

PRODUCTION OF HIGH-QUALITY TUBES BY ELECTRIC RESISTANCE WELDING.

Two tube-making plants now in use at the Corby works of Messrs. Stewarts and Lloyds, Limited, are producing tubes of the high quality required for boilers and superheaters, with electric resistance welded seams. These tubes, made to comply with British Standard 1654, are accepted by Lloyd's Register of Shipping, the Ministry of Transport, insurance companies and other survey bodies. Previously, in this country, tubes produced by welding the edges of strip bent into circular form were employed mainly for mechanical or non-pressure purposes, so the new process is a significant advance, especially when it is remembered that, until comparatively recently, many engineers were

it. Moreover, the preparation of the strip and the removal of the excess metal of the weld, both inside and outside the tube, are just as important.

The development of the "E.R.W." (electric resistance weld) process for tube-making has been due mainly to the Babcock and Wilcox Company, New York. In the United States, such tubes have been in use for some years. The American Navy first used them in 1939, and they are now accepted by the American Bureau of Shipping and the Maritime Commission as the equivalent of seamless tubes. For some time, also, they have been used extensively for land boilers in the United States. The weld is, in fact, as strong as the parent metal, and the finished product can be used for many purposes for which hot-finished seamless tubes and cold-drawn seamless tubes were formerly used. Commercially, the advantage of the method is that it produces high-quality tubes at slightly less cost than conventional methods; it will not, however, replace these

sistency and uniformity are also ensured by direct control of the steel-making materials. Messrs. Stewarts and Lloyds are well placed in this respect at Corby, since they use iron made by themselves and scrap which arises in their own works, the composition of which is therefore known. By using such raw materials the firm are assured that the steel is free from elements which would be undesirable in welding. In addition, the firm's inspectors, working along with the production men but quite independent of them, are empowered to stop production at any time if the product is not satisfactory. Three special inspection points are indicated in Fig. 3, on page 66, which shows the principal stages of manufacture. The ease with which the process can be stopped and started is one of its advantages; there is virtually no waste of time, heat or material. The inspectors act in accordance with their skill and ability in interpreting the indications given by the appearance of

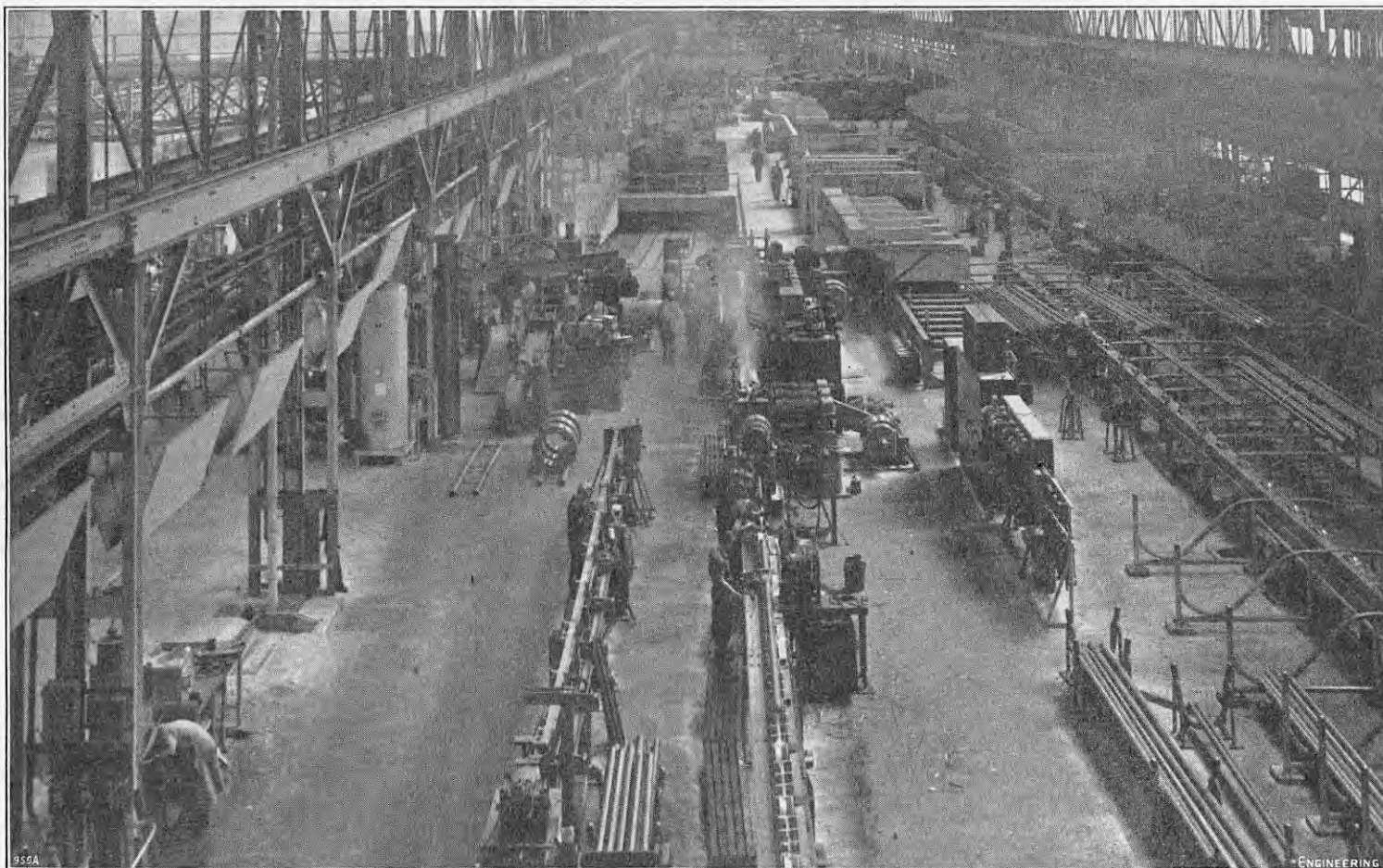
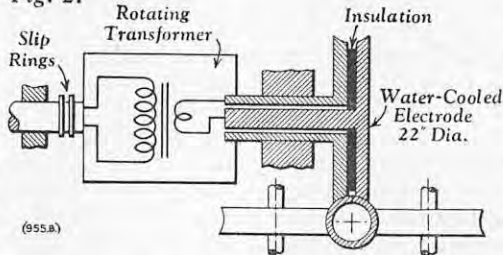


FIG. 1. NO. 2 ELECTRIC RESISTANCE WELDING TUBE MILL AT CORBY.

sceptical of the suitability of welding for first-class engineering work.

The simplicity of the seam-welding method will be appreciated from Fig. 2, herewith, and from Fig. 6, on page 67, which shows the welding head. The strip, bent into a tube, passes continuously beneath a rotating electrode disc, which is in contact with it. The disc is in two parts, of copper, with insulating material between them, the periphery of each part making contact with one of the edges of the strip. A high-frequency low-voltage current passes from one part to the other through the seam, which is subjected to a squeezing pressure by side rolls. No additional metal is deposited. The heating is extremely rapid, since the tube travels at speeds of up to 120 ft. per minute, and the length of the zone where welding takes place is only about $\frac{1}{4}$ in. to $\frac{1}{2}$ in. Though the process is simple, as already stated, the high quality of the weld, illustrated by Figs. 4 and 5, on page 66, is only achieved by precise control of the many factors which affect

Fig. 2.



methods, particularly since it is not practicable to form thick-walled tubes from strip. An average weekly output for the two plants is about 1,000 tons, though of course the figure depends on the sizes of the tubes and the orders in hand.

The main difference between the E.R.W. process and normal electric resistance welding is the use of an alternating welding current of higher frequency, so as to give consistent welding conditions in spite of the speed at which the seam is welded. Con-

the metal, the weld, and the tube. Their work is supplemented by regular crushing and flattening tests on the tube and by magnetic tests on the weld.

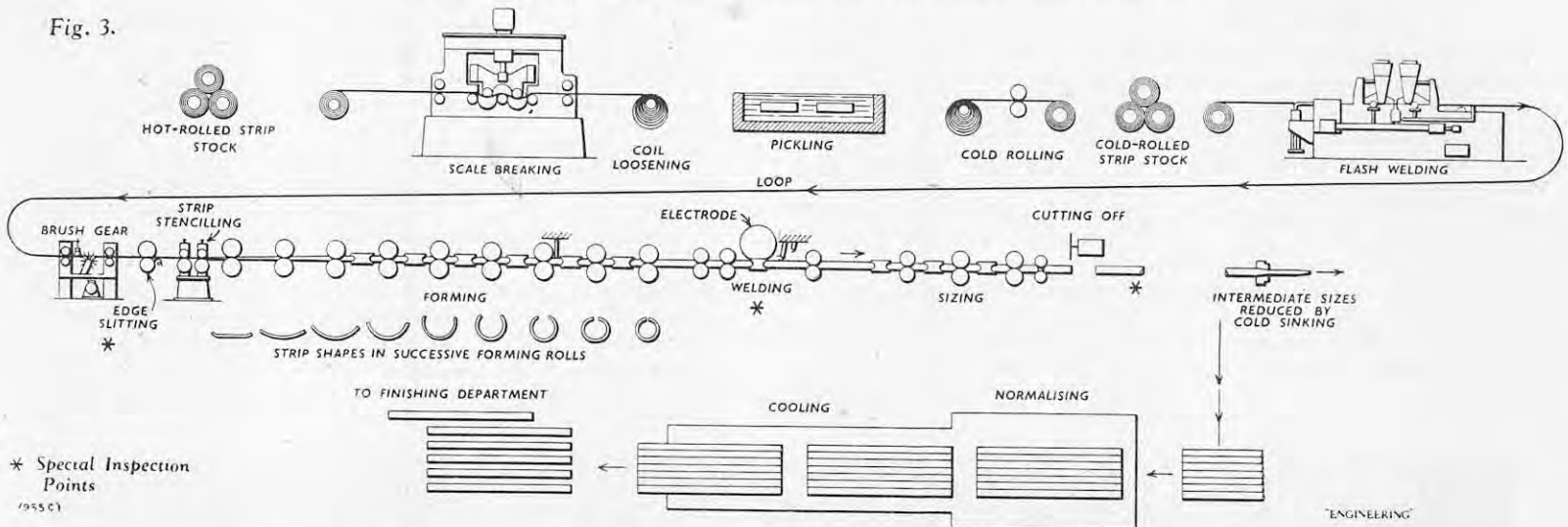
The two E.R.W. mills at Corby deal with different ranges of tube sizes, though otherwise they are practically identical. The principal particulars are given in the Table on the next page.

In order to shorten the development period and to bring the plant into operation as soon as possible, it was arranged with the American company that the plant should be virtually the same as that in the United States, since the Babcock and Wilcox Company are themselves boiler and tube makers and use the E.R.W. process for their boiler tubes and pressure tubes. The main difference between the British and American application of the process is that, owing to the greater production in the United States, a large range of basic sizes of tubes can be produced, whereas in this country recourse is had to tube-sinking (i.e., reduction of diameter by drawing through a die without the use

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Fig. 3.



of an internal plug) so as to produce sizes that are intermediate between the basic sizes for which the mills can be set up. It takes about 8 hours to change the rolls, etc., for a different size, but changes in tube thickness while the outside diameter remains constant are quickly provided for. There is, of course, no disadvantage in tube-sinking; it is already done for tubes produced by conventional methods and may, in fact, improve the surface.

Principal Particulars of E.R.W. Mills, Corby.

		No. 1 Mill.	No. 2 Mill.
Basic size range	Outside diameter, in.	1½-2	2-4
	Max. thickness, s.w.g.	7	5
Speed	Ft. per minute	Up to 120	Up to 100
Coil	Weight, lb.	2,000	2,000
	Length, ft.	200-1,000, depending on thickness	
Max. tube lengths	Off mill, ft.	36	36
	Off sink bench, ft.	50	50
Forming mill	H.p.	60	75
	No. of stands	9	9
Welding mill	Secondary volts	4-5	4-5
	Secondary amps.	Up to 40,000	Up to 40,000
	Motor alternator, kVA	250	500
	Frequency, c.p.s.	200	350
Sizing mill	H.p.	30	40
	No. of stands	3	3
Normalising	Atmosphere	Partly burned moist blast-furnace gas.	
	Temperature, deg. C.	950, quench at 300	
Sinking	Speed, ft. per min.	200	
	Lubricant	Wool fat	
	Max. sink, per cent.	30	

The strip arrives from the hot-strip mills in coils of about 10 to 15 cwt., and is first descaled by passing it through a series of rolls which bend it alternately up and down, cracking off all scale and dirt. After re-winding, the winding gear is reversed so that the turns are loosened, to ensure that the acid may have free access to all surfaces in the subsequent pickling operation. The loosened coil is turned into a horizontal position and conveyed to the pickling plant, shown in Fig. 7, on Plate III, where it is immersed in hot sulphuric acid to remove all traces of scale, rust and grease. It is then washed and returned to the vertical position ready for the cold-rolling operation. The end of the coil is fed into the cold-rolling mill, shown in Figs. 8 and 9, on Plate III, which was built by the Davy and United Engineering Company, Limited, Sheffield. The cold pass, in addition to reducing the thickness by approximately 10 per cent., to create a fine surface finish, produces uniformity of thickness across the width of the strip, and ensures the close thickness tolerances which are a feature of this class of tube. A continuous check on the thickness of the cold-rolled strip is maintained by micrometer control on the outgoing side of the rolls.

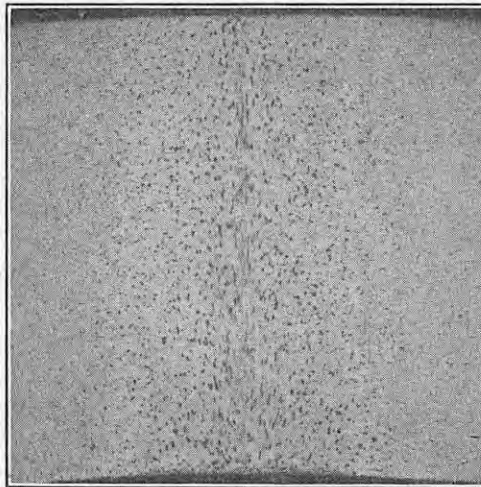


FIG. 4. WELD ZONE OF TUBE AS WELDED; $\times 13$.

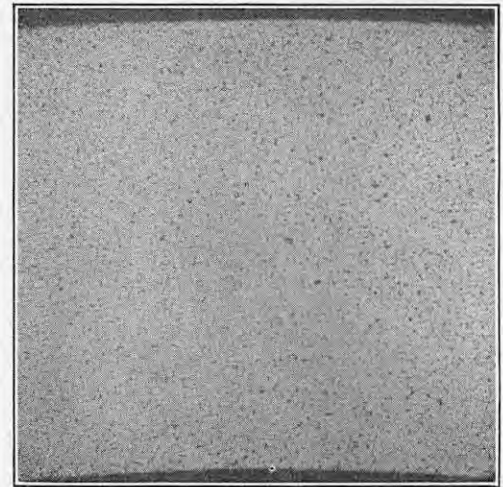


FIG. 5. WELD ZONE AFTER NORMALISING; $\times 13$.

The surface of the cold-rolled strip is oiled to protect it as it enters the cold-rolling mill.

The strip is then conveyed to the tube mill. To make the process continuous, it is necessary for each successive coil to be welded to the previous one, and this is done in a flash-welding machine, which was made by A.I. Electric Welding Machines, Limited, 68, Victoria-street, London, S.W.1. Before entering this machine the coil is unwound through a skelp (i.e., strip) leveller, the rolls of which flatten the strip before the ends of the coil are cut square to present clean surfaces for welding. The "flash" of extruded metal resulting from the joining of the coils together is ploughed off by pulling the strip through a pair of cutters, leaving a flush surface on the strip. At a later stage this transverse weld is cut from the tube, and scrapped. Since the flash-welding of coils is an intermittent process, the strip being stationary while welding takes place, it is necessary to have a loop between the flash-welder and the forming mill to provide a supply of strip for the continuously operating forming mill. Before entering this unit, the strip is brushed by wire brushes and passes through an edge splitter (a pair of rotary shears) which trims it to exact width and provides clean-cut square edges for the welding operation.

The forming mill, illustrated in Figs. 10 and 11, on Plate III, consists of nine sets of rolls which gradually change the flat strip into tubular form by curving up the edges, pressing it down in the centre, and eventually rounding it into cylindrical shape. The several stages of forming are illustrated in

Fig. 3. A central fin on the last forming roll accurately locates the edges prior to welding. Soluble oil is applied freely to the rolls since there is bound to be some slip between the rolls and the plate owing to the fact that, on a roll with a curved periphery, the radius of contact varies across the face. The formed strip with abutting edges uppermost now passes into the welding machine, in which the copper double-electrode wheel runs on the top of the tube, making contact with the edges on either side, as already explained. Two side rolls maintain pressure on the tube at this point, as shown in Fig. 12, on Plate IV, and the current passing across the junction heats the metal locally to welding temperature. As a result of the rapid heating, not only is there little time for oxide to form, but the heat does not spread appreciably and only a narrow incandescent line is formed along the top of the tube. Surplus semi-molten material is squeezed out of the weld by the pressure of the side rolls, thereby ensuring adequate welding. Alternating current is used, but the frequency is increased from the 50 cycles per second of the mains to 200 or 350 cycles per second according to the size of the tube, to give the most efficient welding conditions. The reason for this increase in frequency is that, with the high welding speed used, pulsations of current at mains frequency would cause intermittent welding, but by increasing the frequency the pulsations are so close together that welding is continuous. A rotating transformer, shown diagrammatically in Fig. 2, is used to feed the high-current low-voltage supply to the electrode discs,

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(For Description, see Page 65.)

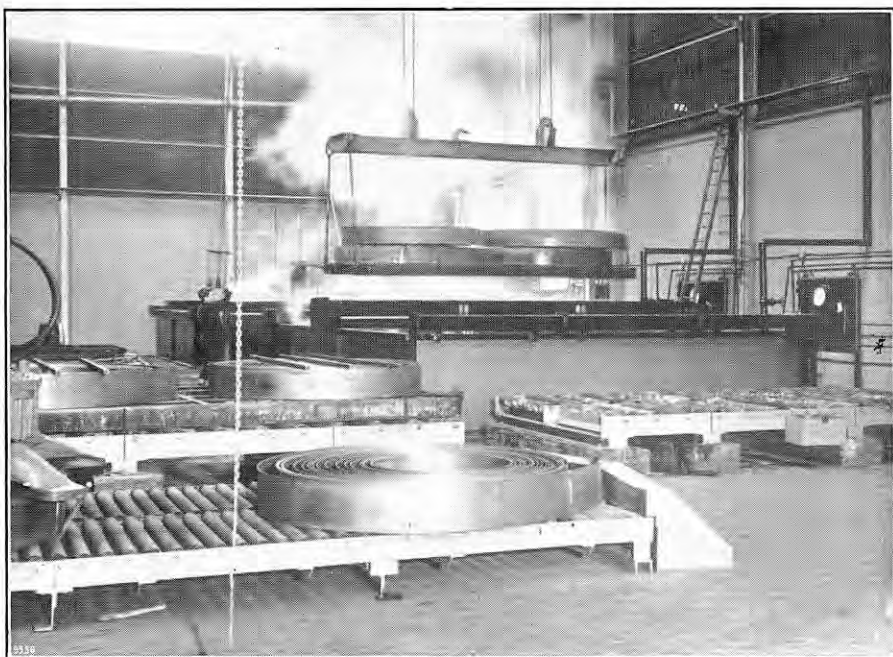


FIG. 7. PICKLING THE STRIP.



FIG. 8. ENTRANCE TO COLD-ROLLING MILL.

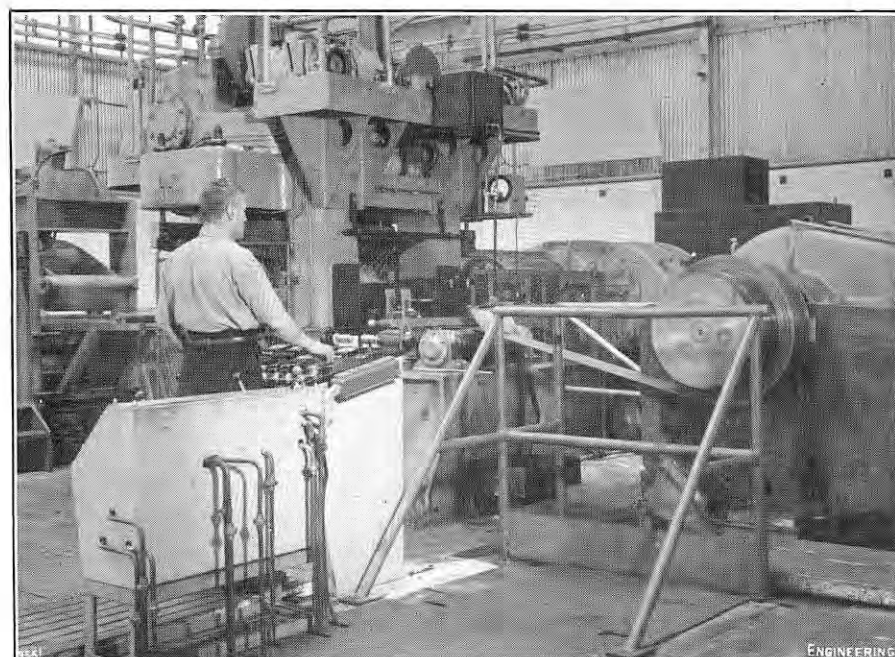


FIG. 9. COLD-ROLLING MILL.

