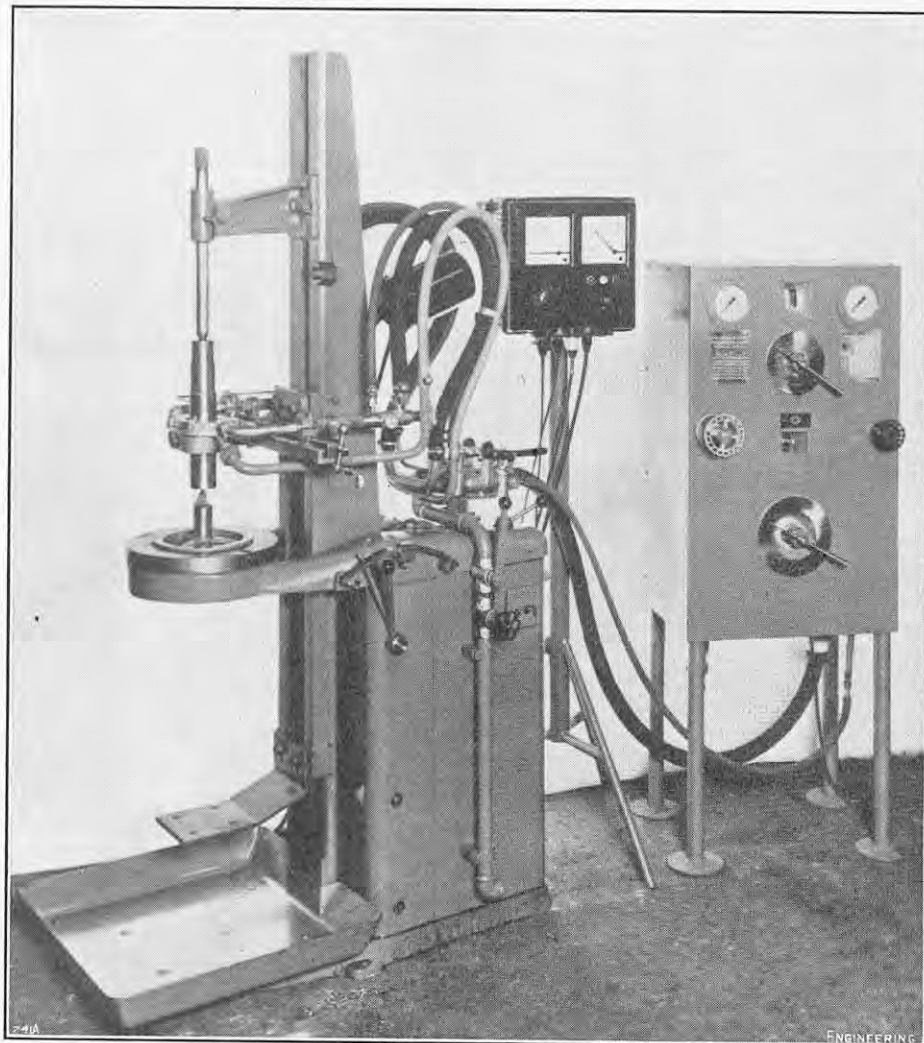


FIG. 1. VERTICAL MACHINE FOR SPINDLES AND SMALL ROLLS.

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### SURFACE-HARDENING WITH TOWN GAS AND OXYGEN.

The process of flame-hardening is widely practised in engineering shops as it offers attractive means of producing local hard surfaces where machine parts are subject to wear. Moreover, at the present time, when some appropriate grades of alloy steel for case-hardening or nitriding are difficult to obtain, perhaps the most commercially advantageous and important feature of surface hardening is that, by its use, plain carbon steels containing, say, from 0.35 to 0.7 per cent. of carbon, are made as effective as alloy steels for many applications. Again, surface-hardening processes are speedy and the depth of the hardened case depends upon the rate of heat input and upon the short space of time between cutting off the heat source and applying the quenching medium. The properties of the slightly heated core remain virtually unchanged, the tensile strength ranging, according to carbon content, from 35 to 50 tons per square inch, if the material was initially in the normalised condition. Cast iron and black-heart malleable iron contain ample combined carbon and may likewise be surface hardened.

In order to develop a flame of sufficient intensity to heat the surface layers of steel, without undue penetration, an oxygen/fuel gas mixture is required. This led the early pioneers, thirty years ago, to adopt for the purpose of surface-hardening the high-intensity oxy-acetylene flame, as used for welding, and this practice became almost universal in this country, on the Continent and in the United States. More recent work has shown, however, that the oxy-acetylene flame, although well suited to welding at 1,500 to 1,600 deg. C., is in reality far hotter than is necessary to raise the surface of steel to its hardening temperature of about 800 deg. C. As a result of research, a German scientist, Mr. P. F. Peddinghaus, of Gevelsberg, Westphalia, has developed a process involving the use of an oxygen/town-gas flame for surface hardening and has designed and manufactured special burners in conjunction with a wide range of flame-hardening machines. These machines are marketed in this

is sufficient account being taken of the low thermal efficiency of the condensing cycle and are some of the stations too remote from industry and coal mines? Has the wider use of generation by pack-pressure turbine and steam engines, linked where suitable to the public supply, been sufficiently encouraged? Could not auxiliary oil-engine generators help the peak-load problem? Has the question of the construction of steam power stations of smaller size, housed in simple buildings, and designed specifically to cater for winter peak loads, been examined?

Limitation of domestic solid fuel has resulted in increased use of gas and electricity which, in turn, has affected industry. In terms of "coal economy efficiency," gas ranks at about 30 per cent. and electricity as low as 18 per cent. at the point of continuous use. Increased supplies of suitable solid fuels would encourage the use of modern domestic appliances for solid fuel. Railway electrification, the wider use of Diesel, Diesel-electric and ultimately coal-burning gas-turbine locomotives would contribute to fuel saving. While the British economy has for many years rested on coal and will continue to do so for many years to come, Britain cannot afford to lag behind the rest of the world in developing other forms of energy. It is hoped the Committee will examine whether enough of the nation's resources for research and development is being devoted to this question.

**FIFTH LOUIS BLÉRIOT LECTURE.**—The fifth Louis Blériot lecture will be given in Paris at 5 p.m. on Wednesday, March 12, in the Salons de l'Hôtel des Anciens Elèves des Écoles d'Arts et Métiers, 9bis Avenue d'Iéna, Paris (16e). The lecturer, Mr. H. Knowler, F.R.Ae.S., has chosen for his subject "The Future of the Flying Boat." The lecture will be read in French by M. l'Ingénieur en Chef Benoit, Director of l'Office National d'Études et de Recherches Aéronautiques. A cocktail party and dinner will be held on the evening of the lecture. Further particulars may be obtained from the Secretary of the Royal Aeronautical Society, 4, Hamilton-place, London, W.1.

## SURFACE-HARDENING MACHINE.

SURFARD LIMITED, LONDON.

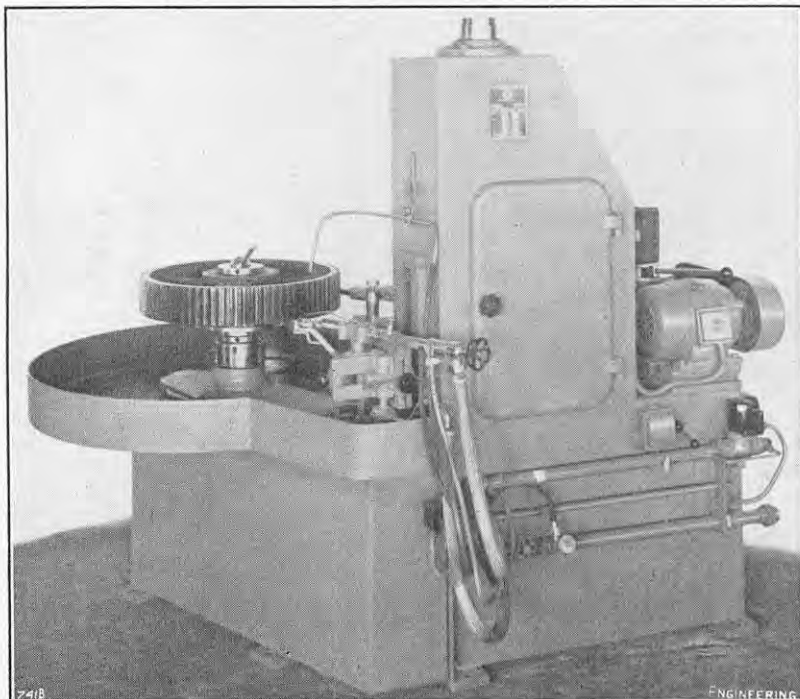


FIG. 2. HARDENING MACHINE FOR GEARWHEELS.

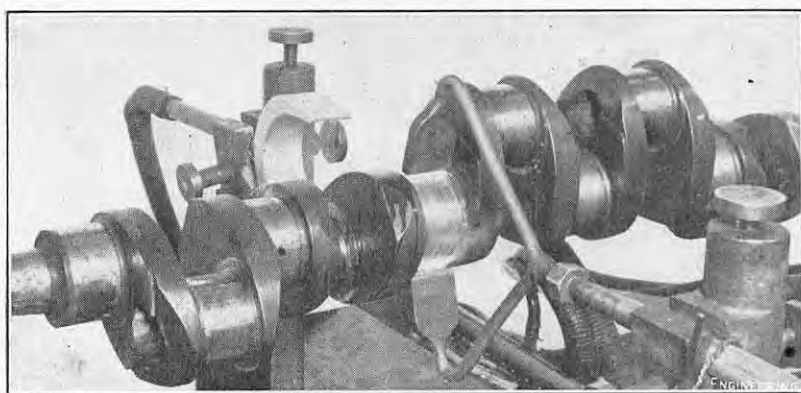


FIG. 3. HARDENING OF CRANKSHAFT JOURNALS.



FIG. 4. HARDENING A LOCOMOTIVE EXPANSION LINK.

country and the British Commonwealth by Surfard Limited, Abbey House, 2, Victoria-street, London, S.W.1, who recently arranged a demonstration of a vertical flame-hardening machine in which small spindles and rolls up to 5 in. in diameter and 24 in. in length can be progressively hardened.

The machine is shown on the left in Fig. 1, opposite. On the extreme right is a gas-flow meter and between this and the hardening machine are the indicator dials for a "Milliscope" automatic temperature-controlling instrument. The gas-flow meter is employed because the pressure of the gas used is increased to 4.2 lb. per square inch. The component to be hardened is held between centres, as seen on the left in Fig. 1, and is rotated at a speed of about 100 r.p.m. Two semi-circular oxygen/town-gas burners having a narrow horizontal slit which emits a ribbon of flame are used for heating. These burners and the quenching jets, situated below them, are mounted on a carrier which is raised hydraulically throughout the length of the part to be hardened. On this carrier is mounted the working head of the Milliscope, the cylindrical black object seen behind the hoses on the left of the indicator dials in Fig. 1. This working head is sighted on to the portion of the work which is being heated. The distance between the working head and the flame ranges from 12 in. to 30 in. The Milliscope is similar to an optical pyrometer of the disappearing-filament type, except that a special photo-electric cell is used to compare the radiation from the comparison filament with that from the work surface. The temperature of the filament is set by means of a rheostat, and an image of it is focused on the cell, the optical path being interrupted by a rotating "chopper" disc. This disc has circular holes around its periphery and is arranged in such a manner that it exposes the photo-electric cell alternately to an image of the work surface and

to an image of the comparison filament. The radiation from these two sources is thus continuously compared and, by the introduction of optical light filters, the comparison is made in a particular wavelength range. If a difference between the two exists, an alternating current is produced by the photo-electric cell, the phase of which is indicative of the direction of unbalance.

The radiation from the comparison filament can be adjusted by varying the current passing through the filament. Since the radiation from the work surface is related to its temperature, it will be seen that, for a particular setting of the comparison-filament current, there will be a particular work-surface temperature at which no alternating current is produced by the photo-electric cell. At this pre-arranged point the direct current generated is utilised to actuate switches on the flame-hardening machine, thus rendering it automatic in action and controlling closely the hardening temperature. The photo-electric cell current is amplified and is applied to a phase-sensitive rectifier arranged to operate a relay when the work temperature reaches the pre-arranged value. In the case of the machine demonstrated (that seen in Fig. 1) the direct current is utilised to control the speed of travel of the burner and the accompanying quenching equipment. The current causes a magnetic valve in the hydraulic system to permit additional oil to pass to the cylinder, thus increasing the speed of travel of the burner and thereby reducing the work temperature. This gives a uniform depth of hardness, while concentricity is assured by the rotation of the component.

During the treatment of a component the conditions obtaining are seen by means of signal lamps and a moving needle on the right-hand indicator dial in Fig. 1, the left-hand dial showing the work temperature. At the commencement of heating a blue signal lamp is

illuminated and, as the temperature approaches that set beforehand, the needle on the right-hand indicator rises to warn the operator that the required temperature is about to be reached. At a point approximately 10 deg. C. before the temperature is attained, the blue lamp is extinguished. At the moment when the work temperature is identical with that of the filament, the needle is at the zero point on the dial and, at about 10 deg. C. above this temperature, a red lamp lights up. The needle then continues to oscillate about the zero point and the red lamp to light up and go out during the entire hardening operation, thus indicating that the hardening temperature is maintained within  $\pm 10$  deg. C.

A comprehensive range of flame-hardening machines, employing the principles outlined above, is now available. That shown in Fig. 2, above, is an automatic machine for the surface-hardening of gear teeth as the gearwheel is rotated. Once the gearwheel is placed in position the teeth are progressively hardened with a minimum expenditure of fuel. Fig. 3 shows a special attachment for the hardening of crankshaft journals; one double-headed burner is seen in the heating position, and, behind this, the water quench. In this case, the Milliscope indicates, by means of a red light, the precise moment at which the operator should replace the burner by the water quench, and, in this and similar machines, a gong or other audible signal is also given to attract the operator's attention. In Fig. 4, above, is shown a locomotive expansion link having the wearing surfaces hardened by the Peddinghaus process. Of particular interest is a machine designed for hardening pins, spindles and other components. In this case, the Milliscope trips the turntable on which the parts are held and rotated, moving it to the quenching position when the pre-arranged temperature has been attained.

## NOTES FROM THE INDUSTRIAL CENTRES.

### SCOTLAND.

**STEEL DISTRIBUTION TO LOCAL FIRMS.**—Authorisations under the new steel distribution scheme are pouring in to local makers. The almost inevitable anomalies have cropped up, but observers believe supplementary allocations will be made to correct any inequity in distribution. Some shipbuilders are to receive only about 50 per cent. of requirements. Calculations of requirements, however, generally include an allowance for the arrears of deliveries resulting from the decline in ingot production. At the present rate of deliveries to the shipyards, the authorisations represent a considerably higher proportion than 50 per cent.

**WITHDRAWAL OF OLD LOCOMOTIVE.**—The British Railways locomotive No. 57695, formerly Highland Railway No. 136, the last of its class, has been withdrawn from traffic and is to be broken up at Kilmarnock Works. The engine was one of ten freight 0-6-0 locomotives built between 1900-1902 for the Highland Railway by Dübs & Co., Glasgow, to the design of Mr. P. Drummond, locomotive superintendent of the Highland Railway from 1896 until 1911.

**INSTRUCTION IN ELECTRON-MICROSCOPY.**—An electron microscope capable of a magnification of 100,000 diameters has been installed in the Natural Philosophy Department of the Royal Technical College, Glasgow. It will be used primarily for the teaching of electron microscopy in the college's associateship course in applied physics. The subject is to be incorporated in normal class routine.

**MINIATURE CIRCUIT-BREAKER.**—At the St. Enoch Hotel, Glasgow, on March 18 and 19, demonstrations are to be given of the miniature circuit-breaker made by Dorman and Smith, Ltd., Manchester, 5. The demonstrations will deal with the technical aspects and applications of the circuit-breaker, and will be held at 11 a.m. and 3 p.m. each day. Tickets are available from the firm's Manchester office.

### CLEVELAND AND THE NORTHERN COUNTIES.

**COAL IN COLLIERY REFUSE HEAP EXPORTED.**—When it was decided to move a pit heap in connection with opencast operations in the vicinity of Widdrington Old Colliery, between Morpeth and Amble, Northumberland, it was found that, beneath the grass-covered surface, the heap consisted of low-quality coal which, nevertheless, was marketable. The coal is now regularly exported to Antwerp and Ghent, where it is pulverised and consumed in power-station boilers. The pit heap had been left undisturbed for some 40 years. Other pit heaps in the Northumberland Division of the National Coal Board have now been surveyed, but with negative results.

**EXCHANGE OF ENGLISH AND GERMAN STEELWORKS APPRENTICES.**—Mr. A. C. Dunkley, education officer to the Workington Iron and Steel Company, has outlined a scheme under which six of the company's apprentices will visit Germany while six young Germans will come to this country. The English youths, former grammar-school boys, will normally stay with the parents of the German apprentices, while the latter will enter the homes of the Workington boys. The details are still being worked out, but it is understood that the company is to finance the scheme. Mr. Dunkley is a former official of the Allied Control Commission in Germany.

**HOLIDAYS IN 1952.**—The Wear shipyards are to take their annual holidays this year simultaneously, from July 25 to August 11. About 10,000 shipyard workers are involved. The arrangements made for Tyneside engineering firms' holidays are that three firms will close from June 20 to July 7, nine from July 18 to August 5, and four from July 25 to August 12. These dates correspond with those already decided upon for the shipyards on Tyneside.

### LANCASHIRE AND SOUTH YORKSHIRE.

**THE LATE MR. A. LORD.**—We note with regret the death of Mr. Arthur Lord, late managing director of Coventry Machine Tool Works Ltd., Halifax, which occurred after a brief illness at his home in Leamington-road, Kenilworth, on February 18. He was a founder of the company.

**STEEL QUOTAS MAY BE INCREASED.**—In some Sheffield industries, the steel allocations for the first period were disappointing, but now it is understood that for the second period, covering April, May and June, there may be substantial increases, designed to safeguard important export trade, especially in tools.

**JAPANESE STEEL NOT TO BE IMPORTED.**—The refusal of the Japanese Government to grant licences for the export of steel to the United Kingdom, under the agreement recently signed for 109,000 tons of steel at an approximate cost of 5,000,000*l.* sterling, is a source of disappointment to some steel users in Sheffield who had received a share of the Japanese steel bought before the 5,000,000*l.* agreement. Payment in sterling has been rejected on the ground that Japan, at present, has a large and mounting surplus of sterling.

**CUTLERY RESEARCH COUNCIL.**—The Sheffield Cutlery Manufacturers' Association, in co-operation with the British Iron and Steel Research Association and the Department of Scientific and Industrial Research, have set up a Cutlery Research Council, of which the chairman is Mr. D. A. Palmer, President of the Sheffield Cutlery Manufacturers' Association. Mr. C. N. Kington, chief engineer-administrator of B.I.S.R.A.'s Sheffield group, has been lent to the Cutlery Research Council as senior research officer.

**NATIONAL-SERVICE CALL-UP AND INDUSTRY.**—Training and production are likely to be adversely affected by the call-up of an extra class of men for National Service. There is already, an acute shortage of men in Sheffield industry. It is stated that many 18-year-olds do not take advantage of facilities for deferment, preferring to "get it over." It is suggested that it might be beneficial to industry to alter the age of entry for National Service to 19, as in many other countries.

### THE MIDLANDS.

**WOLVERHAMPTON AND STAFFORDSHIRE TECHNICAL COLLEGE.**—Extensions to Wolverhampton and Staffordshire Technical College, which have been proceeding since early in 1950, are now nearing completion, and preparations are being made for equipping the new buildings. Wolverhampton Education Committee have decided to apply for permission to raise a loan of 45,000*l.* for equipment. There are eleven new laboratories and workshops, including one which will be devoted to time and motion study, said to be the first time in any technical college in Great Britain. The new buildings will also include separate accommodation for the National Foundry College, which at present shares the main technical college premises.

**STEEL ALLOCATION.**—Mr. Barry Kay, Midland regional controller for the Board of Trade, stated in Birmingham on February 19 that some obvious errors in steel allocations to firms in the Midlands for the first quarter of 1952 have now been corrected. Allocation figures for the second quarter are being sent out, and the necessary amendments will appear in these figures. Mr. Kay added that it was too early yet to see the full effects of the steel allocation scheme.

**EMPLOYMENT IN THE MIDLANDS.**—Mr. J. W. Eldridge, deputy regional controller for the Ministry of Labour, giving employment figures for the Midlands in Birmingham on February 19, said that, between the beginning of the year and February 16, 1,637 persons had been discharged as a result of steel shortage; but the Ministry was having no great difficulty in finding alternative work for those discharged, except in the case of certain workers from the motor industry whose particular skill was not wanted in other trades. Mr. Eldridge reported an increase in the number of mine-workers; there were still vacancies for 2,745 men and boys at the pits in the area, but in the last three months the total employed had risen by about 600.

**ELECTRONIC MULTIPLIER.**—At the Business Efficiency Exhibition at Birmingham, which closes to-day, February 29, the British Tabulating Machine Company have been showing what is claimed to be the first electronic multiplier designed to operate in sterling monetary units. The multiplier was shown in operation carrying out piece-work calculations. Using punched cards on which the appropriate information had been set by other machines, the multiplier calculated the wages payable to a piece-worker, based on the number of articles produced and the rate per article. The multiplication of articles produced by rate was done in three-fifths of a second, the information being punched on the card, ready for use by other machines preparing wage statements.

**CHECKING BANK-NOTES BY WEIGHT.**—W. and T. Avery, Ltd., Soho Works, Birmingham, have supplied to a Coventry bank a sensitive balance for weighing, instead of counting, bundles of bank-notes. The machine is

adapted from one of their standard patterns by the provision of two flat pans and a special weight-indicating chart. It is of the "light and heavy" type, with a central zero mark on the chart to indicate correct weight, or, in this case, correct count. Only one graduated chart is provided—on the bank clerk's side—and it has "light" and "heavy" markings equivalent to  $\frac{1}{16}$ th dram on opposite sides of the central zero. The maximum weight indicated on each side is 1 dram. To use the machine, the clerk places a bundle of 50 or 100 hand-counted notes in one of the pans, and one of the bundles to be checked in the other pan. If the two bundles agree, the weighing-machine indicator settles at zero on the chart. If the bundle being checked is deficient by one, the weight of one note is shown by the indicator on the "light" side of the chart. In the case of a 1*l.* note this weight is  $\frac{1}{4}$  dram. Similarly, an excess in the bundle being checked will be shown on the "heavy" side of the chart. Any excess or deficiency larger than one will be shown by the fact that the indication will not appear on the graduated part of the chart at all. The machine has a dashpot to damp the oscillation of the mechanism, making it possible to check the count within a fraction of a second after the bundle of notes has been placed in the pan. It is expected that the time spent by clerks and customers will be reduced to about a third of that required for counting by hand.

### SOUTH-WEST ENGLAND AND SOUTH WALES.

**TIPPING OF WASTE FROM NANTGARW PIT.**—Despite objections by tenants on the nearby Treforest Trading Estate, the National Coal Board has been given permission to tip waste from the new Nantgarw pit on a spot near the colliery. Following a public inquiry, the Minister of Housing and Local Government stated that there were no suitable alternative sites available and he had to decide whether the progress of the new colliery had to be stopped altogether. It was hoped that underground stowage would be possible in a few years' time, but for technical reasons it could not take place yet.

**ABERDARE FACTORY TO MAKE TUBING.**—Helliwells Ltd., aircraft and general engineers, have acquired a factory at Robertstown, Aberdare, which has been empty for two years. Major aircraft components will be made, but the factory is being prepared to turn out electrically-welded tubing so that, on the completion of the re-armament programme, the factory can be switched over with the minimum of delay.

**OPPOSITION TO NORTH-WALES HYDRO-ELECTRIC POWER BILL.**—The South-West Wales River Board have decided to join in opposing certain clauses in the North Wales Hydro-Electric Power Bill. The Bill is being promoted to authorise the carrying out of a scheme for generating electricity by water power, at Ffestiniog, and to increase the catchment areas serving two existing hydro-electric generating stations. It was pointed out that the scheme did not affect the area of the South-West Wales River Board, but several clauses of the Bill were felt to involve principles which, if unchallenged, would create precedents. The Board were mindful of the proposed Rheidol scheme.

**PROPOSED EAST-WEST BRISTOL-CARDIFF MOTOR ROAD.**—When objections to the line of the proposed new arterial motorways running through Gloucestershire were heard at a public inquiry, Mr. D. G. Roberts, deputy clerk to the County Council, said that great savings in time and transport costs were likely to be made from the proposed new trunk roads. At present, traffic between Bristol and Cardiff must inevitably pass through Gloucester. If a direct crossing of the River Severn existed, as proposed on the east-west motorway, the distance would be cut by 50 miles. The bridge with its approach roads would effect a saving in transport costs of 375,000*l.* a year, based merely on 300 days at 6*d.* per ton-mile over the distance of 50 miles.

**LEAD AND ZINC MINING IN WALES.**—Mr. Joannes van de Velde, a Dutch mining expert who recently visited Wales, has reported that there were "big dumps of zinc just lying around" in the dormant lead and zinc mining districts of North Cardiganshire and West Montgomeryshire. With modern mining methods, he said, mines abandoned throughout the British Isles about 50 years ago might be found economic to-day.

**NORMALAIR LIMITED.**—The works of Normalair Ltd., at Yeovil, are being extended, and additional machine tools and equipment are being added, to meet the rapid expansion which is taking place in the company's business, particularly the manufacture of aircraft-cabin pressurising equipment and high-altitude breathing equipment. The laboratory for high-altitude research has been improved. A subsidiary company is being formed in Australia to service Normalair equipment, and servicing arrangements are being made in Canada and France.

## 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 3, 5.30 p.m., Geological Society, Burlington House, Piccadilly, W.1. "The Random Process for Moulding in the Production of Steel and Bronze Castings," by Mr. G. L. Hancock.