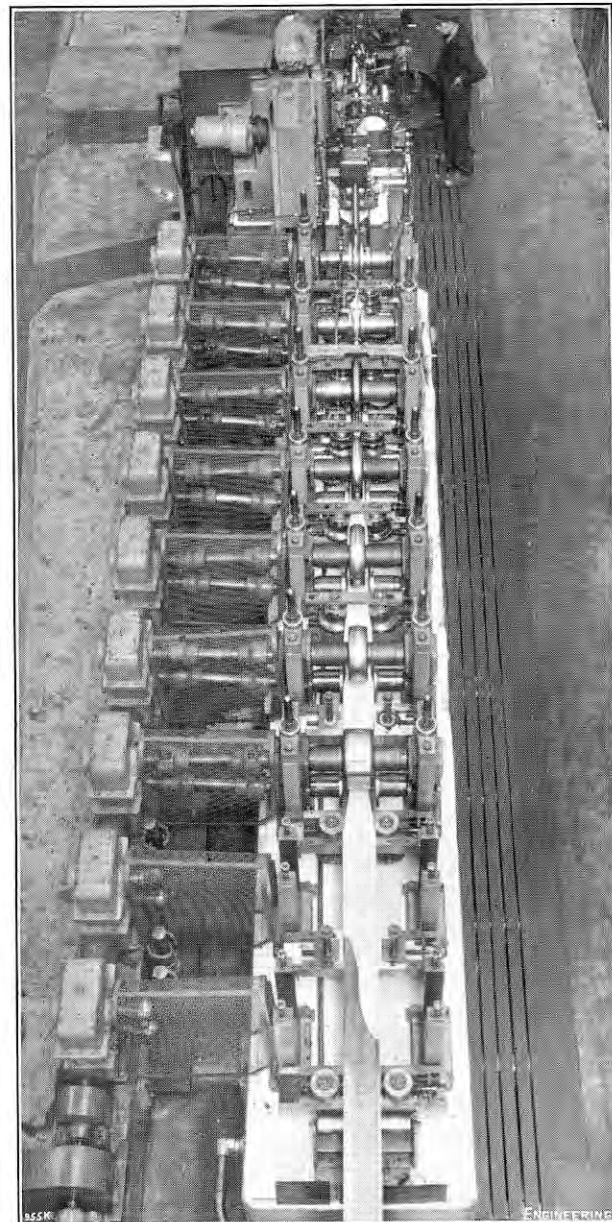


FIG. 10. TUBE-FORMING MILL.



FIG. 11. TUBE-FORMING ROLLS.

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(For Description, see Page 65.)

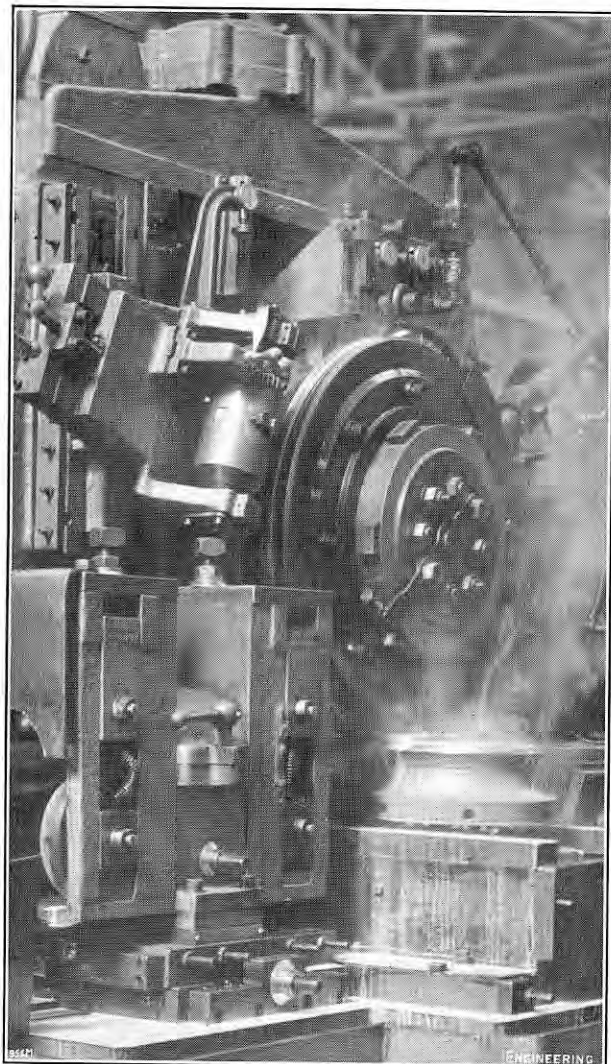


FIG. 12. WELDING HEAD.

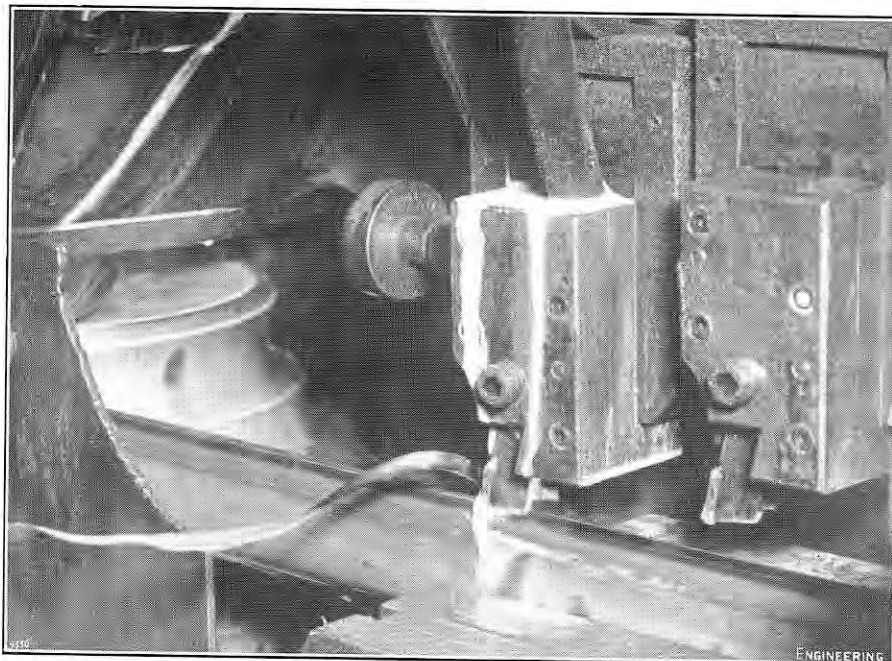


FIG. 14. REMOVING OUTSIDE WELD BEAD.



FIG. 15. NORMALISING FURNACE.



FIG. 13. TUBE-SIZING MILL.

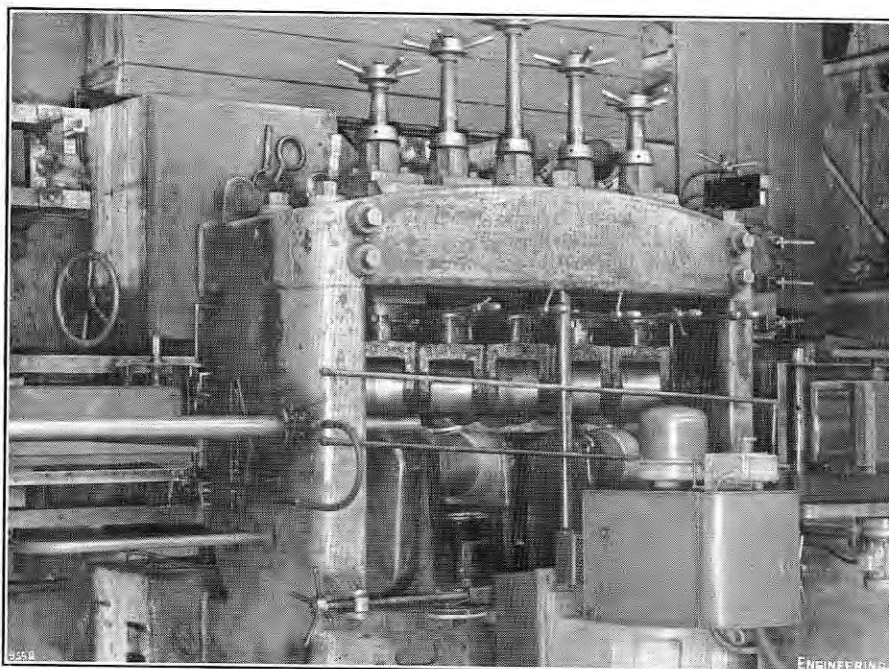


FIG. 16. TUBE-STRAIGHTENING MACHINE.

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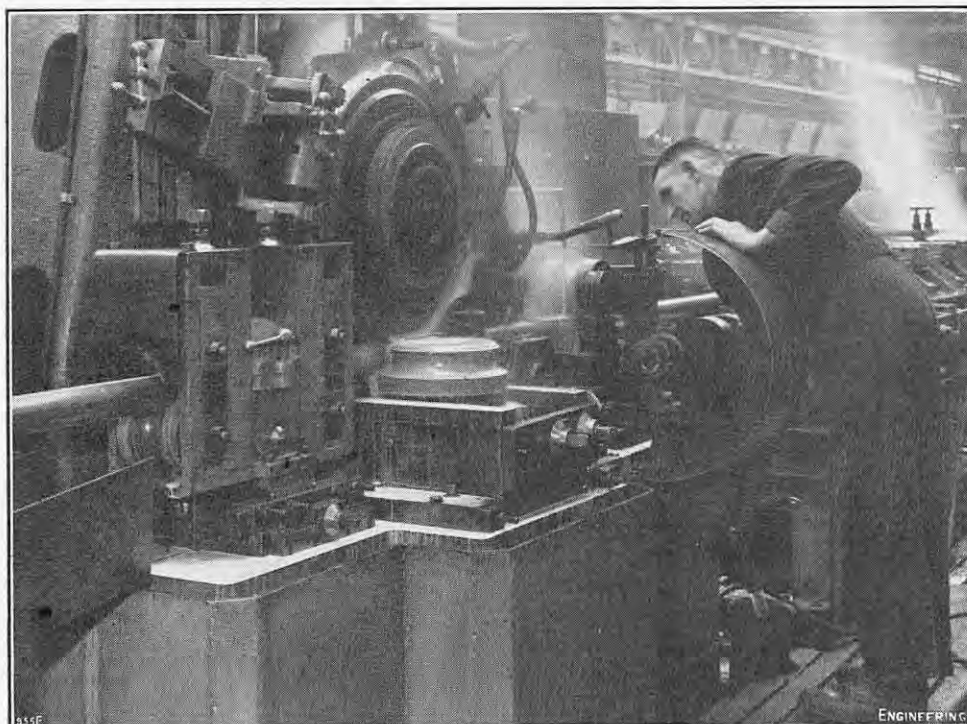


FIG. 6. WELDING HEAD IN OPERATION.

so that only the lower-current higher-voltage primary supply has to be passed through the rotating slip-rings. The welding machine, of Babcock and Wilcox design, was constructed by the Wellman Smith Owen Engineering Corporation, Limited, Wilton-road, London, S.W.1.

Immediately after welding, the external bead formed at the weld is trimmed off to a flush surface by a cemented-carbide cutter on the outside of the tube, as shown in Fig. 14, on Plate IV. A similar cutter to trim the internal bead is supported inside the tube by a long rod held from a point in the forming mill before the strip edges are brought together. Water sprays now cool the weld, and the tube passes through a sizing mill, shown in Fig. 13, on Plate IV, and then into a travelling cut-off machine which, without stopping the tube, cuts it into lengths as required. The forming rolls and the sizing rolls used in producing the tube are power-driven, but the side rolls move freely with the tube. The electrode is also rotated by the tube but it has a small motor drive, incorporating a free-wheel, which ensures that it continues to rotate slowly when, for any reason, the tube is not in contact.

For certain purposes, the tubes may be supplied in the as-welded or semi-bright state, but where ductility is important, for example, in boiler or superheater tubes, the tubes require to be normalised. The cut tubes, therefore, pass into a long normalising furnace in which they are heated to the temperature necessary to restore a uniform structure, as indicated in the Table. They are then cooled slowly in an inert atmosphere which is adjusted to produce a blue-black adherent surface of pleasing appearance. The tubes take about an hour to pass through the normalising plant, which is 256 ft. long, depending on their size and thickness. The furnace, which was supplied by the Incandescent Heat Company, Limited, is shown in Fig. 15, on Plate IV. When the temperature is sufficiently low, a coolant is applied to the tube to bring it down to room temperature, and it emerges ready for straightening. This is done by passing the tube through diagonal rolls, shown in Fig. 16, on Plate IV, after which it is ready for the various finishing operations, and is finally protected by a non-drying oil.

Summing up the main features of this process, it may be said that its outstanding points are as follows: all the raw materials are directly under the firm's control throughout all processes; all strip is given a cold pass to ensure good surface and uniform wall thickness; continuous operation gives improved consistency; the use of relatively high-frequency alternating current provides the most suitable welding conditions; a smooth bore is obtained by the special arrangements developed for the removal of the internal flash; and only single-width strip is used, i.e., the strip, of rimming steel, is rolled to the required width, so that the two edges which form the seam are of similar metallurgical structure.

The mill rolls certain basic sizes, but where intermediate sizes are required they are obtained by cold sinking, as already explained. The reduction in outside diameter causes a slight thickening of the tube which is, of course, allowed for in making the tube. It also increases the length of the tube. The finished cold-sunk tube is normalised after cold sinking, and is indistinguishable from basic-size tubes. E.R.W. tube can be supplied with a bright finish, or it can be cold drawn using an internal plug, depending on the purpose for which the tubes are required. The steel usually employed has a minimum tensile strength of 20 tons per square inch, with a minimum yield point of 11 tons per square inch, though higher tensile steels may be used. At present, however, it is not proposed to have a carbon content greater than 0.25 per cent. The weld in the normalised condition would be almost impossible to find, even under the microscope, except for the fact that the trimming of the inside and outside beads leaves a barely perceptible difference in surface texture, which indicates the position of the weld.

ELECTRICAL ASSOCIATION FOR WOMEN.—The 28th annual conference of the Electrical Association for Women has been arranged for Wednesday, April 15, 1953. The Association's annual general meeting and luncheon will be held in conjunction with the conference and will take place at the Connaught Rooms, Great Queen-street, London, W.C.2. The offices of the Association are at 35, Grosvenor-place, London, S.W.1.

LITERATURE.

Theory of Perfectly Plastic Solids.

By PROFESSOR W. PRAGER and PROFESSOR P. G. HODGE, JR. John Wiley and Sons, Incorporated, 440, Fourth-avenue, New York 16, U.S.A. [Price 5.50 dols.]; and Chapman and Hall, Limited, 37, Essex-street, London, W.C.2. [Price 44s. net.]

FOR engineers the most profitable introduction to the general theory of plasticity is through the study of perfectly plastic solids, since this particular branch has most nearly been reduced to a definite form, and from it numerous results of practical importance have been made available to the designer. Although the concept of a perfectly plastic material appears adequate for investigating the initial stages of plastic flow under constant stress before work-hardening sets in, the concept may seem, at first sight, inapplicable to certain metals that are apt to work-harden, as, for example, the aluminium alloys used in the aircraft industry. Actually, the mechanical behaviour of a work-hardening material in simple tension may be described fairly well by considering a number of perfectly plastic specimens with different yield points. These specimens are all subject to the same longitudinal extension, while the sum of the axial loads supported by them furnishes the axial load acting on the equivalent work-hardening specimen. Dr. Prager and his collaborator take full advantage of this circumstance at the outset of their treatment and formulate, in Chapter 1, a definition of perfect plasticity according to which the yield condition of a perfectly plastic material is indicated by the vanishing of a certain invariant of the stress tensor. If the sign of this invariant is chosen so that the elastic range is characterised by negative values, then positive values of the invariant indicate conditions of stress which cannot be realised in the kind of material under consideration.

The next 50 pages provide opportunities for experience in the manipulation of the mathematical apparatus, in applications of the theory to elementary problems involving the flexure of beams, and torsion of cylindrical and prismatic bars. They also deal with the relations between the theories of St. Venant-Mises and of Prandtl-Reuss in the case of torsion, and also the question of a circular cylinder subjected to combined torsion and tension. Throughout the book, points of practical interest receive attention at the proper places, as in Chapter 4, on plane strain with axial symmetry, where the value of a discussion on the stresses and strains in a thick-walled circular tube under internal pressure is enhanced by the incorporation of matter on the numerical integration of the resulting equations. The procedure subsequently brings under review the variation of the stresses and the radial displacement during a process of unloading and the unrestricted plastic flow of such tubes.

The mathematical background of the book is that of an advanced course of study on the strength of materials, and where additional mathematical equipment is required it is given in explanatory form in the text. This accounts for the development of approximate numerical integration of hyperbolic partial differential equations by the method of characteristics in a chapter on the general theory of plane strain, because, in many problems of practical value, the analytical integration of these equations cannot be performed. The utility of this general theory is well illustrated by the applications given, in Chapter 6, to the indentation of a semi-infinite body by a flat rigid punch under conditions of plane strain, the steady plastic flow associated with rolling, drawing, extrusion and other mechanical processes, and the "pseudo-steady" plastic flow involved in the indentation of a semi-infinite body by a lubricated wedge of rigid material. Other aspects of the theory find a place in the

FIXED END MOMENTS IN BEAMS WITH LINEAR HAUNCHES.

Fig. 1.

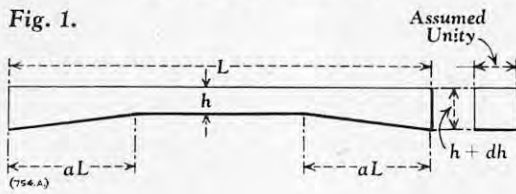


Fig. 2.

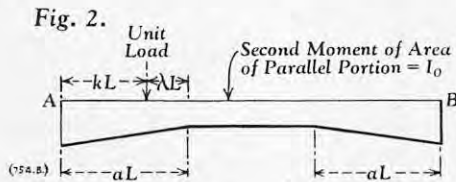


Fig. 3.

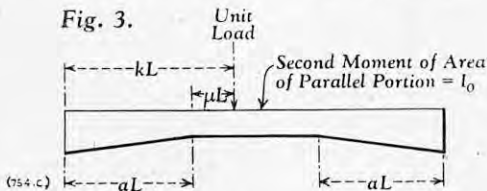


Fig. 6. KNIFE-EDGE END.

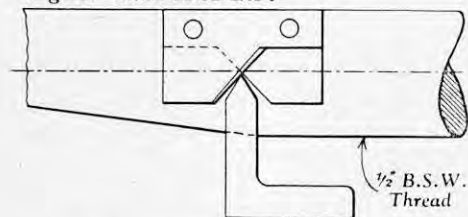


Fig. 7. KNIFE EDGE.

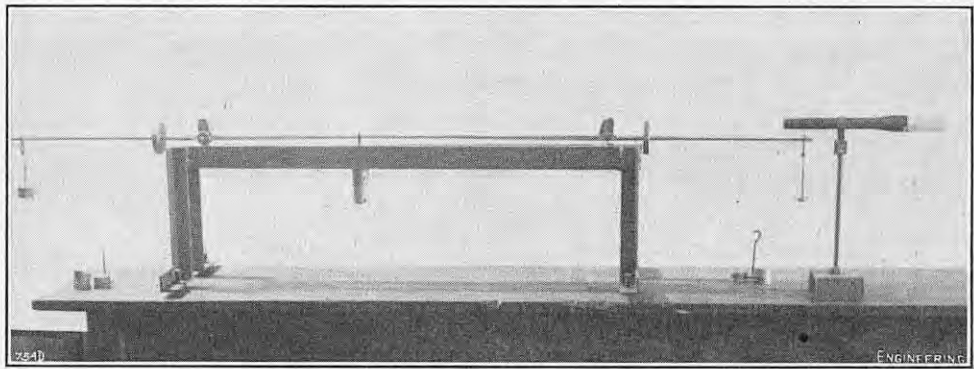
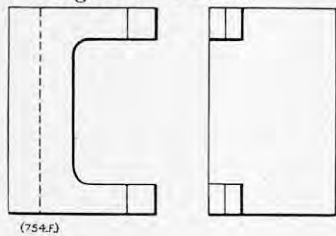
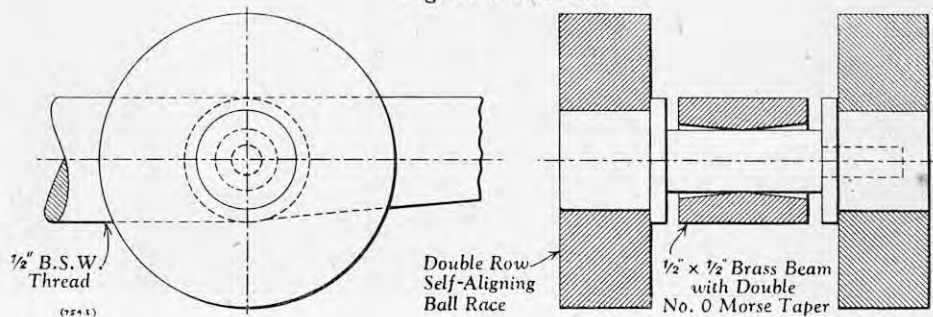


FIG. 4. EXPERIMENTAL APPARATUS.

Fig. 5. ROLLER END.



nical knowledge was covered by the one word "geometry," which became subject to wider and wider interpretations as the interests of the nominal professors of geometry extended into the domains of analysis, mechanics and natural science. To-day the *Elements* of Euclid are treated much more summarily and lightheartedly than was considered necessary even 40 years ago, and similar developments are now taking place in the field of analytical statics. The limitations of the method of moment distribution, even in its more advanced manifestations, are well recognised, but because it provides the constructional engineer with a system corresponding to "French without tears," or "German without much grammar," it must continue to hold the field as the ideal method of primary instruction. Not only does it enable the practical man to solve for himself problems of erstwhile complexity, but the insight into structural behaviour which it affords gives confidence in the adoption of results achieved by more powerful analytical methods.

There are now available so many introductions to the theory and practice of moment distribution that considerable research would be needed to establish the pre-eminence of any one authority, but Professor von Halasz provides an account which goes well beyond the original technique of Hardy Cross, though it is still essentially his system. Moreover, it is not presented, as some expositions have been, with the primitive enthusiasm of the display of a newly-discovered toy, solving problems that are simple by any modern method but leaving awkward questions unanswered. Here the applications progress rapidly from the familiar simple cases to the more complicated designs which naturally arise in engineering practice. The computation of secondary stresses is exhibited, not by merely applying the method to an academic exercise, but on complete examples of practical designs. Members of non-uniform section are fully covered by charts that give end-fixing moments, stiffnesses and carry-over factors which can be directly adopted in the usual routine of computation.

The author, in his preface, mentions that the ms. was destroyed by fire during the war, but remarks philosophically that this enabled him to incorporate the lessons of longer experience in teaching this system.

FIXED END MOMENTS IN BEAMS WITH LINEAR HAUNCHES.

By B. MAYFIELD, B.Sc.(Eng.), and R.C. Coates, B.Sc.(Eng.), A.M.I.C.E.