**INSTITUTION OF MECHANICAL ENGINEERS.**—*North-Eastern Branch*: Monday, March 3, 6 p.m., Neville Hall, Newcastle-upon-Tyne. "Reliability," by Mr. Norman Parry. *London Graduates' Section*: Wednesday, March 5, 6.30 p.m., Storey's-gate, St. James's Park, S.W.1. "Gas Turbines," by Mr. M. Ruddick. *Scottish Branch*: Thursday, March 6, 7.30 p.m., Royal Technical College, Glasgow; and Friday, March 7, 7.30 p.m., Robert Gordon's College, Aberdeen. Thomas Hawksley Lecture on "Some Fuel and Power Projects," by Dr. H. Roxbee Cox. *Institution*: Friday, March 7, 5.30 p.m., Storey's-gate, St. James's Park, S.W.1. Meeting in conjunction with *Internal Combustion Engine Group*. "Use of Heavy Fuels for Medium-Sized Marine and Stationary Diesel Engines," by Mr. J. R. P. Smith. **AUTOMOBILE DIVISION.**—*Coventry Centre*: Tuesday, March 4, 7.15 p.m., Craven Arms Hotel, High-street, Coventry. "The Design and Development of Very Large Road Haulage Vehicles," by Mr. C. E. Burton.

**INSTITUTION OF ELECTRICAL ENGINEERS.**—*South Midland Centre*: Monday, March 3, 6 p.m., James Watt Memorial Institute, Birmingham. (i) "Domestic Electrical Installations: Some Safety Aspects," by Mr. H. W. Swann. (ii) "Earth-Leakage Protection in Parallel with Solid Earths," by Mr. N. Elliott. Wednesday, March 5, 6.30 p.m., College of Technology and Arts, Rugby. "Technical Colleges and Education for the Electrical Industry," by Dr. H. L. Haslegrave. *North-Eastern Centre*: Monday, March 3, 6.15 p.m., King's College, Newcastle-upon-Tyne. "The Application of Transducers as Relays to Protective Gear," by Mr. R. K. Edgley and Mr. F. L. Hamilton. *District Meeting*: Monday, March 3, 7.30 p.m., New Inn, Sandling-road, Maidstone. Film on "Overhead-Line Construction." *Measurements Section*: Tuesday, March 4, 5.30 p.m., Savoy-place, Victoria-embankment, W.C.2. Discussion on "Design of Control Panels Including Instrument Scales and Pointers," opened by Mr. L. B. S. Golds and Mr. H. Murrell. *North-Western Centre*: Tuesday, March 4, 6.15 p.m., Engineers' Club, Manchester. "The Economics of Low-Voltage Electricity Supplies to New Housing Estates," by Mr. F. G. Copland. *Southern Centre*: Wednesday, March 5, 6.30 p.m., Royal Beech Hotel, Portsmouth. "Electricity Supply: A Statistical Approach to Some Particular Problems," by Mr. R. B. Rowson. *Scottish Centre*: Wednesday, March 5, 7 p.m., Heriot-Watt College, Edinburgh. "Instruments for Use in the Microwave Band," by Dr. A. F. Harvey. *Institution*: Thursday, March 6, 5.30 p.m., Savoy-place, Victoria-embankment, W.C.2. "Post-Graduate Activities in Electrical Engineering," by Mr. W. J. Gibbs, Mr. D. Edmundson, Mr. R. G. A. Dimmick and Mr. G. S. C. Lucas.

**INSTITUTE OF PACKAGING.**—*Northern Area*: Monday, March 3, 6.30 p.m., Old Nag's Head Hotel, Manchester. Annual Meeting. *Southern Area*: Thursday, March 6, 6 p.m., Waldorf Hotel, Aldwych, W.C.2. Annual Meeting and Film Evening.

**JUNIOR INSTITUTION OF ENGINEERS.**—*North-Western Section*: Monday, March 3, 7.30 p.m., 16, St. Mary's Parsonage, Manchester. "Oil Well Engineering," by Mr. C. Ratcliffe. *Midland Section*: Wednesday, March 5, 7 p.m., James Watt Memorial Institute, Birmingham. "Enterprise in Engineering," by Air Commodore F. R. Banks. *Institution*: Friday, March 7, 6.30 p.m., 39, Victoria-street, S.W.1. "The History of the Aviation Engine," by Air Commodore F. R. Banks.

**INSTITUTE OF BRITISH FOUNDRYMEN.**—*Sheffield Branch*: Monday, March 3, 7.30 p.m., College of Technology, Pond-street, Sheffield, 1. "Castings to Resist Abrasive Wear," by Mr. E. J. Brown. *Burnley Section*: Tuesday, March 4, 7.30 p.m., Municipal College, Ormerod-road, Burnley. Annual Meeting. "Some Aspects of a Small Foundry Laboratory," by Mr. A. Potter. *Lincolnshire Branch*: Thursday, March 6, 7.15 p.m., Technical College, Lincoln. "Production of Malleable Iron Castings," by Mr. A. E. Peace. *Scottish Branch*: Saturday, March 8, 3 p.m., Royal Technical College, George-street, Glasgow. Annual Meeting. "Ways and Means of Increased Productivity," by Mr. J. Hunter. *Newcastle Branch*: Saturday, March 8, 6 p.m., Neville Hall, Newcastle-upon-Tyne. "The Repair and Reclamation of Non-Ferrous Castings," by Mr. G. Elston. *West Riding of Yorkshire Branch*: Saturday, March 8, 6.30 p.m., Technical College, Bradford. "A System of Studying Casting Defects," by Mr. G. W. Nicholls and Mr. D. T. Kershaw.

**ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS.**—*Leeds Branch*: Monday, March 3, 7.30 p.m., Great Northern Hotel, Wellington-street, Leeds, 1. "The

Factories Act Regulations and the Supervising Electrical Engineer," by Mr. W. Fordham Cooper. *West London Branch*: Tuesday, March 4, 7.30 p.m., Windsor Castle Hotel, King-street, Hammersmith, W.6. "Main Line Traction," by Mr. C. C. H. Wade. *Sheffield Branch*: Wednesday, March 5, 7.30 p.m., Royal Victoria Station Hotel, Sheffield. "Sound and Sound Recording," by Mr. C. L. Bunce.

**ROYAL INSTITUTION.**—Tuesday, March 4, 5.15 p.m., 21, Albemarle-street, W.1. "Dusts and Powders in Nature and Industry.—II. Relative Motion of Particles and Fluids," by Dr. H. Heywood. Thursday, March 6, 5.15 p.m., "Interference and Diffraction as General Wave Properties.—III. Transforms and Fourier Syntheses," by Professor Sir Lawrence Bragg, F.R.S.

**INSTITUTION OF CIVIL ENGINEERS.**—*Road Engineering Division*: Tuesday, March 4, 5.30 p.m., Great George-street, S.W.1. "Recent Development in Highway Bridge Design in Hampshire," by Mr. E. W. H. Gifford.

**ILLUMINATING ENGINEERING SOCIETY.**—*Cardiff Centre*: Tuesday, March 4, 5.45 p.m., Town Hall, Newport, Mon. Discussion on Electrical Problems in the Home. *Liverpool Centre*: Tuesday, March 4, 6 p.m., Electricity Board's Service Centre, Whitechapel, Liverpool. "Lighting and Safety in Factories," by Mr. L. C. Rettig. *Newcastle Centre*: Wednesday, March 5, 6.15 p.m., Minor Durrant Hall, Oxford-street, Newcastle-upon-Tyne. "Colour and Light," by Mr. Gordon Ellis.

**INSTITUTION OF SANITARY ENGINEERS.**—Tuesday, March 4, 6 p.m., Caxton Hall, Westminster, S.W.1. "Sanitation in Multi-Storey Buildings," by Mr. H. E. Gooding.

**INSTITUTION OF STRUCTURAL ENGINEERS.**—*Wales and Monmouthshire Branch*: Tuesday, March 4, 6.30 p.m., South Wales Institute of Engineers, Park-place, Cardiff; and Wednesday, March 5, 6.30 p.m., Mackworth Hotel, Swansea. Film Evening. *Northern Counties Branch*: Tuesday, March 4, 6.30 p.m., Cleveland Scientific and Technical Institution, Corporation-road, Middlesbrough; and Wednesday, March 5, 6.30 p.m., Neville Hall, Newcastle-upon-Tyne. "Impressions of Welding Methods in the United States," by Mr. G. S. Gowland.

**INSTITUTION OF HEATING AND VENTILATING ENGINEERS.**—*North-East Coast Branch*: Tuesday, March 4, 6.30 p.m., Neville Hall, Newcastle-upon-Tyne. "Impact of Environmental Warmth upon Personnel in Industry," by Mr. F. R. L. White. *East Midlands Branch*: Wednesday, March 5, 6.30 p.m., University, Highfields, Nottingham. "Mine Ventilation," by Professor F. B. Hinsley. *Institution*: Thursday, March 6, 6 p.m., Institution of Mechanical Engineers, Storey's-gate, St. James's Park, S.W.1. Symposium on "Church Heating." *Birmingham Branch*: Thursday, March 6, 6.30 p.m., Imperial Hotel, Birmingham. Film on "Manufacture and Installation of Copper Tubes and Fittings."

**INSTITUTION OF WORKS MANAGERS.**—*Wolverhampton Branch*: Tuesday, March 4, 7 p.m., Star and Garter Hotel, Wolverhampton. Discussion on "Foremanship." *Sheffield Branch*: Tuesday, March 4, 7.30 p.m., Grand Hotel, Sheffield. "American Management," by Mr. J. C. W. Stead. *Tees-Side Branch*: Thursday, March 6, 7.30 p.m., Vane Arms Hotel, Stockton. "Incentives in Industry," by Mr. Lewis C. Ord.

**INSTITUTE OF METALS.**—*South Wales Section*: Tuesday, March 4, 6.30 p.m., University College, Singleton Park, Swansea. "Direct-Reading Spectrograph," by Mr. R. T. Staples. *London Section*: Thursday, March 6, 7 p.m., 4, Grosvenor-gardens, S.W.1. "Metallurgical Problems Arising from Stratospheric Flight," by Major P. L. Teed. *Birmingham Section*: Thursday, March 6, 7 p.m., James Watt Memorial Institute, Birmingham. "The Steel Co. of Wales," by Mr. W. F. Cartwright.

**ROYAL AERONAUTICAL SOCIETY.**—Tuesday, March 4, 7 p.m., 4, Hamilton-place, W.1. "Bogie Undercarriages," by Mr. F. A. Cousins. Thursday, March 6, 6 p.m., Institution of Civil Engineers, Great George-street, S.W.1. "A Study of Airport Noise," by Mr. J. D. Hayhurst.

**INCORPORATED PLANT ENGINEERS.**—Tuesday, March 4, 7 p.m., Royal Society of Arts, John Adam-street, W.C.2. Annual Meeting and Film Evening. *Southampton Branch*: Wednesday, March 5, 7.30 p.m., Polygon Hotel, Southampton. Annual Meeting.

**INSTITUTE OF TRANSPORT ENGINEERS.**—*Eastern Group*: Tuesday, March 4, 7 p.m., Co-operative Hall, Midland-road, Bedford. "Rear Axles," by Mr. R. H. Wilson.

**NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.**—Friday, March 7, 6.15 p.m., Neville Hall, Newcastle-upon-Tyne. "Moisture Damage to Cargoes," by Mr. W. McClimont.

**INSTITUTION OF PRODUCTION ENGINEERS.**—*Edinburgh Section*: Tuesday, March 4, 7 p.m., North British Station Hotel, Edinburgh. Debate on "Standard Costs." *Reading Branch*: Tuesday, March 4, 7.15 p.m., Great Western Hotel, Reading. "Costing for Smaller Engineering Firms," by Mr. J. H. Smith. *Coventry Section*: Wednesday, March 5, 7 p.m., Church House,

Church-street, Rugby. "Heavy Machine Tools," by Mr. J. H. Rivers. *Halifax Section*: Wednesday, March 5, 7.15 p.m., George Hotel, Huddersfield. "Visit of British Valve Productivity Team to the United States," by Mr. I. G. Hopkinson. *West Wales Section*: Friday, March 7, 7.30 p.m., Central Library, Alexandra-road, Swansea. "Corby Iron and Steel Works," by Mr. E. A. Taylor.

**INSTITUTION OF ENGINEERING INSPECTION.**—Thursday, March 6, 6 p.m., Royal Society of Arts, John Adam-street, W.C.2. "Glass in Engineering," by Mr. P. M. Davidson.

**MANCHESTER ASSOCIATION OF ENGINEERS.**—Friday, March 7, 6.45 p.m., Engineers' Club, Manchester. "Tubular Structures," by Mr. E. McMinin.

**INSTITUTE OF FUEL.**—*East Midland Section*: Friday, March 7, 7.15 p.m., Loughborough College, Loughborough. "Power in the Future," by Dr. J. Bronowski.

## PERSONAL.

The Lord President of the Council has appointed PROFESSOR A. R. TODD, D.Sc., M.A., F.R.I.C., F.R.S., Professor of Organic Chemistry in the University of Cambridge, to be chairman of the Advisory Council on Scientific Policy on the retirement of SIR HENRY TIZARD, G.C.B., A.F.C., F.R.Ae.S., F.R.S., at the end of March. PROFESSOR S. ZUCKERMAN, C.B., F.R.S., will continue as deputy chairman.

REAR-ADMIRAL (E) I. G. MACLEAN, O.B.E., assumed, on February 25, the appointment of deputy Engineer-in-Chief, Admiralty, Bath, formerly held by REAR-ADMIRAL (E) F. T. MASON, who will join the staff of the Commander-in-Chief, Nore, as from March 3. REAR-ADMIRAL (E) L. E. REBBECK, A.D.C., took charge of reserve aircraft on February 25, on which date REAR-ADMIRAL (E) C. LITTLEWOOD, O.B.E., was appointed to the Admiralty as Assistant Director of Dockyards.

MR. AMBROSE FIRTH, of the Brightside Foundry and Engineering Co., Ltd., has been re-elected President of the Sheffield and District Engineering Trades Employers' Association, 59, Clarkehouse-road, Sheffield, 10. MR. FRANK HEPWORTH, who has been with the Association for 22 years and assistant secretary since 1945, has been appointed secretary. The director of the Association is MR. T. GODDARD MANDER.

MR. W. G. COPESTAKE, A.M.I.Mech.E., has been appointed chief engineer of the City Transport Department, Empire House, Great Charles-street, Birmingham, in succession to the late MR. H. PARKER, M.I.Mech.E. Mr. Copestake has been assistant chief engineer in the Department since 1948.

MR. H. R. GARTH, A.M.I.C.E., assistant civil engineer, North Eastern Region, British Railways, York, retired on February 21, after 44 years of service in the Engineering Department at York.

MR. EDWARD H. JEFFERSON, who has been at the Kingston-on-Thames, Surrey, factory of Hawker Aircraft Ltd., for 31 years, has been appointed resident director of Hawker Aircraft (Blackpool) Ltd., Squire's Gate, Lancashire, a member company of the Hawker Siddeley Group.

MR. D. J. CROWTHER, M.A., has been appointed personnel manager to the Metropolitan-Vickers Electrical Co., Ltd., Trafford Park, Manchester, 17. MR. A. C. ELLIS, who has been on the staff of the firm's Manchester district office for 15 years, has been promoted to become district manager of the Cardiff office of the company, in succession to the late Mr. H. COOPE. The Cardiff office covers an area embracing also Swansea, Bristol and Plymouth.

MR. H. M. MCINTYRE, controller of the Ministry of Supply for Scotland, has now retired.

Under the provisions of Section 6 of the Transport Act, 1947, the Minister of Transport has approved the appointment of ALDERMAN A. L. CHOWN, of Northampton, who is a representative of local authorities, to be a member of the Transport Users' Consultative Committee for the East Midland area.

MR. L. F. McCAUL has been appointed sub-contracts manager of the Aircraft Division of A. V. Roe Canada Ltd., Malton, Ontario. MR. JAMES JACKSON, M.C., and MR. HERBERT McDONALD have been appointed assistant public relations officers to the firm.

VICKERS-ARMSTRONGS LTD., Vickers House, Broadway, London, S.W.1, have purchased the works and plant of HYLAND LTD., Wakefield. In future these works will be known as Vickers Armstrongs Ltd., Wakefield Works. The purchase has been made in order to provide additional capacity for the production of "VSG" infinitely-variable speed hydraulic gears and pumps, manufactured at the firm's Elswick Works.

THE DARTMOUTH MANUFACTURING CO. LTD., West Bromwich, Staffordshire, have acquired the share capital of CHARLES THOMAS & CO. LTD., edge-tool manufacturers, Aston Manor, Birmingham.

G. AND J. WEIR, LTD., Cathcart, Glasgow, S.4, announce a change in telephone number to Merrylee 7141, which took effect on February 19.

## PRESTRESSED-CONCRETE SHEET PILES.

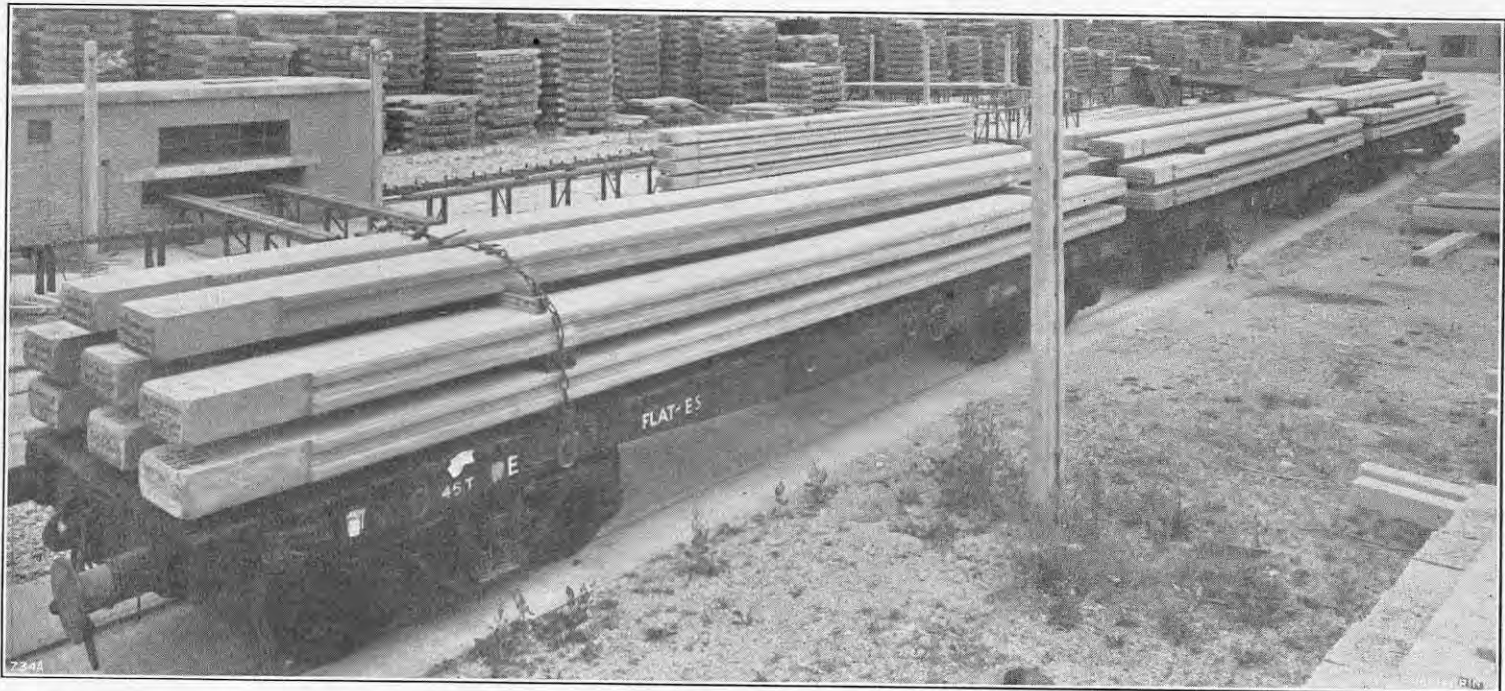


FIG. 1. PILES LOADED FOR DISPATCH.

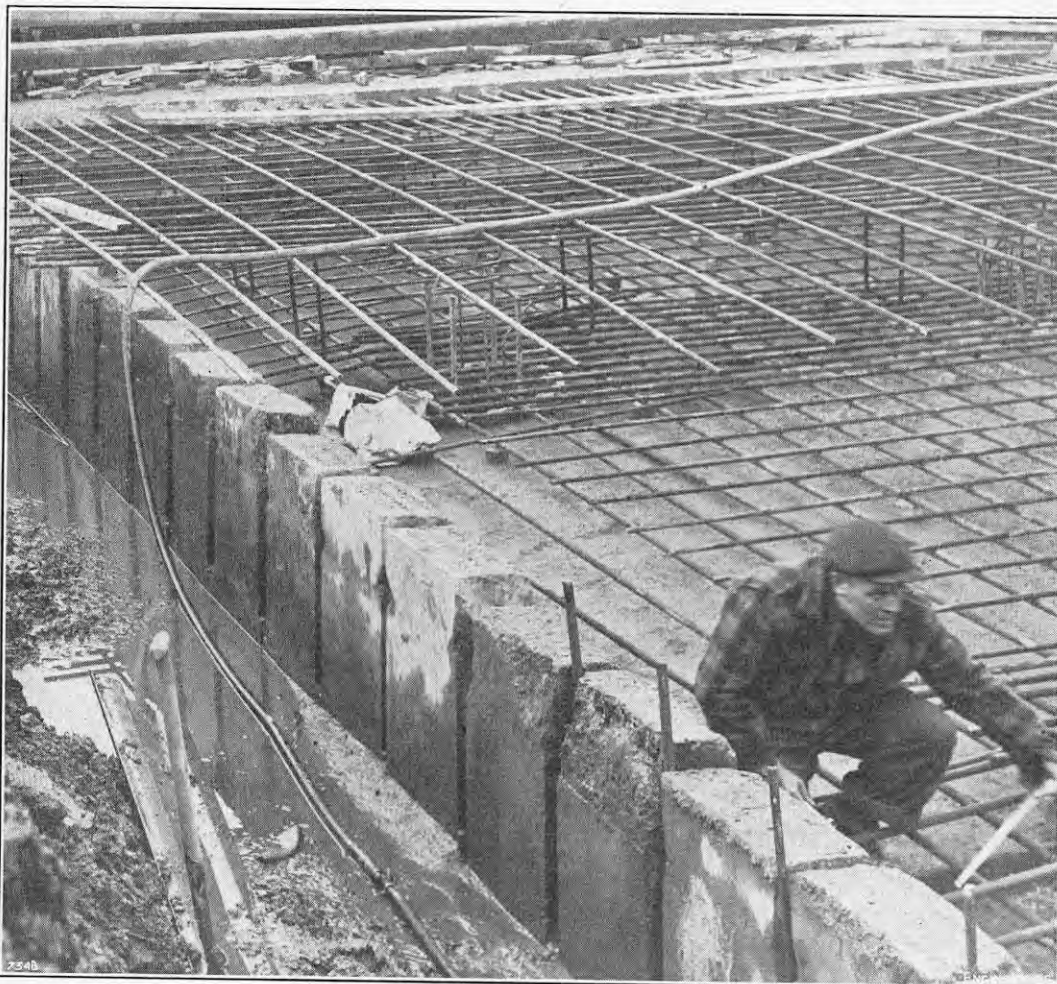


FIG. 2. LINE OF DRIVEN PILES.

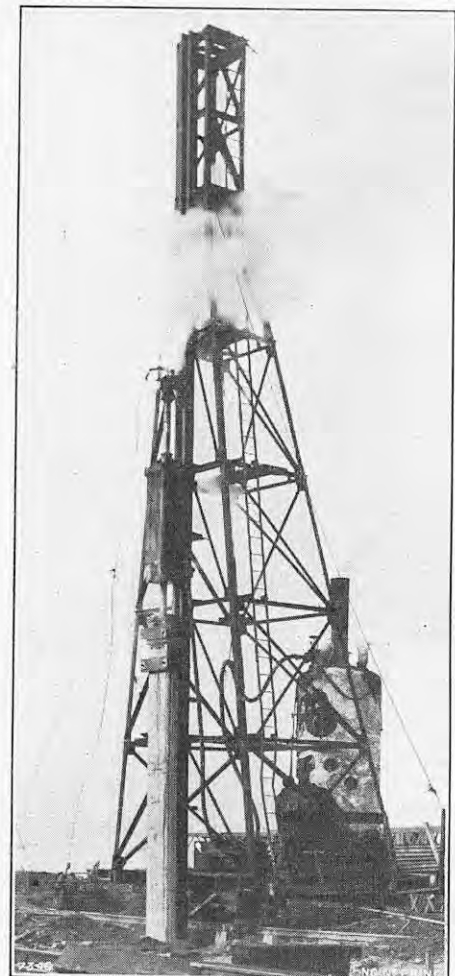


FIG. 3. DRIVING A PILE.

## PRESTRESSED-CONCRETE SHEET PILES.

THE application of prestressed concrete has been extended recently to sheet piles, which are being used to form a curtain wall in the construction of the new Iron Ore Quay at Tyne Dock. The piles are 40 ft. in length and have a cross-section of 23½ in. by 9 in. Tongues and grooves formed on the edges are designed to permit a seal of colloidal grout to be introduced in the joint between adjacent piles after driving. There are 84 high-tensile steel wires, 0.2 in. in diameter, in each pile; the wires are stressed before casting the concrete of the pile. Mild-steel reinforcement is pro-

vided in the head and toe, as well as stirrups throughout the length of the pile. The head of each pile is slightly reduced in section, as can be seen on the left of Fig. 1, and the toe is pointed and bevelled to force it against the adjacent pile and keep it in contact during driving. The permissible tolerances during manufacture were +0 and -½ in. over the broad face and 0.001 of the length in straightness. No shoe is fitted. The piles were made by Messrs. Dow-Mac (Products), Limited, Tallington, near Stamford, Lincolnshire, and one from each cast was subjected to a bending test, which was withstood without the concrete cracking.

Each pile, weighing about 4 tons, was marked with the correct lifting point before dispatch. Fig. 3 shows

a pile being driven by a 3-ton single-acting hammer with a drop of 4 ft. The driving, which was carried out by the main contractors, the Yorkshire Hennebique Contracting Company, Limited, Kirkstall-road, Leeds, 4, was hard, as many as 150 blows per foot of penetration being required in many instances. Nevertheless, the damage to the heads of the piles was negligible, as Fig. 2 shows. Bolt holes in the piles were not allowed, the piles being held in the frame leaders by clamps (Fig. 3). The piles were designed by the joint engineers, Mr. R. B. Porter, M.I.C.E., chief engineer to the Tyne Improvement Commission, and Messrs. Rendel, Palmer and Tritton, consulting engineers, 125, Victoria-street, London, S.W.1.