CALCULATIONS have been made of the necessary design data for beams with haunches, but publications of the results have been in university theses, or in the form of design charts. The former are not readily available to the general public, and the latter are somewhat restricted in scope. The present article gives expressions, in general terms, for the necessary requirements of structural analysis and, in addition, gives details of experimental confirmation of the results obtained. Discussion is limited throughout to the case of the symmetrical beam of rectangular cross-section with a straight soffit, as shown in Fig. 1, herewith. The values of fixed end moment produced by transverse load may best be presented in the form of influence lines. This has been done for two special cases of haunching, for which calculation was followed by experiment (Figs. 8 and 10, opposite). In addition, general expressions are given for the stiffness and carry-over factors required in the moment distribution method of Professor Hardy Cross.

Calculations were based throughout on the column analogy (the convention of sign used being "hogging moments positive"), which may be expressed, for a symmetrical line structure such as this,

$$M = M_F - \left[\frac{W}{A} \pm \frac{M_{yy}}{I_{yy}} \cdot x \right]$$

where

- M = the bending moment at some point, P, of the loaded structure;
- M_F = the "free" bending moment at P, redundancies being removed;
- EI = the flexural rigidity of the structural member;
- x = the co-ordinate of point P, relative to the centre of area of the $\frac{1}{EI}$ diagram;
- W = the elastic weight, the area of the $\frac{M_F}{EI}$ diagram;
- M_{yy} = the moment of the $\frac{M_F}{EI}$ diagram about the YY axis;
- A = the elastic area, the area of the $\frac{1}{EI}$ diagram;
- and
- I_{yy} = the second moment of area of the $\frac{1}{EI}$ diagram about the YY axis through the elastic centre.

subsequent exposition of the plastic deformation of a square prism pierced by a centrally-placed hole, with its more difficult boundary conditions, and in exposition of the upper and lower limits for a safety factor which are derived by means of two theorems. The concluding chapter, on extremum principles, is commendably clear, and is noteworthy because these principles may be expected to play an important part in the future extension of the subject. The student will appreciate the inclusion of problems and references to further sources of information.

Anschauliche Verfahren zur Berechnung von Durchlaufbalken und Rahmen.

By PROFESSOR ROBERT VON HALASZ. Wilhelm Ernst & Sohn, Hohenzollerndamm, 169, Berlin-Wilmersdorf, Germany. [Price DM. 31.50.]

THE adoption by a German professor of the principles of Hardy Cross is an event of moment and significance, whether or not Professor von Halasz is the first to break the ties which seemed to bind the German schools so inflexibly to the traditions of Müller-Breslau and Otto Mohr. In his preface, the author observes that the elements of moment distribution are more easily assimilated by students than the more formal methods of analysis. This is especially relevant now that the fields of engineering knowledge already explored, and the further fields thus brought within sight of immediate exploration, are so broad that fewer graduates can be spared to concentrate exclusively on any special branch of engineering analysis.

Before the Newtonian era of scientific expansion, still not so very long ago, almost the whole of tech-

FIXED END MOMENTS IN BEAMS WITH LINEAR HAUNCHES.

Fig. 8. INFLUENCE LINES FOR FIXING MOMENT, HAUNCH = 0.2 L.

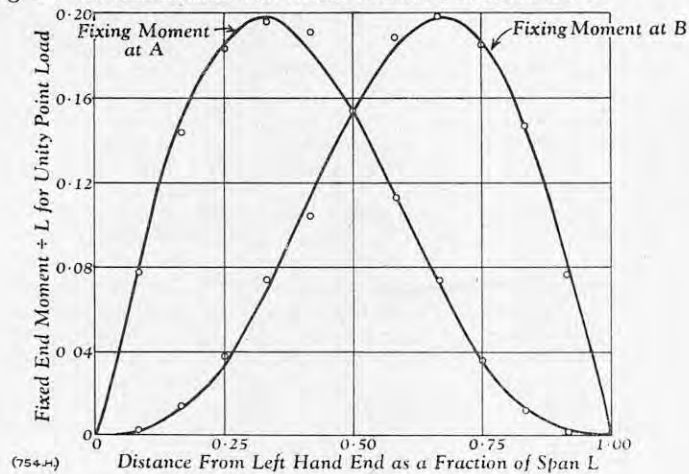


Fig. 10. INFLUENCE LINES FOR FIXING MOMENT, HAUNCH = 0.4 L.

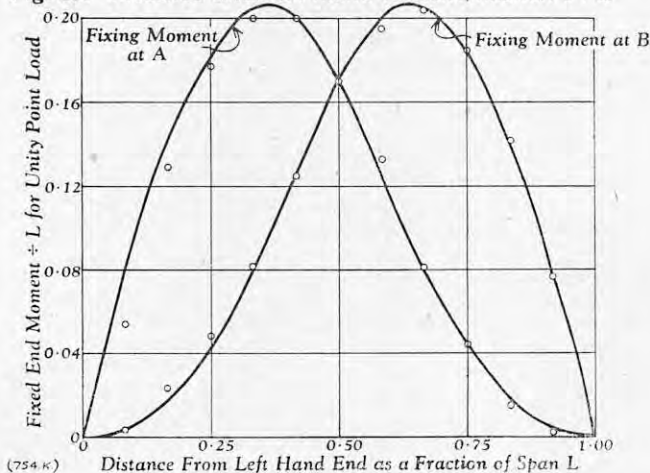
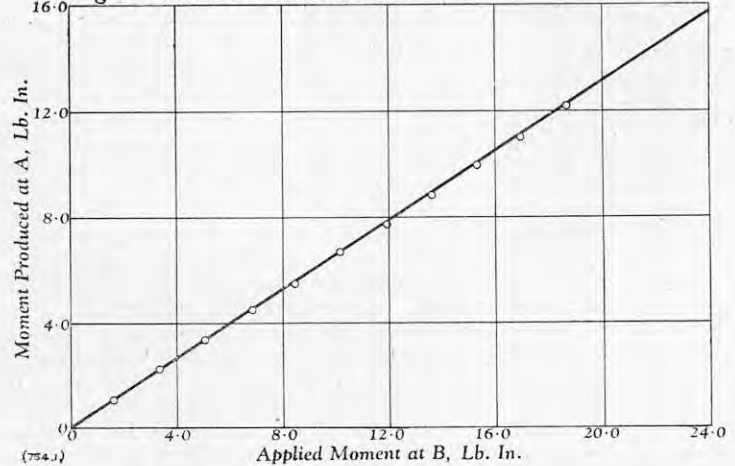
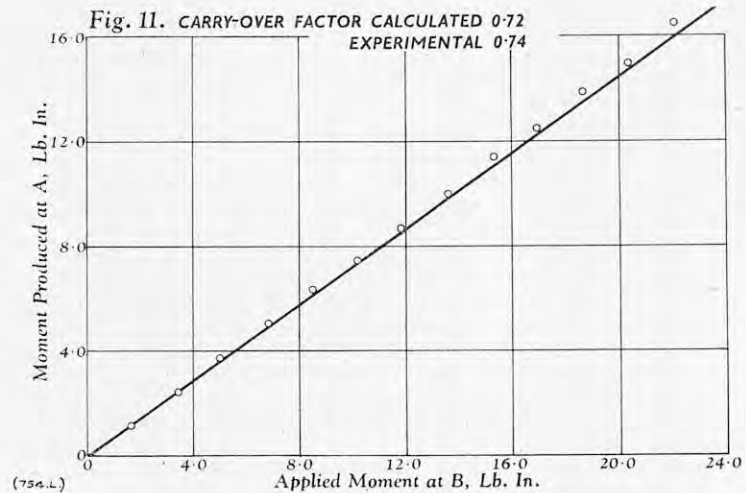


Fig. 9. CARRY-OVER FACTOR = 0.658.

Fig. 11. CARRY-OVER FACTOR CALCULATED 0.72
EXPERIMENTAL 0.74

To obtain the influence lines for fixing moment, the values of the moments produced at A and B, Fig. 2, by unit point load acting in the span were calculated from the expressions below:

Fixing moment at

$$A = M_F(A) - \left[\frac{W}{A} - \frac{M_{yy} L}{I_{yy} 2} \right]$$

Fixing moment at

$$B = M_F(B) - \left[\frac{W}{A} + \frac{M_{yy} L}{I_{yy} 2} \right]$$

It was found impossible to simplify the resulting expressions for fixing moment and to leave a manageable general solution, and it was decided to evaluate each individual term in the equations separately, for any one position of the load, and to combine the numerical results as required.

The elastic properties of the analogous column are,

$$A = \frac{L}{E I_o (1+d)^2} [1 + d(2-3a) + d^2(1-2a)]$$

$$I_{yy} = \frac{L^3}{E I_o} \left[\frac{2a^3}{d^3} \log_e(1+d) + \left(\frac{1-2a}{12} \right)^2 + \frac{1}{d^2(1+d)^2} \left\{ ad^2 \left(\frac{1}{2} + \frac{d}{4} \right) - a^2 d^2 (1+d) + a^3 (d^3 - 2 - 3d) \right\} \right]$$

With unit load acting in the haunch, as shown in Fig. 2, and using the free bending-moment diagram given by assuming the beam to be cantilevered from A, we obtain

$$W = \frac{L^2}{2E I_o} \frac{k^2}{(1+d)^2 \left(1 + d - \frac{dk}{a} \right)}$$

$$M_{yy} = \frac{L^3}{E I_o} \left[\left(\frac{a}{d} \right)^3 \log_e \left(\frac{1+d}{1 + \frac{\lambda d}{a}} \right) + \frac{1}{2(1+d)^2} \left\{ \left(\frac{a}{d} \right)^3 (3+4d) - \left(\frac{1}{2} - a - \lambda \right) + 2d \left(\frac{a}{d} \right)^2 + \lambda \left(\frac{1}{2} - a \right) \left(\frac{a}{d} \right) \right\} \right]$$

$$+ \frac{1}{2 \left(1 + \frac{\lambda d}{a} \right)^2} \left\{ \left(\frac{1}{2} - a - \lambda \right) \left(1 + 2 \frac{\lambda d}{a} \right) \left(\frac{a}{d} \right)^2 - \left(3 + 4 \frac{\lambda d}{a} \right) \left(\frac{a}{d} \right)^3 - \lambda \left(\frac{1}{2} - a \right) \left(\frac{a}{d} \right) \right\} \right]$$

With the load on the parallel portion of the beam, Fig. 3, opposite, we obtain

$$W = \frac{L^2}{2E I_o} \left[\frac{ka(2+d) - a^2(1+d)}{(1+d)^2} + (k-a)^2 \right]$$

$$M_{yy} = \frac{L^3}{E I_o} \left[\left(\frac{a}{d} \right)^3 \log_e(1+d) + \frac{\mu^2}{2} \left(\frac{1}{2} - a - \frac{\mu}{3} \right) + \frac{a}{2(1+d)^2} \left\{ a(\mu + \frac{1}{2} - a) + \mu \left(\frac{1}{2} - a \right) (2+d) - \left(\frac{a}{d} \right)^2 (2+3d) \right\} \right]$$

The calculated influence lines are plotted for cases where $d = 1$ and $a = 0.4$ and 0.2 , in Figs. 8 and 10, respectively. It was found that slide-rule accuracy was inadequate for the solution of some of these expressions, which involve the difference between two terms of comparable magnitude, and, therefore, the numerical work was performed throughout with a semi-automatic calculating machine, using seven significant figures.

It may be proved that the effect of unit rotation at some point in a structure is simulated by the application of unit point load to the equivalent point of the analogous column. Since the stiffness of the beam, AB, is defined as the moment required at A to produce unit rotation at A, and since the carry-over factor may be defined as the moment produced at B by unit moment at A, we may write, from the column flexure formula,

$$M_A = \text{Stiffness} = - \left[\frac{1}{A} + \frac{L}{2} \cdot \frac{L}{I_{yy}} \right]$$

$$M_B = - \left[\frac{1}{A} - \frac{L}{2} \cdot \frac{L}{I_{yy}} \right]$$

and carry-over factor

$$= \frac{M_B}{M_A} = \frac{4 I_{yy} - AL^2}{4 I_{yy} + AL^2}$$

The values of carry-over factors for the two beams with haunches 0.2 and $0.4 L$ are shown graphically in Figs. 9 and 11, respectively. The apparatus used for the experimental confirmation of the calculations is shown in Fig. 4, opposite. The span of the beam used was 36 in., being made fairly long to minimise the effect of differential settlement of the supports on the fixing moments produced; the material chosen was brass, both for ease of manufacture and for its low value of modulus of direct elasticity. The supports themselves were designed to reproduce, as far as possible, the knife-edge and roller ends assumed in a freely supported beam, and are shown in detail in Figs. 5, 6 and 7, opposite. Mirrors were mounted on the beam, immediately over the supports, and readings were taken in these mirrors of a graduated scale viewed through a telescope fitted with a graticule. A transverse point load was placed on the beam, and measurement was made of the moments required at the two supports to restore both scale readings in the mirrors to their original values. This fixing moment was applied by disc weights, moving freely on threaded portions of the beam overhanging the two supports. The transverse point load used varied with the amount of haunching, being 5 lb. in the case of the prismatic beam of rectangular cross-section and $1\frac{1}{2}$ lb. with the most flexible type.

For the determination of carry-over factors, the initial zero reading in one mirror (at B, say) was noted. Some moment was applied at A, and measurement was made of the restoring moment required at B. The ratio between the two moments gave the carry-over factor, and experimentally derived values are plotted for comparison with theoretical lines in Figs. 9 and 11. The agreement obtained between the calculated and experimental values was good, both for fixed end moments and carry-over factors, and the graphs shown are representative of several obtained during the course of this work.

The authors are indebted to the authorities of the University of Nottingham for permission to reproduce these results.

THE EDUCATION OF ENGINEERS IN SOME EUROPEAN COUNTRIES.*

By PROFESSOR S. J. DAVIES, D.Sc. (ENG.).

REFERENCE to the proceedings of our engineering institutions shows that the subject of engineering education has been perpetually under discussion, and that, in particular, there have been few presidential addresses in which the training of the rising generation was not mentioned. There have been, from time to time, periods of especial activity in this discussion, and we have, since the war, experienced such a period in which our methods have been subjected to a new re-examination. The opinions that have been expressed are many and varied, and, though much progress is being made, final decisions have yet to be reached on a number of important questions. The United States have often been mentioned, and broad and complimentary references continue to be made to the well-known Technical High Schools at Zürich and Delft; but little serious study has been applied to the systems of engineering education in European countries, the subject on which I am invited to address you.

Consideration will be limited to those countries not under control of the U.S.S.R., but, of these, Finland, Portugal and the Mediterranean countries will be omitted; this leaves the three Scandinavian countries, the Netherlands, Belgium, France, Germany, Switzerland and Austria. Within the scope of this address, I can only treat the preparation of professional engineers, though I shall mention the possibilities of the promotion of the lower grades to the professional level. We all recognise the high value of the contributions made by the subordinate technicians and the skilled artisans, and the systems of providing their training would afford an interesting discussion, but this is a matter that falls outside the immediate responsibility of the Regional Council.

I should like to emphasise that no single European country can claim such a superiority over the others in engineering achievement that its system of education calls for special consideration. On the other hand, reflection shows that, in all these countries, distinguished work is done by engineers in one branch or another, and the conclusion to be drawn is that the preparation of engineers and the background against which they work in each of the individual countries reach a generally satisfactory standard. A warning may also be interjected against the frame of mind of those who are always ready to see the good points in foreign systems, but who are prone to exaggerate the deficiencies of our own; for, in spite of our deficiencies, an immense volume of excellent engineering work is being done here, and in a wide variety of branches. The systems of engineering education in the various countries will be examined, therefore, with the principal object of drawing from them any ideas that may be of value in the solution of our own problems, and, in conclusion, I shall venture to set out briefly my own views on the directions in which we should press for improvement.

It is well, perhaps, at this stage, to point out that there is no single system of engineering education that might be termed Continental, but that in European countries, as here, there is complexity and inconsistency. It might be thought, for example, that grouping these countries on the basis of their populations would indicate some kind of broad differentiation; or, again, that comparisons might throw light upon the question, sometimes under discussion, whether engineers should be prepared in separate colleges of technology or in engineering faculties in the universities. But, as we shall see, in neither respect does investigation help.

In relation to population, Germany and France are grouped with Great Britain as the larger countries, while all the other countries mentioned must be considered as small. Germany, before the war, had ten technical high schools distributed among

its States and now, without Dresden and Breslau, has eight; these work under a clearly-defined organisation independently of, but in parallel with, the universities. France, on the other hand, has many more recognised engineering schools even than Great Britain, and, though some of these are constituted as faculties of universities, a large proportion are independent specialist schools. Thus, each of the three larger countries has its own separate and individual system, and no useful points of similarity can be found.

The systems of organisation in the smaller countries also show variety. Denmark, Norway and the Netherlands each have a single technical high school, independent of the universities. Sweden has two, also independent, the large school at Stockholm and a smaller one at Gothenburg. Austria has two independent technical high schools, at Vienna and Graz. Switzerland has two schools: one, the Federal Technical High School at Zürich, is independent, and the other, the Ecole Polytechnique at Lausanne, is a faculty of the University of Lausanne, which university, like all in Switzerland, is cantonal and not federal. Lastly, in Belgium, the connection of engineering education with the universities is very close, and, broadly, only graduates of the engineering faculties of the four universities, Brussels, Louvain, Ghent and Liège, and of the Faculté Polytechnique at Mons, together with a very small number of military engineers, from the Ecole Royal Militaire, are recognised as qualified engineers. Thus, among the small countries also, no clear tendency can be discovered.

Before coming to a more detailed description of schools and methods, it must be emphasised that engineering schools, of whatever type of organisation, should not be considered from the academic standpoint alone; account should be always taken of other contributions that may be asked of them and of their professors, in addition to that of training engineers. In this country, for example, the work of research and development, as it touches engineering over the range from the most fundamental study to the most practical application, is carried out in university departments, in Governmental research establishments, in the laboratories of the industrial research associations, and in the research and testing departments of industrial companies. Though there are, happily, no rigid lines of demarcation between the contributions of each to fundamental and to applied research, in general the universities are looked to for fundamental research. In some countries, especially in the smaller, in the absence of the other facilities available here, the engineering schools are called upon to provide a much greater part of the contribution of applied research necessary from the national point of view. The conditions under which the professors work in the two cases will be very different. These conditions will affect the mental attitude of the professor, and thus his methods of teaching his subject, two things which will go far in determining the outlook of his pupils.

Again, we work in this country against a background of special libraries, such as those under Government direction at H.M. Patent Office and at the Science Museum, and those of the engineering and scientific societies. If these were not available, the technical and scientific libraries of the universities would be called on to render general services to the country; this would change their character from that of easily-accessible specialist collections of books to that of highly-organised reference libraries. In addition, in this country, through the media of the scientific and technical societies and of a highly-developed scientific and technical Press, publication of the results of research and other new work is well provided for, and our professors of engineering do not need to concern themselves unduly in that field. In smaller countries, the principal means of publication depend often, and necessarily, on the editorial activity of certain professors.

Lastly, in a small country, a professor may be the only independent authority in his field of work and, apart from his contacts with industry, he may be required to take part in all Governmental activities touching his field. I knew a professor of mechanical engineering who, in addition to his

normal duties, was called on to advise his Government on the technical aspects of groups of patents, on regulations for mechanically-propelled vehicles, on traffic restrictions, and on safety regulations for boilers. He was thus a busy man, necessarily executive in type, and it is not surprising that he had little time for research. Our professors, on the other hand, while they may contribute in various ways by serving on committees, have a high degree of freedom, especially in selecting the particular branches of engineering research and development to which to devote their energies.

I am only concerned with setting out the different circumstances met with in various countries, and not with drawing comparisons, but such factors as these play a part in determining where the emphasis is placed in the contributions of the professors and of their laboratories. While generalisation may not be without risk, since the individuality of the professor will always affect the issue, it is to be expected that, in the smaller countries, stress will be placed upon the solution of immediate practical problems, and the preparation of engineers competent to do this work on graduating. In this country we take, in general, a long-term view and are more concerned with the potential value of the engineer after he has matured through suitable professional experience.

The variety referred to earlier, in the types of organisation in the several countries made it a little difficult to decide in what order to treat them. After consideration, I found it best to begin with France, then to take Belgium, next Germany, Austria, Scandinavia and the Netherlands, and lastly, Switzerland.

ENGINEERING EDUCATION IN FRANCE.

Engineering education in France is remarkable for its diversity, though some unification was introduced in 1934, when a permanent Government commission was set up with the responsibility of establishing standards upon which the title of *Ingénieur Diplômé* should be conferred. The commission gives effect to this responsibility by recognising the engineering diplomas of certain schools as of sufficiently high standing. There are nearly 100 recognised schools, covering the whole range of engineering practice, and with this large number diversity is to be expected.