## ENGINEERING

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

Registered at the General Post Office as a Newspaper.

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

Telegraphic Address:

ENGINEERING, LESQUARE, LONDON.

Telephone Numbers:

TEMPLE BAR 3663 and 3664.

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

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

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

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## ADVERTISEMENT RATES.

Terms for displayed advertisements on the green art paper wrapper, on the inside black and white pages and in the buff art paper two-colour supplement, as well as for insets, can be obtained on application to the Manager. The pages are 12 in. deep and 9 in. wide, divisible into four columns 2½ in. wide. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

The charge for advertisements classified under the headings of "Appointments Open," "Situations Wanted," "Tenders," etc., is 10s. for the first four lines or under, and 2s. 6d. per line up to one inch. The line averages six words and when an advertisement measures an inch or more, the charge is 30s. per inch. If use is made of a box number the extra charge is 1s. per insertion, with the exception of advertisements appearing under "Situations Wanted." Series discounts for all classified advertisements can be obtained at the following rates:—5 per cent. for six; 12½ per cent. for thirteen; 25 per cent. for twenty-six; and 33½ per cent. for fifty-two insertions.

## TIME FOR RECEIPT OF ADVERTISEMENTS.

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

"Copy" instructions and alterations to standing advertisements for display announcements must be received at least 10 days previous to the date of publication, otherwise it may be impossible to submit proofs for approval.

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

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## ENGINEERING

FRIDAY, FEBRUARY 29, 1952.

VOL. 173.

No. 4492.

## THE DEFENCE ESTIMATES.

DURING the past week, the 1952-53 Estimates for the Royal Navy, the Army and the Royal Air Force have been laid before Parliament, together with explanatory statements by the civil heads of the respective departments, so that it is now possible to study in a more factual light the *Statement on Defence*, 1952, which had been issued a few days earlier. That *Statement*, for which H.M. Stationery Office charges the modest sum of 6d., showed what progress the Government were making in spending the 4,700l. millions which, it was estimated by the late Government, would be required to place this country, by March, 1954, in what Robinson Crusoe would have described as "a posture of defence," adequate to meet any emergency that might be expected to arise in the near future. Not all of this vast expenditure was to be laid out on weapons; much of it was earmarked for "stockpiling" of essential materials and for the provision of machine tools. It is to be expected that the outlay on new tools will decrease progressively as the orders are filled; and the Vote on Account for 1952-53, which was presented to Parliament on February 27, shows that the expenditure on reserve stocks of materials during the coming financial year will be considerably less, which may indicate either that the necessary stocks are now available or that arrangements have been made with the United States or the Commonwealth countries for some pooling of resources which would reduce the neces-

sity to accumulate reserves here to the same extent as formerly. Even so, and after making allowance for the 85l. millions of American aid, of which 25l. millions will be allocated to the Navy and 30l. millions each to the Army and the Royal Air Force, the proportion of the national income that will be absorbed by the defence programme in 1952-53 is sufficiently sobering to contemplate.

The *Statement on Defence* showed that, of the 4,700l. millions required for the complete programme as drafted, some 2,000l. millions represented production at the prices ruling at the end of 1950. This production was to have been spread over three years, but shortages of labour, materials and machine tools have enforced a revision of the estimated time, which must now be extended. Most of the requisite 35,000 machine tools have been ordered and the raw-materials position (except in the case of steel) is stated to be less serious than had been expected. In the 1952-53 programme, aircraft will account for over 20 per cent. of the production expenditure, and tanks and other vehicles for a further 20 per cent. Ammunition and stores of various kinds will absorb about 25 per cent. An interesting sidelight on some of these round figures has been provided by the second report of the Select Committee on Estimates, from which it appears that Centurion tanks (of which "several hundreds" will be delivered in 1952-53) now cost 38,000l. each, as against 35,000l. twelve months ago; and that a bomber which cost less than 16,000l. in 1945 had increased in cost to 77,600l. in 1951 and now costs 89,105l.—the price of a destroyer at the outbreak of the 1914-18 war. Aircraft also form a large item in the Navy's requirements, as also does ammunition, particularly for anti-aircraft and anti-submarine armaments; and in all three Services the cost of instrumentation of all kinds is becoming a major item. It is to be hoped, indeed, that sufficient attention is being given to practice in handling ships, aircraft, weapons and men without relying completely on such equipment; the next war may start with a *crescendo* of button-pushing, but it is not likely to finish in that way.

The First Lord of the Admiralty, Mr. J. P. L. Thomas, M.P., in his statement on the Navy Estimates, explains that, after allowing for the Navy's proportion of American aid, he will require 332,250,000l. in the coming year. This is 78,750,000l. more than in the previous year, and, of the total, 188l. millions will be required for production and research—an advance of 56l. millions on 1951-52. The operational strength of the Fleet is now two fleet aircraft carriers, three light fleet carriers, 12 cruisers, 31 destroyers, 36 frigates, two fast minelayers, 39 submarines and 46 minesweepers. Vessels described as "training and experimental," with "special complements," comprise the battleship Vanguard (though she is now being refitted) and three fleet carriers, two light carriers, two cruisers, 13 destroyers, 19 frigates and 15 minesweepers. In reserve there are four battleships, two fleet carriers and one light carrier, one escort carrier, 12 cruisers, 66 destroyers, 110 frigates, one fast minelayer, two monitors, 14 submarines and 85 minesweepers. The vessels under construction are one fleet cruiser, seven light carriers, three cruisers, six destroyers, nine frigates, and 65 minesweepers; but, as we mentioned last week, little work is being done on the three cruisers.

The section of the First Lord's statement which deals with research and development contains some interesting references to work in progress. It is observed, for instance, that "all possible means of submarine propulsion are under investigation, including systems using nuclear energy and oxygen-bearing fuels"; among the anti-submarine measures now being developed are new types of detection and location equipment, new weapons of the "ahead-thrown" type, and "a torpedo which will seek out and destroy its target whatever evasive

measures are taken." Guided weapons are also being studied for use against enemy aircraft. In the marine-engineering field, "good progress continues to be made" in the development of high-performance steam engines, light-weight Diesels, and gas turbines for ship propulsion, and in the design of auxiliary machinery.

The memorandum of the Secretary of State for War, on the Army Estimates, seldom devotes as much space to developments of an engineering character as does the First Lord's statement on the Navy Estimates, and the present occasion is no exception to this general rule. Under the heading of "Armaments and Stores," however, it is mentioned that some two-thirds of the estimated expenditure under this heading in 1952-53 will be for tanks and for anti-aircraft and other weapons, including their maintenance. During the next financial year, "new weapons and equipment will begin to come into the hands of troops in substantial quantities"; meanwhile, much work has been done in modernising equipment remaining from the recent war, pending the quantity production of guided missiles, etc. A similar situation obtains in the case of Army transport—designated as "soft" vehicles to distinguish them from armoured types. Many new types have been designed and ordered, and it is expected that the first production of these in quantity will take place in 1952-53. The extensive programme for the rebuilding of wheeled vehicles, undertaken by the Ministry of Supply three years ago, has been completed, nearly 50,000 such vehicles having been overhauled in this way.

The shortest of the three introductory statements on the defence estimates is the memorandum by the Secretary of State for Air, Lord de L'Isle and Dudley, and the information in it regarding aircraft and equipment is almost non-existent, apart from a few generalities. On this point, indeed, there is more information to be gained from the *Statement on Defence*, 1952, previously quoted. An important item in that *Statement*, on the question of the supply of aircraft, is that "arrangements have been made for the supply of a substantial number of F.86 (Sabre) jet aircraft," to be constructed in Canada and provided with engines and equipment by the United States. This is supplemented by the assurance, also given in the *Statement on Defence*, that "the aircraft programme provides many new aircraft of all types, for the Air Force and the Navy." The memorandum of the Secretary of State for Air also mentions, however, that "there have been further increases in the strength of the forces for defence of the United Kingdom"; that "nearly all the regular day interceptor squadrons now have the latest marks of Meteor aircraft" and the Royal Auxiliary Air Force squadrons all have jet aircraft; and that "the re-equipment of night fighter squadrons with jet aircraft is almost complete." Bomber Command has received its first squadrons of the Canberra type; and Coastal Command is being strengthened with Shackleton aircraft and is receiving Neptunes from the United States under the Mutual Security Act.

To summarise the three Defence Estimates: the Navy is applying for a net total of 332,250,000*l.*, the Army for 491,500,100*l.*, and the Royal Air Force for 437,640,000*l.* Obviously, the greater part of this outlay will go in wages. Where the labour is to be found without detriment to the flow of exports needed to maintain the nation's solvency is a question much less easy of solution than the provision of the materials; and a further complication is that all three of the fighting Services must have an increasing supply of technically-skilled men to use and service the equipment that is provided. The *Statement on Defence* does emphasise the labour difficulty, but hardly enough. Individual productivity is believed to be increasing steadily, if slowly, but a much bigger increase is needed before the situation can be regarded as satisfactory.

## BRITISH FACTORY CONDITIONS.

THE main objects of the Factories Acts may be stated quite briefly; they are to ensure that the buildings in which all types of productive activity are carried on shall be fit to work in and that the great variety of machinery with which these buildings are equipped shall be safe to operate. The administration of the Acts is in the hands of a skilled body of inspectors and the success of their efforts to attain these objects is amply demonstrated in the annual report\* of the Chief Inspector (Mr. G. P. Barnett) for the year 1950, which was published last week. As, however, it is better to prevent accidents than to analyse their causes after they have occurred, the report is not a mere catalogue of statistical information, but contains a lengthy discussion of trends in factory design and equipment and the effects of these trends on working conditions and especially on the personnel.

The number of factories at the end of 1950 was 241,064, a decrease of 2,530 on the 1949 figure. The number of factories in which mechanical power was used increased by 2,394 and the number without this aid to production fell by 4,924. There were 193,059 accidents notified during the year, of which 799 were fatal, as against 192,982 and 772 in 1949. As, however, the labour force in the manufacturing industries increased by 200,000 during the same period and extra overtime was worked, owing to the needs of the re-armament programme, the position cannot be regarded as altogether unsatisfactory. Nevertheless, there are certain features which need, and are receiving, close attention.

A study of the report shows that, generally speaking, accidents in factories fall into two main categories: those due to the human element, as disclosed by carelessness or ignorance on the part of the operator, and those due to faulty design of the equipment, in which, of course, the human element also plays a part. An example of the first class is that of the skilled operator who raised the guard covering the teeth of a circular saw in motion. This was unnecessary, and the man added further to the unsafe conditions by not making the guard secure in the raised position. The guard began to drop back into position, and he tried to hold it. It was, however, too heavy, with the result that his arm was forced on to the saw and amputated.

Unfortunately, many accidents are suffered by the less skilled personnel; and in this connection, attention is rightly called to the lack of thought, often approaching gross carelessness, which is still found in the training and continued supervision of the new employee. Unless they are carefully watched, the novelty of their surroundings, together with natural traits such as curiosity and high spirits, restlessness and boredom, lead them into trouble. For instance, a boy lost the tip of his thumb on a circular saw because he was attempting to rib a piece of wood to a pencilled line, using neither side guide nor push stick. Investigation showed that the works carpenter, who was the boy's instructor, did not himself know how to use the machine properly; indeed, he had taught both himself and the boy to use it incorrectly. A worse case was that of a girl of 17 who was allowed to work on a power press, stamping out blanks from metal strips with the tool so poorly guarded that there was a space of 4 in. beneath the so-called screen. In putting the strip through the press, her right thumb and index finger were amputated. She had apparently been given no instructions about fencing, and her training had merely consisted of the foreman running a strip through the press for her to see how it was done. It is pointed out that such occurrences are the result of infringements of the Factories

Acts and of the relevant regulations, and it is hoped that the implications of this warning will be duly noted by all likely to be concerned.

Absolute safety can only be secured by more attention to detail when the machinery is designed. Had this been done, several accidents would probably have been avoided. For instance, while a man was tilting the table of a large drilling machine (to which a heavy and offset casting was clamped) by turning a star-wheel, the load took charge and one of the spokes flew out and injured another worker. It appears that the star-wheel was coupled directly to a worm which meshed with a worm-wheel on the table and it was believed by the makers that the drive was irreversible. The accident, however, indicated the erroneousness of this opinion and that the design was faulty. A second point of faulty design was that the spokes of the star-wheel were merely forced into a well-fitting hole in the boss. Had they been screwed in, they would have been capable of withstanding the stresses due to centrifugal force.

Lack of interest in safety on the part of some designers is illustrated by the case of an automatic wood-shaping machine consisting of a vertical spindle carrying a cutter and a revolving feed head. This head was fitted with a series of clamps which carried the wood blocks from the front of the machine to the cutter at the back and thence to the delivery point. All the unskilled operator had to do was to insert the blocks, one by one, in the clamps, but on one occasion when an attempt was made to straighten a block that was not properly in position an accident occurred, owing to the absence of proper fencing. The makers considered the machine safe and, according to the report, showed a complete lack of co-operation in the attempts that were made to improve its design. Other examples of this state of things are given, many of which might have been obviated with no great difficulty in the design stage.

The increasing mechanisation of factories, which is a feature of modern times, is bringing with it a corresponding increase in the use of electrical equipment of both well known and novel types. Included in the latter are those associated with electronic processes, which have the advantage of producing more healthy conditions in the factory, and of enabling greater automaticity to be employed. X-ray sets are also being increasingly used, as are radio-active isotopes and other radio-active material, such as radon; developments which are of themselves to be encouraged, but which necessitate the application of new and appropriate precautionary measures. That precautions are necessary is also true of the more common electrical equipment, for, while the newer installations are generally well up to standard, some of those which have been in use for some years show that wear and tear are more marked than the efforts taken to combat them. Here again, of course, improvement is both necessary and possible. To prevent too gloomy a view being taken of the situation, however, it is, pointed out that the increasing authority of the works electrical engineer is having the effect of preventing many accidents and is one reason, at least, why the number of these accidents has remained at about the same figure each year, in spite of the enormous increase in the use of electricity.

A perusal of the report leaves little doubt of the value of the work the Factory Inspectorate is doing, and that this is recognised in industry is shown by the demands upon its members for advice on special problems. As in other fields of human endeavour, there is, however, a shortage of inspectors; a shortage, moreover, which can only be slowly made up owing to the intensive and lengthy training which is necessary and which can only be given to new entrants by existing members of that body. It is suggested that some relief might be secured if employers with substantial industrial experience adopted a policy of inspecting their own factories.

\* *Annual Report of the Chief Inspector of Factories for the Year 1951.* London: H.M. Stationery Office. (Price 6s. 6d. net.)

## NOTES.

## IRON AND STEEL DEVELOPMENTS.

It was announced last Friday, February 22, that Mr. Steven J. L. Hardie, D.S.O., LL.D., chairman of the Iron and Steel Corporation of Great Britain, had tendered his resignation to Mr. Duncan Sandys, Minister of Supply, and that the latter had accepted the resignation. In a parliamentary debate on the subject of Mr. Hardie's resignation, on Monday, February 25, Mr. Sandys announced that he had appointed Sir John Green, deputy chairman of the Corporation, to succeed Mr. Hardie. He also announced that he had issued Orders, to come into effect on February 27, increasing the controlled maximum prices of iron and steel. Particulars of these price changes are contained in a brief note issued by the Ministry of Supply. This states that the increases are due, partly to the rising costs and greater volume of imported steel and raw materials, and partly to higher costs at home, including wages, transport, coal, coke, fuel oil and scrap. The Government have decided, the statement continues, to maintain the policy, adopted by the previous Government, of averaging the prices of imported and home-produced steel. Moreover, while the Iron and Steel Corporation of Great Britain adhere to the view, which they expressed to the late Government, that the extra cost of imported finished steel should be borne by an Exchequer subsidy and should not be included in home prices, they agreed that the additional costs of other imported materials, like increased home costs, should be charged against the prices of steel produced in this country. The full increase in costs, the statement concludes, is not reflected in the new prices now announced, the Minister of Supply having decided, in agreement with the Iron and Steel Corporation of Great Britain and the British Iron and Steel Federation, that a proportion of the extra cost should be met out of the profits of the industry. Typical examples of the revised basis price of iron and steel products, with the previous basis price shown in brackets, are given below:—basic pig iron, 12l. 10s. (11l. 15s. 6d.); soft basic billets, 25l. 4s. 6d. (21l. 11s. 6d.); sheet and tin-plate bars, 25l. 3s. 6d. (21l. 16s.); and heavy sections, 27l. 17s. (23l. 15s. 6d.).

## THE LOSS OF THE "BIRKENHEAD."

On February 26 fell the centenary of a maritime disaster which probably attracted more attention than any other until the loss of the Titanic in April, 1912, namely, the sinking of the iron paddle troopship Birkenhead after she had struck a submerged rock off Danger Point, about 50 miles from Simon's Bay, Cape of Good Hope. She was conveying drafts of troops for about a dozen regiments in the forces with which Sir Harry Smith, Governor at the Cape, was engaged in subduing a Kaffir rebellion. The number of persons on board has been variously computed, and, so far as the incomplete records indicate, appears to have been about 638, including a number of women and children; 445 lives were lost. The Birkenhead was built as a frigate of four guns and was launched in January, 1846, from John Laird's yard at Birkenhead, where she was No. 51 on the yard books. She was 210 ft. in length, 37 ft. 6 in. beam, and had a tonnage of 1,400 (builders' measurement). Her engines, of 560 h.p., were supplied by George Forrester and Company, Liverpool, and gave her a speed of about 12 knots. She was rigged as a barque. The public interest in the disaster arose from the fine behaviour of the troops—mostly young and inexperienced—and the heavy loss of life that they suffered while the few available boats carried the women and children to the shore. From the technical point of view, however, the catastrophe was of equal interest, though, as none of the navigating officers survived, there was much conflict of evidence regarding the root cause of the disaster. The Birkenhead was built with five watertight compartments, and appears to have struck on or near the forward bulkhead of the machinery space; according to survivors, the boiler fires were extinguished almost at once, though not before the engines had made possibly a score of revolutions astern, on the orders of the commanding officer, Commander Robert Salmond, R.N. It is probable that running

the engines astern contributed to the almost complete severance of the forepart of the vessel; but the after part also broke in two, apparently at the strength deck, the tear extending down both sides until the after third of the ship was attached to the middle body only by the keelsons and bottom plating. Why this should have happened does not seem to have been satisfactorily explained; but it is conceivable that the designers, impressed by the remarkable strength shown by certain other iron ships (notably the Great Britain, and the Mersey ferry-boat Nun, which was Laird's yard number 37) when exposed to stresses that had not been foreseen, decided that a considerable reduction in scantlings would be perfectly safe, and indeed desirable, in a vessel that was intended initially to be used—though, in fact, she never was employed—as a fast frigate.

## EXTENSION OF WHITTLE GAS-TURBINE PATENT.

In 1936, Air Commodore Sir Frank Whittle (then a flight lieutenant serving with the Royal Air Force) applied for a patent (British Patent 471,368) covering a "by-pass" type of gas-turbine engine for aircraft propulsion, utilising a double thermal cycle, whereby only a small portion of the air compressed in the lower cycle passed through the higher cycle in which it was further compressed and burned with fuel to provide power for the whole of the compression process. The main mass of compressed air was by-passed directly to the jet. A private company, Power Jets, Limited, was formed to develop the Whittle patents. In 1944, the Government took over the work of Power Jets, Limited, and a nationally-owned company, Power Jets (Research and Development), Limited, was formed to hold and exploit patents in the gas-turbine field resulting from publicly-financed research and development. They are the present holders of the by-pass engine patent. British Patent 471,368 was due to expire on March 3 this year, and owing to causes beyond the control of the patentees, it was not possible in the years between 1936 and 1946 to exploit the patent. It is believed by many, however, that it may prove to be an economical form of propulsion for long-range aircraft flying at high subsonic speeds. Petitions were therefore brought by Sir Frank Whittle, and the two companies associated with the patent, for the extension of its life. There was no opposition to the petitions, and on Monday, February 25, in the Chancery Division, Mr. Justice Lloyd-Jacob granted an extended life of 10 years.

## THE ELECTRICAL RESEARCH ASSOCIATION.

The annual general meeting of the British Electrical and Allied Industries Research Association, and the luncheon which usually follows it, were arranged to be held this year at the Connaught Rooms, London, on Friday, February 8. The meeting was held on that date and the 31st annual report, for the year ended September 30, 1951, was presented, but the luncheon was postponed until Friday, February 22, on account of the death of H.M. King George VI. The chair at the luncheon was occupied by the President, Sir George Nelson, F.C.G.I., M.I.Mech.E., M.I.E.E., who, after the loyal toast had been duly honoured, invited the chief guest, Sir Harold Hartley, K.C.V.O., M.C., F.R.S., to propose the toast of "The E.R.A." In introducing this, Sir Harold referred to the understanding and sympathy with which His late Majesty regarded the work of engineers and scientists and said that, for that reason, they had special cause to mourn his loss. Continuing, he said the electrical industry was built on research and it was fortunate that the scientific genius of this country should lie in experimental investigation. Britain, he pointed out, had won more Nobel Prizes in Physics than any other nation. Sir Harold then referred to the work of the Association on circuit-breakers, cable ratings, dielectrics, magnetic materials, the use of electricity in agriculture, etc., some of the aspects of which were mentioned in *ENGINEERING*, vol. 172, pages 585 and 615 (1951), when referring to the Association's "open days." Finally, the speaker endorsed the appeal the Association is making for increased subscriptions and a rehousing fund. The new building, so urgently needed, would have to be postponed on account

of the restrictions in capital spending, but the money required should be available for use immediately the expenditure was permitted. In thanking Sir Harold, in his response to the toast, the President said he was glad Mr. E. B. Wedmore's research on circuit-breakers had been referred to. Even to-day this work had a great influence in connection with circuit control. Although less spectacular, Dr. S. Whitehead's work on dielectrics had been a great benefit to the manufacturing and supply industries, having enabled apparatus to be made more cheaply and more reliable. The principle that had been followed by the two industries at the time the E.R.A. had been founded was that there should be a centre in which fundamental research could be carried out on behalf of industry, but industry itself should apply the results to its designs. He thought that the fact that the industry was to-day the greatest exporting electrical industry in the world fully vindicated that principle. The Association, however, could only play its part if it had the necessary finance and he emphasised the need for providing additional laboratories and equipment at Leatherhead as early as possible.

## VISIT OF AMERICAN ELECTRICITY SUPPLY ENGINEERS.

A representative team from the American electricity supply industry is to visit this country during March to discuss common problems with members of the British electricity supply industry. The visit is the result of an invitation from the British Electricity Authority and has been arranged with the Anglo-American Council on Productivity. The team, which will be led by Mr. C. W. Jones, vice-president of the Narragansett Electric Company, Rhode Island, will number 18 and will be made up of employees of all ranks in the United States Electric Light and Power Utilities. They will arrive to-morrow, Saturday, March 1, and will be in this country until Thursday, April 10. The party is a "reverse flow" to the productivity teams from this country which have visited the United States. Its members will be afforded the opportunity of examining the British electricity supply industry in all its aspects. Among the subjects to be covered will be generation, transmission and distribution, engineering and construction, labour and personnel relations and commercial practices. Arrangements are being made for the party to undertake a comprehensive tour of the country to cover a number of Area Boards and the Authority's Generation Divisions. The party will also be shown some of the schemes which are being developed by the North of Scotland Hydro-Electric Board.

## THE WORSHIPFUL COMPANY OF SHIPWRIGHTS: APPRENTICES COMPETITION.

Arrangements have now been completed for the 1952 competition for apprentices, organised by the Worshipful Company of Shipwrights, Baltic Exchange Chambers, 24, St. Mary Axe, London, E.C.3. The competition is open to shipwrights and plater apprentices in all shipbuilding and ship-repairing establishments in England, Scotland, Wales and Northern Ireland, and shipwright apprentices who have only boat-building experience may also enter. A booklet giving full details of the conditions of entry and the prizes available, including the Silver Medal offered by His late Majesty King George VI, who was Permanent Master of the Company, may be obtained from the honorary clerk at 24, St. Mary Axe, E.C.3. Firms wishing to enter candidates should apply for the necessary forms to the honorary clerk and the forms, when completed, should be sent to the chairman of the appropriate local committee, whom they should reach by April 30. The final examination of candidates will be held in London on Friday, June 27. The chairman of the Scottish local committee is Sir Harold Yarrow, Bt., Scotstoun, Glasgow, W.4; for Northern Ireland, North-West England and North Wales, Mr. H. Flett, Alfred Holt and Company, India Buildings, Liverpool, 2; and for the North-East and East Coast of England, down to but excluding the Thames estuary, Mr. G. Wigham Richardson, Armadores House, Bury-street, London, E.C.3. The chairman for the rest of England and Wales, including London and the Thames estuary, is Mr. J. A. Milne, C.B.E., J. Samuel White and Company, Limited, Cowes, Isle of Wight.

## OBITUARY.

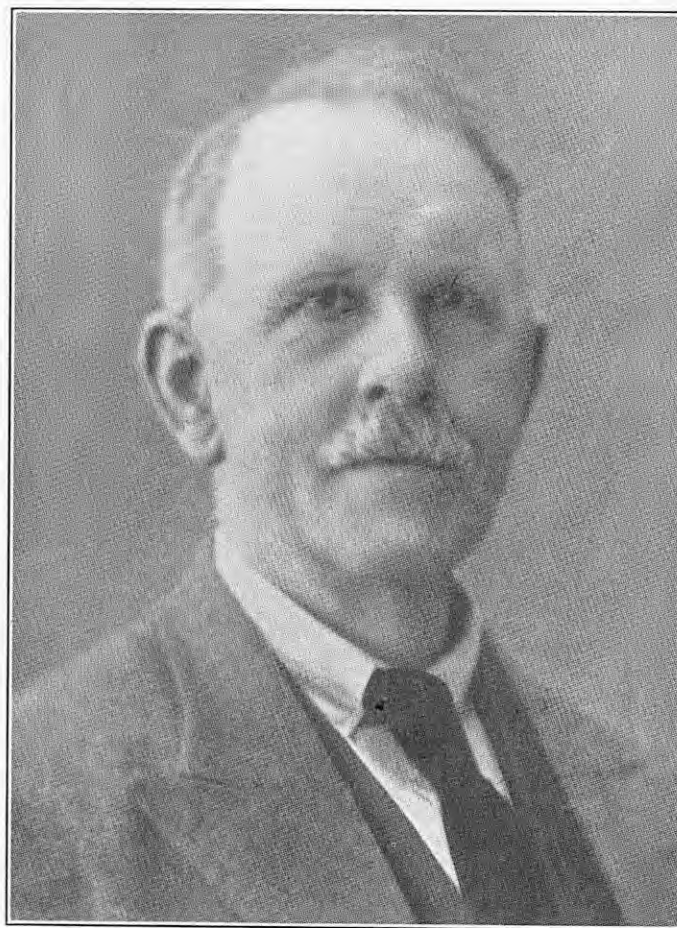
## DR. H. W. DICKINSON.