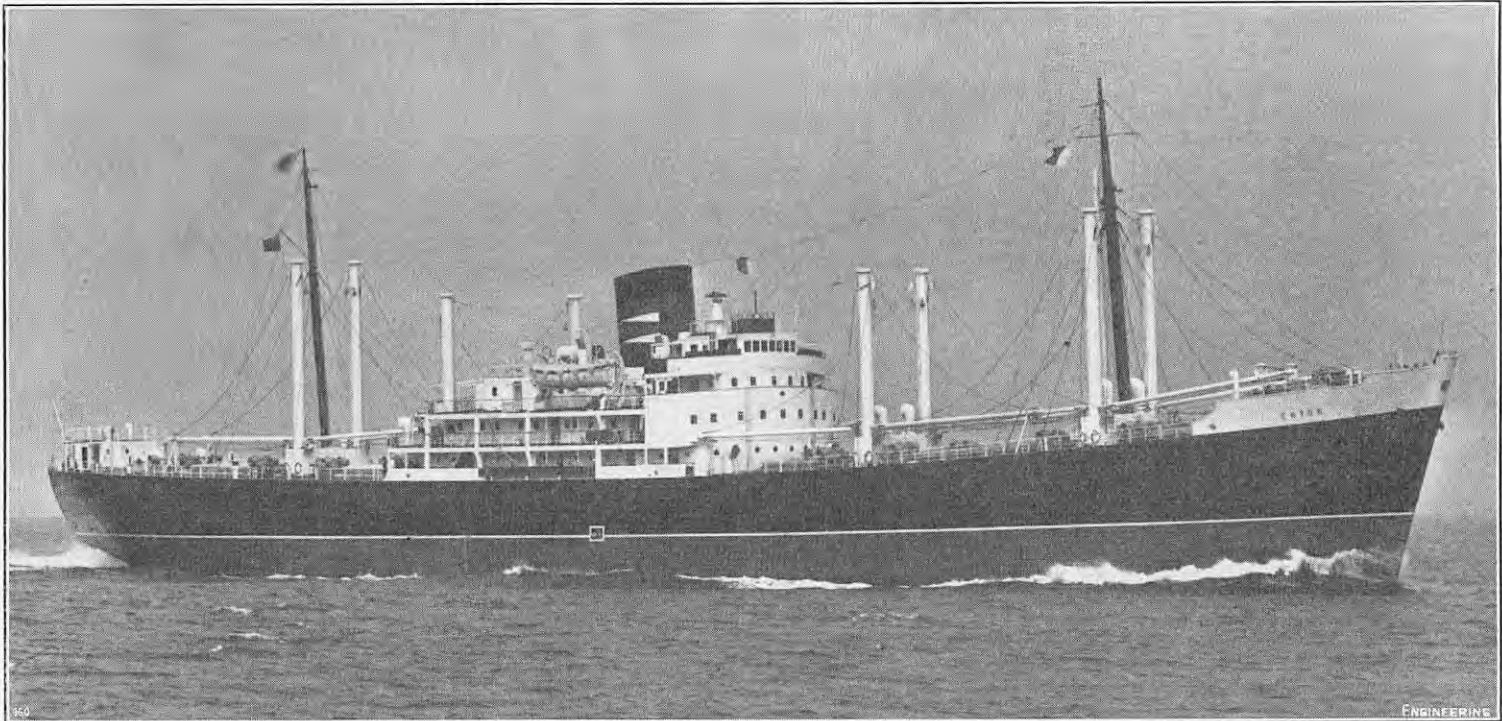
This diversity touches both the organisation and the emphasis of the studies, and will also be found in the standards; in judging the standards, however, account must be taken of the emphasis of the instruction, which may be placed variously on (a) basic scientific and general culture; (b) general application; or (c) exceptional knowledge of a specialised branch. This question of emphasis is all-important to the proper consideration of the French system and indicates the most convenient classification to be applied to the schools. It will be seen that a small number of students, in order to obtain their full specialised training, may attend at three separate schools, covering, respectively (a), (b) and (c); a considerable number attend two schools for (a) and (b), but the majority receive their academic training at single schools which combine (a) and (b).

As a predominant example of the schools that provide only for (a), basic culture, let us consider the famous Ecole Polytechnique, which exists primarily to satisfy the needs of the military and civil services of France and her colonies. This school provides a two years' general course of an essentially scientific character, including mathematics carried to a high standard, physics, and chemistry, together with cultural subjects. Admission is by examination and is for men only, between 17 to 21 years of age, the entrance examination requiring normally two years of special preparation at a *lycée* from the *Baccalauréat*. It is residential, and students are kept, clothed, and instructed without fee, on their undertaking not to leave the school, to pass the final examinations, and to serve the State during a minimum period of 10 years. On leaving, they choose their service according to their position on the final examination list and the places available; they are then sent to a school with emphasis (b), an Ecole d'Application, appropriate to the branch in which they will later make their careers, such as mines, roads and bridges,

* Address delivered at the fourth annual meeting of the Regional Advisory Council for Higher Technological Education (London and Home Counties), held at Hasting on July 10, 1952.

MOTOR CARGO LINER "ENTON."

ALEXANDER STEPHEN AND SONS, LIMITED, LINTHOUSE.



forests, post office, broadcasting, surveying. Competition to enter the Ecole Polytechnique is severe, since the *polytechniciens* are regarded in France as a *corps d'élite*, and it is presumably for this reason that the student on leaving is recognised as an *Ingenieur diplômé*, in spite of his lack of applied study at that stage.

It is convenient at this point to consider the Ecoles d'Application, which concentrate exclusively on (b), general as distinct from specialised, application in a branch. They may be national, such as the Ecole Nationale Supérieure d'Electrotechnique et Hydraulique at Grenoble, or may be private, such as the Ecole Supérieure d'Electricité near Paris. The courses at such schools take two years and the instruction is still largely academic in character, in spite of the fact that many of the professors are engineers in industry who teach part-time. Practical experience is not taken very seriously. Although they are generally recognised as Ecoles Supérieures, the term is not, as will be seen, used exclusively for such schools. But their principal characteristic is the insistence that, on entry, their students must, above all, have high qualifications in mathematics, physics, and chemistry. On leaving, the graduates are ready to take posts in the service of the State or of industry, in which, as they gain practical experience, they will rise to the posts of high responsibility.

It has been seen that the Ecole Polytechnique provides the kind of basic scientific culture necessary as a preparation for such an Ecole d'Application. A similar preparation may be obtained at the Ecole Centrale des Arts et Manufactures or at the Ecole Normale Supérieure. But a large proportion of the candidates obtain their preparation in the science faculty of a university, where, by following a three years' course, they usually obtain a science degree, the *Licence ès Sciences*, in mathematics, physics and chemistry. Not all of the men from these groups, however, go on to higher schools; some go direct to industry.

(To be continued.)

GRADUATES OF THE INSTITUTION OF CIVIL ENGINEERS.—A new class of membership—namely, graduate—has been introduced by the Institution of Civil Engineers. The age limits for admission are 21 to 28, but graduates may remain on the roll until they are 32. Candidates must be in course of training for, or obtaining experience in, civil engineering, and have either passed the final parts I and II of the Institution examination or obtained a qualification recognised by the Council as exempting therefrom.

THE CARGO LINER "ENTON."

WE illustrate above the single-screw motor cargo-liner *Enton*, recently completed by Messrs. Alexander Stephen and Sons, Limited, Linthouse, Glasgow, for Messrs. Birt, Potter and Hughes, Limited, London. She is 432 ft. in length between perpendiculars, 58 ft. 9 in. in breadth, and 39 ft. 6 in. in depth. The gross tonnage is 6,440 and the deep-load draught is 27 ft. 2 in. The vessel is of the open shelter-deck type and is designed to carry 6,600 tons of deadweight cargo at a sea speed of 14 knots. She has been built under the special survey of Lloyd's Register of Shipping and is partly welded and partly riveted. Following the builders' practice, sections weighing up to 24 tons each were fabricated as units before being lifted into place on the berth. Most of the framing is transverse, but longitudinal framing is used in the double bottom.

The machinery, consisting of a single Barclay Curle-Doxford five-cylinder opposed-piston Diesel engine, is placed amidship. It is of the enclosed balanced type, with pistons 670 mm. in diameter and a combined stroke of 2,320 mm. The service output is 5,500 brake horse-power at 115 revolutions per minute. Reversing is by hand gear.

No passengers are carried, the accommodation (in the superstructure amidship, and all above the weather deck) being for the officers and crew only. In addition to the large dining saloon at the forward end of the deckhouse, there is a smokers room for the deck and engineer offices at the forward end of the bridge deck. The cabins for the deck officers, engineers and petty officers are also on the bridge deck, and the accommodation for the captain, radio officers and cadets, together with the owners' rooms and the hospital, is on the boat deck. Separate messes are provided for the seamen, stewards, greasers and petty officers. A complete system of mechanical ventilation and heating extends throughout the vessel. The galley is all-electric. The dry store rooms and refrigerated provision rooms are on the deck below.

The hull is subdivided by seven watertight bulkheads, making five holds or compartments for cargo; the holds have 'tween-deck spaces above them, forward and aft, and No. 3 hold is arranged to contain either dry cargo or water ballast. The five large hatches are served by 10-ton derricks mounted on derrick posts, and a 30-ton derrick is carried on the foremast, to serve No. 2 hold. The

winches are electric, and there is also a warping winch aft. A fire-detecting and extinguishing system protects all parts of the ship, with a visual indicator and an audible detector in the wheelhouse. The navigating equipment includes a gyro-compass with automatic steering control, radar, an electric log, an Echometer, and a wireless installation with automatic alarm and direction-finder. The steering gear is of the electro-hydraulic type. An electrically-driven windlass is provided forward, and two steel lifeboats, one motor-propelled, are carried in gravity davits.

THE ASSOCIATION OF PUBLIC LIGHTING ENGINEERS.

IN conjunction with the annual conference of the Association of Public Lighting Engineers, which has been arranged to take place at the Royal Hall, Harrogate, from Tuesday, September 16, to Friday, September 19, there will be an indoor exhibition of street-lighting apparatus and equipment, as well as an open-air display of lamp columns, tower wagons, extending ladders, bollards and traffic signs. A number of manufacturing firms have announced their intention of participating in these events. The annual general meeting of the Association will be held at 10.30 a.m. on September 16, and this will be followed by the induction of Mr. E. Howard as President. He will read his presidential address in the afternoon of the same day. Papers to be read at the conference will include "Methods of Controlling Street Lighting," by Mr. N. Axford; "Illuminations and Decorative Lighting," by Mr. H. Carpenter; "Street Lighting in the United States," by Dr. A. F. Dickerson; "Street Lighting—A Wise Compromise," by Mr. N. Hudson; and "The Design, Manufacture and Erection of Concrete Lighting Columns," by Dr. D. F. Orchard. There will be a civic reception by the Mayor of Harrogate, Councillor A. V. Milton, on September 16, at 8 for 8.30 p.m., and a reception by the President and Mrs. Howard on September 18 at 8 for 8.30 p.m.; both these functions being held at the Royal Hall. The Association's annual luncheon will take place at the Cairn Hydro Hotel, Harrogate, on September 18 at 12.30 for 1 p.m. The afternoon of the last day of the conference will be devoted to a coach tour to Fountains Abbey. Further particulars may be obtained from the secretary of the Association, 22, Surrey-street, London, W.C.2.

THE ROYAL AGRICULTURAL SHOW AT NEWTON ABBOT.

(Concluded from page 43.)

ALTHOUGH the attendance figures for the Royal Agricultural Show, held this year at Newton Abbot, were down on those for last year, it must not be assumed that the event was unsuccessful for, as mentioned in our earlier reports, the lack of livestock, coupled with the remoteness of the site, were bound to have had a deterrent effect. Lack of livestock undoubtedly had the greater effect, as it is generally conceded that the cattle, sheep and pigs entered for the Royal Show are of an exceptionally fine class and rarely are to be seen elsewhere in such numbers and variety. But attendance figures are not necessarily a true measure of any show's success or failure for it is the volume of business transacted that really matters and, judging from preliminary reports, the inquiries made and orders placed in the implement yard, particularly by overseas visitors, exceeded all expectations. In general, the machinery and implements shown were of a high order and there was, fortunately, a marked absence of those machines which, although of ingenious design, bear little relationship to practical farming, most of the machinery on view being of a severely utilitarian nature. Compared with other post-war shows, there were fewer new implements, but this was only to be expected, the efforts of the manufacturers now being concentrated more on consolidation of existing designs and expansion of production rather than on the introduction of new designs. This trend is to be welcomed as there was a definite tendency to introduce novelties for novelty's sake. There were, however, quite a number of new or improved machines and we continue below our description of some of them.

COMBINE HARVESTER.

The smaller farmer has always experienced difficulty with the harvesting of his crops, particularly if he wants to use a combine harvester. Normally, he cannot afford to buy such a machine and has therefore to rely on the services of a contractor at a time when every other farmer in the area also needs his services. As a consequence, he frequently misses the best harvesting weather. In an attempt to overcome this, Massey-Harris, Limited, Barton Dock-road, Stretford, Manchester, have introduced the tractor-drawn combine machine illustrated in Fig. 15, herewith, which was being exhibited for the first time and has been designed for use by smaller farmers. Known as the model 750, this machine can be towed by any average tractor. It is not driven from the rear power take-off, however, a Morris four-cylinder water-cooled engine designed so that it can operate on either tractor vaporising oil or petrol and developing 25 brake horse-power at 2,220 r.p.m. being employed for this purpose. The engine, which is mounted at the near-side of the machine, is fitted with a Weyburn governor and the drive is transmitted to the various moving parts through an 8-in. diameter Borg and Beck clutch. The cutter bar, which is of the usual reciprocating type, is 5 ft. 6 in. wide with a width between dividers of 5 ft. 9 in., the table height being adjustable so that the machine can cut from 1½ in. to 33 in. above the ground. This adjustment can be carried out from the tractor driving seat.

The machine is of the "straight-through" type in that the straw is discharged at the rear in line with the cutter bar. In accordance with usual practice, the cut crop is delivered to the threshing drum by an endless rubberised-canvas belt provided with a number of transverse slats, the crop being directed on to the belt by a six-arm reel the position of which can be adjusted both horizontally and vertically. The threshing drum, or cylinder, is of the rasp-bar type; it has a width of 5 ft. and a diameter of 15 in. and can be driven at speeds varying from 300 r.p.m. to 1,750 r.p.m. Beaters are fitted at the front and rear of the cylinder and, on leaving the cylinder compartment, the straw passes over a 60-in. wide straw rack which is reciprocated by means of two Pitman arms, one at each side. The shaker is of the two-sieve type with

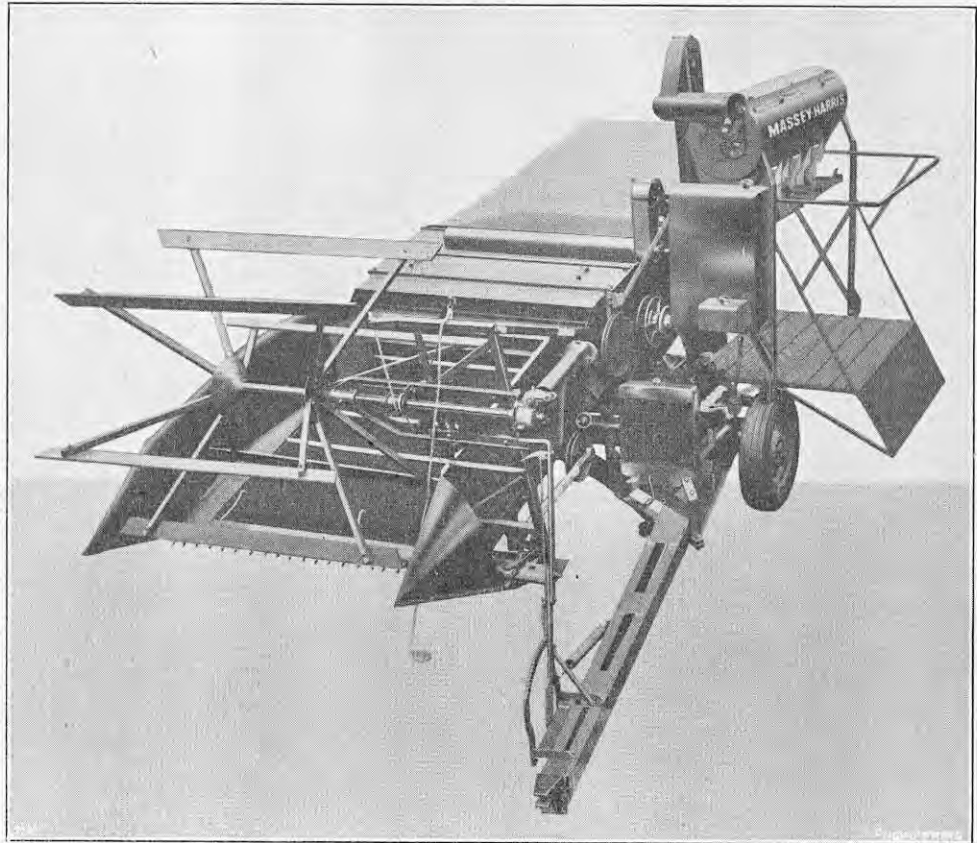


FIG. 15. TRACTOR-DRAWN COMBINE HARVESTER; MASSEY-HARRIS, LIMITED.



FIG. 16. GAME FLUSHER; HARRY FERGUSON, LIMITED.

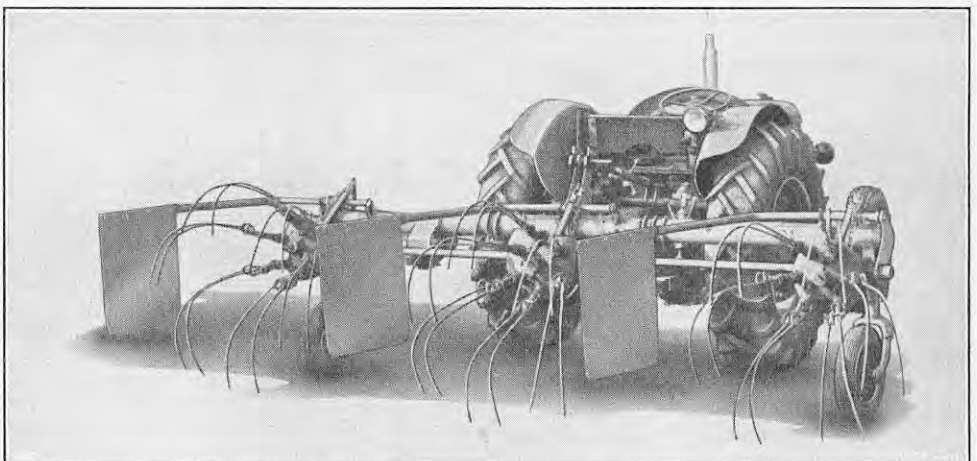


FIG. 17. TRACTOR-MOUNTED THREE-ROW SWATH-TURNING MACHINE; BAMFORDS, LIMITED.

EXHIBITS AT THE ROYAL AGRICULTURAL SHOW



FIG. 18. "SABRE" UNIVERSAL CUTTER; J. FOSTER AND COMPANY, LIMITED.

under-shot fan, various sizes of sieves being available to suit all types of crops. A paddle-type fan is used which is driven at speeds of from 850 to 950 r.p.m. through a V-belt, the diameter of the fan being 16 in. and the width 35 in. The bagging attachment is arranged at the rear side of the machine and is provided with a rotary screen and three spouts, the bagging platform being attached to the machine so that it can be folded easily for transport purposes. The drawbar also is arranged so that it can be swung towards the centre of the machine, and when in this position and with the bagging platform folded, the overall width is reduced to 8 ft. 6 in., from a working width of 10 ft. 10 in. The overall length is 20 ft. 9 in. and the height is 9 ft. 4½ in.

GAME FLUSHER.

The prototype model of a somewhat unusual device, namely, a game flusher, was shown by Messrs. Harry Ferguson, Limited, Coventry. This device, which is illustrated in Fig. 16, opposite, has been developed to satisfy the demand for some means of protecting sitting pheasants, partridges and young game birds from fast, tractor-mounted mowers working in hay and forage crops. As will be seen from the illustration, the game flusher consists of a boom fitted with nine weighted chains; these are 3 ft. long and are so disposed that they pass through the crop some distance ahead of the mower cutter bar and flush the game from the path of the mower. This not only saves the adult birds but enables the driver to spot and mark the positions of nests and mow round them; it also gives the driver an opportunity of avoiding running broods. The boom is attached to the front of the tractor through a simple mounting and, when extended, has an effective working width of approximately 5 ft. The device has been tested this season on a number of well-known sporting estates in Norfolk and Suffolk, now being extensively farmed, and has met with general approval. It should be added that the unit shown at Newton Abbot was purely a prototype model and production will not be started until it has been proved that the demand justifies this course. Furthermore, although the illustration shows it in use with a rear-mounted cutter bar, it can be used with equal facility in conjunction with a mid-mounted machine.

TRACTOR-MOUNTED SWATH TURNER AND WINDROWER.

The exhibits on the stand of Bamfords, Limited, Uttoxeter, included the three-head swath-turning and windrowing machine illustrated in Fig. 17, opposite, which was being shown for the first time. As will be clear from the illustration, it is a mounted implement, having been designed for use in conjunction with the normal three-point linkage fitted to the rear of most tractors; there are, however, two castor wheels fitted with pneumatic tyres to control the working height. The main frame consists of a strong large-diameter tube and the drive is transmitted to the three turning heads from the tractor power take-off through bevel gearing arranged to drive a transverse shaft. Further bevel gears transmit the drive to the turning heads, all gears being enclosed and operating in oil baths. The main gears are machine cut and the main driving

pinion is supported by ball bearings. When swath turning, all the turning heads rotate in the same direction, the two outer heads being adjustable to allow for slight variations in swath width; it will be appreciated that the provision of three turning heads permits three swaths to be turned during a single run. When windrowing, the centre head is reversed so that the left-hand and centre heads turn inwardly relative to each other to form a complete windrow, the right-hand head continuing to turn outwardly and thus form half a windrow which is completed on the return run. Owing to its width, the machine is arranged so that it can be towed endwise. This is accomplished by providing a detachable third wheel which, when it is required to transport the implement along the highway, etc., is connected to the main frame by means of a separate bracket; this third wheel is also of assistance when the implement is being fitted to a tractor. The swath turner can be used behind all the better-known makes of tractor and, when at work, is capable of covering three 5-ft. swaths during a single run.

SCRUB-CLEARING AND HEDGE-CUTTING ATTACHMENT.

The exhibits of J. Foster and Company, Limited, North Cave, Brough, East Yorkshire, included a new tractor-mounted scrub-clearing and hedge-trimming machine. This machine, which is shown at work in Fig. 18, on this page, is known as the "Sabre" and has been developed for use with the Nuffield "Universal" tractor, having been officially approved by the Nuffield Organisation. As will be seen from the illustration, it consists of a long arm extending from the front of the tractor, to the outer end of which is fitted a circular saw blade. This can be set horizontally, vertically or at several intermediate positions, so that it can be used for cutting down scrub or sawing trunks and limbs of felled trees into convenient lengths. By raising the arm, or jib, it can be used for trimming the tops of hedges, the maximum height to which it can be raised for this purpose being 7 ft. 6½ in. The unit consists of a 4½-in. diameter tube fitted to the rear side of the tractor frame, the forward end of which is fitted with a swivelling bracket arranged so that it can be moved through an arc of approximately 90 deg. in the horizontal plane, this motion being imparted to the bracket by a double-acting hydraulic ram and piston assembly. The jib also is tubular and the rear end is connected to the swivelling bracket in such a way that it can be raised and lowered by means of a single-acting ram and cylinder assembly, the cylinder of which is joined to the apex of the swivelling bracket and the ram to a lug welded to the jib. The lug is provided with alternative connecting points so that the position of the jib relative to any one position of the ram can be altered.

The forward end of the jib carries the cutting head which, as previously indicated, can be set in several different positions. The single-acting ram which determines the height of the jib is controlled by the standard hydraulic-lift operating lever, which is located at the right-hand side of the tractor-driver's seat. The double-acting ram which swings

the jib across the front of the tractor, however, is controlled by a special glandless valve of the manufacturer's design mounted at the opposite side of the tractor. This valve is spring-loaded so that it returns to the neutral position automatically and is arranged so that it also controls the speed at which the bracket swings the jib across the front of the tractor. The cutting head is designed so that two adjustments are available, it being possible to alter the angle of the blade relative to the jib as well as move it round so that it is either vertical or horizontal with several intermediate positions. The unit is driven from the tractor belt-pulley power take-off, the transmission group comprising two bevel gearboxes, one at the head of the jib for driving the cutter and the other at the rear end of the horizontal tube bolted to the tractor frame, the input shaft of the latter being driven from the power take-off pulley by a 1¼-in. V-belt. The two gearboxes are joined to each other by shafting located inside the tubes, universal joints being provided in the region of the swivelling bracket and at the cutter head to permit freedom of movement of the jib and cutter. All the driving mechanism is totally enclosed and the shafts and gears are provided with either ball or roller bearings sealed with dust-proof glands. Two forms of cutter are available, namely, a 48-in. diameter 100-tooth saw blade and a 48-in. diameter four-cutter slashing blade, the recommended maximum cutting capacity for the saw blade being 20 in. diameter growth and for the slashing blade, 4 in. diameter growth.

GREEN-CROP CUTTER AND LOADER.

Recent developments in grass drying and the manufacture of silage have given an added stimulus to the introduction of green-crop harvesting machinery. Several of these machines were shown at Newton Abbot, including the Mowlift, illustrated in Figs. 19 and 20, on page 74, which was being shown by Featherstone Agricultural, Limited, Durham-road, Boreham Wood, Hertfordshire. Actually, this machine consists of two separate parts, namely, a standard Featherstone mid-mounted cutter bar to which may be attached an elevator, thus converting the cutter bar into a cutter loader, and it is this latter part which is known as the Mowlift. The Featherstone mid-mounted cutter bar was described on page 55 of our 168th volume (1949). It consists of a standard reciprocating-type cutter arranged so that it extends from the side of the tractor in approximately the mid-position and driven by means of a V-belt from the rear power take. The cutter bar is designed so that it can be raised by the tractor hydraulic power lift to give ground clearance at the outer shoe for turning or by a mechanical lift against the side of the tractor for transportation. As will be seen from the illustrations, the Mowlift is fitted directly to the cutter bar and is arranged so that the cut crop is directed on to the inclined bed of the machine by picktines which subsequently carry the crop to the top of the bed, from which it is directed by a chute into a trailer drawn behind, as shown in Fig. 20. The bars to which the picktines are attached are joined at each end to endless chains, the lower sprockets for which are driven by a further chain from a sprocket bolted to the off-side rear hub of the associated tractor. The weight of the elevator is taken by a triangulated structure bolted to the side of the tractor, the connection to the apex of the structure being made through coiled springs to give the required flexibility.

FORAGE HARVESTER.

A forage harvester which employs an entirely new form of cutter was shown for the first time by the Shearnow Harvester Company, Limited, 66, Victoria-street, London, S.W.1. This machine, known as the "Shearnow," is illustrated in Figs. 21 and 22, on Plate V. It has been designed specifically to cut crops for forage purposes, either for silage-making or artificial drying, and is able to cope with grass, oats and vetch mixtures, lucerne, etc. Cutting is accomplished by means of impact only, there being no sharpened blades, knives or ledger blades, the cutting unit consisting of a light cylinder or rotor, to which two relatively blunt shearing bars are bolted, the bars extending the full width

EXHIBITS AT THE ROYAL AGRICULTURAL SHOW, NEWTON ABBOT.



FIG. 19.

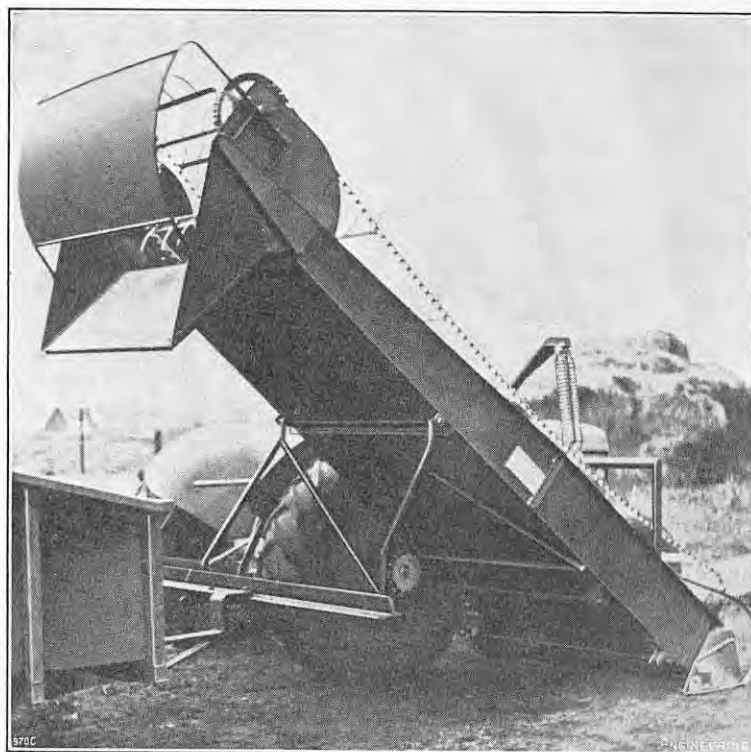


FIG. 20.

FIGS. 19 & 20. MID-MOUNTED GREEN-CROP CUTTER AND ELEVATOR; FEATHERSTONE AGRICULTURAL, LTD.

of the rotor and are disposed at 180 deg. to each other. The rotor is arranged with its axis horizontal and immediately in front of it is a vertical plate; this plate is known as the deflector plate and plays an important part in the cutting operation, as it pushes the crop down and away from the rotor so that the stems are presented first to the shearing bars, while its position relative to the rotor determines whether or not the crop is chopped.

The rotor is driven in the direction opposite to that of the harvester's travel at a relatively high speed. The tractor rear power take-off is employed for this purpose, the drive being transmitted to the rotor through a speed-increasing gearbox that forms an integral part of the machine. As the crop is severed, it is carried up between the rotor and the deflector plate, the amount of chopping which takes place depending on the distance between this plate and the rotor. If, for example, the distance is small, then the cut crop will tend to crowd the available space, thus slowing down the speed at which it passes through the gap; the shearing blades, therefore, will strike it a number of times before it is thrown clear on to the elevator. On the other hand, if the distance is large, the crop will not be crowded and will pass straight through without being chopped or lacerated. On leaving the rotor, the crop passes towards the rear of the machine, where it is deposited on the elevator which delivers it into a trailer drawn behind the machine. The elevator is of the normal canvas-belt type and is driven from the speed-increasing gearbox, the complete unit being enclosed in a canvas hood to prevent the crop being carried away by the wind. Both the cutting rotor and elevator are inclined to the direction of travel so that the crop can be delivered to a trailer drawn in line with the tractor without recourse to a cross conveyor. The height of discharge of the conveyor can be varied from 4 ft. 8 in. to a maximum of 7 ft. 3 in. The designers claim that stones or similar obstructions have no material effect on the machine's capabilities.

TRACTOR-MOUNTED PUMP.

A wide range of pumps was being shown by Messrs. James Beresford and Son, Limited, Stork Works, Marston Green, Birmingham. These included the tractor-mounted unit illustrated in Fig. 23, on Plate V, where it is shown fitted to the tractor. It is suitable for irrigation by spraying,

fire fighting, insecticide spraying, dewatering, etc. It is capable of delivering 100 gallons of water per minute against a pressure of 100 lb. per square inch, the maximum power absorbed for normal duty being in the region of 15 h.p.; the load on the tractor engine, therefore, is quite moderate. The pump is a five-stage centrifugal unit with an additional priming stage, the impellers and casings being constructed from bronze and the impellers fitted to a high-tensile stainless-steel shaft mounted in double-row self-aligning ball bearings. The packing glands are self-lubricating. The pump is driven from the rear power take-off through a telescopic shaft fitted with Hardy Spicer needle-roller universal joints. This shaft is connected to a speed-increasing gearbox, the output shaft of which is joined directly to the pump. The pump and its associated gearbox are mounted in a fabricated-steel chassis, which also provides accommodation for the suction hose, strainer and basket, two lengths of delivery hose, etc.

TRACTOR-MOUNTED SAW BENCH.

A novel form of tractor-mounted saw bench that can be used for cross-cutting and ripping was exhibited by Messrs. T. Baker and Sons (Foundry and Engineers), Limited, Compton, Berkshire. As a rule, tractor-mounted saw benches are arranged with the axis of the saw-spindle parallel to the back axle of the tractor, and the length of wood that can be ripped, or sawn longitudinally, is therefore limited. This limitation has been overcome on the Compton saw-bench, as the new machine has been designed, by arranging the table and saw-blade assembly so that it can swing through 90 deg., the axis of the saw spindle being set parallel to that of the tractor rear axle when sawing logs and at right angles when it is required to rip long planks, etc. The "Compton" saw-bench is illustrated in Fig. 24, on Plate V, from which it will be seen that, to obtain the swinging movement of the bench and saw assembly, the bench has been made circular. It is located in the frame by suitable guides designed so that the minimum of free play is permitted and is securely locked in the two working positions by a quick-release bolt. The saw is driven from the tractor rear power take-off by means of a flexible shaft fitted with universal joints, the drive being transmitted to the saw spindle through two sets of bevel gearing disposed at the

top and bottom of a vertical shaft. A dog clutch is incorporated in the transmission so that the operator can stop the saw without having to put the tractor power take-off out of gear. When in use, the bench stands on three legs, thus ensuring stability. It is raised by means of the tractor hydraulically-operated rear-implement linkage for purposes of transport and, although designed primarily for use with the Nuffield "Universal" tractor, can be used in conjunction with any tractor fitted with a rear power take-off and implement-lift linkage.

SMALL TWO-STROKE PETROL ENGINES.

Two new two-stroke engines were being shown by the Villiers Engineering Company, Limited, Marston-road, Wolverhampton. These two engines are exceptionally light and compact and their size renders them particularly suitable for driving the smallest types of cultivators, hoes, lawn-mowers, scythes and similar implements. The new models have been designated Mark 2G and Mark 3G and are illustrated in Figs. 25 and 26, on Plate V, respectively. Basically the two units are the same, the essential difference between them being that the Mark 2G is the engine in its simplest form, whereas the Mark 3G is provided with a built-in cooling fan and associated cowling. They are designed to run in the horizontal position and have a bore of 40 mm., a stroke of 48 mm., and a maximum output of 0.75 h.p. at 2,600 r.p.m.; for continuous running, however, the rating at this speed is 0.55 h.p. The cylinder barrel, which is well finned for cooling, is an iron casting and is fitted with a 14-mm. spark plug. A flat-top aluminium-alloy piston is used. Ignition is by a Villiers flywheel magneto, the moving parts of which are mounted on the crankshaft journal extension. The carburettor also is of Villiers manufacture, the design being such that speed control is obtained by a single lever, a strangler being provided for easy starting. Roller bearings are fitted to the big end. The overall length of the Mark 2G engine is 11½ in., this measurement including the sparking plug, while the overall width is 10¼ in., excluding the rope starting pulley; with this component in position, the width is increased by 1¼ in. For the Mark 3G engine, the overall length is 11¾ in. and the width 12 in., the latter dimension including the starting pulley. The weights are 18¾ lb. for the Mark 2G model and 21½ lb. for the Mark 3G model.

EXHIBITS AT THE ROYAL AGRICULTURAL SHOW, NEWTON ABBOT.

(For Description, see Page 72.)



FIG. 21.



FIG. 22.

FIGS. 21. AND 22. TRACTOR-OPERATED FORAGE HARVESTER; SHEARMOW HARVESTER CO., LTD.

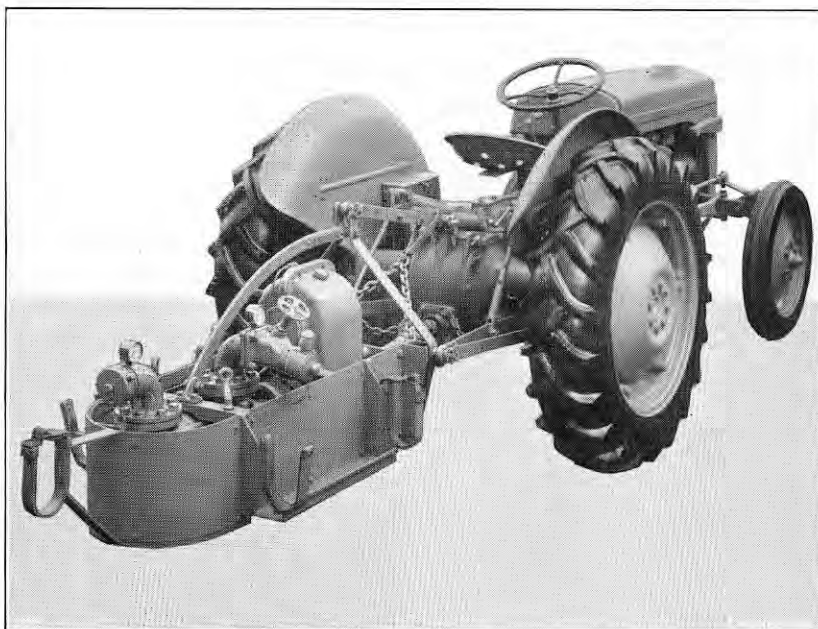


FIG. 23. TRACTOR-MOUNTED MULTI-STAGE PUMP; JAMES BERESFORD AND SON, LTD.



FIG. 24. TRACTOR-MOUNTED CIRCULAR SAW; T. BAKER AND SONS (FOUNDRY AND ENGINEERS), LTD.

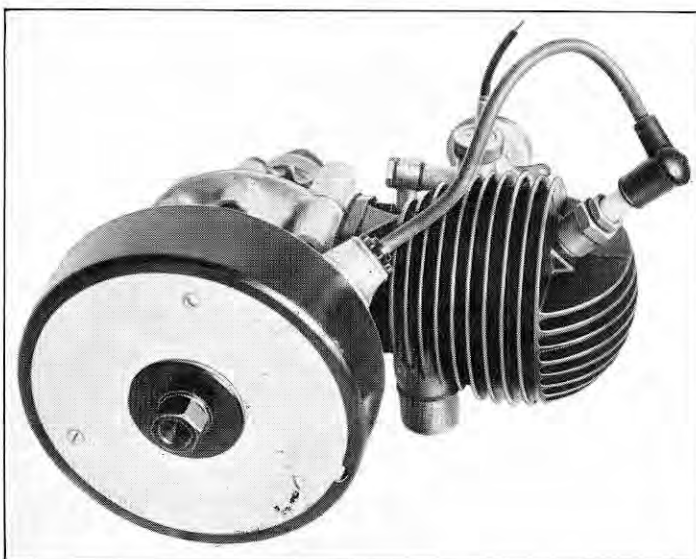


FIG. 25.



FIG. 26.

FIGS. 25 AND 26. HORIZONTAL TWO-STROKE PETROL ENGINES; VILLIERS ENGINEERING CO., LTD.

CONCRETE SHELL ROOF CONSTRUCTION.

Fig. 1. ELEMENTS OF A BARREL VAULT ROOF.

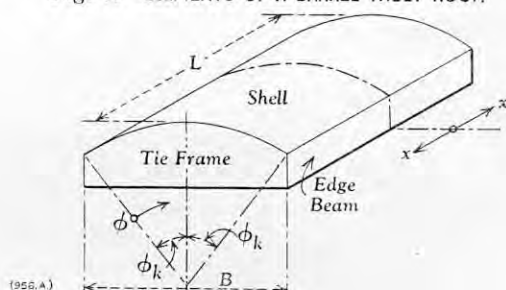


Fig. 3. MOMENT EQUILIBRIUM.

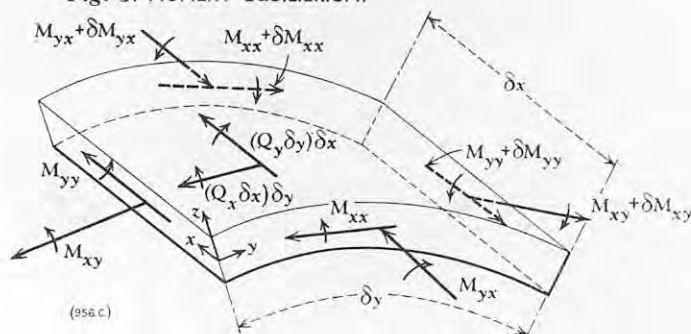
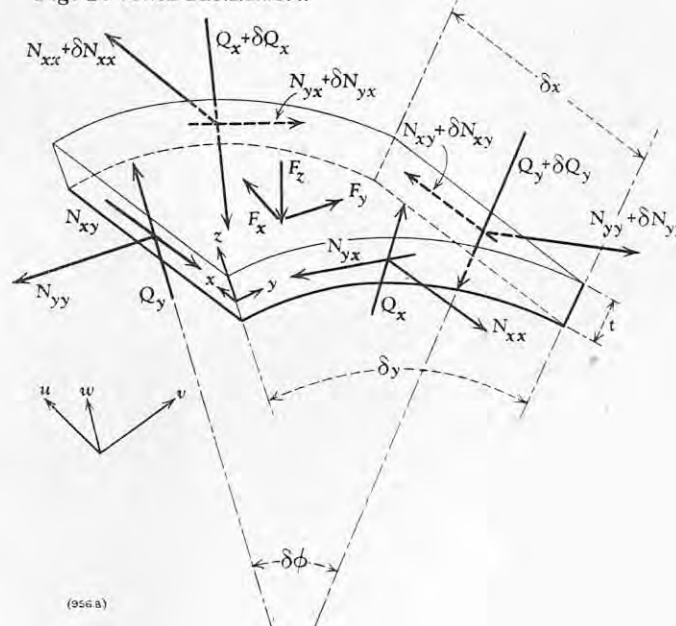


Fig. 2. FORCE EQUILIBRIUM.



CONCRETE SHELL ROOF CONSTRUCTION.

(Continued from page 56.)

ARCHITECTURE OF SHELL ROOFS.

In the final paper of the first part of the symposium organised by the Cement and Concrete Association, Mr. E. L. Gale set out the problems of shell roof construction which had to be recognised and overcome by the architect from the outset of the design. From the constructional aspect, it was indicated that the thickness of the shell was usually either 2½ in. or 3 in., with layers of fabric near the top and bottom of the shell and possibly diagonal or trajectory bars between them. Because of the closeness of the reinforcement it was essential to restrict the maximum size of aggregate to ¾ in. for the shell concrete. Provisions for the introduction of expansion joints through stiffening beams, columns and the main structural elements should be made in conjunction with the engineer's requirements. Enclosing walls should be carried on ground beams supported off the column foundations, but there must be expansion jointing between the wall panels and columns.

Insulation of the roof had four purposes: of reducing heat losses and thus saving on the size of the heating plant required; of reducing the penetration of solar heat; of preventing condensation following climatic changes; and of reducing thermal changes and movements in the shell. Since a concrete shell of 2½ in. had a low coefficient of heat transmission, 1.40 B.Th.U. per hour per square foot per deg. F., additional insulation was generally required. The earliest method used in this country, the use of soft board as a permanent shutter, was not to be recommended, since, despite the use of patent clips and other expedients, satisfactory adhesion was rarely achieved and the corners of the boards broke away from the shell. Furthermore, it was no longer necessary to use the soft board to obtain a fair internal finish, since this could be gained by modern shuttering, which would leave a pattern that need not be unattractive. For external insulators, four characteristics had to be considered: lightness, ease of fixing, suitability as an underlay for waterproofing materials, and cost.

For an external finish, Mr. Gale suggested that it was not good practice to rely on the compactness of the concrete of the shell, since the cover over reinforcement was usually only ½ in. Materials and processes available as external finishes included bitumen/hessian and cold bitumen processes; bituminous roofing felt, of which a single heavy-duty sheet was adequate if it had a mineral surface and was bonded to the insulation; and asphalt, which

was rather heavy, relatively costly and liable to crack. In dealing with natural lighting it was pointed out in the paper that ordinary systems of patent glazing were adaptable to north-light construction. For incorporation within the normal shell, two arrangements could be considered: either the use of continuous lanterns or skylights, or, alternatively, individual fixed lights. In either case, pre-cast concrete frames curved to the radius of the shell could be conveniently incorporated in the construction of the roof. Either patent glazing, lenses, or circular glass dome lights were available. During the discussion to a later paper on the Friday, Mr. Wingrave Newell made an important contribution on natural lighting.

Mr. Newell began by declaring that designers must give greater consideration to lighting, and while admitting that further research was necessary, he pointed out that far better use could be made of existing knowledge. Brightness alone was not sufficient; glare, or the contrast between areas of high intensity of light and adjacent areas of comparative darkness, was a source of danger in extreme instances and always a cause of tiredness and inefficiency in workpeople. It was therefore the uniformity of light at the work bench or at normal sight level that was the criterion of good lighting. Mr. Newell expressed himself unequivocally in favour of optically-designed lenses in preference to pressed glass. The extra cost could well be offset by the fewer lights required and the improvements in lighting obtained, which would contribute to better and more efficient workmanship. Lenses had the further advantage of being able to sustain some loading during maintenance of the roof. Mr. Newell also criticised the use of single skylights along the crown of the shell and showed how more uniform lighting could be achieved by the use of less skylight area, but distributed at the quarter points of the shell.

To return to Mr. Gale's paper, the author dealt finally with the provision of services. In general, he said, the beauty of a shell roof lay in the unobstructed roof space, which should never be disfigured by an array of pipes, unit heaters and conduits that were so unsightly against a smooth interior surface. Mr. Gale ended his paper by reference to drainage of the catchment area; he indicated that the structure of barrel vault roofs naturally formed large gutters and that guttering was readily accommodated above edge beams.

ENGINEERING DESIGN.

The second part of the symposium, held at the Institution of Civil Engineers on July 3, was devoted to the engineering design of barrel vault and other forms of shell roof construction. The range of the

five papers, listed at the beginning of this report, on page 55, *ante*, is wide—a comparison of the existing analyses of secondary effects; office computation by the particular method of flexibility coefficients; a historical review of theoretical and experimental work and of experiments in hand; a powerful analysis in matrix notation capable of reducing the solution of more intricate shell forms; and finally, a paper devoted to the advantages to be gained by prestressing the shells and the problems ensuing thereby. Vast as the scope of these papers is, the promoters of the symposium may be criticised for having omitted from an otherwise complete programme a paper devoted to the derivation of the basic formulae at present used.