NOT only the members of the Newcomen Society, but students of technical and scientific history all over the industrial world will deplore the death of Dr. H. W. Dickinson, which occurred on February 21, as last week's issue of *ENGINEERING* was going to press. At that time, we could do no more than insert a brief paragraph, recording the fact and our intention to deal more extensively with his long and active career in the present issue; but he did so much to set the history of technology on a firm basis, and explored so many fruitful by-ways in the doing of it, that even now it is hardly possible to tell the full tale of his original researches. Certain it is that none in this country and few in any other have equalled him in the range of his interests or in the thoroughness with which he applied himself to build up an authentic and connected history of technological development, especially in connection with the evolution and application of steam power, on which he was the foremost authority in the world.

Henry Winram Dickinson was born in Ulverston, Lancashire, on August 28, 1870, and so was in his 82nd year at his death. He was the eldest son of John Dickinson, a prominent local resident, in whose memory the John Dickinson Lecture was founded. He was educated at Manchester grammar school and afterwards at Owen's College, Manchester, where he took a two years' engineering course. This was followed by an apprenticeship of four years at the Parkhead steelworks of William Beardmore and Company, Glasgow, on the completion of which, in 1892, he spent a year in the office of a consulting engineer as draughtsman. His next appointment—his previous employer having retired from practice—was in the Wishaw works of the Glasgow Iron and Steel Company, also as draughtsman, where he spent some twelve months in 1893 and 1894; after which he was employed for a year by the Frodingham Iron and Steel Company as assistant engineer on the erection of new steelworks plant. In 1895 he was successful in a competition for an appointment as junior assistant in the Science Museum, South Kensington, where he remained until his retirement in 1930.

Dickinson's progress on the staff of the Science Museum was rapid. In 1897, he was made an assistant keeper, and in 1914, in addition, was appointed assistant to the Director and secretary to the Advisory Council. During the first world war, from 1915 to 1918, he was seconded to act as secretary of the Munitions Inventions Panel. He was made a senior keeper, in charge of the mechanical engineering collections, shortly after the war, retaining this position until he retired.

He served under four Directors—General E. R. Festing, W. I. Last, Sir Francis Ogilvie and Sir Henry Lyons—and had a great deal to do with the planning of the new eastern block of the Museum, which was opened by King George V in 1928, and with the acquisition and arrangement of many of the most important historical exhibits. Prominent among these were the early Watt engines and James Watt's garret workshop, the contents of which were transferred complete from Watt's house, Heathfield, outside Birmingham, and arranged, under Dickinson's supervision, exactly as James Watt had left them when he died in 1819.



THE LATE DR. H. W. DICKINSON.

While all branches of mechanical engineering (and many other subjects) claimed Dickinson's active interest, his special study was that of the lives and the work of the pioneers of steam engineering. When, therefore, the centenary of Watt's death was commemorated in Birmingham in 1919, it was natural that he should be selected to represent the Science Museum on the organising committee. The centenary proceedings were very fully reported in our columns at the time, and it is sufficient to mention, therefore, that it was in the course of them that he had the opportunity to endorse and actively to support the suggestion of the late Mr. Arthur Titley, M.I.Mech.E., a consulting engineer in Birmingham, that a society should be formed "for the study of the history of engineering and technology." Thus originated the Newcomen

Society, named after Thomas Newcomen, maker of the first successful industrial steam engine, which was set to work near Dudley in 1712. The Society was founded in 1920, with Titley as first President and Dickinson as honorary secretary and editor of the *Transactions*—a dual post which he filled with rare distinction for 31 years, interrupted only partially by his own tenure of the presidency from 1932 to 1934. He edited 25 volumes of the *Transactions* and had completed much of the 26th before increasing infirmity obliged him to delegate the remainder of his task. To that unique compilation of original historical research, the high standard

of which it was his constant pre-occupation to maintain, he had contributed more than a score of papers, some jointly with other authors, but fully three-quarters of them from his own pen. In addition, he organised a succession of summer meetings and other excursions, made several lecture tours in the United States, and found time to contribute a number of articles and reviews to various periodicals. His first contribution to *ENGINEERING*, incidentally, was in our issue of December 4, 1908, on the subject of John Wilkinson, the iron-master, whose cast-iron monument at Lindale, a few miles from Grange-over-Sands, had been familiar to him from his youth.

Dickinson was the author or part-author of a number of books, all of which are accepted as classics in their respective fields. His first, published in 1913, was a biography of *Robert Fulton, Engineer and Artist*. This was followed, in 1914, by *John Wilkinson, Iron-master*. His next work, and the most imposing of them all, was *James Watt and the Steam Engine*, in which he was joint author with Mr. Rhys Jenkins; a definitive biography of Watt which is unlikely to be shaken in its supreme authoritativeness by any future review of Watt's life and work. In 1933, he collaborated with Arthur Titley in producing the centenary volume on *Richard Trevithick, the Engineer and the Man*; and, three years later, he produced a similar biography of Watt, entitled *James Watt, Craftsman and Engineer*. In 1937, he completed the tale of Watt

and his partner with *Matthew Boulton*; one of the illustrations to this book, showing specimens of the "toys" on which Boulton built up his business, provided part of the design for the Presidential jewel of the Newcomen Society, in which is incorporated the actual membership badge of Arthur Titley, the founder. Dickinson's latest book, so far, is his *Short History of the Steam Engine*, published in 1939; but he also wrote a history of the water supply of London which appeared serially in *The Engineer* and is to be produced in book form by the Newcomen Society. The intention was to publish it as an acknowledgment to the author of his long service to the Society; now, most regrettably, it must be a memorial volume. Shortly before his death, Dickinson gave to the Society a large collection of miscellaneous papers, some relating to its

domestic affairs, but others possibly containing the material for further papers, or suggestions on which papers might be based. These, we understand, are now being examined; but they are so voluminous that it is not yet possible to say what they may or may not contain.

In addition to his work for the Newcomen Society, Dickinson was active in many other organisations. He was a member of the Institution of Mechanical Engineers, to which he had belonged for more than 50 years; a vice-president of the Cornish Engines Preservation Society and a life member of the Sheffield Trades Historical Society; President, in 1944, of the Croydon Natural History and Scientific Society and, in 1946-47, of the Purley Natural History and Scientific Society; and in 1949, a section chairman at the Sixth International Congress on the History of Science and Technology, held in Amsterdam. In 1925, he was the British representative at the opening of the Deutsches Museum, at Munich, where he established a close friendship and collaboration with its founder, the late Dr. Oscar von Miller, and his colleague, Dr. Conrad Matschoss, of the Verein Deutsche Ingenieure. He was also a corresponding member of the Académie Internationale d'Histoire des Sciences and, in 1931, acted as honorary secretary of the Second Congress on the History of Science and Technology, held in London in that year. In 1939, during his second lecture tour in the United States, he received the honorary degree of Eng.D. from Lehigh University, a distinction of which he was justly proud.

That no British university saw fit to honour him was, perhaps, no more than the natural consequence of his own modest disposition. He never sought recognition of his labours; indeed, he was probably too deeply absorbed in the prosecution of them to care greatly whether public acknowledgment of their worth came in his lifetime or not. His main concern was that the facts of industrial history should be put on record for the benefit of posterity, and, for him, the satisfaction of accomplishing that much was sufficient reward. He had, however, another reward, to which he responded with the keenest pleasure, in the warm friendship of a host of fellow-workers—a host who were largely unknown to each other until his activities as secretary of the Newcomen Society brought them into contact. Of him, even more than most, it is true to say that a man does not die so long so his friends remember him. It is a reasonable prediction that his memory will persist still longer, and that future generations of the students of engineering history will rank him not less in eminence than Samuel Smiles; for he was an engineer first, which Smiles was not, and was able to bring to his researches the practical knowledge without which they could have been neither so complete nor so authoritative. To say that he will be greatly missed is trite, though true enough, and the standard that he set in the quality of his researches will not be easy to emulate; but the fact that he did so much, usually single-handed and with no special influence other than that resulting from his own work and enthusiasm, should be an inspiration to others to continue with the task of establishing the history of technology on a level not inferior to that of any other philosophical study.

### SIR JAMES LITHGOW, BT.

THE news of the death, on February 23, of Sir James Lithgow, Bt., the well-known Scottish shipbuilder and industrialist, was not unexpected on Clydeside, as he had been in poor health for a considerable time; so much so, in fact, that the conferment upon him of the freedom of Port Glasgow, last year, had to be carried out privately in his home at Langbank, Renfrewshire, instead of at a public ceremony, as had been planned.

Sir James, who was 69 years of age, was educated at Glasgow Academy and in Paris, and received his training as a shipbuilder in the Port Glasgow firm of Russell and Company, of which his father, W. T. Lithgow, was one of the founders. He served a full apprenticeship, passing through all the shipyard departments and, after some administrative experience, was taken into partnership in 1908. For some years previously, he had held a commission in the Renfrew and Dumbarton R.G.A., and

on the outbreak of war in 1914, was called to the colours. He served in France as a gunner officer, being mentioned in dispatches and awarded the Military Cross. In 1917, however—by which time he had been promoted to the rank of major—he was recalled from the Army to take up the post of Director of Shipbuilding Production, subsequently becoming Controller. In the same year, he was gazetted lieutenant-colonel.

On the termination of hostilities, Lithgow returned to his family business (the name of which he changed to Lithgows, Limited) and devoted himself to modernising the yard and extending his connections with shipbuilding and marine engineering. As an industrialist, he was an outstanding figure and the depression between the wars tested his ability to the full. He was President of the Shipbuilding Employers' Federation in 1921-22, of the National Confederation of Employers' Organisations in 1923, of the Federation of British Industries from 1930 to 1932, and of the British Iron and Steel Federation in 1943-45. On more than one occasion, he represented the British employers at the International



THE LATE SIR JAMES LITHGOW, BT.

Labour Conferences at Geneva. He was President of the Institution of Engineers and Shipbuilders in Scotland from 1929 to 1931 and a member of the Central Electricity Board from 1927 to 1930. As chairman of the Scottish Development Council, he took a prominent part in organising the Glasgow Exhibition in 1938. During the war of 1939-45, he served again at the Admiralty, this time as Controller of Merchant Shipbuilding and Repairs, and for a time, also, he was chairman of the Tank Board, in the Ministry of Supply. He had been made a baronet in 1925, and for these further services received the G.B.E. in 1945 and the C.B. in 1947. He was also a Deputy Lieutenant for Renfrewshire and an honorary LL.D. of Glasgow University.

Sir James's business activities were spread over a very wide field. In 1936 he became chairman of William Beardmore and Company, Limited, holding that position for some 15 years. He was also chairman of Lithgows, Limited, and of the Fairfield Shipbuilding and Engineering Company, Limited, David Rowan and Company, Limited, and of other companies; and a director of the Ayrshire Dockyard Company, British Polar Engines, Limited, the North British Electric Welding Company, R. Y. Pickering and Company, William Hamilton and Company, the Lancefield Foundry Company, and a number of other firms. For the past 11 or 12 years, too, he had been an extraordinary director of the Royal Bank of Scotland. In all of these associations, he displayed an initiative and a compelling influence which exerted a notable effect on the recovery of Scottish (and particularly Clydeside) industry from the results of two world wars, and in these and many less publicised directions his loss will be widely felt.

### SIR ROGER G. HETHERINGTON, C.B., O.B.E.

WE also regret to record the death of Sir Roger G. Hetherington, a former President of the Institution of Civil Engineers, which occurred at Highgate, London, on Sunday, February 24. Sir Roger, who was 76 years of age, had had a long career as an engineer in the Government service.

Roger Gaskell Hetherington was born on February 10, 1876, and was educated at Highgate School and Trinity College, Cambridge, where he obtained the degree of Master of Arts. He then served for three years as a pupil with Messrs. John Taylor, Sons and Santo Crimp, with whom he was engaged on designs in connection with water works at Bristol, Herne Bay and in the Colne Valley, and on drainage and sewage schemes at Ilford, Shrewsbury and Chelmsford. In 1900, he received an appointment with the Ilford Urban District Council to supervise work in connection with the construction of a new sewerage outfall to the Thames and the erection of the engines and machinery connected therewith. A year later, however, he returned to Messrs. John Taylor, Sons, and Santo Crimp as principal assistant and under Mr. G. M. Taylor had direct charge of the firm's drainage work. He also carried out a number of investigations into various drainage schemes and presented reports thereon, as well as representing the firm before Parliamentary Committees and at Local Government Board inquiries. He also assisted in preparing evidence for submission to the arbitrators in connection with the purchase of the London water companies when the Metropolitan Water Board was constituted.

In 1908, he became a temporary engineering inspector with the Local Government Board, but shortly afterwards returned to his old firm as resident engineer in charge of the construction of the Hoddesdon drainage scheme. He, however, again became an engineering inspector with the Local Government Board in 1909 and subsequently became established in that Department. Eventually he was transferred to the Ministry of Health, being chief engineering inspector of the latter department from 1930 until his retirement in 1944.

Hetherington received the honour of knighthood in 1945, having been previously appointed an Officer of the Order of the British Empire in 1918 and a Commander of the Bath in 1932. He was elected an associate member of the Institution of Civil Engineers in 1901 and transferred to the class of member in 1913. Having served on the Council and as vice-president, he became President in November, 1947. He devoted his presidential address on that occasion to a survey of that part of engineering to which he had devoted his professional career, namely, the maintenance of pure water supplies. It was the engineer, he said, who had to tackle the problem of increasing these supplies, on which an industrial civilisation so largely depended, of securing them against pollution and, in some cases, of discovering entirely new sources. He thought that chlorination might be responsible for the reduction in death rate which had occurred since 1913; and pointed out that the work of the engineer in improving water supplies during the past 150 years had depended largely on the introduction of the steam engine and of cast-iron pipes. Drainage systems had also advanced in step with water supply, but one of the most urgent problems of the day was how to deal with the sewage of small hamlets or groups of houses which would soon be given a piped water supply.

**FATIGUE OF PERSONNEL.**—The Ergonomics Research Society, which was formed in the spring of 1950 to develop the study of the relations between man and his work and environment, is to hold a symposium at the College of Aeronautics, Cranfield, Bletchley, Buckinghamshire, on "Fatigue" (of personnel), from Monday, March 24, to Thursday, March 27. The first session will take place on March 24, commencing at 2.30 p.m., and will consist of a discussion on "Psychological Criteria of Fatigue," to be opened by Professor Sir Frederick Bartlett, C.B.E., F.R.S., and Professor G. P. Crowden, O.B.E. A discussion on "Fatigue Allowance," to be opened by Mr. T. U. Matthew and Mr. J. V. Connolly, will be held on March 26. In addition, some 25 papers will be read and discussed. The symposium fee is 17.10s. Further details may be obtained from Mr. S. H. Mound, 71, Princes-square, London, W.2.

## "KNOCK" IN AUTOMOBILE ENGINES.

THOUGH the three papers presented at a meeting of the Institution of Mechanical Engineers on February 22 were in the nature of interim reports on research being conducted by two oil companies and an engine-designing firm, they gave some information on knock that will be of immediate practical utility. A summary of such information in the papers is given below.

Mr. J. D. Davis, M.A., M.I.Mech.E., of the Shell Refining and Marketing Company, reported on "Factors Affecting the Utilization of Anti-Knock Quality in Automobile Engines." The data were derived from tests on a wide range of cars and engines developed since the war. The two C.F.R. methods of measuring gasoline anti-knock quality, or the octane number, are the Motor Method and the Research Method. With both, the test consists of bracketing the test fuel, at a constant knock intensity, with blends of iso-octane and normal heptane, under standard conditions of speed, in revolutions per minute, mixture temperature or inlet air temperature, spark timing, and a maximum-knock air: fuel ratio. The Motor Method, however, involves more severe conditions than the Research Method, and the value obtained for a given gasoline is generally lower by the Motor Method than by the Research Method. In general, the octane number obtained by the Motor Method correlates best, though by no means exactly, with ratings obtained at high speed (about 2,500 r.p.m.) in engines on the road, and the best correlation between Research rating and the rating on the road occurs at low speeds (about 1,000 r.p.m.).

Gasoline "sensitivity" refers, in its broadest sense, to the change in anti-knock value with engine operating conditions. The generally-accepted measure of sensitivity, and the one used by the author, is the difference between Research and Motor method ratings, i.e., sensitivity = (Research - Motor method) octane number. Engine "severity"—another term requiring prefatory definition—is defined thus: an engine is said to be "severe" if it causes the anti-knock value of a gasoline to be depreciated under a fixed set of conditions. For a given engine the depreciation is most marked in the case of highly sensitive gasolines. Engine severity varies with operating conditions. A graph in the paper illustrates this point by three curves, obtained from three engines, of the octane rating of a fuel against a base of speed in revolutions per minute; in all cases, the rating falls with increase of engine speed, but the two relatively severe engines give ratings lower than those given by the "mild" engine over the whole speed range. One of the severe engines de-rated the gasoline at low speeds and the other at high speeds.

The author gave details of an examination of the fuel anti-knock requirements of various engines in terms of blends of iso-octane and normal heptane. The data were obtained from bench tests; these were carried out under conditions equivalent to deceleration at full throttle, whereas road tests are done during a road-load full-throttle acceleration. The general result of this difference is that octane requirements obtained in the laboratory are slightly higher than those obtained on the road. The octane requirement of an engine is the blend of iso-octane and normal heptane which gives knock-free operation under some specified conditions. It is difficult to define, because it varies with operating conditions such as engine temperatures, speed, load, spark advance, mixture strength, and engine condition. Graphs of the octane requirements of 16 engines at speeds from 1,000 to 3,000 r.p.m., and at full throttle with the ignition set to 99 per cent. maximum power, showed that in all cases except one the maximum requirement occurred at 1,000 r.p.m., and was generally between 80 and 90. With all engines except a slide-valve engine, octane requirements were reduced by between 10 and 15 numbers when engine speed was increased to 3,000 r.p.m. Many slide-valve engines show a tendency to maintain a fairly constant requirement at all engine speeds. It was also found that many of the engines tested conformed to a linear relationship between octane requirement for maximum-power spark timing and indicated mean effective pressure.

A study was made of the effect of spark advance (degrees before top dead-centre) on octane requirement and power output. The curve of octane requirement is almost linear with spark advance, but there is only a small loss of power (about 2 per cent.) in the first 10 deg. retard from the angle of spark advance required for maximum power. This emphasises that it is most undesirable, from the point of view of octane-number utilisation, to set the spark timing of an engine at the absolute maximum-power advance. With one of the engines tested the octane requirement could be reduced by 20 numbers for a power loss of only 2 per cent.; this characteristic is obviously very desirable in respect of octane-number utilisation, and the engine would appear to be a particularly suitable design for use with high compression ratios, provided the charac-

teristic is maintained at higher ratios. Tests on two other engines indicate that, to obtain the best knock-limited performance from a particular gasoline, an engine should be over-compressed and operated with retarded ignition.

While the fuel anti-knock requirements of engines, expressed in terms of iso-octane and normal heptane, are of considerable interest, the knock-limited performance of engines with blends made from refinery components is of greater practical significance. The octane requirement of an engine is only useful in determining whether a particular gasoline is satisfactory if the rating of the gasoline in the same engine is known, since there is no known way of calculating, solely from the C.F.R. rating of a gasoline, its behaviour in that engine. The only sure way of ascertaining whether a gasoline will give knock-free performance in a particular engine is to test it in that engine. The performance of two chosen gasolines in a number of engines was examined; gasoline A, which approximated to United Kingdom Pool gasoline quality, had an octane number of 70 by both the Motor and Research methods, and gasoline D, which was typical of United States Premium gasoline quality, prior to the Korean war, had an octane number of 80 by the Motor method and 92 by the Research method. Curves of knock-limited brake mean effective pressure for the two fuels in four post-war British engines showed that, whereas some engines are capable, without re-design, of benefiting from the higher-quality gasoline, with others there is little or no improvement. Engines in which the recommended spark timing for Pool gasoline is close to the maximum-power timing are those which are unable to benefit from improved anti-knock quality. It is under conditions of over-compression and retarded spark timing that the best use is made of fuel anti-knock quality. Each increment of compression ratio gives a corresponding increase in thermal efficiency over the whole load-speed range.

The problem of balancing the compression ratio against spark timing is important in vehicles made for several markets in which gasoline quality varies. The engine must give satisfactory performance on the lowest grade fuel it is likely to meet and yet benefit from the highest grade. It is necessary either to produce an engine with a fixed compression ratio for all markets and to achieve knock-free performance by adjusting spark advance or, alternatively, to supply different compression ratios to each market, thereby obtaining a greater power increase and reduction in consumption from gasoline of improved anti-knock quality. Ideally, for the best utilisation of a given quality of fuel, engines should have their compression adjusted so that they operate with ignition retarded at full throttle, and advanced, by means of a vacuum control, for maximum economy at part throttle.

It is fortunate that the most sensitive gasolines are at the same time fuels of high anti-knock quality. Because of this, there is, in general little danger of high-speed knock occurring. It appears, however, that with sensitive fuels some side-valve engines are more likely to knock at high speeds than at low speeds, if for some reason the octane requirement is abnormally high. Overhead-valve engines have much higher octane requirements at low speed than at high speed and are able to take full advantage of the high rating of sensitive gasolines at low speed. Side-valve engines, on the other hand, do not benefit from a high rating at low speeds.

In the utilisation of anti-knock quality, carburation can play an important part, particularly in engines where knock is critical at low speed and full throttle. In a certain engine, the effect on knock-limited spark advance of richening the mixture from an air: fuel ratio of 12:1 to one of 10.5:1 was quite marked, and was equivalent to an increase of 5 octane numbers. It has been customary to express the effect of combustion-chamber deposits on knock in terms of the increase in octane requirement of an engine due to deposit formation. This has been found to be a misleading parameter, and the change in knock-limited spark advance with a commercial-type gasoline is now preferred.

The research described is still in progress. It now remains to explain more fully the reasons why engines react differently to gasoline anti-knock quality.

In the second paper, on "Recent Developments in 'Knock' Research," Mr. D. Downs, B.Sc. (Eng.), A.M.I.Mech.E., and Mr. R. W. Wheeler, B.Sc., described work carried out in the laboratory of Messrs. Ricardo and Company, Engineers (1927), Limited, on behalf of the Shell Petroleum Company, Limited. They said that the two theories of knock which have been held for the past 30 years are, firstly, that it is akin to the phenomenon of detonation observed during the propagation of flame in closed tubes, and, secondly, that it is an auto-ignition, under the influence of high temperature and pressure, of a body of the mixture after the initiation of flame by the spark. The auto-ignition theory, they said, holds perhaps the allegiance of the majority of engineers. Mr. C. D. Miller has recently surveyed the literature and, based on this and his own

experimental work, has proposed a combined auto-ignition and detonation-wave theory.

The broad facts relating to knock are quite simple. In a normal engine cycle, the flame is initiated at the spark and travels in a fairly uniform manner across the combustion chamber, compressing the unburnt gas before it. This "end-gas" receives heat due to compression by the expanding gases and by radiation from the advancing flame front. If the temperature and pressure are below certain critical values, the flame front will move across in a regular manner to the farther wall of the chamber, burning the mixture as it goes. If, on the other hand, the temperature and pressure conditions are sufficiently severe, the rate of chemical reaction will exceed a certain critical value and, just before the flame reaches the farther side of the combustion chamber, the unburnt or partially burnt mixture in the "end-gas" will be consumed at a very high rate. This high rate of burning and consequent momentary upset of the pressure equilibrium in the combustion chamber sets up a shock wave which, impinging on the cylinder wall, gives the high-pitched "knocking" sound characteristic of detonation in an engine.

It has been established with fair certainty that knock is a phenomenon confined to the last part of the charge to burn. The normal flame velocity and the pressure development in the cylinder prior to the inflammation of the "end-gas" give no indication of whether or not knock will take place. The occurrence of knock depends on the temperature-pressure-time relationship of the mixture in the "end-gas." Thus, any condition which raises the temperature or pressure, such as increasing the compression ratio or the air intake temperature, or any condition which increases the induction time interval, such as increasing the length of flame path or lowering the engine speed (provided this does not affect other factors), will encourage knock. What is not so certain, however, is the exact sequence of events taking place in the "end-gas," that is, whether the mixture spontaneously ignites as the temperature and pressure exceed certain critical values or whether the reactions occurring in the "end-gas" predispose the mixture to support a true detonation wave initiated either in the flame or in the auto-igniting "end-gas." The approach to this more fundamental study of knock has been in general from two main directions. There is first the study of the chemical reactions occurring in the "end-gas" prior to knock, and the determination of the limiting critical chemical factors controlling the occurrence of knock. Secondly, there is the study of the knocking process itself, notably by pressure measurements and high-speed flame photography.

The practical way of following the sequence of chemical reactions occurring in the "end-gas" is to abstract samples from the combustion chamber and analyse them chemically. A sampling apparatus was developed for use with the Ricardo E6 variable-compression engine. Tests with this apparatus appeared to show that the two products whose actions yield the key to an understanding of the knock reactions are formaldehyde and organic peroxides, and, for this reason, the sampling investigation was largely concentrated on an estimation of them.

It has been established that the pressure-temperature ignition diagrams for paraffinic fuels show two main regions, a so-called "high"-temperature region and, superimposed on this, a so-called "low"-temperature ignition peninsula. Ignition in the low-temperature region is by a two-stage process involving a first time interval to the appearance of the "cool" flame and a second from the appearance of the "cool" flame to the appearance of a normal flame. Ignition in the high-temperature region is by a continuous one-stage process. The low-temperature two-stage process was found to correspond to an inflexion in the curve of peroxide concentration against crank-angle, and the study of the pre-flame reactions makes it fairly certain that the reactions leading to knock with ordinary paraffinic fuels are, in the main, of the "low"-temperature type.