The membrane theory for the stresses in thin shells of the type shown in Fig. 1, for convenience referred to as the primary stresses, shown in Fig. 2, is based upon the assumption that there is no change of shape of the shell on loading. The membrane stresses, thrusts and shears confined to the plane of an element of the shell are statically determinate and are given by three equations first published in an engineering text in English by Mr. H. Savage in 1930.* Since, however, the abutments at the springing of the shell are not, and can rarely be assumed to be rigid, there are resultant secondary stresses in the shell, Fig. 3; it should be recognised that these so-called secondary stresses may well exceed those designated as primary stresses. The solution of the problem is found in an eighth-order differential equation in terms of the chosen indeterminacy, for example, the transverse bending moment in the shell. The displacements and other forces and moments may all be related to the chosen indeterminacy and may be resolved in terms of the boundary conditions.

Dr. McNamee devoted his paper to a comparison of five existing methods of analysis of singly curved shell roofs; each of these analyses was based on the linear theory of elasticity, but give rise to somewhat differing solutions according to the approximations made by their original authors when making the analysis. No account was taken in Dr. McNamee's paper of plastic theories of behaviour of reinforced-concrete shells since these were as yet insufficiently developed to be of use in design. The paper was divided into two main sections: a theoretical analysis of the factors in the five equations concerned and a numerical analysis by comparing the stresses computed by the use of the equations in two examples of roofs.

(To be continued.)

* "Reinforced Shell Roofs," by H. Savage, *Concrete and Constructional Engineering*, vol. 25, page 490 (September, 1930).

AXIAL-FLOW MINE-VENTILATING FAN.

A SINGLE-STAGE axial-flow fan, measuring 17 ft. 5 in. in diameter and believed to be the largest ever built for mine ventilation purposes, has recently been constructed by Messrs. Walker Brothers (Wigan), Limited, at their Pagefield Iron Works, Wigan. It is the first of two which are being supplied by the firm to the Zinc Corporation, Limited, for use in Broken Hill mine, Australia. An impression of the size of the fan can be gathered from Fig. 1, on this page, which shows the part of the casing which houses the guide vanes. The view is from the inlet end. Other views of the installation, as assembled for test in the workshops at Wigan, will be found on page 80.

The layout to be adopted at Broken Hill mine is shown in Fig. 2. The fan will be installed in a new upcast shaft which is 20 ft. in diameter, and will be used to exhaust foul air from the mine workings. When installed early in 1953, it will be required initially to pass 720,000 cub. ft. of air per minute at a pressure difference across the fan equal to 2.69 in. of water, and, later, 900,000 cub. ft. per minute at 3.74 in. water gauge. These are summer ratings, however, and, by an increase in the running speed and adjustment of the blade settings, the fan will be capable of passing an appreciably greater quantity of air under winter conditions. The volume of air passing under any particular condition will be determined by means of a Pitot tube traversed at the section of the horizontal drift indicated in Fig. 2.

The air entering the fan passes through two sets of fixed guide vanes. The first of these is situated in the drift referred to above and is designed to turn the air through an angle of 32 deg. 30 min. The second set is immediately in front of the fan and its function is to impart such initial swirl to the air as will result in the latter leaving the fan axially and without rotation under the most favourable conditions of operation. Owing to the relatively high cost of electricity at the mine, an effort will be made always to run the fan as efficiently as possible. The maximum efficiency, based on the design data, is 81.4 per cent., and this figure has been achieved partly by arranging to have a comparatively long and slowly diverging diffuser behind the fan. A short contraction in the duct ahead of the fan will assist in steadying the air before it enters the swirl guide-vanes. The fan drift, contraction, diffuser and chimney are being constructed in concrete on the site. The fan will be driven by an 850-h.p. alternating-current slipping motor positioned outside the entry duct, an arrangement made possible by the abrupt change in direction of the drift at the fan.

The fan can be seen mounted behind the guide vanes in Fig. 3, on page 80, in which the installation is viewed from the outlet end. It has 12 blades, of tapered and cambered Joukowski aerofoil section, cast from manganese-bronze. Two of these blades are shown, held by a workman, in Fig. 1, and two are shown being tested for balance in Fig. 5. Each blade is about 5 ft. long, weighs 5 cwt., approximately, and is solid, apart from a hole drilled centrally into the shank for balancing purposes. All the blades were subjected to examination by X-rays after manufacture and they were balanced by the method illustrated in Fig. 5. The hub of the fan is of cast steel and some details of its design may be gathered from Fig. 6. The outer surface of the rim is a portion of a sphere and the blade roots are similarly shaped, so that each blade may be rotated in its socket without a gap appearing between the end of the blade and the hub in any position. At the blade tips, however, the same is not true, since the housing is cylindrical but, as the blade settings are always within ± 10 deg. of a mean value, the variation in tip clearance is not large and the clearance is in all cases comparatively small. Each blade is also fitted with a device for setting the pitch correctly within fine limits. This consists of a mild-steel cam, passing through the blade shank, which engages with a slot in the hub. When the cam is rotated by means of a spanner—the nut which holds the blade having been slackened previously—the blade

AXIAL-FLOW MINE-VENTILATING FAN.

WALKER BROTHERS (WIGAN), LIMITED, WIGAN.

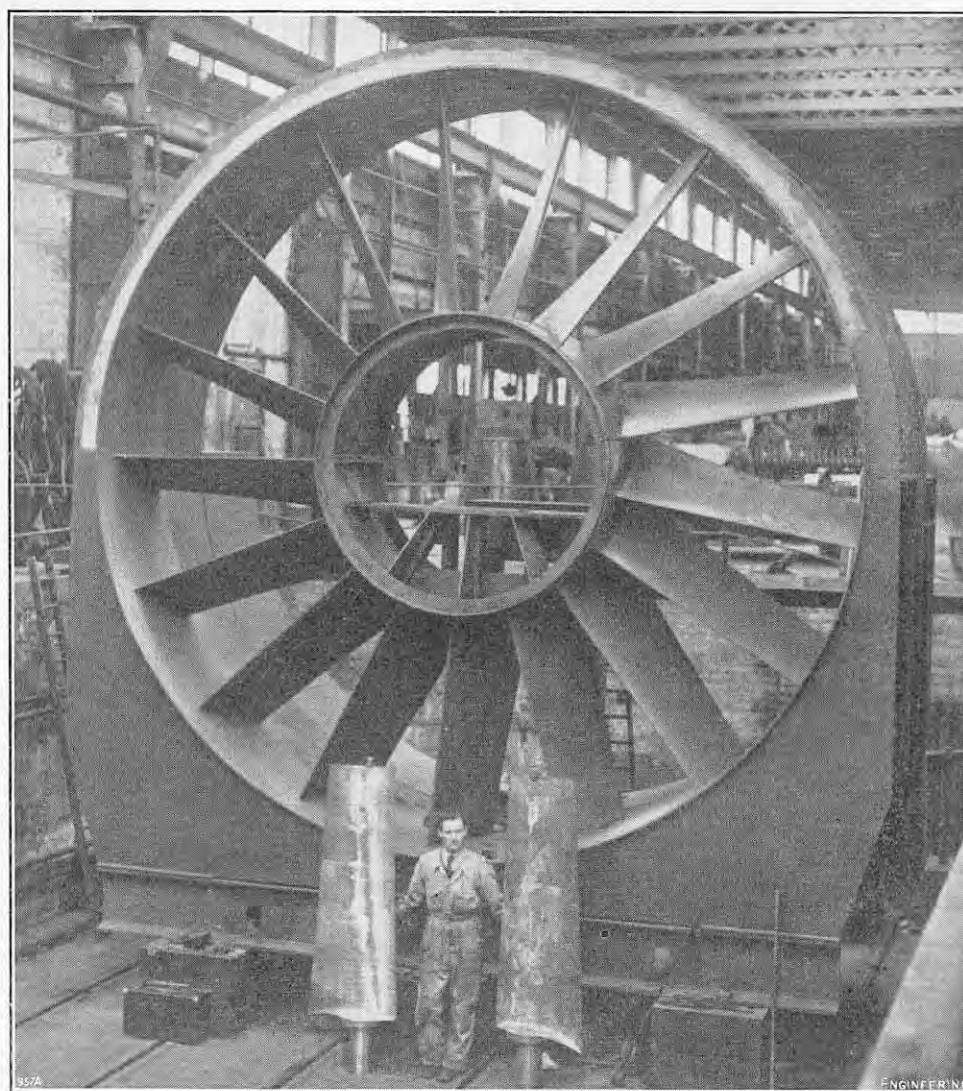
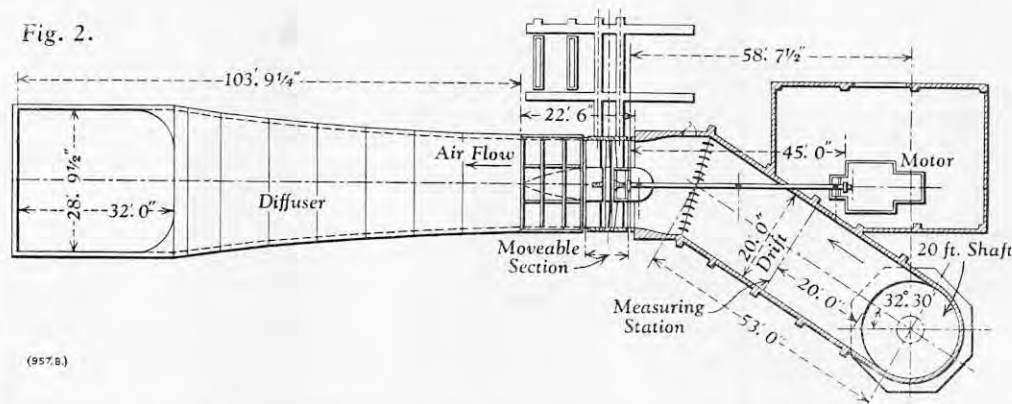


FIG. 1. FAN CASING AND GUIDE VANES.

Fig. 2.



revolves slowly about its centre and a reference line on the blade root traverses a scale indexed in degrees which is mounted on the hub.

Each blade is held in the hub by means of a large bronze nut provided with a locking device. To ensure that all the blades were secured adequately and uniformly and would not work slack under centrifugal load, a pre-tensioning device was used, which is illustrated in Fig. 6. The shank of the blade is shaped so that, effectually, a hydraulic cylinder is formed. This cylinder was pressurised with the aid of a screw-type grease injector and, in consequence, the shank of the blade was stretched longitudinally. The hydraulic pressure being the same in each case, the extension was also the same. The holding nut was then screwed up lightly and locked, after which the hydraulic pressure was released. The shaft on which the fan is mounted is a high-tensile steel forging having a tensile strength

between 35 and 40 tons per square inch. It was tested ultrasonically to ensure that no internal flaws were present. The shaft is supported on two bearings, that between the fan and the guides being a combined thrust and journal bearing. It is tapered in the section on which the hub is mounted, and the latter, being similarly tapered, is keyed to the shaft and secured by a castellated ring nut. The rear bearing is enclosed by a conical mild-steel fairing which matches with the periphery of the hub and provides the requisite streamlining. The fairing, which is supported on streamlined struts, is also continued ahead of the fan to the ring, shown in Fig. 1, which supports the guide vanes. It is completed by a spherical cap mounted ahead of the latter, as shown in Fig. 4.

The driving shaft, which can be seen in Fig. 4 passing through the centre of the spherical fairing, is 45 ft. long and is supported on three bearings

SHAPING MACHINE FOR SHEET METAL.

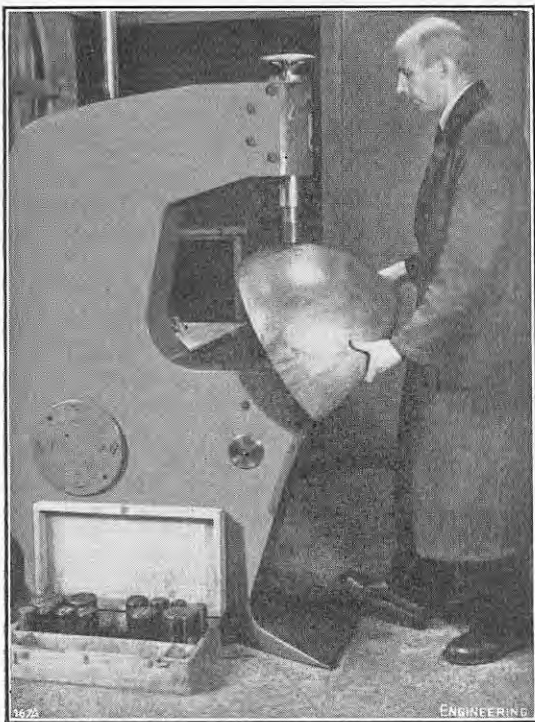


FIG. 1. POWER-DRIVEN MACHINE.

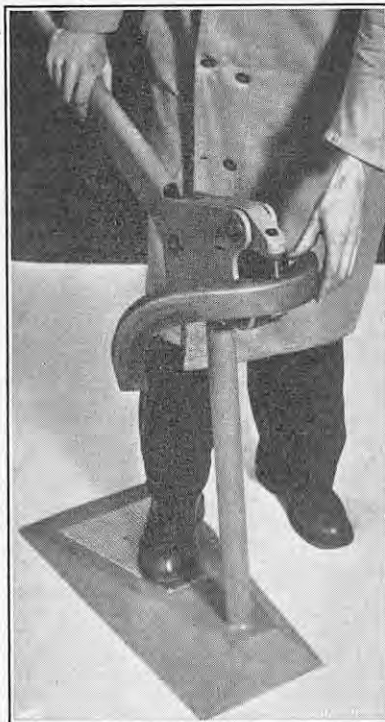


FIG. 2. HAND-OPERATED MACHINE.

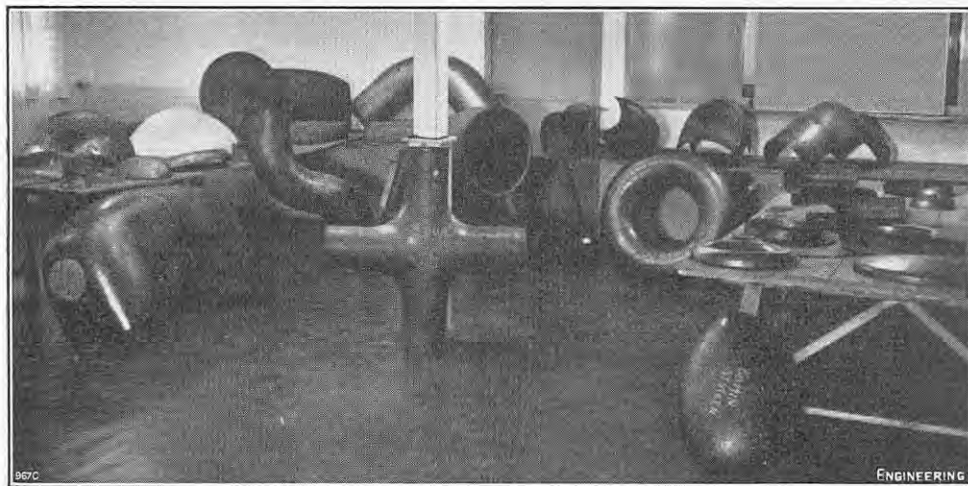


FIG. 3. EXAMPLES OF WORK PRODUCED.

spaced evenly apart at a distance of 20 ft. 6 in. between centres. Like the fan shaft, the driving shaft is a high-tensile steel forging and was examined ultrasonically. Its tensile strength is between 28 and 32 tons per square inch. The end bearings are combined thrust and journal bearings and the pedestals of all three bearings will be mounted on solid foundations at the site. The fan bearings, however, are mounted on a removable carriage which also supports the portion of the casing which surrounds the fan, and this portion of the assembly may be run out sideways on rails should it be necessary to replace the fan by another. The driving shaft and fan shaft are connected by means of a flexible coupling, and a similar coupling connects the driving shaft to the motor. All the bearings are of the Michell type and will be fed with oil from a single tank in the motor house.

The swirl guide-vanes, 17 in number, are made of mild-steel plate which was pressed to the correct curvature before the guides were welded to the casing and the runner ring. The casing is constructed of mild-steel plates rolled to the requisite curvature. Rolled-steel sections secured to the plates give the structure adequate strength and rigidity. The casing surrounding the rotor is supported on the carriage by feet welded to the casing. The carriage is substantially built and

is equipped with wheels carried on sleeve bearings. They are so designed that they can turn through a right angle when required to do so. Provision has been made for raising the carriage by means of hydraulic jacks, and suitable pads and shims have been provided so that the wheels will be clear of the ground when the fan is running. Once the removable part of the installation has been correctly positioned, the carriage will be bolted down securely on a concrete foundation and the various sections of the ducting and fairing will be connected by air-tight jointing rings.

Owing to the considerable current of natural ventilation in the mine, and the large diameter of the fan, a brake has been incorporated so that the fan can be stopped quickly, should this be necessary. As an additional precaution, distant-reading thermometers have been fitted to all the bearings. These thermometers have dual contacts arranged so that, first, a warning light appears in the motor room if the temperature of any bearing approaches an abnormally high value and, secondly, the circuit breaker on the driving motor is tripped if the temperature nears the danger point. The brake, which consists of a dead load applied through a lever to a brake band, is held off by a solenoid which is de-energised when the motor circuit-breaker opens. The brake, therefore, is applied at the same time

as the motor circuit is broken, whenever any bearing reaches a dangerously high temperature. An interlocking switch prevents the motors from being started when the fan brake is on.

As already mentioned, two fan units are being supplied to Broken Hill mine, one to be retained as a standby. The second fan will be similar in design to that described above, but it will have variable-pitch blades which can be rotated simultaneously by means of an internal toggle mechanism. This will reduce the time necessary to alter the blade settings, should conditions in the mine change.

The electrical equipment has been supplied to the Zinc Corporation, Limited, by Messrs. Mather and Platt, Limited, Newton Heath, Manchester, under a separate contract. The driving equipment consists of a main wound-rotor induction motor of 850 brake horse-power, supplied with three-phase 40 cycles per second alternating current at 6,900 volts pressure, and an auxiliary direct-current motor of 65 brake horse-power coupled to the main motor shaft. The direct-current motor is connected to the slip-rings of the induction motor through a six-phase mercury-arc rectifier. By this means, the output from the rotor of the induction motor, when the latter is running at reduced speed, is converted into useful power instead of being dissipated as heat in the rotor resistance. A liquid starter-resistance is employed in running the motor up to the required speed, after which the slip-ring connections are changed over to the rectifier. Variation of the running speed is then accomplished by means of a shunt regulator in the field circuit of the direct-current motor. A variation of this speed from 240 to 280 r.p.m. can be obtained in this way. When the induction motor is running alone, with the slip-rings short-circuited, the speed at full load is 296 r.p.m. A spare induction motor is also being supplied. In the event of a breakdown in the direct-current motor or rectifier, the main motor can run the fan alone at full speed. All the mechanical components of the plant have been designed to transmit a maximum of 1,200 brake horse-power at 296 r.p.m.

SHAPING MACHINE FOR SHEET METAL.

A POWER-OPERATED machine capable of rapidly cold-forming sheets of aluminium, copper and steel into a wide variety of shapes is illustrated in Fig. 1, herewith; examples of its work are shown in Fig. 3. It is capable of forming sheets of light alloy up to 5 mm. (No. 6 Birmingham Gauge) in thickness, copper up to 3 mm. (11 B.G.), mild steel up to 2½ mm. (12 B.G.) and stainless steel up to 1½ mm. (16 B.G.). The manufacturing and selling rights of the machine, the Fokker-Eckold sheet-metal shaper, have been acquired by N. V. Koninklijke Nederlandsche Vliegtuigenfabriek, Amsterdam, Holland.

Power for the machine is supplied by a 2-h.p. electric motor, which is controlled by a pedal, leaving the operator's hands free to manipulate the work-piece. The upper tool head is rigidly fixed, only the lower one moving when the machine is running. Both the upper and lower tools are identical and are supplied in pairs of various diameters to suit different sizes of work; a set of tools can be seen in Fig. 1.

Each tool consists of a housing in which two movable high-tensile steel plates or rams, separated by rubber packing, work in nearly vertical notches. When the tools are forced against the work the two rams are pressed back into the housing along the inclined notches so that—for a shrinkage process—the rams tend to close together; the faces of the rams momentarily in contact with the work induce a local contraction of the material. Conversely, in the stretching process, the rams tend to press outwards when coming into contact with the work, so causing a local stretching of the material. This action is repeated at 300 strokes per minute as the operator guides the work through the machine, so forming the sheet into the required shape. The process is almost noiseless and the wear on tools is negligible. A hand-operated shaper for smaller and lighter works is illustrated in Fig. 3.

NOTES FROM THE INDUSTRIAL CENTRES.

SCOTLAND.

THE LATE MR. A. W. STEVEN.—The death occurred on July 3 of Honorary Sheriff-substitute Alexander William Steven, J.P., of Polmont, a former chairman of Allied Ironfounders, Ltd. He began work in the family business of McDowall, Steven, & Co., Ltd., when he was 18, and as a director, in 1923, he initiated a merger with other firms to form Light Castings, Ltd., and became the first chairman. This firm amalgamated with several other Scottish and English foundries in 1929 to form Allied Ironfounders, Ltd., of which he was chairman from then until 1943. He had been a director of Andrew Barclay, Sons & Co., Ltd., Kilmarnock, of which he was chairman till his death. Mr. Steven was 84.

THE STEEL INDUSTRY.—Steel production in June increased to the equivalent of 2,210,200 tons per annum, as compared with 2,150,700 tons in May and 2,140,500 tons in June, 1951. The rate for the first six months of the present year was 2,070,500 tons, against 2,231,800 tons in the corresponding period of 1951. A decision was taken in May last year to restrict production on account of the cut in scrap imports. Pig-iron outputs in June were at a rate of 904,500 tons per annum, compared with 904,270 tons in May, and 756,400 tons in June last year. The production in the first half of the year rose to the equivalent of 888,800 tons, against 765,400 tons in the corresponding period of 1951. Scottish steel producers are now receiving more than one-half of all the scrap imported into the United Kingdom, according to Mr. Henderson Stewart, Under-Secretary of State for Scotland, speaking on Scottish steel supplies in the House of Commons on July 10. Scotland is also being given a substantial share of the steel ingots received from the United States.