A large body of evidence has been assembled which suggests that, with most fuels of the higher paraffinic and naphthenic types, the pre-flame combustion mechanism which controls the occurrence of knock is of the two-stage "low"-temperature type. The final reaction which is the end-product of this preceding chemical mechanism is best described as an auto-ignition but occurring in a mixture which has been so pre-sensitised that the speed of the reaction approaches that of a detonation wave. The correlation between engine knock and auto-ignition phenomena studied both in motored engines and in laboratory combustion apparatus supports this conclusion. The evidence of the high-speed flame photographs of engine combustion, which their authors state show auto-ignition followed by detonation, might be said rather to show the "cool" flame followed by the hot flame of auto-ignition. Whether or not this is a reasonable explanation can only be decided by some further work on the Schlieren photograph of "cool" flames in engines.

Fuels such as benzene and methane which give no "low"-temperature peninsula in experiments in glass apparatus must knock mainly by a "high"-temperature combustion mechanism because: (a) The effect of additives on the knock tendency of these fuels in the engine is in accord with their effect on "high"-temperature ignition in the laboratory; (b) There is an absence of peroxides in the case of benzene and only a small concentration in the case of methane. The small, but significant, concentration of peroxide with methane may indicate that, under the conditions obtaining in the engine, a certain amount of "low"-temperature ignition is superimposed on the "high"-temperature ignition of methane. (c) No "cool" flames have been detected in the engine when running with benzene or methane. In the case of benzene the final reaction is a single-stage auto-ignition and, because there has been little chemical reaction before inflammation, the "end-gas" is not pre-sensitized throughout its mass to the same extent that it is with fuels which oxidise by a two-stage process. Consequently, the spread of inflammation throughout the "end-gas" is less rapid and, in general, the knocking with benzene corresponds more with the rough running of a Diesel engine operating on low cetane fuel than with the high-frequency noise characteristic of knock with other fuels.

Although it is possible to classify fuels roughly into these two groups—those which knock by a "high"-temperature mechanism and those which knock by a "low"-temperature mechanism—there are some borderline cases where it is possible that a certain proportion of both types of oxidation occurs. Ethane is a fuel which appears to knock mainly by a "high"-temperature process but whose oxidation may have a certain "low"-temperature component. Further work will be necessary to determine the relative importance of the two types of oxidation in the knocking mechanism of other fuels. There are indications that this question may be of importance when considering the effect of operating conditions on the performance of a fuel in the engine and such questions as fuel temperature-sensitivity and lead response.

In the field of road transport, economy and high power/weight ratio are demanded. Both these aspects of performance are largely controlled by the permissible compression ratio, which, in turn, is limited by the onset of knock. In a field which is so highly competitive, both from the engine and from the fuel-supply angle, there is a continuing emphasis on knock elimination, both by improvements to the fuels and by improvements in combustion-chamber design. The selection of operating conditions to take maximum advantage of the combustion characteristics of available fuels is an aspect of the problem which is receiving increasing attention to-day, as also is the question of combustion-chamber deposits.

The third paper, on "The Significance of Octane Numbers in Relation to Road Performance," was by Mr. H. J. Eatwell, M.B.E., A.M.I.Mech.E., and Mr. J. G. Withers, B.Sc., A.M.I.Mech.E., of the Anglo-Iranian Oil Company's research laboratory. In this paper, the authors gave a readable description of knock, the conditions controlling it, road-test methods for fuel rating, and the relation between laboratory and road octane numbers. Their concluding "discussion" of the subject is given below, abridged, but as it includes a reference to the "Borderline" road-test method of fuel rating, a brief description of that method is given first. The Borderline knock test method enables the knock ratings of fuels to be obtained at different speeds over the operating range of the engine, thus giving additional data regarding both fuel and engine behaviour. Borderline tests are made by carrying out full-throttle accelerations at each of a number of static spark-advance settings with the automatic advance mechanism inoperative, and the speeds are recorded at which knock just ceases. Thus, a curve of knock extinction or borderline knock speed against spark advance is obtained for each fuel.

It has been shown that, as fuel sensitivity increases, road octane numbers of fuels depart farther from Research method ratings and in severe engines may equal or even drop below Motor method. Also, as the fuel sensitivity rises the critical knock speed can be transferred from the low to the high end of the speed range. Borderline-method road tests normally give ratings approximately equal to Research octane number at low engine speeds and approximately equal to Motor method at high engine speeds. It follows, therefore, that the trend is for low-speed knock to be related to Research method ratings and high-speed knock to the Motor method ratings. The combination of fuel sensitivity and engine severity will, however, determine whether or not the critical knock will occur at high speed or low speed in a vehicle on the road.

Refinery developments to ensure an increasing supply of high-quality motor fuel depend upon processes which produce fuels of high sensitivity, for example, catalytic cracking. The products from these processes have

very high Research octane numbers, and it is important to both the automotive and petroleum industries that the best advantage shall be taken of them. Since severe engines are at a disadvantage in not being able to make full use of the Research octane number of sensitive fuels it is helpful to discuss why they are severe and why they promote knock at high speeds. Side-valve engines, and particularly the smaller ones, are liable to give high-speed knock when using fuels of high sensitivity. This is probably associated with difficulties in providing sufficient cooling to the sparking plugs and exhaust valves and to excessive charge-heating resulting from the close proximity of the inlet and exhaust valves. Particular attention should, of course, be paid to these points in the design. The authors believe that the main reason for the difference between the most severe American engine and the most severe British engine is the difference in size: the smaller horse-power British side-valve engines present much greater design difficulties in providing sufficient cooling in the small cylinder castings.

Another factor that will increase severity is a distributor characteristic that gives excessive advance in the higher speed range. Many engines have distributor characteristics designed to give optimum spark advance at maximum speed, while at low speed the ignition is retarded to reduce the low-speed octane requirement. In some cases examined, it has been found, after as little as 6,000 miles, and frequently before 12,000 miles, that the automatic distributor advance at high speed had increased due to wear by as much as 8 deg. beyond the designed figure. This has an adverse effect on the high-speed octane requirement. Severity is also increased by carburettor settings that give too weak a full-throttle mixture strength at full speed. Excessive mixture heating is also to be avoided, particularly at the higher speeds.

Increase in compression ratio is likely to result in reduced severity; this is confirmed by published work at very high compression ratios on the General Motors research engine. As expected, the octane requirements increased with compression ratio, but when sensitive fuels were used the minimum Motor-method octane number to give knock-free operation increased at a lower rate than the Research method. For various reasons, the overhead-valve design is most suitable for use with high compression ratios. It is therefore likely that there will be increasing numbers of overhead-valve engines manufactured as the octane number of available fuels rises to permit the use of the higher compression ratios.

There are, however, other design trends which may increase the tendency to high-speed knock and thereby increase severity. In the United States, the introduction and increasing popularity of automatic transmissions is a factor which is of major importance in this direction. These transmissions prevent full-throttle operation below a particular engine speed, and thus bring critical knock into a higher speed range. The use of petrol injection could also affect the critical knock speed. This system is only in the development stage but it has been successfully applied to an automobile in Great Britain. During a discussion on the performance of an engine fitted with manifold petrol injection, it was stated that the improved performance arising from gains in volumetric efficiency and improvements in mixture distribution increased the octane requirement by about 8 octane numbers at 2,600 r.p.m., with little effect on the low-speed requirement. It is possible, therefore, that critical knocking could be moved from the low-speed range to the middle- or high-speed range if petrol injection were adopted and fuels of high sensitivity used. The foregoing remarks apply mainly to means for reducing high-speed knock and engine severity; but it is, of course, equally important that the same attention should be given to reducing overall octane requirements for a given compression ratio.

High compression ratios are justified only if their use results in an overall saving to the consumer; thus, gains in economy and performance must more than offset increased fuel costs. Future high-quality motor fuels will be produced mainly by processes which give fuels of high sensitivity, and the best use of these fuels will necessitate attention to the relevant design features so that octane requirements for a given compression ratio are reduced as much as possible, and so that conditions giving rise to excessive severity and to high-speed knock are avoided. In engines of low severity, road ratings of fuels are equal to Research method ratings for fuels with sensitivities up to 10 octane number; for fuels of higher sensitivities, road ratings will be one or two octane numbers below the Research octane numbers and critical knock will always be in the low-speed range. As engine severity and fuel sensitivity increase, the critical knock speed moves from low to high speed and road ratings fall markedly below Research-method ratings; and with a combination of high fuel sensitivity and high engine severity road ratings may be even below Motor-method ratings.

## 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.

**INTERNATIONAL AGRICULTURAL MACHINERY EXHIBITION.**—Tuesday, March 4, to Sunday March 9, at the Parc des Expositions, Paris. Organised by the Union des Exposants des Machines et Outillages Agricoles, 33, Rue de Chateaudun, Paris (9e.)

**"DAILY MAIL" IDEAL HOME EXHIBITION.**—Tuesday, March 4, to Saturday, March 29, at Olympia, London, W.14. Organised by the *Daily Mail*, New Carmelite House, Carmelite-street, London, E.C.4. (Telephone: CENTRAL 6000.)

**VIENNA SPRING FAIR.**—Sunday, March 9, to Sunday, March 16. Agents: British Austrian Chamber of Commerce, 29, Dorset-square, London, N.W.1. (Telephone: PADDINGTON 7646.)

**GENEVA INTERNATIONAL MOTOR EXHIBITION.**—Thursday, March 20, to Sunday, March 30, at Geneva. For further information, apply to the secretary of the exhibition, 1, Place du Lac, Geneva, Switzerland.

**SECOND UNITED STATES INTERNATIONAL TRADE FAIR.**—Saturday, March 22, to Sunday, April 6, at the Navy Pier, Chicago. Representative for the United Kingdom and Ireland: Mr. A. P. Wales, 12, St. George-street, London, W.1. (Telephone: MAYfair 4710.)

**SYMPOSIUM ON FATIGUE OF PERSONNEL.**—Monday, March 24, to Thursday, March 27. See page 277.

**MANCHESTER BUILDING TRADES EXHIBITION.**—Tuesday, March 25, to Saturday, April 5, at the City Hall, Deansgate, Manchester. Apply to Provincial Exhibitions, Ltd., City Hall, Deansgate, Manchester. (Telephone: Deansgate 6363), or to the London agent at 167, Oakhill-road, Putney, London, S.W.15. (Telephone: VANDYKE 5635.)

**ASLIB (ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX), NORTHERN BRANCH.**—Thursday, March 27, at the Central Library, Sheffield. Apply to the secretary of the Association, 4, Palace-gate, Kensington, London, W.8. (WESTern 6321.)

**FIRST SUPERVISING ELECTRICAL ENGINEERS NATIONAL EXHIBITION.**—Friday and Saturday, March 28 and 29, at the Royal Horticultural Society's new hall, Greycoat-street, Westminster, London, S.W.1. For further information, apply to the conference secretary, Mr. P. A. Thorogood, 35, Gibbs-green, Edgware, Middlesex. See also our issue of February 22, page 230.

**INSTITUTION OF NAVAL ARCHITECTS, ANNUAL MEETING.**—Wednesday, Thursday and Friday, April 2, 3 and 4, on the "Wellington," Temple Stairs, Victoria-embankment, W.C.2. Details obtainable from the secretary of the Institution, 10, Upper Belgrave-street, London, S.W.1. (Telephone: SLOane 4622.)

**EXHIBITION OF BRITISH COMPONENTS, VALVES AND TEST GEAR FOR THE RADIO, TELEVISION, ELECTRONIC AND TELECOMMUNICATIONS INDUSTRIES.**—Monday to Wednesday, April 7 to 9, 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.)

**SWISS INDUSTRIES FAIR.**—Saturday, April 19, to Tuesday, April 29, at Basle. Apply to the Division Economique, Swiss Legation, 18, Montague-place, London, W.1. (Telephone: PADDINGTON 0701.)

**SYMPOSIUM ON DIAMOND DRILLING.**—Monday, Tuesday and Wednesday, April 21, 22 and 23, at Johannesburg. Organised by the Chemical, Metallurgical and Mining Society of South Africa and the Diamond Research Laboratory. Apply to the director of the Laboratory, P.O. Box 916, Johannesburg.

**ROYAL SANITARY INSTITUTE HEALTH CONGRESS.**—Tuesday, April 22, to Friday, April 25, at Margate. Apply to the secretary, the Royal Sanitary Institute, 90, Buckingham Palace-road, Westminster, London, S.W.1. (Telephone: SLOane 5134.)

**LIÈGE INTERNATIONAL FAIR.**—Saturday, April 26, to Sunday, May 11, at Liège. Apply to the Fair secretariat, 17, Boulevard d'Ayroy, Liège.

**TELEVISION CONVENTION.**—Monday, April 28, to Saturday, May 3, at Savoy-place, Victoria-embankment, London, W.C.2. Organised by the Radio Section of the Institution of Electrical Engineers. Apply to the secretary of the Institution at the address given above. (Telephone: TEMple Bar 7676.) See also our issue of September 21, 1951, page 371.

**INTERNATIONAL FOUNDRY CONGRESS AND SHOW.**—Thursday, May 1, to Wednesday, May 7, at Atlantic City, New Jersey, U.S.A. Organised by the American Foundrymen's Society, 616, South Michigan-avenue, Chicago 5, Illinois, U.S.A.

**CHEMICAL WORKS SAFETY CONFERENCE.**—Friday, May 2, to Sunday, May 4, at the Palace Hotel, Buxton,

Derbyshire. Organised by the Association of British Chemical Manufacturers. For further details, apply to the secretary of the Association, 166, Piccadilly, W.1. (Telephone: REGent 4126.)

**BRITISH INDUSTRIES FAIR.**—Monday, May 5, to Friday, May 16, at Earl's Court, London, S.W.5, and Olympia, London, W.14; and Castle Bromwich, Birmingham. Particulars 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.)

**INTERNATIONAL EXHIBITION OF ELECTRICAL APPLIANCES.**—Tuesday, May 13, to Tuesday, May 27, at Bologna. Apply to the Ente Autonomo Fiera di Bologna, via Farina 6, Bologna.

**SWEDISH INDUSTRIES FAIR.**—Saturday, May 17, to Sunday, May 25, at Gothenburg. Agents: John E. Buck and Co., 47, Brewer-street, London, W.1. (Telephone: GERrard 7576.)

**GERMAN EXHIBITION OF CHEMICAL APPARATUS.**—Sunday, May 18, to Sunday, May 25, at Frankfurt-on-Main. Organisers: Dechema Deutsche Gesellschaft für Chemisches Apparatewesen E.V., Frankfurt.

**ELECTRICAL ASSOCIATION FOR WOMEN, 27TH ANNUAL CONFERENCE.**—Monday, May 19, to Saturday, May 24, at Scarborough. Apply to the director, the Electrical Association for Women, 35, Grosvenor-place, London, S.W.1. (Telephone: SLOane 0401.)

**INTERNATIONAL HIGH TENSION CONFERENCE.**—Wednesday, May 28, to Saturday, June 7, at the Fondation Berthelot, 28, Rue Saint Dominique, Paris. Apply to Mr. R. A. McMahon, secretary, British National Committee, Thorneroff Manor, Dorking-road, Leatherhead, Surrey. (Telephone: LEatherhead 3423.)

**CANADIAN INTERNATIONAL TRADE FAIR.**—Monday, June 2, to Friday, June 13, at Toronto. Apply to Miss M. A. Armstrong, Canadian Government Exhibition Commission, Canada House, Trafalgar-square, London, S.W.1. (Telephone: WHItchall 8701.)

**MECHANICAL HANDLING EXHIBITION.**—Wednesday, June 4, to Saturday, June 14, at Olympia, London, W.14. Apply to the exhibition organisers, Iliffe and Sons, Ltd., Dorset House, Stamford-street, London, S.E.1. (Telephone: WATerloo 3333.)

**CONFERENCE ON CIVIL ENGINEERING PROBLEMS IN THE COLONIES.**—Monday, June 16, to Friday, June 20, at the Institution of Civil Engineers, Great George-street, Westminster, London, S.W.1. Details obtainable from the secretary of the Institution at the address given. (Telephone: WHItchall 4577.)

**INDUSTRIAL FINISHING EXPOSITION.**—Monday, June 16, to Friday, June 20, at International Amphitheatre, 43rd and Halsted Streets, Chicago, Illinois, U.S.A. Sponsored by the American Electroplaters Society. Further details available from the secretary, Suite 580-84, 35, East Wacker-drive, Chicago, 1.

**ROYAL AGRICULTURAL SHOW.**—Tuesday, July 1, to Friday, July 4, at Newton Abbot. Organised by the Royal Agricultural Society of England, 16, Bedford-square, London, W.C.1. (Telephone: MUSeum 5905.)

**WELDING DESIGN AND ENGINEERING SUMMER SCHOOL.**—Wednesday, July 16, to Sunday, July 20; and Sunday, July 20, to Friday, July 25, at Ashorne Hill. Organised by the British Welding Research Association, 29, Park-crescent, London, W.1. (Telephone: LANgham 7485.)

**INTERNATIONAL ASSOCIATION FOR BRIDGE AND STRUCTURAL ENGINEERING, FOURTH INTERNATIONAL CONGRESS.**—Monday, August 25, to Friday, August 29, at Cambridge. For further information, apply to the secretary of the Association, Swiss Federal Institute of Technology, Zürich, Switzerland.

**INTERNATIONAL MACHINE TOOL EXHIBITION.**—Wednesday, September 17, to Saturday, October 4, at Olympia, London, W.14. Organised by the Machine Tool Trades Association, Victoria House, Southampton-row, London, W.C.1. (Telephone: HOLborn 4667.) See also our issue of July 13, 1951, page 51.

**ASLIB (ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX).**—Friday, September 19, to Monday, September 22, Annual Conference at The Hayes, Swanwick, Derbyshire. Apply to the secretary of the Association, 4, Palace-gate, Kensington, London, W.8. (WESTern 6321.)

**SYMPOSIUM ON MINERAL DRESSING.**—Tuesday and Wednesday, September 23 and 24, at the Imperial College of Science and Technology, Prince Consort-road, South Kensington, London, S.W.7. Organised by the Institution of Mining and Metallurgy, Salisbury House, Finsbury-circus, London, E.C.2. (Telephone: MONarch 2096.) See also our issue of February 15, page 211.

**COMMERCIAL MOTOR SHOW.**—Friday, September 26, to Saturday, October 4, 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.)

## LABOUR NOTES.

MUCH concern is felt among prominent trade-union officials at the threats of strike action against the Government's proposals for effecting economies. Warnings regarding the dangers of taking action of this kind were given by Mr. Herbert Morrison, M.P., a former Lord President of the Council and Leader of the House of Commons, at the annual meeting of the South Lewisham branch of the Labour Party on February 22. Mr. Morrison said that he had noticed that moves were being made in a few quarters to resort to certain forms of industrial action as a means of protesting against the policy of the Government or coercing them into changing it. He felt certain that the general view of the labour movement, political as well as industrial, would be that efforts at industrial coercion against an elected Parliament, which was acting within the limits of the constitution, would be wrong in principle, difficult and ill-advised in practice, and damaging to the labour movement.

It was for Parliament and the electorate to deal with the Government, he considered, and industrial labour was well represented among both of these. The labour movement had quite properly asserted that capitalist private interests had no right to use their financial and economic power to sabotage the work of a Labour Government. They could not switch round now, merely because the electors had returned an anti-Labour majority at the last election. It must not be forgotten that if industrial production were impeded for political reasons, the nation's economic effort, which was so vital to the well-being of everyone, would be damaged, and the consequences to the working classes, trade unionism, the consuming public and, indeed, the whole community, might be highly injurious. For his own part, he did not believe that there was much danger of such a policy being widely pursued in the industrial field, but he had thought it right to sound a friendly note of warning about it to his fellow trade unionists.

Condemnation of strikes for political ends was also expressed by Mr. Arthur Deakin, the general secretary of the Transport and General Workers' Union and this year's chairman of the Trades Union Congress, in the course of a speech at Westbury, Wiltshire, on February 22. In his view, the day of strikes and industrial struggle, as a means of obtaining for trade unionists the consideration which they felt to be their due, had passed. The unions had striven, whenever possible, to negotiate on behalf of their members, and, when they could not obtain a satisfactory settlement by that means, they had endeavoured to get their disputes referred to arbitration. It was his submission that this policy, pursued during the past fifteen years in particular, had produced more lasting advantages to the great masses of people in this country than could have been secured by any other means. The trade-union movement had to make the best of the Government, regardless of its political complexion.

There were many people at the present time who were saying that trade unionists should take industrial action of some kind, by way of strikes or refusals to work overtime, and that the miners should not work the extra shift on Saturdays, because of the policies which the Government were pursuing. That kind of counsel could only bring the nation into still greater difficulties than those with which it was already confronted. More coal, not less, was needed from the pits. The nation needed higher outputs from its factories to enable its economy to be restored to the point where it could pay its own way, and so buy the food and raw materials which had to be imported from overseas. On these the country's industrial activity and export trade depended.

Any failure on the part of workpeople to do their best to produce as much as they could, would have only one result, which would be, to reduce the size of the national income to the extent that it would no longer be possible to maintain the present standard of living. As far as this country was concerned, and as far as the trade-union movement was concerned, they should not engage in industrial action for the purpose of deciding political issues. The economy proposals of the Chancellor of the Exchequer should be resisted not by industrial action but through the efforts of their political party. They were not going to be fractious in their reactions to the present Government, and they were not going to create trouble for the sake of doing so, but, through their political organisations, they were going to oppose, in the most effective manner they could, those policies which they regarded as injurious to working people.

Mr. James Griffiths, M.P., a former President of the South Wales Miners' Federation and Secretary of State for the Colonies in the Labour Government, has

added his support to these appeals. In the course of a speech to South Wales miners at Ammanford, Carmarthenshire, he urged workpeople to reject entirely all proposals that were being made to them to use industrial action as a means of expressing their opposition to the proposals for imposing limitations on the social services. He expressed his understanding of the resentment which the cuts were causing, but condemned strikes and the boycotting of Saturday work as a means of showing that resentment. The adoption of such policies would hurt the country, damage the miners' cause and divide their ranks. The exercise of the vote provided the best means of opposing the Government's intentions. Sir Vincent Tewson, the general secretary of the Trades Union Congress, and Mr. Alfred Robens, until recently Minister of Labour, are among other prominent trade-union leaders who have spoken, during the past few days, against the taking of industrial action for political purposes.

Strong protests against increased charges being imposed in connection with the health service were recorded at the monthly conference of the Lancashire area council of the National Union of Mineworkers, which was held at Bolton on Monday last. It was decided to send a letter of complaint to the Chancellor of the Exchequer. At a meeting of officials of the Derbyshire area of the union at Chesterfield, on the same day, a resolution was carried recommending the abolition of voluntary shifts on Saturdays throughout the area, should the Government's intentions regarding economies in the social services be enforced. It is estimated that more than thirty thousand miners would be involved.

The number of collieries at work throughout Britain on Saturday, February 23, declined to 632, according to a report issued by the National Coal Board on that day. The Board stated that, on the previous Saturday, voluntary shifts were in operation at 724 mines and resulted in the production of some 279,500 tons of deep-mined coal. Voluntary shifts were worked at 95 mines in the South Wales area on February 23. No work was done at 65 collieries, however, and 39 of these were idle as a result of grievances due to the Government's proposals for affecting economies in the social services and to the recent abolition of workmen's fares on South Wales 'bus routes. This was an increase of 19 in the number of pits in the area stated to have declined to work a Saturday shift for those reasons. It may be mentioned that most Scottish collieries open only on alternate Saturdays and that the decline in the number of pits open on February 23, as compared with the preceding Saturday, was largely due to that reason. The unofficial ban in the South Wales area on Saturday working was discussed at an area delegate conference at Cardiff on Wednesday last.

A deputation representing several national organisations interested in obtaining equal pay for men and women was received by the financial secretary to the Treasury, Mr. John Boyd-Carpenter, on Monday last. It was urged that equal pay for both sexes should be introduced immediately in the public services as a matter of expediency and social justice. Mr. Boyd-Carpenter promised that these views would be carefully considered by the Chancellor of the Exchequer, but drew the attention of the deputation to the country's grave financial outlook at the present time.

The possible effect of increases in prices and the reduction of subsidies were referred to by Mr. Arthur Deakin in the course of a speech at Bristol on February 23. He considered that the Government would have to face up to the prospect of further increases in wages, should there be any substantial advancement in the cost of living. In his view, the trade unions had acted with much restraint with respect to wage increases. They would continue to act in this way provided that they were assured that it was the intention of the Government to stabilise prices. It should then be the policy of the Government to create such economic conditions as would allow prices to decline as the purchasing power of the pound sterling improved.

Problems arising from the recruitment of Italians for work in British collieries were discussed at a meeting in London on February 21 between members of the National Coal Board and representatives of the National Union of Mineworkers, who were headed by Sir William Lawther, the union's President. There have been many signs of the increasing unpopularity of Italian man-power, especially in Yorkshire, and the N.U.M. decided recently to request the Board to discontinue recruiting. Sir Hubert Houldsworth, chairman of the N.C.B., is understood to have expressed the Board's regret at the union's present attitude to this question. When a new wage agreement for the industry was reached early last year, the union undertook to encourage its members to accept the Italians.

## DIRECT-CURRENT MILLIWATT CALIBRATOR.

STANDARD TELEPHONES AND CABLES, LIMITED, LONDON.



FIG. 1.

## DIRECT-CURRENT MILLIWATT CALIBRATOR.

THE checking and calibration of electrical test-sets and of instruments such as thermocouples requires a stable source of electrical power of low but accurately-known wattage. A standard cell, such as the Weston cell, is an obvious choice when accuracy and stability are required, but for test and calibration purposes a means must be found of obtaining power for an appreciable period of time, which is not possible with a Weston cell alone. The problem presented by this requirement has been solved in a satisfactory manner by Standard Telephones and Cables, Limited, Connaught House, Aldwych, London, W.C.2, who have evolved the direct-current milliwatt calibrator illustrated in Figs. 1 and 2, on this page. This instrument, known as Model 74131-A, uses a miniature Weston standard cell to provide a reference voltage in a circuit which places no load on the cell. The cell is one manufactured by Messrs. Muirhead and Company, Limited, Elmers End, Beckenham, Kent, and sold as Type D-550-A. It is of robust construction and provides a potential, at 20 deg. C., of 1.0183 volts correct within  $\pm 0.01$  per cent. Its temperature coefficient of voltage variation is 0.004 per cent. per deg. C.