NEW PLANT OF SCOTTISH GAS BOARD.—The value of new projects approved by the Scottish Gas Board, during the second half of the present year, was estimated at 666,800l., it was stated by Baillie S. Leith, of Glasgow at a meeting of the Scottish Gas Consultative Council in Edinburgh on July 9. One of the outstanding items of work, he added, was the installation of an 8,000,000-cub. ft. per day carburetted water-gas plant at Provan Works, Glasgow. This, it was estimated, would cost 317,790l.

ELECTRONICS INDUSTRY IN EDINBURGH.—In a written reply in the House of Commons to a question on the development of the electronics industry in Scotland, the Minister of Supply reported on July 10 that a scheme had been worked out for a new laboratory block to be erected adjacent to the premises of Messrs. Ferranti Ltd., in Edinburgh. The total cost was estimated to be 513,000l. Machine tools to the value of 102,000l. had been allocated to the firm from Ministry stocks.

OVERSEAS STUDENTS AT HERIOT-WATT COLLEGE.—Whereas, before the war of 1939-45, Norwegians in search of higher technological training used to go to Germany, they now tended to come to this country, said Principal H. B. Nisbet at a presentation ceremony in the Heriot-Watt College, Edinburgh, on July 10.

WASHERY SLURRY AS FUEL.—It is reported that a new steam electricity-generating plant having a capacity of 60 MW is to be built to use washery slurry as a fuel. The slurry will come from the washery plant at a new colliery to be sunk in Ayrshire, the power station being built beside the pit. The plant is estimated to cost 4,000,000l.

CLEVELAND AND THE NORTHERN COUNTIES.

WORK OF TEES CONSERVANCY COMMISSION.—Revenue received from the River Tees tolls and dues for May of this year was the highest ever recorded for the month of May. The amount raised in revenue was 29,394l., an increase of 1,525l. on April and of 4,419l. on May of 1951. In June, the net registered tonnage of ship clearances in the Tees was 374,420, an increase of 147,489 on June of last year. The number of vessels concerned, however, was 257, or 14 fewer than in June, 1951. Imports, during May, totalled 333,330 tons, the highest since August of last year, and an increase on April unloadings of 16,615 tons, due mainly to increased imports of coal, phosphates, and steel billets. The total tonnage exported in May reached 140,398 tons and was the highest since March, 1951. This was due mainly to increased loadings of sulphate of ammonia.

COAL-FIRED GAS-TURBINE LOCOMOTIVE.—Following successful tests of their experimental gas-turbine, operating on pulverised coal, Messrs. C. A. Parsons & Co., Ltd., Heaton Works, Newcastle-upon-Tyne, have received from the Ministry of Fuel and Power an order for a main-line geared gas-turbine locomotive to use pulverised coal. The design and construction of the locomotive are being undertaken by the firm jointly with the North British Locomotive Co., Ltd., who will supply the main frame and running gear.

ORE DISCHARGING ON THE TEES.—Rapid discharge of foreign ore cargoes in the River Tees continues to be achieved. At the South Bank Wharf of Dorman Long & Co., Ltd., five large ore ships were completely discharged, and two more partly discharged in the week ending June 28. The total quantity of ore handled over the wharf in that week was 41,838 tons, which was dealt with in 12½ working shifts. Another quick turn-round was achieved on July 3, when the S.S. Holmside arrived at 12.30 a.m. and her cargo of 3,778 tons of iron ore was completely discharged in less than 12 working hours.

LADLE CRANES FOR MIDDLESBROUGH.—Newton Chambers & Co., Ltd., Thorndiffe Ironworks, are fabricating the structural steelwork for three 160-ton ladle cranes for the new Lackenby steel plant, Middlesbrough, of Dorman, Long and Co., Ltd. The structures comprise main girders, main trolley frames, auxiliary trolley frames, auxiliary trolley girders, end carriages, etc. The crane span is 75 ft., the bogie centres, 33 ft., and the weight of each structure approximately 165 tons.

EMPLOYMENT AT NEW FACTORIES.—A report submitted to the Northern Regional Board for Industry, Newcastle-on-Tyne, states that the priority scheme for steel supplies is operating smoothly, but that orders for steel are "somewhat difficult" to place for work not included in the priority class. The position, however, is expected to improve towards the end of the year. In shipbuilding, the steel shortage is restricting construction and lengthening building times, although new orders are still being received. The amount of work obtained by the repair yards is steady and the Admiralty are assisting firms to obtain materials and components so that they can complete orders on schedule. Mr. K. G. Sillar, the Board of Trade Regional Controller, in a report to the Northern Regional Board, states that, in a period of two months, 18 licences for industrial developments, covering 738,899 sq. ft. of factory space, have been issued. These are expected to result in the employment of 1,381 additional men and 215 women. Two factories on the Aycliffe trading estate have been allocated to firms already operating on the estate, and, on the Bede estate, Jarrow, a firm making electrical components have been allocated another 7,000 sq. ft. of space, which will provide work for another 110 persons.

INVESTIGATION ON DISTRIBUTION OF INDUSTRY ACT.—The North-East Development Association, in co-operation with the Northern Industrial Group, is to carry out research work into the effects of the Distribution of Industry Act. Questions to be investigated will include the amount of employment new industries have created and the proportion of men and women employed; the possibility of expanding the new industries; whether they are working for home or export markets; and whether they are subject to the same fluctuations in prosperity as the old-established industries in the region. It is hoped that the research work will help to formulate proposals to prevent a situation arising similar to that which occurred in Lancashire at the time of the sudden slump in the cotton industry.

TIMBER DISCHARGING AT WEST HARTLEPOOL.—The National Dock Labour Corporation proposes to bring surplus men from other ports to help in the unloading of timber-carrying ships at West Hartlepool, during the port's busiest season which has just begun. It has been the custom, up till now, to employ seasonal employees to help out at busy times. These are men normally employed at other work. The Dock Labour Corporation, however, which is faced with a surplus of men at certain other ports, wishes to employ them at West Hartlepool.

WORK AT BILLINGHAM.—About 140 men employed at the Billingham-on-Tees Works of Imperial Chemical Industries, Ltd., have been transferred to other tasks at the plant, owing to a falling-off in the demand for some of the firm's products. The falling-off relates to plasterboard, resulting in the transfer of 27 men to other work; "Perspex" (80 men transferred); salt production (13 transferred); and the amines pilot plant (20 transferred).

AUSTRALIAN FACTORY PROJECT.—Messrs. Steel & Co., Ltd., Sunderland, are considering the establishment

of a factory in Australia for the assembly and partial manufacture of earth-moving equipment. Mr. J. E. Steel, the chairman and managing director, has been studying Australian conditions and investigating suitable sites for new works.

LANCASHIRE AND SOUTH YORKSHIRE.

STEEL WORKING WEEK SHORTENED.—The labour shortage in the steel industry will be accentuated by the recent agreement, within the industry, to introduce a 44-hour working week in place of that of 48 hours. It is computed that the operation of the new agreement will require an additional man for every eleven previously employed.

ALLOY-STEEL PRODUCTION.—Sheffield makers of alloy steels are achieving noteworthy success in maintaining production at a high level by the use of alternative alloying elements. A good deal of concern, however, is being caused by increased pilfering from works stores of alloy steels, which are marketed after the distinguishing marks have been removed.

THE COST OF LABOUR TURNOVER.—Research workers at Sheffield University have ascertained that a fifth of the labour force of an average Sheffield firm changes every year, and they have been endeavouring to find out what this costs. Their latest report shows that, in Sheffield, women change their jobs at least twice as often as men. Most unsettled of all are women under 20. The firms with the best record for keeping their employees are the small family concerns having under 100 employees and the large concerns having over 2,000. The worst are those employing between 100 and 250. With firms of between 250 and 1,000 employees, an effective personnel relations department brings the rate of leaving down again. As a firm grows beyond 1,000 to 2,000 employees, the possibilities of betterment within the firm bring about a greater stability.

LANCASHIRE-BUILT TRANSFORMERS FOR UNITED STATES.—News was received in this country, on July 16, that the United States Department of the Army had accepted the tender of Ferranti Ltd., Hollinwood, Lancashire, for nine 33,000-kVA power transformers for installation in connection with the Garrison Dam project, near Bismarck, North Dakota. The sum quoted by Ferranti Ltd. is given as 1,137,605 dol., or about 406,093l.

THE MIDLANDS.

SEARCH FOR WORKPEOPLE.—It is officially stated that the need for more workpeople for the iron and steel industries in North Lincolnshire will continue to increase during the next four months. The quarterly report of the Scunthorpe Employment Exchange shows that, in the three months ended June 30, employees obtained from outside areas included 415 from Grimsby, 168 from Goole, 107 from Thorne, 107 from Brigg, 76 from Barton-on-Humber, 40 from Sunderland, 20 from Doncaster, and smaller numbers from 26 other areas.

GASWORKS EXTENSIONS.—The new retort house at the Tipton works of the West Midlands Gas Board has now been completed. The extension, which was planned in 1947, is a completely new building adjacent to the existing works, and contains 22 Woodall-Duckham vertical retorts. It can carbonise up to 165 tons of coal a day. Space has been reserved for another six retorts.

BRIDGNORTH CASTLE HILL RAILWAY.—The 60th anniversary of the opening of the cable railway at Castle Hill, Bridgnorth, was celebrated on July 7. It is the only passenger-carrying cliff railway in the Midlands. Bridgnorth is situated at a point in the Severn valley where there are steep sandstone cliffs. Part of the town is at the river side, and the remainder at the top of a cliff. The Castle Hill Railway was opened in 1892 to join the two parts of the town; previously, the only means of communication between High Town and Low Town was a winding road which made a long detour, or a stairway with over 200 steps. The railway is 201 ft. long, and rises 111 ft. At first, it was worked as a water-balance lift, but later it was electrified. There are two cars, connected by cable and controlled from the head of the incline.

MESSRS. KENNETH HUDSON AND SON.—The Long Lea works, Elland, Yorkshire, of Kenneth Hudson & Son have been removed to Darlaston, Staffordshire. The firm, manufacturers of agricultural implements, form a subsidiary of J. E. Brassey & Son, Ltd., of

Chester, who are, in turn, members of the Owen organisation. The Elland business is to be carried on at the Darlston works of Rubery Owen & Co., Ltd., but will retain its own identity.

OPENCAST COAL PROJECTS.—The National Coal Board have notified the town council of Walsall of their intention to prospect for open-cast coal at three sites within the borough. Originally, four sites were named, but one was withdrawn from the list after objections had been raised by the Walsall Planning Committee. Open-cast coal mining on the remaining three sites is to be resisted by the Council on the grounds that the land is either wanted for housing, or has a high agricultural value. It has also been stated locally that the coal obtained from adjacent sites has been of such low grade as to be useless, and that the land is particularly liable to flooding.

COAL OUTPUT IN THE WEST MIDLANDS.—The chairman of the West Midlands Division of the National Coal Board, Mr. I. W. Cumberbatch, has stated that the output of coal in the Division for the first half of this year shows an increase of 29,557 tons compared with the same period in 1951, in spite of the fact that the output from the voluntary Saturday-shift working has fallen by nearly 10,000 tons.

MESSRS. JOHN THOMPSON, LTD.—Mr. E. W. Thompson, the chairman of John Thompson, Ltd., the parent company of the Thompson group of engineering companies centred at Wolverhampton, said in his report at the annual meeting of the company, on July 23, that orders in hand were valued at 33,000,000l., not including certain re-armament work.

SOUTH-WEST ENGLAND AND SOUTH WALES.

WELSH IRON AND STEEL PRODUCTION.—Figures issued by the British Iron and Steel Federation show a slight improvement in the South Wales steel production for June, though it remained below the average for the first half of the year. The weekly average output of steel ingots and castings, in June, was 68,440 tons, compared with 66,810 tons in May, and 68,670 tons in the first half of the year. For June, 1951, the average weekly figure was 68,730 tons. The production of pig iron averaged 27,220 tons a week, compared with 27,370 tons in May and 26,680 tons for the first six months of the year. Last June, it was 25,910 tons.

TRAFFIC AT SOUTH WALES PORTS.—The gross receipts from the South-Wales ports in 1951, namely, 3,520,000l., were better than those from any other area. This was disclosed in the British Transport Commission's report, which, however, points out that there was a deficit of 23,000l. on the year's working. This, however, was an improvement of 182,000l. on the previous year. The Swansea docks operated at a profit, but deficits at the other ports more than offset this.

EXPORTS OF COAL TO EUROPE TO BE INCREASED.—Hopes in South Wales of some improvement in the level of the coal-export trade in the last six months of the year, following the decision to expand the country's exports, are confirmed by the announced intention to build up the French trade. This, which started at the beginning of the present year at a level of between 30,000 and 40,000 tons a month from South Wales, is expected to reach 100,000 tons a month under a new six-months contract recently arranged. There are also prospects of improved exports to Italy.

SHIPBUILDING ON RIVER USK.—A further step in connection with the project for a shipbuilding yard on the River Usk, at Newport, is the formation of a development company. This has been registered as the Bailey Shipbuilding Development Co., with a nominal capital of 100l.

BRISTOL AEROPLANE COMPANY APPRENTICES.—The Vice-Chancellor of Bristol University, Sir Philip Morris, C.B.E., M.A., LL.D., presented the prizes awarded to successful apprentices of the Bristol Aeroplane Co., Ltd., Filton, Bristol, at the ceremony held on June 28. In an introductory speech, Mr. W. R. Verdon Smith, joint managing director of the Bristol company, said that the premises of the company's technical school were inadequate, and a new school has been planned with greatly improved laboratory, workshops and classroom facilities. It was hoped that it might be possible to start building the new school in 1953-54. At present, 58 Bristol apprentices had been sent to universities, and nine were studying at the College of Aeronautics, Cranfield. Altogether there were 918 apprentices in all the divisions of the company, including the Car Division and the works at Weston-super-Mare.

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.

Electrical Equipment and Indicating Instruments for Aircraft.—A new specification in the series relating to aircraft, B.S. No. G.100, deals with the general requirements for electrical equipment and indicating instruments for use in aeroplanes. The publication is concerned with airworthiness requirements as these govern the design of equipment and instruments, the detailed requirements for which are covered in individual specifications designated by the letter G in the series relating to aircraft. The specification contains sections on requirements relating to operating conditions, materials and processes, data on particular design requirements, and tests. Appendices deal with recommended practices for the avoidance of corrosion, a test for flameproof equipment, impact acceleration tests and other matters. [Price 6s., postage included.]

Glossary of Terms used for Solid-Fuel Burning and Allied Appliances.—A new publication, B.S. No. 1846, entitled "Glossary of Terms used for Solid-Fuel Burning and Allied Appliances," has been prepared at the request of the Combustion Engineering Association. Its principal object has been to cover as wide a field as practicable in connection with appliances burning solid fuel. Included are definitions of space-heating, water-heating and cooking appliances, steam boilers, and pulverised-fuel, gasification and other plant. A comprehensive index is provided. [Price 3s., postage included.]

Pipe Cutters.—Another new publication, B.S. No. 1857, deals with pipe cutters of the link type and the three-wheel type, and forms one of a series of specifications under preparation which will cover a variety of commonly-used hand tools. The wide field of application, coupled with the onerous conditions and abuses to which these tools are subject, have made necessary a strict review of interchangeability requirements on account of the insistent demand for spares and replacements. Accordingly, tables giving dimensions and tolerances for all components which may require to be replaced are included. The quality of the tools is safeguarded by requirements relating to materials, hardness, finish and accuracy of assembly. A concluding section is concerned with performance tests. [Price 3s. 6d., postage included.]

Analysis of Zinc in Aluminium and Aluminium Alloys.—The British Standard method for the polarographic determination of zinc in aluminium and its alloys is published as B.S. No. 1728; Part 4. This is an alternative to the mercuric thiocyanate method already issued as Part 3 of the specification. As with polarographic methods in general, the method described is particularly useful for alloys having a low zinc content, and, over a range of 0.02 per cent. to 3 per cent. of zinc it gives results having close agreement with the mercury thiocyanate method. The specification lays down the reagents to be used and recommended methods of sampling and test procedure. An indication of the reproducibility expected is given, this being derived from experiments carried out by a number of independent analysts. [Price 2s., postage included.]

Sizes of X-Ray Film and Intensifying Screens.—A revision of B.S. No. 1443, covering sizes of X-ray film and intensifying screens has now been issued. The specification, which was first published in 1948, relates to material for medical and industrial use, other than dental X-ray films and X-ray films for crystallography, for which separate specifications will be issued in due course. In preparing the new edition, a careful review of the nominal sizes has been made and it has been found desirable to include two additional sizes, namely, 11 in. by 14 in. and 15 cm. by 40 cm. Minor adjustments have been made in respect of the tolerances on the cutting sizes of the films, and, where the nominal sizes are the same as those for photographic sheet film, as specified in B.S. No. 1772, the cutting dimensions and tolerances have now been brought completely into accord in the two specifications, namely, B.S. Nos. 1443 and 1772. Reference to the internal dimensions of cassettes has been omitted, as it is intended to prepare a separate specification for the dimensions of cassettes. The method of marking packaged films and screens is indicated in the present publication. [Price 2s., postage included.]

RE-OPENING OF "DESIGN REVIEW."—The Council of Industrial Design, Tilbury House, Petty France, London, S.W.1, have re-opened *Design Review*—a photographic index of good current British designs of durable consumer goods, which was first presented at the South Bank Exhibition last year.

PERSONAL.

AIR COMMODORE SIR FRANK WHITTLE, K.B.E., C.B., D.Sc., F.R.S., is relinquishing his position as honorary technical adviser on jet development to the British Overseas Airways Corporation, as from the end of this week.

MR. H. BISHOP, C.B.E., B.Sc. (Eng.), F.C.G.I., M.I.E.E., M.I.Mech.E., becomes director of technical services, British Broadcasting Corporation, in succession to Sir Noel Ashbridge, B.Sc., M.I.C.E., M.I.E.E., F.K.C., who is retiring. Mr. R. T. B. WYNN, C.B.E., M.A., M.I.E.E., is to be chief engineer in succession to Mr. Bishop. Mr. F. C. McLEAN, M.B.E., B.Sc., M.I.E.E., will succeed Mr. Wynn as deputy chief engineer.

MR. J. CECIL MITCHESON, B.Sc. (Birm.), has been elected President of the Institution of Mining Engineers, 436, Salisbury House, Finsbury-circus, London, E.C.2, for 1953-54, in succession to Mr. R. J. WEEKS.

MR. A. G. SALISBURY retires from the motor engineering department of the British Thomson-Houston Co., Ltd., Rugby, at the end of this month, after some 44 years of service.

MR. ARTHUR DAVENPORT, F.R.Ae.S., has relinquished the office of technical director of Westland Aircraft Ltd., but retains his seat on the board. Mr. D. L. HOLLIS WILLIAMS, B.Sc., F.R.Ae.S., has been appointed technical director, in succession to Mr. Davenport.

MR. W. M. WIDGERY, F.R.Ae.S., has been appointed technical director of Normalair Ltd. Mr. N. H. PAYNE, B.Sc., M.I.Mech.E., is joining the company as chief engineer in August.

MR. L. R. E. JENKINS, steelworks superintendent, Workington Iron & Steel Co. since 1937, is retiring after 41 years of service with the company. His successor is Mr. F. B. CAWLEY, M.Met.

MR. H. T. WORDSWORTH has retired from the post of general manager of Sanderson Brothers and Newbould Ltd., Newhall-road, Sheffield, but remains on the board. He has been with the company for 54 years. Mr. J. R. A. BULL, formerly sales director, is appointed managing director.

MR. G. B. PROCTOR, B.Sc.Tech., A.M.I.E.E., has been appointed managing director to Transformers and Welders, Ltd., Watford, Hertfordshire.

MR. K. C. T. MARSHALL has been appointed a director of Lightalloys Ltd., Alpax Works, St. Leonards-road, London, N.W.10.

MR. W. E. FULLER has been appointed information officer of the British Steel Founders' Association.

MR. R. C. CROSS has resigned his position as foundry manager and chief metallurgist with David Brown-Jackson Ltd., Salford, to take up a new appointment with Foundry Services Ltd., Long Acre, Nechells, Birmingham, 7, in connection with future developments of the company in South Africa.

MR. F. R. HEAD, J.P. formerly production controller of the Biscot-road Works, Luton, Bedfordshire, of George Kent Ltd., has been appointed manager of the firm's new Lea Works, Luton.

MR. C. B. PAGET, A.M.I.C.E., A.M.I.Mun.E., has been appointed to the Colonial Engineering Service to be an executive engineer in Northern Rhodesia.

MR. F. A. CALLABY has been appointed financial controller of the Westinghouse Brake and Signal Co. Ltd., 82, York-way, King's Cross, London, N.1. He will be directly responsible to the managing director.

MR. B. (PETER) HAWLEY has taken up a directorship with A. E. Walsh & Partners Ltd., management and industrial consultants, 92, New Cavendish-street, Portland-place, London, W.1.

SUNVIC CONTROLS LTD., 10, Essex-street, Strand, London, W.C.2, are opening a continental office at Skindergade 38, Copenhagen K., Denmark, under Mr. B. HVEISSEL, as from August 15.

WILD-BARFIELD ELECTRIC FURNACES LTD., Elecfurn Works, Watford By-Pass, Watford, Hertfordshire, in conjunction with their associates, G.W.B. ELECTRIC FURNACES LTD., have established an office in Scotland, at 131, West Regent-street, Glasgow, C.2, under the control of Mr. D. McDERMOTT.

The Northern Ireland Minister of Commerce states that negotiations with the WANDLESIDE CABLE WORKS LTD., of London, for the establishment of a manufacturing unit in Northern Ireland have been successful. The company, a subsidiary of FALK, STADELMANN & CO. LTD., will occupy a new factory for the production of electric cables at Newcastle, Co. Down.

The title of the KING'S COLLEGE LONDON OLD STUDENTS' ASSOCIATION ENGINEERING BRANCH has been changed to KING'S COLLEGE LONDON ENGINEERS' ASSOCIATION.

209-IN. AXIAL-FLOW MINE-VENTILATING FAN.

WALKER BROTHERS (WIGAN), LIMITED, WIGAN.

(For Description, see Page 76.)