A simplified circuit diagram, illustrating the main features of the instrument, is shown in Fig. 2. The power unit contains a voltage doubler and draws power from the supply mains through a transformer. The direct-current output is stabilised by means of a neon reference-valve and is set at its optimum value by means of a variable resistor. The circuit is completed through the two chains of resistors on the right of the diagram and the bridge network on the left. The latter has a double-triode thermionic valve, type 6SN7, in its two balancing arms, an arrangement which not only ensures high sensitivity but also provides a high input impedance as a protection for the standard cell. A central-zero microammeter, of range 25-0-25, is connected across the bridge to indicate balance and variations of power. Two rectifiers are connected into the microammeter circuit to protect the instrument against overload, the protection afforded being such that an amount of unbalance in the bridge sufficient to cause a current many times greater than the maximum of the range to pass through the meter does not overload the instrument.

The degree of sensitivity afforded by this arrangement is such that when calibrating a milliwatt test-set, a change of 0.05 decibel in the power fed to the set produces a deflection of the meter needle amounting to more than 0.5 in. on the scale. The thickness of the needle is 0.01 in. and, assuming that the smallest deflection which can be discerned is a similar amount, the corresponding change in power is approximately 0.001 decibel. After the calibrator has been switched on and allowed ten minutes to warm up, its short-term stability is amply sufficient for changes of input power of this order to be used in calibration work.

All necessary adjustments in the calibrator circuit are effected by means of a six-position switch and variable resistances. The standard output of 1 mW can be fed into either a 600-ohm or a 75-ohm load. Positions 1 and 2 of the switch are used in both these cases during preliminary adjustments. Subsequently, and depending on the load selected, one of two additional pairs of positions, each marked 3 and 4, is employed.

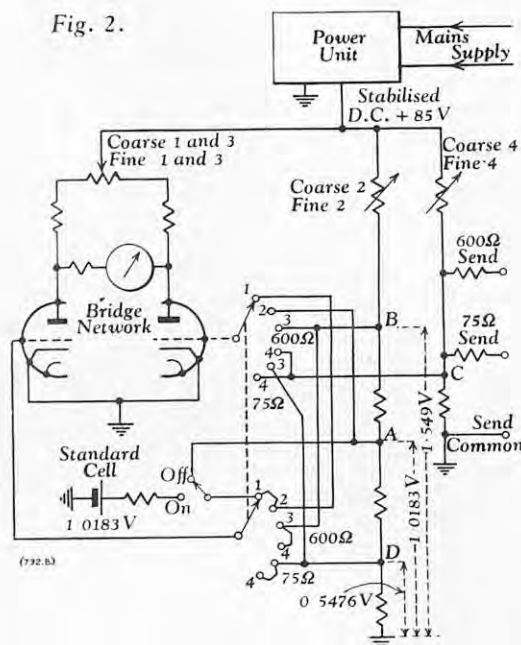
In position 1 of the switch, the voltage of the standard cell is applied to both grids of the valve so that preliminary balancing of the bridge can be effected by means of the coarse and fine controls designated 1 and 3, in the diagram. On turning the switch to position 2, the standard cell is connected to one grid only, the other grid being connected to point A. The coarse and fine controls marked 2 are then adjusted to balance the bridge once more. When this is accomplished, point A is at a positive potential equal to that between the terminals of the standard cell when the latter is on open circuit, and points B and D are at the voltage which corresponds to an output of 1 mW from the instrument into a load of 600 or 75 ohms. Since, however, the balance of the bridge depends on the mutual conductances of the two components of the double-triode valve, and these may not be identical, some additional adjustment of the bridge may be necessary. This is effected by turning the switch to one of the positions marked 3 and readjusting the fine and coarse controls numbered 3.

When the switch is turned finally to one of the positions marked 4, either the point B or the point D is connected to one valve grid and the point C to the other. The bridge is then balanced once more, but this time by adjusting the coarse and fine controls marked 4. The point C is then at a positive voltage equal to that of either B or C. Under this condition the instrument delivers an output of 1 mW, within fine limits, into a load of either 600 or 75 ohms. As a means of checking the input impedance of test-sets, accurate 600-ohm and 75-ohm resistors are built into the instrument. When these are used, impedance variations of as little as 0.2 per cent. from the nominal value can be detected.

The dimensions of the instrument are 17½ in. by 9½ in. by 9 in. and it weighs 7½ lb., approximately. It may be connected to alternating-current supply mains having voltages between 100 and 150 or 200 and 250 and frequencies between 40 and 60 cycles per second. The intention is to produce other models, suitable for 140-ohm and 125-ohm loads.

PRICE CONTROL ON SCRAP LEAD REMOVED.—The Minister of Supply (Mr. Duncan Sandys) has made an Order removing price control from remelted and scrap lead. Supplies of these materials have recently increased and are now sufficient to meet all demands from consuming industries. The Order—The Non-Ferrous Metals Prices (No. 9 Order) (Amendment) Order, 1952—Statutory Instrument, 1952, No. 333, came into effect on February 23. [H.M. Stationery Office, price 2d.]

Fig. 2.



## FUELS FOR MARINE AUXILIARY OIL ENGINES.\*

By C. D. BREWER, M.I.Mech.E., F.Inst.Pet.

(Concluded from page 251.)

CARE is taken by the refiner to see that fuels as free as possible of suspended mineral matter are distributed, and the low ash contents of Diesel fuels reflect his success in this direction; a gas oil with any measurable ash content is exceptional. Crude oil, however, usually contains a certain amount of inorganic ash-forming constituents in solution; while none of this should be carried over with the purely distillate fuels, it naturally tends to become concentrated in the residuum at the bottom of the fractionating tower. Thus a marine Diesel fuel, having residual components, is liable to contain some ash, but this is generally below 0.01 per cent. by weight.

The chief danger of contamination is between the site storage or bunkers and the engine. An examination of the condition of the tanks and pipelines of engine installations would reveal very few entirely free from scale and dirt, which is stirred up by every delivery of the fuel or the normal movement of the ship. The risk of abrasive matter being present in the fuel is greater as the fuel becomes heavier. The abrasive particles that do the harm are not the big lumps that any reputable filter will remove, but the very fine particles, roughly those less than 6 microns in diameter, that can get through any standard type of filter and then find their way into the fine clearance spaces of the injection pump and injector. It is even suspected that they contribute to cylinder wear, particularly where the proper functioning of the injectors is concerned. The hardness and shape of such particles are important; if they are hard and have sharp edges, like silica, they are most likely to cause damage. They will settle out from the lightest fuel if it is allowed to stand for a time; in the case of the heavier fuels, the settling process may be appreciably slower, too slow to stop the damage to the injector equipment if additional steps to clean the fuel are not taken. Water ballasting in the fuel tanks is a serious source of trouble, since some scale and sea water is inevitably carried over with the fuel.

Purifying temperatures necessary for the optimum performance of equipment must be maintained and the throughput of the centrifuges, and clarifiers where they are fitted, matched to suit the viscosity of the fuel being handled. It is also important that the fuel should be subjected to centrifugal force for as long as possible. There is no doubt that the rated capacity of centrifuges must be reduced when purifying high-viscosity fuels for Diesel engines. It is therefore advisable for operators to satisfy themselves that claims by machine manufacturers that the throughput need not be reduced are substantiated before they are accepted.

Insoluble ash is derived mostly from solid matter which is picked up between the distributing centre and the injection equipment. The larger and heavier

\* Paper read at a meeting of the Institute of Marine Engineers, in London, on February 12, 1952. Abridged.

particles settle out naturally if the fuel is left undisturbed for some time, but the smaller ones remain in suspension for a long time unless removed by practical means, such as filtering and centrifuging. Heating the fuel reduces its viscosity and, incidentally, its specific gravity relative to the particles of solid matter, thus facilitating separation, particularly by centrifuging. The most suitable temperature for centrifuging heavy fuels of high viscosity is normally about 180 deg. F.; a higher temperature could be used, but in the great majority of cases little advantage would result. Settling tank temperatures should be maintained at about 100 deg. F. From the point of view of separation of foreign matter, a higher temperature would be of some advantage, but the adverse effect on some heavy fuels that can result from being kept at these temperatures for long periods renders their use undesirable. Some fuels are unstable at elevated temperatures, where they are liable to give rise to sludging to an extent sufficient to overload the centrifuges in a very short time.

Boiler fuel which has been properly treated will generally be satisfactory in the largest marine Diesel engines, provided that it is heated to reduce its viscosity before it reaches the high-pressure fuel pumps. This is necessary to allow free flow to the pump and to avoid excessive pressures in the injection system. The fuel entering the high-pressure system should therefore be maintained at a temperature, normally between 160 and 200 deg. F., depending on the grade of fuel used. While no difficulty should be experienced in maintaining this temperature under full load running, special care is necessary when running at slow speeds and when starting up from cold. Preheating the system before starting up from cold is particularly important since it is also necessary to pre-heat the cylinder jackets prior to starting if excessive wear is to be avoided; the two systems can be interdependent. Where the fuel nozzle cannot be adequately heated from the cylinder jacket, the provision of a separate circulating system is justified.

While all fuel must be as clean as possible, this is even more important with the smaller engines which usually comprise the auxiliary units. If they are sharing the same fuel as that of the main engine, the auxiliaries will normally draw their supply from the main day tank. However, there is little doubt that some additional treatment of the fuel, before use in the auxiliary engines, will be necessary for really satisfactory results, and the best procedure would be the provision of a separate clarifier and day tank, fed from the main-engine day tank, set aside specifically for the use of these engines. Since the auxiliaries will also be needed in port, the power requirements may be considerable and sufficient fuel storage of prepared fuel must be provided to cover these requirements, or arrangements made to supplement this supply from the main bunkers.

It is appropriate now to consider what the foregoing means in terms of engines used for auxiliary purposes, considered principally in respect of size rather than of duty. Consideration first will be given to the medium-size medium-speed group of engines, which forms by far the greatest bulk of those used. For lack of a better definition, they will be considered to be in the speed range of 250 to 850 r.p.m. and of bore sizes from 7 in. to 15 in. in diameter.

There is little economic justification in using gas oils in the main propulsion engines when marine Diesel fuels are available and where it is known that the engines will perform satisfactorily on them. These circumstances offer the greatest incentive to use these fuels in the auxiliary engine also. The possibility of using heavy fuels in the main engines has been investigated by the Anglo-Saxon Petroleum Company in tests conducted in the m.v. *Auricula*, which has been fully described in recent papers by Mr. John Lamb. These tests have shown that operation on these fuels in engines of the largest size can be entirely satisfactory where the fuel-handling precautions are carefully observed. However, the use of heavy fuels in the smaller auxiliary engines is not likely to result in an acceptable standard of operation in all cases, though there may be notable exceptions amongst the larger and more conservatively rated units.

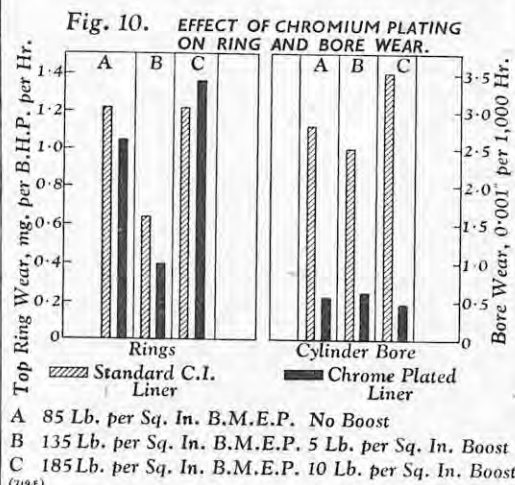
Engines in the group under consideration are used in many land installations and are often run on distillate fuels, though these may not in some areas come up to the requirements of the B.S.S. 209-1947 Class "A" stipulation. This may be because, as in this country, Class "B" or Diesel fuel grades are not generally available except at ports with a bunkering installation.

Experience has shown that these medium-speed engines can run satisfactorily on a marine Diesel fuel meeting Class "B" requirements. In many cases this has resulted in no deterioration in reliability and availability, but in others this has not always been the case. To what extent these failures can be attributed to engine design or to lack of proper maintenance is difficult to determine.

Reference has been made to the considerable work carried out at the Thornton Research Centre in the

search for correlation between engine performance and fuel properties. There was, however, the additional objective of determining how heavy a fuel is practicable in engines of medium size and speed. In order that a wide range of fuels might be explored, test time was generally limited, except in the case of a few selected fuels, to a few hours. The question of engine endurance, therefore, was not exhaustively examined. These tests, which were conducted in two engines, a four-stroke and a two-stroke of 240 and 212 mm. bores, respectively, showed that correlation between fuel properties and maximum brake thermal efficiencies were not clearly evident. The most striking feature of the results was the narrow range of brake thermal efficiency into which all the fuels tested fell—only 33 to 35.5 per cent. in the case of the two two-stroke engines and 32.2 to 33.2 per cent. in the four-stroke unit.

The tests were characterised by the complete absence of any major difficulty in operating for short periods on heavy fuel oils, provided they were preheated so that at the injection pump inlet a viscosity of about 150 secs. Redwood I was not exceeded. One fuel only was ruled out, and that only in the two-stroke engine, because of its low ignition quality—about 25 cetane number—which gave rise to excessive knock. There was some evidence that part-load efficiency falls slightly more rapidly when heavy fuels are used; as this is presumably the result of deteriorating combustion, some increase in wear and fouling at light loads might be expected in their case, relative to their incidence with lighter fuels. Although deposits on the exterior of the injector nozzles did not noticeably



interfere with the short tests, the appearance of the nozzles after use with some of the heavier fuels suggested that it would be necessary to pay attention to this aspect of engine fouling where extended running periods were concerned.

To obtain further information on the endurance of engines in respect of wear and fouling in this size group, the two engines referred to were submitted to two runs of about 150 hours continuous running on each of three heavy fuels, having viscosities, respectively, of 350, 90 (4 and 2,000 seconds Redwood I at 100 deg. F. One of these runs was mainly on high load, the other on low load, though periods of idling were interspersed. The pistons were taken out for examination at the end of each run; they were in no case excessively dirty and, for any particular fuel, were cleaner after the high-load running than after the low load. This was also generally true for the combustion-chamber deposits, though these were heavy after only short periods of light-load operation. No ring-sticking, port-blocking or over-penetration of the fuel spray was experienced. Engine and lubricating oil cleanliness appeared to decrease as the asphaltene content of the fuel increased, while ring and bore wear seemed to increase with the sulphur content rather than with any other property of the fuel; bore wear was actually very slight, and ring wear not excessive.

In these tests, the fuel was not centrifuged but passed through an Auto-Klean filter with 0.005 in. spacing only; felt-pack filters were tried, but were found to disintegrate with the hot fuel. It is possible that, if the heavy fuels were centrifuged, better results would be obtained; there was, of course, no sea-water or bunker scale to remove in these laboratory tests, as there probably would be on a ship, but there may have been enough abrasive material in the fuel to cause appreciable wear of the injection equipment at least.

While engines of 6-in. bore or less find many applications as auxiliaries on board ship, their numbers are relatively small in comparison with the medium-speed units discussed above. Because of their size, engines of this group would be expected to be relatively fuel-sensitive, and in the smallest sizes there certainly would be little economic justification for using in them a

marine Diesel fuel in preference to a bunker gas oil, except as a matter of sheer convenience or unavailability of the latter. The use of marine Diesel fuels in high-speed engines will inevitably result in reduced engine endurance in the form of heavier ring and ring groove wear, pitting of the exhaust valves, and injector fouling. For instance, strictly comparable tests have shown that the rate of bore and ring wear experienced with marine Diesel fuel can, in this size of engine, be as much as five times that normally observed with a gas oil. The actual degree of reduction will be greatly influenced by engine design and other factors, and no doubt these faults can and will be overcome, or at least mitigated to some extent, by special attention to detail either by design or the use of new and better materials. The reduced rate of bore wear by the use of chromium-plated bores or of chromium-plated rings and plain bores observed in some tests supports this view, as is illustrated in Fig. 10, herewith. Ring wear, however, does not appear to be greatly influenced by chromium plating the bores.

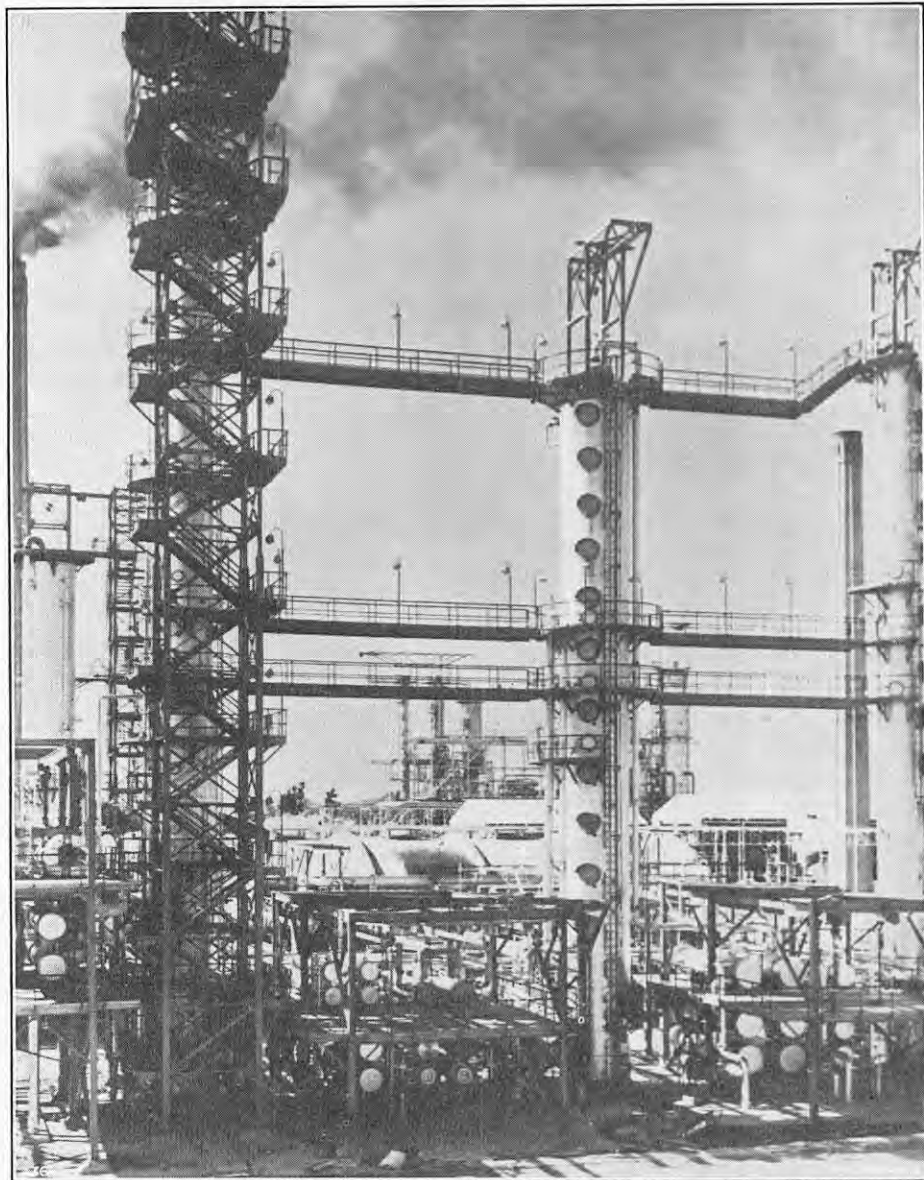
Nevertheless, while these smaller high-speed engines are primarily designed to run on gas oil (B.S.S. 209 Class A), it is known from experience that certain types will run reasonably satisfactorily on Class B Diesel fuels, although it is hardly practicable to use any fuels heavier than these. In this size of engine, fuel heating is not always readily available, so that the fuel must not be too viscous to be handled by the high-pressure pump with safety. The viscosity limit for Class B is 100 seconds Redwood I at 100 deg. F., but a fuel only just complying with that limit would be much more viscous even at 60 deg. F.—up to 270 seconds—and almost solid at 32 deg. F.—up to 1,000 seconds. The heaviest fuel, therefore, that can be considered practicable for use would have a viscosity of about 60 seconds (Redwood I at 100 deg. F.). Having the fuel filter in contact with the exhaust manifold, as is standard on some engines, eliminates most of these viscosity troubles. Even when starting from cold, the filter will warm up before wax can collect to clog it.

Bench tests using Class B fuels in various engines in this class, including a high-speed two-stroke engine of advanced design, suitable for some auxiliary purposes, have given very interesting results. Operating under varying load and speed conditions simulating those found in small craft on harbour duty, examination of the cylinders and pistons at 200-hour intervals, with the minimum disturbance of parts, revealed that, though the engine was decidedly dirty at the first strip, conditions thereafter appeared to stabilise and no trouble was experienced from this cause. Although the final examination did reveal that, under the conditions of test employed, the limit of operation before a top overhaul had been reached in 700 hours, there was nothing to suggest that the use of such a fuel in an engine of this type for short periods or in emergencies was not a reasonably sound proposition. Tests on the smallest size of engine have shown that, while giving an otherwise satisfactory performance for limited periods on B grade fuels, fouling and cylinder-bore and ring-groove wear, and consequently increased maintenance, were out of all proportion to any saving in fuel cost.

The rapidly increasing application of supercharging to marine auxiliary engines can be expected to have an appreciable influence on their fuel tolerance. In the first instance, the higher mean temperatures which result from supercharging are beneficial from the point of view of combustion-chamber deposits. It is to be expected, therefore, that, size for size, the supercharged engine would be better in this respect. The higher density and temperature of the compressed-air charge which results are also of direct benefit in reducing ignition delay. The improved combustion of heavy fuels resulting from supercharging should be reflected also in improved general cleanliness and reduction in wear. Laboratory tests with a small supercharged engine have shown a substantial reduction in wear, when operated under conditions of moderate boost, both of the rings and cylinder bore, over that normally experienced with atmospheric induction, despite an increase in load of about 50 per cent. Fig. 10 illustrates this point also. This experiment well indicates the sort of improvement in wear which may be expected under favourable circumstances when moderate supercharge is used. The actual mechanism by which this improvement was effected is not clear, but it may be associated with improved combustion and therefore reduction in combustion ash and deposits under conditions of supercharge.

No assessment of the possibility, or even the advisability, of operating auxiliary compression-ignition engines on any particular fuel would be complete without reference to the important part that the lubricating oil has to play. Although most of the experiments cited have been conducted on straight mineral oils, so that the issues should not be masked by the possible influence of the lubricating oil, it is significant that the use of a heavy-duty additive-type oil has always resulted in a substantial reduction in

## EXTENSIONS TO THE BERRE OIL REFINERY.



wear and fouling when used in the smaller engine sizes operating on Class B fuels. It has also been shown that the use of such oils can result in an engine strip after running on a marine Diesel fuel equal in appearance, as regards cleanliness, to that normally expected with a gas oil. Thus it can be said that, when used in conjunction with heavy-duty oils, the range of usable fuels in any engine size group can be greatly extended. While it cannot be claimed yet that an engine condition comparable in all respects with that obtained with Class A fuels can be achieved, results on all sizes of engines have shown that this is not beyond the bounds of possibility. The encouraging results obtained when using experimental additive-type oils for cylinder lubricants in the larger size of propulsion and auxiliary engines completely substantiates this.

**RATIFICATION OF IRAQ OIL AGREEMENT.**—The new agreement signed recently between the Government of Iraq and the group of companies represented by the Iraq Petroleum Company, which includes British, Dutch, French and American interests, was approved by the Iraq Chamber of Deputies on February 14 and ratified by the Senate on February 17. This brings to a successful conclusion the series of friendly negotiations which began in 1950 between the Government of Iraq and the oil interests concerned and led to the signing of the agreement on February 3. By the terms of the agreement, the Iraq Government will receive half of the profits resulting from the companies' operations; these will, of course, vary, but on the basis of current estimates, the Iraq Government can expect 31,000,000*l.* in 1952, rising to nearly 60,000,000*l.* in 1955. The group of companies has guaranteed to produce minimum quantities of crude oil. The Iraq Petroleum Company and the Mosul Petroleum Company will together produce a minimum of 22,000,000 tons of crude oil a year from 1954 onwards and the Basrah Petroleum Company has undertaken to produce annually a minimum of 8,000,000 tons from the end of 1955. Oil will commence to flow along the new

556-mile 30-in. pipeline from Kirkuk to the new Mediterranean terminal at Banias, Syria, in April of this year and, when in full operation, this project will add some 14,000,000 tons annually to the 8,000,000 tons already pumped along the existing pipelines to the Mediterranean seaboard at Tripoli, Lebanon. By certain clauses in the agreement, the Iraq Government is assured that in all circumstances its total income will not be less than 25 per cent. of the seaboard value of all oil exported by the Iraq and Mosul companies, plus 33½ per cent. of the seaboard value of the crude oil exported by the Basrah Petroleum Company. Fluctuation of world prices will be taken into account in assessing the profits to be shared and the Iraq Government will be entitled to take in kind at seaboard 12½ per cent. of the oil produced for export by the three companies as part of its 50 per cent. share of profits. Provision has been made to increase the opportunities of Iraqi nationals to participate in the development of their country's oil resources, and the number of Iraqi directors on the boards of the various companies will be increased.

**ELECTRICITY SUPPLY STATISTICS.**—During January, 1952, the power stations of the British Electricity Authority, the North of Scotland Hydro-Electric Board and the Lochaber Power Company generated 6,353 million kWh, compared with 5,946 million kWh during the corresponding period of 1951, an increase of 6.8 per cent. The installed capacity during the month was 16,351 MW, compared with 15,099 MW a year earlier, an increase of 8.3 per cent.

**INCREASED CHARGES FOR BULK ELECTRICITY SUPPLY.**—The British Electricity Authority have given notice that, owing to the continuing rises in cost, the kilowatt demand charges for bulk supplies given to the Area Boards will be increased from 4*l.* 2*s.* 6*d.* to 4*l.* 5*s.* 6*d.* from April 1, 1952. The running charge will remain at 0.33*d.* per kilowatt-hour, subject to a coal price adjustment of 0.0007*d.* per 1*d.* variation in the price of fuel from the basic figure of 38*s.* per ton.

## EXTENSIONS TO THE BERRE OIL REFINERY, FRANCE.

The opening on January 17 of extensions to the Shell Berre refinery near Marseilles marked a further stage in the development of the oil-refining industry in western Europe. The extensions make the plant one of the largest in France, and Shell Berre, with its other installations at Petit-Couronne, near Rouen, and Pauillac, in Bordeaux, now controls refineries having a total throughput of more than 5,000,000 tons a year. In 1950, the Berre refinery had a total intake of 1,140,000 tons, and by 1951 this figure had risen to 2,360,000 tons. Its annual capacity at present is almost 3,000,000 tons, approximately six times greater than immediately before the war. The feed-stock is being obtained largely from Kuwait on the Persian Gulf, which supplies some 70 per cent. of the total throughput, the remainder coming from Iraq, Venezuela, etc., with a minor proportion from France and Algeria.

The increased output at Berre has been brought about largely by the construction of a new crude distillation, or "topping," unit and the installation of a modern reforming plant, more than 95 per cent. French labour and materials having been employed for both projects. The distillation unit has been designed to separate the crude oil into a variety of products ranging from liquid gases to fuel oils and has a capacity of 8,000 tons per day. It has six fractionating columns, one of which is the largest in Europe, weighing over 300 tons. Some of the columns can be seen in the photograph of the Berre plant reproduced on this page. The reforming plant has a capacity of 1,200 tons per day and is used to convert part of the distillate into high-octane fuels, a high-temperature cracking process being employed for this purpose. Part of the remaining products from the distillation unit act as a feed-stock for a catalytic-cracking plant of the Houdry type, which produces high-grade aviation and motor gasoline. By the end of 1953, however, it is hoped to have in operation a new plant employing the more modern fluid catalytic-cracking process, the design of which will be based largely on those already in operation in the Shell refineries at Pernis, in Holland, and Stanlow.

The storage facilities at Berre have been expanded considerably and the total capacity is now over 500,000 tons, part of which is set aside for storing crude oil from the Middle East. The tanks are fed directly by a pipeline from the growing oil port of Lavéra, situated some 21 miles away on the Mediterranean. Each month approximately 200,000 tons of products are shipped from the port of La Pointe on L'Etang de Berre, the inland sea adjoining the refinery. The liquid gases are handled at Rognac, near Berre, where the Société pour l'Utilisation Rationnelle des Gaz, a Shell subsidiary, operate what is believed to be the largest filling plant in the world for liquid gases, the storage capacity being in the neighbourhood of 2,600 tons. Both butane and propane are piped from the refinery to the filling plant and the Société markets these products throughout France.

## TRADE PUBLICATIONS.

**Battery-Powered Miners' Cap Lamps.**—The recently re-designed Nife alkaline battery-powered miners' cap lamps and a system of controlled self-service in colliery lamp rooms are described in an illustrated publication (No. 4451) issued by Alkaline Batteries, Ltd., Redditch, Worcestershire.

**Foundry Iron and Brass.**—Three leaflets dealing, respectively, with high-tensile brass alloys (No. 14), nodular cast iron (No. 48) and malleable cast iron (No. 49) have been issued by Foundry Services Ltd., Long Acre, Neehells, Birmingham, 7. These information sheets, as they are called, have been specially prepared for foundrymen.

**Coal Milling and Pulverised-Fuel Firing.**—Pulverised-fuel firing is being increasingly adopted in large electric power stations. Interest therefore attaches to a brochure on "Coal Milling and Pulverised-Fuel Firing" published by International Combustion Ltd., 19, Woburn-place, London, W.C.1, in which, after the various systems of firing have been described, details are given of the different types of mill in use. Burners and furnace design are also dealt with.

**Copper: Its Ores, Mining and Extraction.**—The Copper Development Association, Kendals Hall, Radlett, Hertfordshire, have prepared and issued a 48-page booklet (C.D.A. Publication No. 46), entitled "Copper, its Ores, Mining and Extraction," which describes in simple language how commercial copper bars, billets and ingots are derived from the ore by mining, ore dressing, smelting, refining and fabricating. A coloured plate shows typical copper-ore minerals, and the principal ore-producing countries are indicated on a map of the world. The various steps, from the mining of the ore to the smelting and refining processes are illustrated by numerous diagrams and reproductions of photographs.

## OILFIELD-EQUIPMENT TRANSPORTER WITH TIPPING BODY.



FIG. 1. TRANSPORTER WITH BODY IN TRAVELLING POSITION.

## 20-TON TRANSPORTER WITH TIPPING BODY FOR OILFIELD EQUIPMENT.

NORMALLY, self-loading oilfield vehicles are rigid-type lorries which pull heavy loads on to their platform bodies by means of a winch situated behind the driver's cab. To assist in loading, the equipments, such as pumps, Diesel engines, etc., are mounted on skids and, during the actual loading operation, the winch cable is attached to the forward end of the load, which subsequently is drawn towards the tail of the vehicle by the winch; alternatively, the vehicle can be reversed up to the load. When the point of attachment of the winch cable is vertically below a roller fitted to the rear of the platform body, it draws the forward end of the skid upwards until it makes contact with the roller. Continuation of the winching operation causes the bottom surfaces of the skid to ride over the roller until the load reaches a state of balance on the roller, with the result that, if the load is sufficiently heavy, the front wheels of the vehicle leave the ground. Further winching then lowers the load on to the platform and, at the same time the wheels return to the ground, sometimes gently and at other times rather violently.

This method, although efficacious, has at times somewhat adverse effects on the structure of the vehicle, particularly if those carrying out the loading are unskilled or new to the task. There is much to commend, therefore, in the design of the latest type of oilfield vehicle placed in service recently by the Anglo-Iranian Oil Company; they are of the semi-trailer type with the trailer arranged so that the rear of the platform body can be brought into contact with the ground, so enabling the load to be winched more easily on to it, without causing the front wheels of the tractor to leave the ground. These vehicles were produced jointly by Leyland Motors, Limited, Leyland, Lancashire, who supplied the tractors, and Messrs. Cranes (Dereham), Limited, Dereham, Norfolk, who produced the semi-trailers. One of the vehicles is illustrated in Figs. 1 and 2, on this page, Fig. 1 showing the trailer in the normal travelling position and Fig. 2 with the rear lowered to the ground and a large pump being winched on to the platform body. The combination is designed to carry loads up to a maximum of 20 tons and, with the tractor, the overall length is approximately 48 ft. The trailer platform is tipped hydraulically and as the full weight of the load is not to be lifted a hand-operated pump is fitted. When loading has been completed with the platform in the tipped position, a valve is opened which allows the platform to sink gradually to the horizontal or travelling position. Suitable locking clamps are then placed in position and are secured to prevent any movement of the upper frame when travelling.

The trailer incorporates a beam type of suspension originally developed by Messrs. Cranes for use on 40-ton tank transporters. It consists of a cross-shaft carried by brackets bolted to the trailer frame on which two rocking beams are mounted, so that they are free to move about their centres in the vertical plane. The ends of each beam are, in turn, provided with smaller beams, or axles, and these also are free to rock in the vertical plane, but at right angles to that in which the main beams oscillate, so that the road wheels fitted to the ends of the axles are free to rise and fall independently according to the contours of the ground. It will be realised that with this form of suspension there are eight road wheels. The deck of the semi-trailer is of a laminated construction,

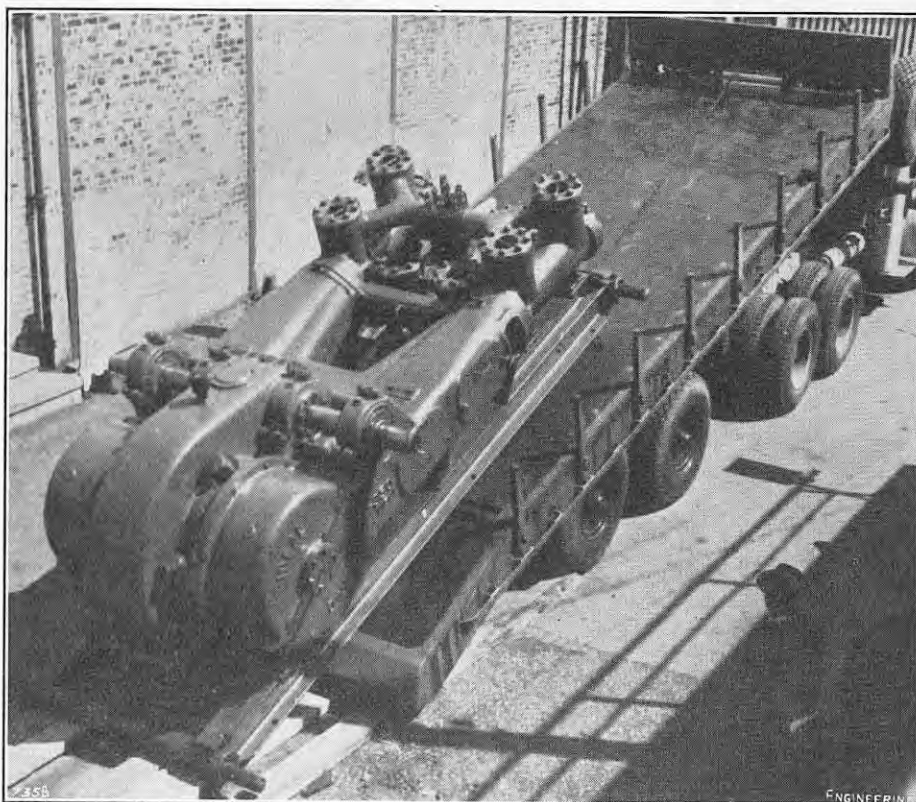


FIG. 2. BODY RAISED AND LOAD BEING WINCHED TO TRAVELLING POSITION.

2-in. thick oak boards being covered with  $\frac{1}{4}$ -in. thick mild-steel plating. The timber acts as a shock absorber and the steel provides a good surface along which to slide the loads. Short steel stanchions are arranged along the sides of the load-carrying platform, and guide rollers and fairleads are provided to take the winch rope to any required position.

The tractor is a Leyland EH 4 AL Super-Hippo unit of substantially standard construction, but provided with a Darlington model 70 winch. This is installed behind the driver's cab and has arranged above it a frame for carrying two spare wheels together with a davit for lowering them to the ground. This ancillary equipment was installed by Messrs. Bromilow and Edwards, Limited, Foundry-street, Bolton, Lancashire, who were also responsible for the manufacture of the hydraulic tipping gear.

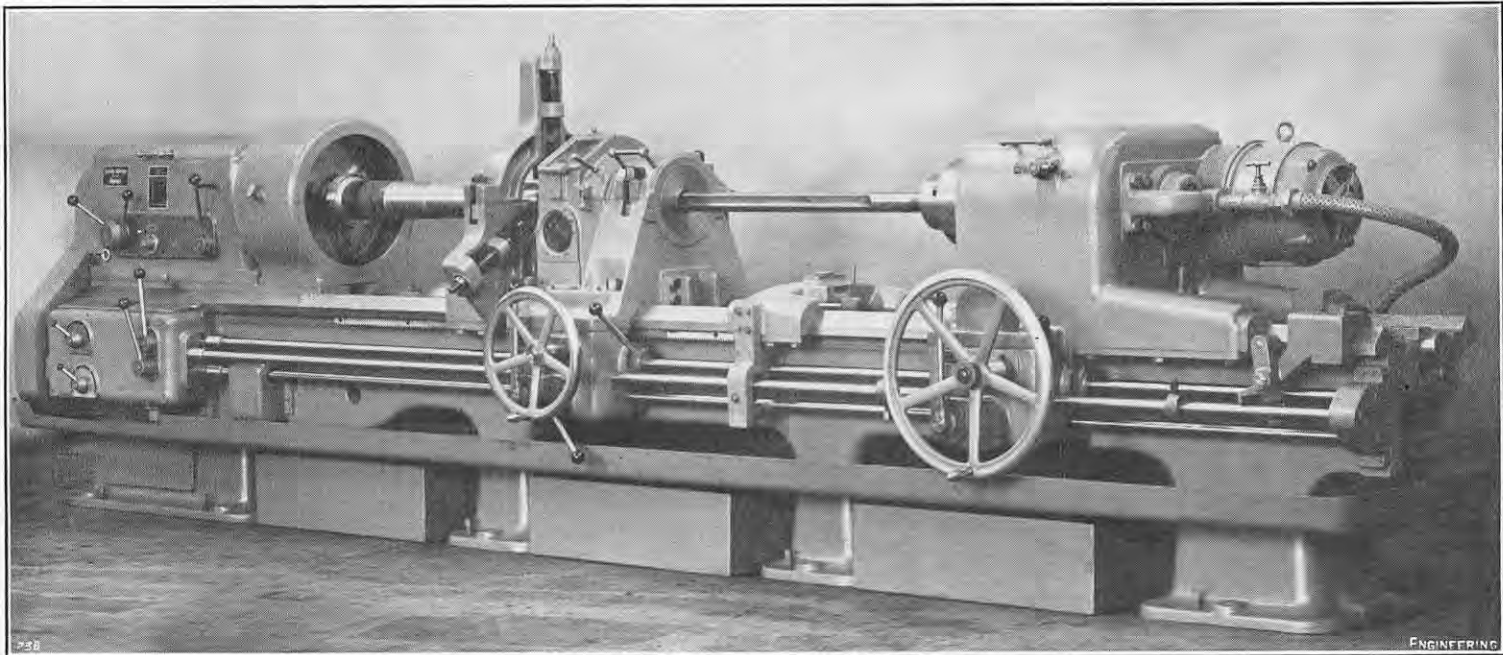
**INSTITUTE OF METALS: STUDENTS' ESSAY PRIZE COMPETITION.**—The Council of the Institute of Metals, 4, Grosvenor-gardens, London, S.W.1, will present annually two prizes, each of 20 guineas, comprising 10 guineas in cash and 10 guineas in the form of technical books, for the best essays submitted in accordance with the following regulations. The competition is open to student members and to associate members of local sections who are eligible for student membership of the Institute, provided that candidates are between 17 and 25 years of age. Essays must be submitted in type-written form in English and they should be between

2,500 and 3,500 words in length. For the 1952 competition candidates may select a subject which comes under one or other of the headings "Non-Ferrous Metal Foundry Practice," and "Metallography in Industry." Entries must be submitted not later than Monday, May 19, to the secretary of the Institute, from whom further particulars may be obtained.

**BRITISH COUNCIL COURSES.**—We have received a brochure issued by the British Council giving particulars of summer schools at British universities and short educational and specialist courses arranged for overseas visitors to the United Kingdom. Among the specialist courses there are three which may be of interest to engineers. From June 29 to July 12 a course, arranged in conjunction with the Institution of Civil Engineers, will be held on "Engineering Aspects of Public Health," including visits to sewage works, etc., in London, Birmingham and Manchester. A course on television, for radio and television engineers, organised in conjunction with the British Broadcasting Corporation, the Post Office, and television-equipment manufacturers, will be held in London from September 21 to October 4. The Ministry of Labour and National Service have co-operated in arranging a course on "Industrial Relations" which will be held in London from October 6 to 22. Copies of the brochure and further particulars of the courses may be obtained from representatives of the British Council or from the director of the Courses Department, British Council, 65, Davies-street, London, W.1.

## DEEP-HOLE BORING MACHINE.

GEBR. BOEHRINGER, G.M.B.H., GÖPPINGEN, GERMANY.



## DEEP-HOLE BORING MACHINE.

THE machine illustrated above is the type B5B "V.D.F." deep-hole boring machine, which is equipped with a power-driven boring head. It is made by Gebr. Boehringer G.m.b.H., Göppingen, Germany, for whom the agents in this country are the Sykes Machine Tool Company, Limited, Terminal House, Victoria, London, S.W.1. A similar machine, but with a stationary boring tool, is also made, and Heidenreich and Harbeck, Hamburg, make a smaller deep-hole boring machine of the same V.D.F. design, known as the B3B. The B5B illustrated has a swing over the bed of 24½ in., and boring capacities, when drilling out of the solid, of 4½ in. in diameter, and, when trepanning, of 7½ in. diameter. The maximum diameter of boring bar is 7½ in. and the hole in the headstock spindle is 4½ in. There is a range of lengths of bed, from 17 ft. to 50 ft., and the corresponding maximum boring depths are 3 ft. 3 in. and 19 ft. 8 in. The steady admits workpieces from 2½ in. to 9½ in. in diameter.

Alternative main driving arrangements to the headstock are available, using a 14½-h.p. motor: either by V-belts from a motor which is mounted on a bedplate at the back of the headstock, or by a direct drive from a flange-mounted motor. With the first arrangement, it is possible to provide 21 headstock-spindle speeds, i.e., three more than the standard 18 speeds of the machine. The speed ranges are 9.5 to 475 r.p.m., with a V-belt drive, and 11.8 to 600 r.p.m. with a flange-mounted motor. The drive to the spindle is through a multi-plate clutch, which is interconnected with a mechanical brake so that disengagement of the clutch applies the brake and stops the spindle. The gears are of high-grade steel, hardened and ground, and they slide on ground spline shafts which run in anti-friction bearings.

Power for the feed motion of the boring head is transmitted from the headstock spindle through a reversing gear and change gears to a feed-box; from there it is through worm gearing to a lead-screw mounted between the main V-ways of the bed. The reversing gear enables boring and reaming to be done by the draw-cutting method. There are 20 feed rates, ranging from 0.00047 in. to 0.335 in. per spindle revolution, though higher or lower ranges can be provided if required. The splined gear-shafts in the feed-box run in plain bearings, and a slipping clutch in the feed drive protects the machine against overloading. A separate flange-mounted motor is used to provide the power for quick traverse of the boring head, the speed being adjustable from 3½ to 6½ ft. per minute by means of two change gears. Adjustable stops are used for automatically releasing the boring-head feed. In the machine with a stationary boring head, the drill or boring bar is held in a collet. In the other machine, i.e., that illustrated, three boring-spindle speeds are available, namely, 37.5, 47.5 and 60 r.p.m.

The saddle is designed to enclose the boring bar and the workpiece at the point where one enters the other, and swarf and coolant are discharged through a

chute at the back, thus avoiding damage to the guide ways and the lead-screw. The boring bar is supported by a guide bush. The coolant is normally delivered at a pressure of 284 lb. per square inch, though the design permits the use of pressures up to 711 lb. per square inch if required.

## NOTES ON NEW BOOKS.

*P.L.A. Railways.*

By THOMAS B. PEACOCK. The Locomotive Publishing Company, Limited, 88, Horseferry-road, London, S.W.1. [Price 15s. net.]

MENTION of the Port of London Authority (P.L.A.) evokes thoughts of an organisation which, in Mr. Peacock's words, "has earned pride of place among commercial undertakings in public ownership," but the associated railways are not likely to spring to mind first. Nevertheless, as one of the numerous band of "voluntary workers" engaged in the recording of railway history, Mr. Peacock has compiled a substantial monograph on the P.L.A. railways. The jurisdiction of the Authority extends for a distance of 69 miles, from Teddington almost to the sea, and the docks estate covers an area of over 2,000 acres. There are 35 miles of deep-water quays, and between 600 and 700 vessels enter and leave the port every week. The Authority took over from the former dock companies in 1909, and when the main-line railways were nationalised in 1948 the P.L.A. railways were omitted from the control of the British Transport Commission. Mr. Peacock devotes a chapter each to the railways of the "Royal" docks, the Millwall docks and the Tilbury docks, and to the administration of the system, train working, traffic rates, the Royal Albert Dock passenger line, and the Millwall Extension Railway. He also provides a tabulated statement of the chief particulars of the locomotives. The illustrations, of which there are many, together with the maps and reproductions of old documents, add to the interest of the book and enhance its value as a record.

*Steels in Modern Industry.*

W. E. BENBOW, General Editor. Iliffe and Sons, Limited, Dorset House, Stamford-street, London, S.E.1. [Price 42s. net, 42s. 11d. post free.]

THE present shortage of steels, particularly of alloy steels, has made it more than ever necessary for all concerned to make the utmost use of such supplies as are available. *Steels in Modern Industry* has been prepared as a guide to engineers and designers on the general and special properties and characteristics of steels and how they may be given anti-corrosive and other surface treatments. The book has been planned by a committee of eminent engineers and metallurgists headed by Dr. H. J. Gough, C.B., M.B.E., F.R.S., who contributes a foreword. There are 26 sections, each

written by authorities in the particular field involved and dealing with such matters as wear, fatigue, creep, corrosion, scaling resistance, weldability and machinability. Further sections are concerned with steels for structural engineering, aircraft and automobile engines, gas and steam turbines, boilers and piping, pressure vessels, the chemical industry, tools and dies, cold pressing and deep drawing, electrical applications and magnets. The chapters on surface treatments include sections on nitriding, carburising, flame and induction hardening and shot peening. Much practical information, rendered easily accessible by good indexing, is contained in the 550-odd pages of the book, which is well illustrated.

*Structural Adhesives: The Theory and Practice of Gluing with Synthetic Resins.*

Lange, Maxwell, & Springer, Limited, 41-45, Neal Street, London, W.C.2. [Price 21s.]

IT may be remembered that in September, 1951, Messrs. Aero Research, Limited, manufacturers of synthetic adhesives, of Duxford, Cambridge, held a summer school in Cambridge for the instruction of persons interested in the technology of these substances. The lectures delivered at this school, which continued for a week, have now been reprinted in a quarto volume of some 200 pages adequately illustrated by reproductions of diagrams, sketches and photographs. The school was the first of its kind to be held in this country and the lectures, which were delivered by Dr. N. A. de Bruyne, and members of the staff, of Aero Research, Limited, as well as by several experts in various applications of synthetic adhesives from other organisations, cover practically all aspects of the subject, the importance of which is becoming rapidly more apparent. The school comprised two main courses, devoted, respectively, to the woodworking industries and the engineering, electrical-manufacturing and allied industries, but also included introductory lectures applicable to both courses. The introductory lectures cover general considerations and the properties, chemistry and characteristics of synthetic resin adhesives, while the lectures relating to the woodworking industries deal mainly with veneering and plywood manufacture. An interesting lecture in the other course, delivered by Mr. H. Giddings, of the Bristol Aeroplane Company, Limited, deals with the design of aircraft structures for the use of "Redux" bonding, and discusses the strength of joints made with this adhesive. A lecture by Mr. F. H. Parker is also devoted to this method of bonding metals. Other subjects dealt with in this course are "Recent Developments in Ethoxylene Resins," by Mr. E. Preiswerk; "Adhesives in the Electrical Industry," by Mr. R. F. Archer; and "The Bonding of Friction Fabrics," by Mr. G. S. Learmonth. It will be clear from the foregoing summary of its contents that the book will be of interest and value to a wider circle of technologists than were able to attend the school, and its use will be materially facilitated by the comprehensive general index included in the volume.

## INDUCTION HEATER FOR SURFACE HARDENING.

BIRLEC LIMITED, BIRMINGHAM.



FIG. 1. LOADING SHAFT INTO HEATER.

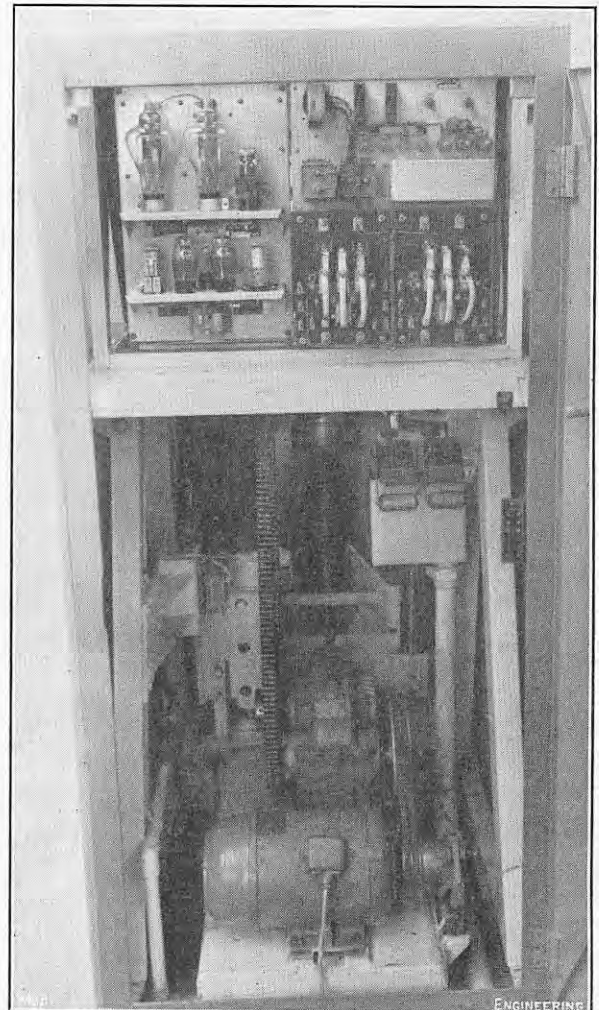


FIG. 2. DRIVING MECHANISM AND ELECTRONIC SPEED-CONTROL PANEL.

## INDUCTION HEATER FOR SURFACE HARDENING OF SHAFTS.

THE four illustrations on this page are of a high-frequency induction heater which is designed to surface harden certain types of steel shafts; the machine is arranged so that the manner of loading and unloading the shafts is similar to that used on a machine tool, such as a centreless grinder or a milling machine. The operation of loading is shown in Fig. 1. Induction heaters of this type have been supplied by the makers, Messrs. Birlec, Limited, Tyburn-road, Erdington, Birmingham, 24, to a number of automobile-engine manufacturers. The shafts pass slowly through the machine, in which they are first heated and then quenched by a water spray.

The machine obtains its high-frequency power from a valve oscillator unit rated for a continuous output of 25 kW at a frequency of approximately 350,000 cycles per second. The valve oscillator, with its associated high-tension transformer and rectifier equipment, is housed in a sheet-metal cubicle (not illustrated) which stands directly at one side of the hardening machine to keep high-frequency connections to minimum length. The complete installation can be put down anywhere in the works, needing no special foundations and requiring only the connection of electric power, water and drain services. The total floor space occupied by the equipment is approximately 40 sq. ft., which may be considered very moderate, by comparison with conventional furnace practice, in relation to an hourly output of, for example, 100 shafts 20 in. long by  $\frac{3}{4}$  in. diameter. The machine, however, does not simply replace the conventional furnace; it introduces new heat-treatment possibilities which are virtually unobtainable by other means. A particularly important feature is the reduction in distortion which results from the fact that only the outer surface of the shaft is heated and hardened, thus simplifying final finishing operations. Another feature, which may be equally important in many cases, is the ability to harden only selected portions of the shaft; for example, journal areas. In the case of the rocker shaft of an overhead-valve engine, for instance, only those areas are hardened



FIG. 3. CAM PLATE.

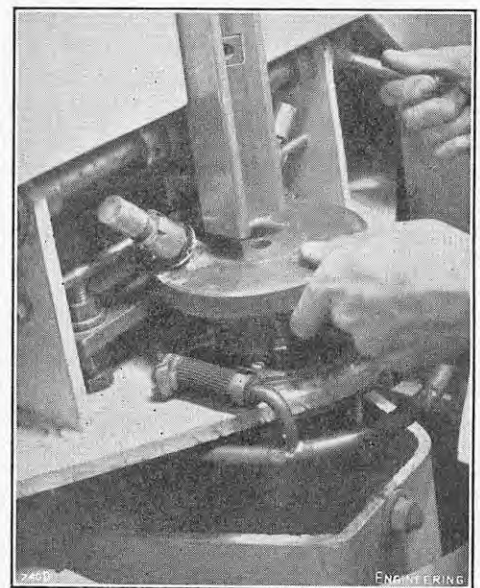


FIG. 4. CHANGING THE INDUCTOR.

which form bearings for the valve rockers, with consequent economy in power and further reduction in distortion. In the work for which this machine is mainly used by the automobile-engine manufacturers—

rocker shafts, gearbox selector shafts, etc.—these advantages over furnace practice are important.

The machine is housed in a fabricated steel framework with the front sloping backwards towards the top at a slight angle to the vertical. Mounted parallel with the front is a rigid large-diameter guide post on which a carriage can run up and down. The carriage has an outrigger arm fitted with bearing pads which embrace a second, parallel-guide member to prevent rotation of the carriage about the main guide-post axis. A forward projection from the carriage supports a stem, on the head of which rests the lower end of the shaft to be hardened. The shaft itself lies in a V-guide

## RESILIENT BOGIE SUSPENSION AND PIVOT.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, LIMITED, MANCHESTER.

Fig. 1.

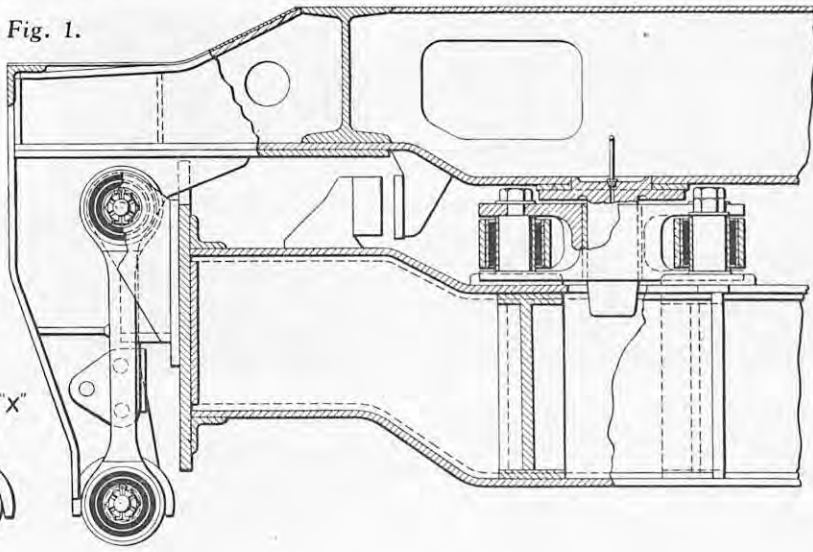
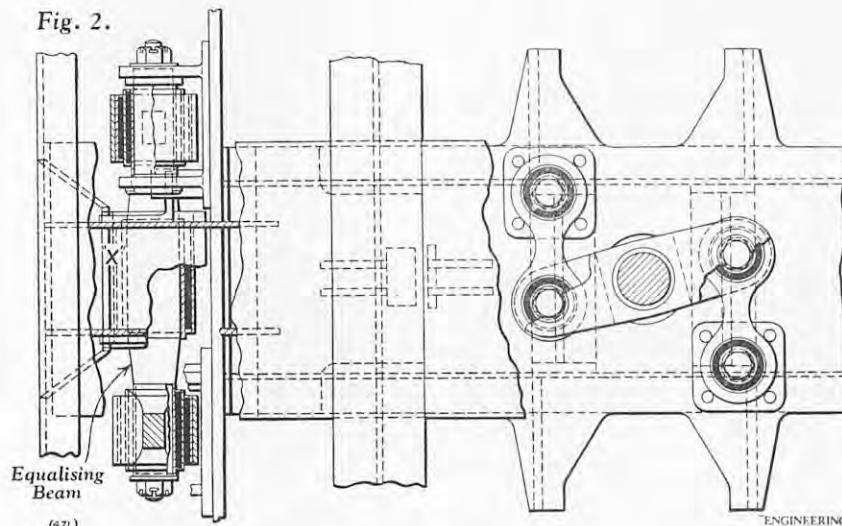
Fig. 3.  
SECTION AT "X"

Fig. 2.



Equalising Beam

(47.)

"ENGINEERING"

on the front of the casing; as the carriage descends on its guide-member, therefore, the shaft to be hardened follows it under its own weight. The carriage is raised and lowered by duplex roller chain which is driven, through a reduction gearbox, by a variable-speed motor. The speed of the motor is controlled automatically by an electronic regulator (Fig. 2, opposite) so that the rate of downward travel of the carriage is kept constant within very close limits, irrespective of variations in mains frequency or voltage. The rate of travel can be adjusted by a calibrated dial to suit work of any diameter between  $\frac{3}{8}$  in. and  $1\frac{1}{2}$  in. A relatively high speed is obtained in the upward direction to return the carriage quickly to the top position.

Interposed between the carriage and the V-guide is the high-frequency inductor, which is designed to facilitate rapid interchange of alternative sizes. The inductor is held rigidly in position by a quick-acting cam, and a wide range of different inductors, each designed for a particular production component, can be interchanged rapidly and easily, as shown in Fig. 4, opposite, using a plug gauge to ensure correct alignment with the V-guide. The inductors are water-cooled and quickly-detachable water connections are provided, the electrical connections being made automatically by the act of clamping the inductor in position. The lower limit of travel of the carriage is set by a limit switch actuated by a cam plate on the side of the carriage. The cam plate is readily exchangeable, being located by dowels and held in position by knurled nuts, as shown in Fig. 3. The cam plate is also profiled to operate a second limit switch which controls the application of high-frequency power to the inductor when only certain parts of a long shaft are to be hardened. Thus, a cam plate may be cut to suit a particular job and, in conjunction with the appropriate inductor and motor speed setting, it completely defines the heat-treatment conditions, thus ensuring consistent repetition results. It will be seen that re-tooling is simple, requiring only about 10 minutes, and the machine can be used efficiently for

relatively short runs on a variety of components if required.

The work is quenched automatically by a water spray as it emerges, heated, below the inductor. Water safety relays are fitted to prevent the application of power until inductor cooling water and quench water are turned on. Hinged access doors are provided, one at the side for changing cam plates and the other at the rear for general servicing, both being electrically interlocked to ensure the interior is dead when either door is opened. Operating controls are all at the front of the machine. In normal use, only two controls are required; namely, the main switch and a foot switch, the latter serving to initiate each cycle. The moving carriage always returns to the top-most position, and the operator, after placing a workpiece in position, depresses the foot switch; a complete hardening cycle is then completed automatically and the machine comes to rest. Motor-speed and inching controls are on a recessed panel covered by a locked and glazed door on the front of the machine, and access to the inductor is obtained by lifting off the surrounding sheet-metal guard. All setting-up adjustments are protected by locks against unauthorised access.

**LAST OF A LOCOMOTIVE CLASS.**—The recent withdrawal of British Railways (London Midland Region) locomotive No. 52857 brings to an end not only the Class "31", but the former Lancashire and Yorkshire Railway 0-8-0 freight engines as a whole. Class "31" was the final development of L.Y.R. 0-8-0 freight tender engines. They were designed by George Hughes and built at Horwich works, the first appearing in 1912. There were 155 engines, 115 being new engines and the remainder conversions of 40 of the non-superheated Class "30" 0-8-0 engines to superheated engines. These engines spent practically the whole of their working life on the L.Y.R. and were capable of hauling heavy loads of mineral traffic over the severe gradients of the Pennines. No. 52857 spent its last days working from Wigan depot.

## RESILIENT SUSPENSION AND PIVOT FOR LOCOMOTIVE BOGIE.

THE drawings reproduced above show the construction of a resilient swing-link suspension and centre pivot which has been designed by the Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester, 17. It depends for its resilience on rubber-bonded flexible bushes which are supplied by Silentbloc, Limited, Victoria-gardens, London, W.11. Swing-link and centre-pivot systems of this type—though more complex and with Metalastik as well as Silentbloc bushes—are fitted to the Metropolitan-Vickers gas-turbine locomotive recently delivered to British Railways; the design of this application of the system was described in the issue of February 15, on page 195. Figs. 1 to 3, on this page, however, relate to the system used on the mixed-traffic locomotives recently built by the Metropolitan-Vickers Electrical Company for the Irish State Railways.

The weight of the locomotive is transmitted to each bogie through four swing links, two on each side; as Fig. 1 shows, the swing links are in tension, the weight passing from the locomotive frame to the centre of an equalising beam and thence to the lower ends of the swing links. From the upper ends of the swing links the weight is applied to the bogie frame. The Silentbloc bearing in the centre of the equalising beam is of standard construction, with a single rubber sleeve (Fig. 3), but those in the ends of the swing links are of the duplex type. The bogie is thus free to move laterally in relation to the locomotive, the angularity of the swing links providing the restoring force in the conventional way. The rubber in the Silentbloc bearings provides the rotational flexibility at each point as well as a damping effect. Rotation of the bogie about its vertical axis, when the locomotive is on a curve, is also provided for, in the swing links, by the resilience of the rubber bearings.

The arrangement of parallel links at the centre of the bogie (as shown in plan in Fig. 2) serves as a bogie pivot, while allowing lateral swing of the bogie on the swing links and transmitting the tractive force from the bogie to the body. The four pins are fitted with rubber bushes, thereby allowing for the oscillations and changes in alignment which occur on the track. Any longitudinal pitching of the bogie relative to the locomotive is allowed for, in the swing-link suspension, by the centre bearing of the equalising beam.

## 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.

**Turnbarrels, Tension Rods and Swaged Cable-End Connections for Aircraft.**—A further publication in the series of specifications for aircraft has now been issued. It comprises seven specifications, namely, S.P. Nos. 33 to 39, which are all included in one publication. They provide a tensioning device for aircraft control cables and a variable range of cable-end fittings as a safeguard against the crossing of controls. The turnbarrel and tension rod are designed to connect screwed-end and tapped-end fittings, respectively; these, in turn, are swaged to cables. S.P. No. 33 covers turnbarrels; No. 34, screwed ends; No. 35, tension rods; No. 36, tapped ends; No. 37, eye ends; No. 38, fork ends; and No. 39, eye ends for chain. For each load rating of cable, two alternative thread sizes are provided for the end fittings, each thread size having an alternative left-hand and right-hand thread. It is, therefore, possible to provide eight turnbuckle assemblies for any one load rating of cable in such a manner that no control run can be crossed when all are assembled. Details of such an arrangement of the fittings, together with figures showing the dimensions of the assemblies, are given in an appendix to the present publication. The seven specifications deal with such matters as material, finish, dimensions, identification and marking. [Price 2s. 6d., postage included.]

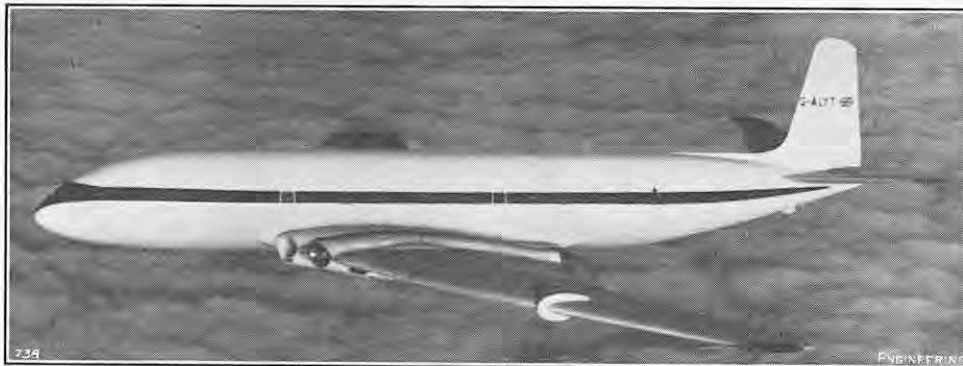
**Masonry-Rubble Walls.**—A further Code of Practice issued in final form by the Council for Codes of Practice for Buildings, Construction, and Engineering Services, Lambeth Bridge House, London, S.E.1, is C.P. No. 121.202, covering masonry-rubble walls of both solid and hollow construction. Recommendations are made on the selection of stone and mortar, materials for damp-proof courses, and wall ties and flashings, and a list of definitions is furnished. Stability and weather-proofing are considered, while other matters dealt with are minimum thicknesses, bonding, the dressing of stones, footings, bearings, and surrounds to openings. Some recommended methods of construction are illustrated by diagrams, and advice is given on the choice and mix of mortar. [Price 7s. 6d., postage included.]

## BOOKS RECEIVED.

- Ministry of Labour and National Service. Factory Department. Second Report of the Committee on the Safeguarding of Milling Machines.* H.M. Stationery Office, Kingsway, London, W.C.2. [Price 3s. 6d. net.]
- Founded on Fact. An Industry's Service to the Nation.* By BASIL H. TRIPP. The Council of Ironfoundry Associations, 14, Pall Mall, London, S.W.1. [For private circulation.]
- Lloyd's Register of Shipping. Register Book Appendix, 1952.* Offices of the Register, 71, Fenchurch-street, London, E.C.3.
- Overseas Economic Surveys. United States of America.* Prepared by members of the staff of His Majesty's Embassy in Washington. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 8s. 6d. net.]
- Technological Applications of Statistics.* By L. H. C. TIPPETT. Williams and Norgate, Limited, 36, Great Russell-street, London, W.C.1. [Price 18s. net.]
- Werkstattkniffe. No. 9. Hundert Kniffe für den praktischen Former.* By FRITZ NAUMANN. Third revised edition. Carl Hanser-Verlag, Leonhard-Eck-Strasse 7, Munich 27, Germany. [Price 3.60 D.M.]
- Heat and Thermodynamics.* By PROFESSOR MARK W. ZEMANSKY. Third edition. McGraw-Hill Publishing Company, Limited, Aldwych House, Aldwych, London, W.C.2. [Price 42s. 6d.]
- Werkstattbücher. No. 8. Die Praxis der Warmbehandlung des Stahles.* By PAUL KLOSTERMANN. Sixth revised edition. Springer-Verlag, Reichpietschstrasse 20, Berlin, W.35, Germany. [Price 3.60 D.M.]
- United States Army Corps of Engineers. Stages and Discharges. Mississippi River and its Outlets and Tributaries, 1950.* The President, Mississippi River Commission, Vicksburg, Mississippi, U.S.A. [Price 1 dol.]
- United States National Bureau of Standards. Miscellaneous Publication No. 201. Hydraulic Research in the United States.* Edited by HELEN K. MIDDLETON and SONYA W. MATCHETT. The Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., U.S.A. [Price 1.25 dols.]
- Ohio State University Engineering Experiment Station. Bulletin No. 145. Proceedings of the Ohio Highway Engineering Conference, 1951.* Held at the Ohio State University, April 3-5, 1951. The Director, Engineering Experiment Station, The Ohio State University, Columbus, Ohio, U.S.A. [Price 1 dol.]
- Thermodynamics of Alloys.* By JOHN LUMSDEN. The Institute of Metals, 4, Grosvenor-gardens, London, S.W.1. [Price 35s.]
- The U.S. Market. Principal Features and Basic Statistics.* O. W. Roskill and Company (Reports), Limited, 14, Great College-street, London, S.W.1. [Price 2 guineas, post free.]
- A Guide to the Principal Safety Requirements of the Factories Acts, 1937 and 1948.* Second edition. [Price 15s. net.] *A Complete Guide to the Building (Safety, Health and Welfare) Regulations. Statutory Instrument 1948, No. 1145.* [Price 15s. net.] The Royal Society for the Prevention of Accidents, Terminal House, 52, Grosvenor-gardens, London, S.W.1.
- Department of Scientific and Industrial Research. Radar Research. Special Report No. 22. The Siting of Direction Finding Stations.* By W. ROSS and F. HORNER. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 1s. 6d. net.]
- Class Rates Section of Standard Charges 6 to 750 Miles. (Provincial.)* 31st December, 1951. The Railway and Shipping Publishing Company, Limited, 12, Cherry-street, Birmingham, 2. [Price 15s., post free.]
- Alternating Current Machines.* By PROFESSOR H. COTTON. Cleaver-Hume Press, Limited, 42a, South Audley-street, London, W.1. [Price 10s. 6d.]
- La Locomotive à Vapeur.* By ANDRÉ CHAPELON. Second edition. Vol. I. J. B. Baillière et Fils, 19, Rue Hauteville, Paris (6e). [Price 7,000 francs.]
- Ministry of Transport. Railway Accidents. Report on the Collision which Occurred on 17th August, 1951, at Newcastle Central Station in the North Eastern Region British Railways.* H.M. Stationery Office, Kingsway, London, W.C.2. [Price 1s. 6d. net.]
- Oil Shale and Cannel Coal. Vol. 2. Proceedings of the Second Oil Shale and Cannel Coal Conference held in Glasgow in July, 1950.* Edited by GEORGE SELL. The Institute of Petroleum, Manson House, 26, Portland-place, London, W.1. [Price 63s., post free.]
- The Electrician Blue Book. Electrical Trades Directory, 1952.* Edited by STANLEY G. RATTEE. Benn Brothers, Limited, Bouverie House, 154, Fleet-street, London, E.C.4. [Price 50s.]
- A System of Labels for Gassing Casualties Sent to Hospital.* Association of British Chemical Manufacturers, 166, Piccadilly, London, W.1. [Price 3s., post free.]
- Industrial Furnaces. Vol. I.* By PROFESSOR W. TRINKS. Fourth edition. John Wiley and Sons, Incorporated, 440, Fourth-avenue, New York 16, U.S.A. [Price 10 dols.]; and Chapman and Hall, Limited, 37, Essex-street, Strand, London, W.C.2. [Price 80s. net.]

## "COMET" AIR LINER, SERIES 2.

DE HAVILLAND AEROPLANE COMPANY, LIMITED, HATFIELD.



## "COMET" AIR LINER, SERIES 2.

At Hatfield, Hertfordshire, on Saturday, February 16, the first of the Series 2 Comet air liners, which are fitted with more powerful engines than the Series 1 Comets, made a successful maiden flight. Four Rolls-Royce axial-flow jet engines, each developing 6,500 lb. static thrust at sea level, provide power for the Series 2 Comet, a photograph of which is reproduced in the accompanying illustration. The aircraft, flown by the chief test pilot of the de Havilland Aircraft Company, Limited, flew for nearly two hours at heights up to 25,000 ft.

In the statement issued by de Havilland Enterprise, no claims are made for the performance of the Series 2 Comet beyond the information that it will be capable of carrying 44 passengers, with freight and mails, on "the world's very long stages." It may be recalled, however, that the British Overseas Airways Corporation have said, in their 1950-1951 annual report, that the Avon Comet, five of which are on order for them, is expected to be capable of operating economically over the longest sectors of their routes and to reduce the flying time between London and New York to a few hours. It is hoped that the Series 2 Comets will go into service with B.O.A.C. in about two years. Series 2 Comets are also to be operated by British Commonwealth Pacific Air Lines on their route connecting Australia and New Zealand with the United States and Canada by way of Fiji, Canton Island, and Honolulu.

## CONTRACTS.

FLETCHER & CO. (CONTRACTORS), LTD., Forest-road Mansfield, Nottinghamshire, have been entrusted with the reconstruction, in prestressed concrete, of the superstructure of bridge No. 17 at Bulwell station on the Nottingham and Mansfield line of British Railways.

BRITISH POLAR ENGINES, LTD., Govan, Glasgow, have booked orders for seven engines during January. Among these is a 1,310 b.h.p., M.47M. marine propelling engine for a vessel to be built by Ardrossan Dockyard Ltd., for Tasmania Steamers Pty., Ltd., Melbourne, Australia. Another propelling engine, M.45I, has been ordered by the Goole Shipbuilding and Repairing Co., Ltd. Auxiliary generating sets ordered include four K.56E. units for Cammell Laird & Co., Ltd., and one for David Rowan & Co., Ltd.

ROSSER and RUSSELL, LTD., 30, Conduit-street, London, W.1, have obtained the contract for supplying a steam heating and hot-water service to the laundry and amenity buildings, and a steam supply to the kitchen, at the new carriage shed at Willesden, on the London Midland Region of British Railways.

HALL, RUSSELL & CO. LTD., Aberdeen, have received contracts from Silvertown Services, Ltd., London, for the construction of two cargo motorships of about 5,000 tons deadweight capacity and having a length, between perpendiculars, of 330 ft., a breadth moulded of 50 ft., and a depth moulded of 26 ft. The vessels are intended for the transport of raw sugar in bulk from the West Indies direct to the reconstructed Peruvian Wharf, adjoining Tate and Lyle's Plaistow refinery in London. The propelling machinery in both vessels will consist of twin British Polar Diesel engines developing 3,000 b.h.p., geared to one shaft, giving a service speed of about 13 knots.

THE BURNETISLAND SHIPBUILDING CO. LTD., Burntisland, Fife, are to build a cargo motorship of 10,500 tons deadweight capacity for Sarac Compania Naviera S.A., Panama. She will have a length of 435 ft., a beam of 60 ft. and a depth moulded of 39 ft. 6 in. Her propelling machinery will consist of 5,500-b.h.p. Kincaid-B. & W. Diesel engines constructed by JOHN G. KINCAID AND CO. LTD., Greenock.

## LAUNCHES AND TRIAL TRIPS.

S.S. "STANLEY ANGWIN."—Twin-screw cableship, built and engined by Swan, Hunter, and Wigham Richardson, Ltd., Newcastle-upon-Tyne, for Cable and Wireless, Ltd., London. Main dimensions: 315 ft. by 41 ft. 2 in. by 25 ft. 9 in. to upper deck; deadweight capacity, about 2,200 tons on a draught of 19 ft.; gross tonnage, 2,550; coiling capacity, about 18,000 cu. ft., equal to 400 miles of deep-sea cable; operating range, 10,000 miles. Two triple-expansion steam engines, developing a total of 1,450 i.h.p. at 104 r.p.m., and two oil-fired forced-draught multitubular Scotch boilers. Speed, about 11½ knots. Launch, February 11.

S.S. "WALLARAH."—Single-screw collier, built by S. P. Austin and Son, Ltd., Sunderland, for the Wallarah Coal Co., Ltd., of London and Sydney, New South Wales. First vessel to be built by Austin and Son for these owners. Main dimensions: 228 ft. 6 in. by 38 ft. 0½ in. by 16 ft. 2 in.; deadweight capacity, about 1,570 tons. Triple-expansion steam engines developing 750 i.h.p. at 83 r.p.m., and two forced-draught boilers, constructed and installed by the North Eastern Marine Engineering Co. (1938), Ltd., Sunderland. Speed in service, 10 knots. Launch, February 12.

M.S. "LUNEDA."—Single-screw trawler, built by Cochrane & Sons, Ltd., Selby, Yorkshire, for J. Marr & Son, Ltd., Hull. Main dimensions: 123 ft. 6 in. between perpendiculars by 26 ft. 6 in. by 13 ft.; gross tonnage, 300. Seven-cylinder four-stroke direct-reversing Diesel engine, developing 695 s.h.p. at 228 r.p.m., constructed by Mirreles, Bickerton and Day, Ltd., Stockport, Cheshire, and installed by Amos and Smith, Ltd., Hull. Launch, February 13.

M.S. "HARWI."—Single-screw oil tanker, built by Joseph L. Thompson & Sons, Ltd., Sunderland, for Rolf Wigand Skipsrederi, Bergen, Norway. Main dimensions: 475 ft. between perpendiculars by 67 ft. 4½ in. by 37 ft. 4 in.; deadweight capacity, 15,135 tons on a draught of 29 ft. Four-cylinder opposed-piston oil engine developing about 4,400 b.h.p., constructed and installed by William Doxford & Sons, Ltd., Sunderland. Service speed, 12½ knots. Launch, February 14.

M.S. "KING ALEXANDER."—Single-screw cargo liner, built and engined by Harland and Wolff, Ltd., Belfast, for the King Line, Ltd., London, E.C.3. Second vessel of an order for three. Main dimensions: 435 ft. between perpendiculars by 59 ft. by 39 ft. 9 in. to shelter deck; gross tonnage, about 5,770. Harland-B. and W. six-cylinder single-acting four-stroke Diesel engine. Launch, February 14.

M.S. "LONDON VICTORY."—Single-screw oil tanker, built by the Furness Shipbuilding Co., Ltd., Haverton Hill, County Durham, for the London and Overseas Freighters, Ltd., London, W.1. Third vessel constructed for these owners. Main dimensions: 525 ft. between perpendiculars by 71 ft. by 39 ft. 3 in.; deadweight capacity, 18,100 tons on a summer draught of 30 ft. 5½ in.; oil-cargo capacity, about 17,280 tons. N.E.M.-Doxford six-cylinder opposed-piston single-acting two-stroke reversible oil engine, developing 6,800 b.h.p. at 119 r.p.m. in service, constructed by the North Eastern Marine Engineering Co. (1938), Ltd., Wallsend-on-Tyne. Speed, about 15 knots. Trial trip, February 19.

M.S. "MALEKULA."—Single-screw cargo vessel, with accommodation for twelve passengers, built by Barclay, Curle & Co., Ltd., Whiteinch, Glasgow, for Burns, Philp & Co., Ltd., Sydney. Main dimensions: 336 ft. by 47 ft. by 27 ft. 6 in. to shelter deck; gross tonnage, 3,786. Burmeister and Wain-Harland and Wolff-Kincaid eight-cylinder two-stroke trunk-piston oil engine, developing 2,200 b.h.p. at 150 r.p.m., constructed by John G. Kincaid & Co., Ltd., Greenock. Trial trip, February 20.