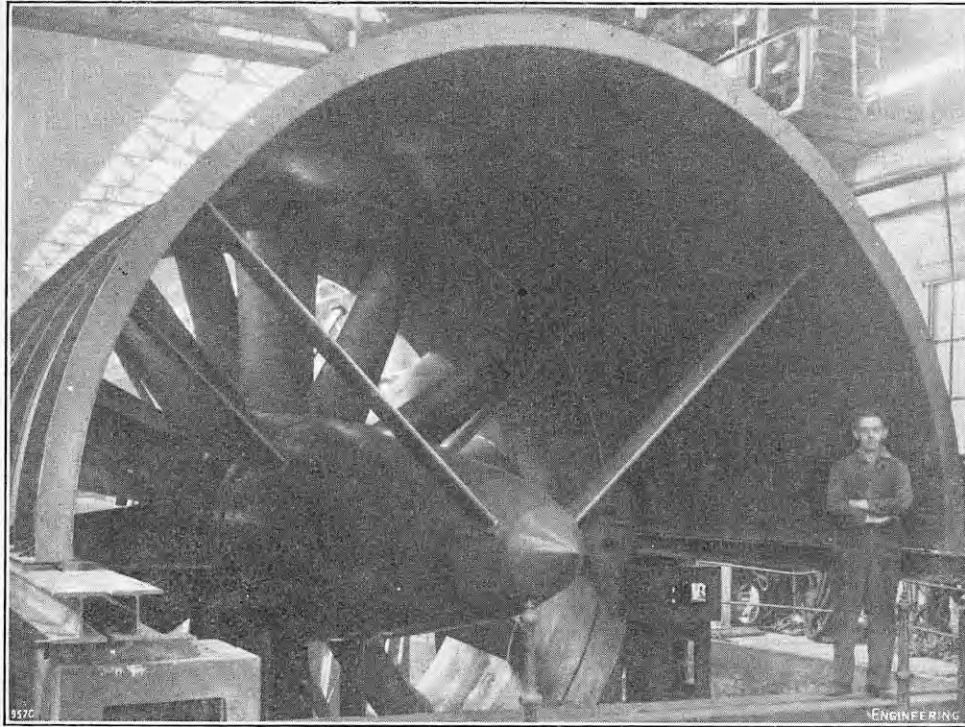


FIG. 3. OUTLET END OF FAN.

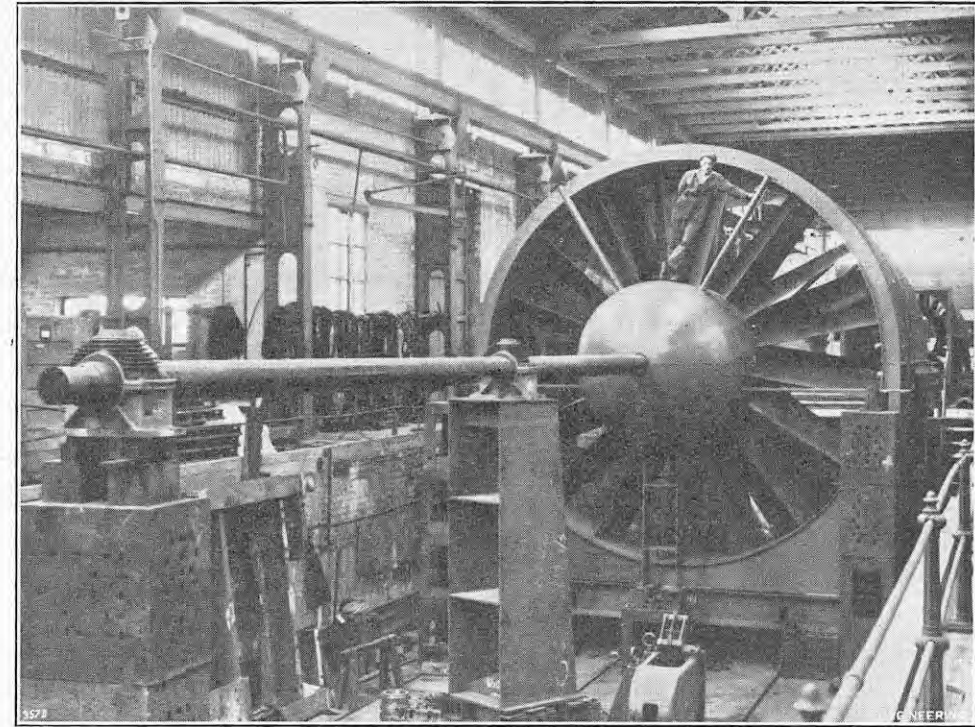


FIG. 4. FAN AND DRIVING SHAFT FROM INLET END.

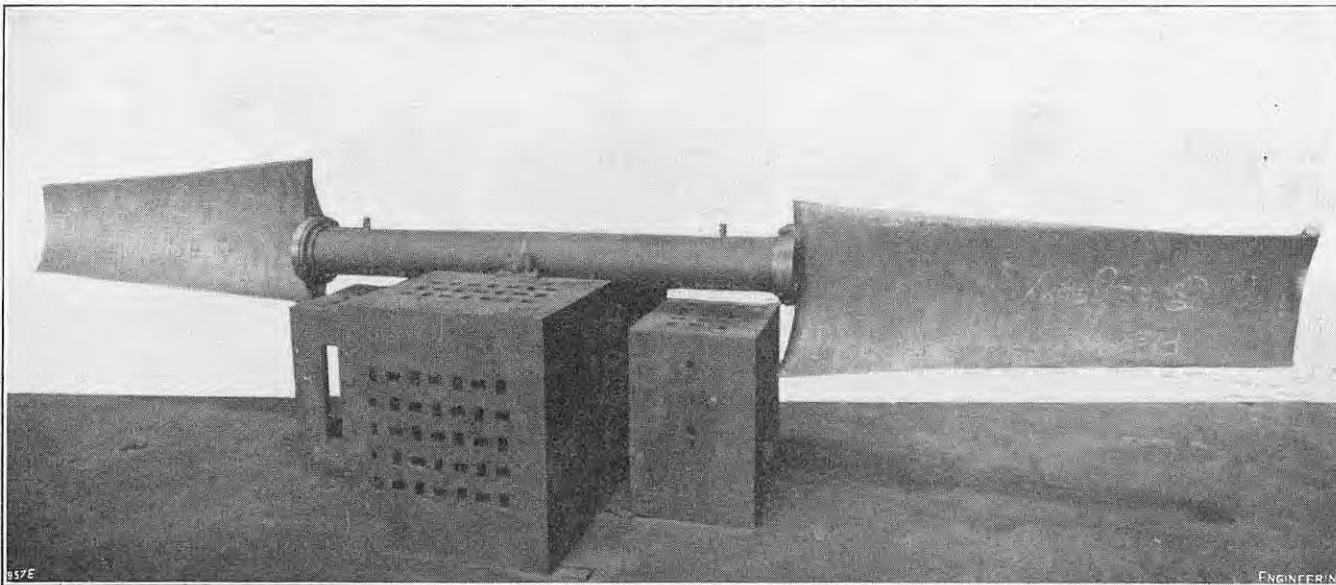


FIG. 5. BALANCING FAN BLADES.

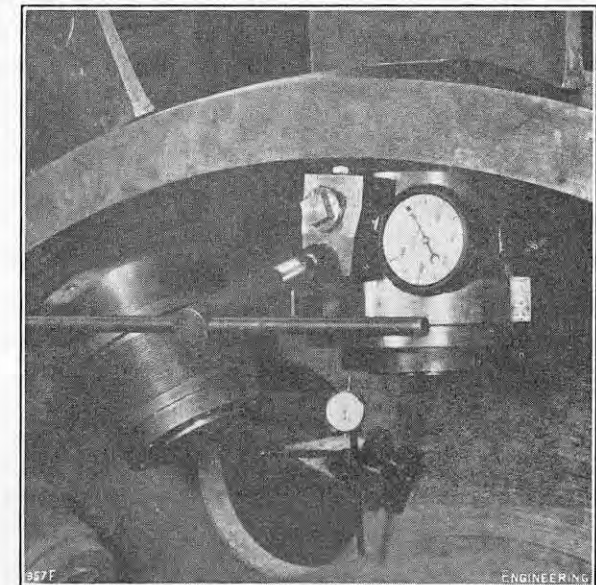


FIG. 6. BLADE-SHANK TENSIONING DEVICE.

ENGINEERING

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

Registered at the General Post Office as a Newspaper.

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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, JULY 18, 1952.

VOL. 174.

No. 4512.

TRANSPORT ENGINEERING.

THE annual reports of the British Transport Commission, reviewing the work of the Railway, London Transport, Road Haulage, Road Passenger, Hotels, and Docks and Inland Waterways Executives, cover an enormous range of activities—legal, financial, commercial, operating, administrative, engineering, scientific, welfare, advertising and public relations (to mention some at random)—of an industry which employs over 888,000 people. Only inadvertently is a little light relief afforded in these ponderous documents, as when, in the report for 1951 published last week,* the Docks and Inland Waterways Executive state, under the heading "Pleasure Craft," that "The cruises on the Caledonian Canal, which were operated by a private firm, were discontinued, but a motor boat belonging to the Executive was used on the Crinan Canal for the carriage of passengers, although the trips were limited by inclement weather." There is an opening here for students of the relative merits of private enterprise and State monopoly, but our immediate concern is with the engineering subject-matter of the report; it covers a wide field in some detail,

* British Transport Commission. Fourth Annual Report for the year ended 31st December, 1951. H.M. Stationery Office. [Price 5s. net.]

and contains pronouncements of some importance on engineering policy.

A decision of the Commission that comes in this category relates to the acceptance of a recommendation, made by the Railway Executive, that the most suitable type of wagon for the conveyance of coal is a four-wheeled vehicle of 24½ tons capacity. Generally speaking, there are no obstacles to the running of these wagons over the railways, but their height above rail level (9 ft. 11½ in. for the flat-bottom design and 10 ft. 11½ in. for the hopper design) exceeds that permitted at many colliery screens. The discharging appliances at ports may also be required to be adapted. During the year, 36,910 new wagons of all types were constructed, but this total was 10,000 wagons less than the capacity of the railway and industrial shops. The shortage of steel was the chief cause of the inadequate number, as it was of the arrears of construction of coaching stock; 1,923 were built, but this was 1,487 less than the authorised programme. The railways made the most of their rolling stock, however, by cutting down the proportion under or awaiting repair; since 1947 the maximum and minimum percentages of wagons under or awaiting repair have been reduced from 16·62 and 11·08, respectively, in 1947, to 8·80 and 6·28 in 1951. In the better design and use of wagons, substantial progress was made in expanding the number of fully-braked and partially-braked freight trains travelling at passenger-train speeds.

The first main-line Diesel-electric locomotives used in this country—the two 1,600-h.p. units built for the former London Midland and Scottish Railway—completed a total of 164,000 miles during the year, hauling heavy passenger trains between London and Glasgow in the summer. They regularly hauled the "Royal Scot" in one direction daily and one of the sleeping-car expresses nightly. The 827-h.p. mixed-traffic Diesel-electric locomotive did good service, too, covering 40,000 miles, mostly on freight work, but in the application of Diesel traction to British requirements the Railway Executive continued to place greatest confidence in Diesel-electric shunting locomotives. Over the next five years, 432 of the standard 350-h.p. type and 141 Diesel-mechanical locomotives are to be built. They will replace 635 life-expired steam locomotives, and the annual saving is expected to be over 1,000,000l. The report makes no special point of the two gas-turbine locomotives, but steam locomotives are given the attention their numbers still warrant. Eighty-nine of the first five standard classes were completed, and four more new standard types are expected to appear this year. In 1951, 317 steam and Diesel-electric locomotives and 23 electric locomotives were built.

Development work was started on electric-traction problems to reduce capital and maintenance costs and to improve efficiency, and experiments were begun on the design and lubrication of pantographs and on schemes for quickening the response of supervisory control systems. The Manchester-Sheffield-Wath line was prepared for the commencement of electrically-hauled traffic on a limited section in February of this year. The Commission approved the preparation of detailed plans for the electrification of the London, Tilbury and Southend line, and, as a result of the successful use of high-voltage 50-cycle current in France, a small-scale experiment was put in hand on the Heysham-Morecambe line.

In the civil engineering department, the shortage of steel and labour continued to restrain the maintenance and renewals of permanent way. The Commission state that, "until British Railways can be assured of sufficient steel and staff to carry out the maintenance and renewals, no return to pre-war speeds is practicable." Clearly, the high standards of safety which the railways of this

country have always insisted on are not going to be lowered. In the circumstances, the Railway Executive can do little more than make the most economical use of man-power. They are achieving this by obtaining more mechanical equipment, particularly Matisa ballast-cleaning and ballast-tamping machines, as well as equipment for laying prefabricated track. The renewal of bridges also suffered from the shortage of steel, and in spite of efforts to economise in the use of steel and to use other materials where possible, only 96 bridges, representing two-thirds of the year's programme, could be completed.

The old problems of the railways and canals are in marked contrast to the new problems of the Road Haulage Executive. The acquisition of a large number of private road-haulage businesses, most of them with small fleets of vehicles, has necessitated the development of a soundly organised network of depots, including workshops and offices. Unfortunately, the Commission are now in possession of "an estate, the selection of which was outside their control, comprising a collection of properties of many types and sizes." A large number are entirely unsuitable for the purpose. The Executive have planned an engineering organisation by which maintenance will be divided into five categories and workshops will be similarly classified, but the future of this scheme depends on the fate of the Transport Bill now before Parliament. For the Docks and Inland Waterways Executive the main problem has been to transfer to other authorities the responsibility for canals which are now useful only for drainage, water supply, or recreational and amenity purposes, while developing the commercial possibilities of canals that are still economic for transport. At the docks, efforts have been directed towards the extended mechanisation of handling operations, but progress in this direction depends on the co-operation of the trade unions and their members. On London Transport, technical improvements included the use of pilot-injection equipment in Diesel 'buses and of thinner lubricating oils, the latter development resulting in reduced fuel consumption. The Executive are also investigating fuel consumption trends in 'buses, as affecting traffic congestion and transmission losses; and the effect on railway track capacity of different types of signalling.

Research is undertaken by most of the executives. Some of the work that the railways were concerned with included the treatment of deteriorated brickwork, anti-foam compounds for locomotive boilers, the suitability of the vacuum brake for controlling long freight trains, stress distribution in underframes, static and dynamic strain measurements on bridges, the load-strain characteristics of prestressed concrete, and factors influencing the wear of rails. The Road Haulage Executive have devoted more attention to the use of pallets for loading traffic, transferable bodies for road/rail vehicles, the effect of the use of fork-lift trucks and pallets on the design of vehicles and vessels, the layout of freight depots and stations for integrated road and rail working, and the merits of articulated vehicles, rigid vehicles and rigid vehicles with trailers. The Docks Executive have made progress towards building a small hydraulic laboratory for research into the design and maintenance of waterways, craft and equipment; meanwhile they have investigated other problems with existing equipment. There can be no doubt of the value of investigations of this nature in promoting a more efficient transport service, and when Parliament debates the Transport Bill it is to be hoped that they will consider carefully the choice between an integrated service, supported by extensive research and development but hampered by its bureaucratic tendencies, and a decentralised system which lacks overall co-ordination but flourishes on the enterprise of a large number of private firms.

ATMOSPHERIC DUST AND FUMES.

INTEREST in the annual reports of the Chief Inspectors of alkali works is not confined to those concerned with chemical-manufacturing processes. This is clearly illustrated by the latest report* in which 16 pages deal with "unregistered processes." These comprise spoil banks, power stations, coke ovens, gas works and various other types of establishment which do not require to be registered under the Alkali & c. Works Act. It is indicated in the report, however, that the extent of this valuable supplementary activity may have to be curtailed in the future. The reason for this is that many small chemical works have been closed and their operations transferred to larger and more efficient establishments. This has reduced the total number of registered works but as the larger factories are more complex and are frequently located in less populated districts more time has to be spent by the inspectors during their visits, and also in travelling. The average number of visits to registered works per annum has fallen from four in pre-war years to three in 1951. This state of affairs is considered to be unsatisfactory and the report states that it should be rectified either by appointing more inspectors or by "curtailing quite severely the attention given to non-registered processes."

In view of the value of the comments made and advice given to those responsible for the operation of many unregistered processes, this latter alternative is not to be welcomed, though it is possible that Treasury control, or lack of suitable candidates, may prevent increase of the technical staff. In the course of last year, 283 visits were made to works not registered under the Alkali Act and 95 to spoilbanks. It is probably no part of the duty of the alkali-works inspectors to make a complete survey of the spoilbanks of the country, but on the information available, it is thought that the total number at the end of 1951 was 473, as compared with 466 at the end of 1949. Of the 473, much smoke or fume was being produced by 29 and slight smoke or fume by 199. Most spoilbanks are made up of colliery refuse, but others consist of waste from steelworks or chemical factories. Attention is frequently called by local authorities to the emission of smoke or fumes from spoilbanks, and as the inspectorate has now much accumulated experience it is able to advise about the most effective way of applying water sprays or to suggest that the burning section of a bank should be isolated by cut-off trenches and then blanketed with incombustible material.

Complaints about smoke, dust and grit emitted by steam-raising plants are also largely made by local authorities. Many of the complaints relate to power stations, but industrial power plants and furnaces are also concerned. These latter may involve more difficult cases of suppression than those arising in connection with power-station boilers. The report gives brief information about emissions, and remedial measures adopted, at a number of electricity-generating stations. With the exception only of Battersea power station, the names and locations of the generating stations are not given; they are indicated only by code numbers. The general impression conveyed is that any undesirable conditions which have arisen have been due to obsolescent types of boilers, which, under present conditions, have to be retained in service; "the British Electricity Authority's policy is to instal the latest eliminating devices as labour and materials for the purpose become available." In some cases in which stations have been held to be responsible for gross atmospheric pollution, the Authority has

set up standard deposit gauges and it has been found either that the charges were greatly exaggerated, or that the excessive deposits originated from other sources, not from the power station.

Presumably, rather more detailed information is given about Battersea power station owing to the importance and interest of the work being conducted there on the removal of sulphur oxides from the waste boiler gases. This work will have a bearing on the arrangements to be adopted at the new Bankside station. It is stated that waste gas from Section A of the Battersea station is delivered into a long horizontal flue and discharged through the N.W. and S.W. chimneys; the gas passing to the S.W. chimney was not washed until last October, when the S.W. washer was completed and put into service. All gas from Section B is discharged through the N.E. chimney, the washer of which was commissioned in 1945. During the winter of 1950-51, repairs were carried out to one uptake of the N.E. washer, but last April a complete collapse of the scrubbing elements occurred and it had to be taken out of service again. Repairs have sometimes had to be postponed because shortage of generating plant made it necessary to keep all available plant in service. As a consequence, a large proportion of the waste gas had to be discharged without washing for substantial periods. The position is expected to improve during the current year, and efficiency of operation to be increased, following the provision of metering devices, which should give better control. From November, 1950, to November, 1951, waste gas arising from 59 per cent. of the coal burned was washed, the washed gas retaining 15 per cent. of the sulphur originally present in the coal. The overall result, covering washed and unwashed gas, was that sulphur was removed from gas representing 50 per cent. of the coal burned. The corresponding figure for the preceding 11 months was 45 per cent.

In connection with industrial steam-raising plants, it is stated that complaints of black smoke have become less frequent, indicating increasing efficiency in operation. Some cases of excessive dust emission have been met by fitting cyclones or electrical precipitators, but often the installation of improved arrangements has been delayed by difficulties in obtaining material. In some cases, trouble has been caused by the poor type of coal supplied, a matter over which the user has little or no control. Some industrial processes cannot be carried on without emissions; in connection with gasworks, for instance, it is remarked that "complete elimination of all offensive emissions is impracticable." The Gas Council, however, are giving the matter close attention and new works are planned to give "a reasonably satisfactory compromise between the competing interests of the industry and of the general public."

Atmospheric dust may be caused by stone crushing and the handling of the product, and a case is quoted of a large quarry about which complaints had been received. The crushed stone is handled by conveyors and elevators and the opinion is expressed that "hooding and draughting of all these to dust collectors would be an impracticable proposition." The best that can be done is probably to enclose the worst points of emission. This remark applies also to cement manufacture, which is an industry registered under the Alkali Act. The report states that "the cement-dust problem is... far from being solved and, indeed, in the Thames-side region, where 4 million tons of cement are produced annually, it is probably insuperable." In the larger works, electrical precipitators are usually fitted to deal with kiln gases, but it is stated that certain details regarding their operation are obscure and that stoppages for repairs or inspection may put them out of use for 10 to 100 hours per month. Much atmospheric pollution may also result from grinding and bagging operations.

* *Eighty-Eighth Annual Report on Alkali, Etc., Works by the Chief Inspectors. Proceedings During the Year 1951.* H.M. Stationery Office. [Price 2s. net.]

NOTES.

BRITISH WELDING RESEARCH.

THE annual report of the British Welding Research Association for the year ended March 31, 1952, shows that a great deal of useful work is being done in this important branch of engineering. The activities of the Association may be expected to extend still farther in future since, during the year under review, the new laboratory building at Abington, near Cambridge, has been completed. An illustrated description of the laboratory appeared in our issue of July 4, on page 12, *ante*. Apart from one item, which was obtained on loan from the Ministry of Supply, the cost of the equipment, it is satisfactory to note, has been met out of current income. Attention is called to the activities of the summer school, which was held at Ashorne Hill during July, 1951, and at which a number of lectures and demonstrations on all aspects of welding were given. The report of the Anglo-American productivity team on welding, of which Dr. H. G. Taylor was leader, was also the basis of a number of lectures, which were delivered throughout the country. Requests for technical assistance increased to 160, of which 34 involved laboratory investigation. In this connection, the useful suggestion is made that it would be an advantage if senior research workers were brought into closer connection with members' problems. It has been arranged, therefore, for these to be investigated on the spot by specialists in the particular branch concerned, a procedure which should be of mutual advantage.

PUBLIC HEALTH ENGINEERING.

On several occasions, we have drawn attention to the courses in public-health engineering arranged jointly by the Imperial College of Science and Technology and the London School of Hygiene and Tropical Medicine. The second of these post-graduate courses has been completed recently, and we have now received a report on it from Mr. F. E. Bruce, the Rockefeller Lecturer in the subject at the Imperial College. Six students, representing the United Kingdom, Ireland, Egypt and Pakistan, took the course, which followed generally on the lines laid down for the previous course, except that advantage was taken of the improved facilities provided for the study of various subjects; for example, the laboratory for the study of public-health engineering at the City and Guilds College was extended during the summer of 1951, a considerable amount of new equipment being installed; and a laboratory is now available in the London School of Hygiene for training in air sampling, dust counting, and other aspects of air hygiene. In the arrangement of the course, the chemistry, botany, mathematics and civil-engineering departments of the Imperial College co-operate in teaching the student the chemical, bacteriological, hydrological and engineering aspects of water supply and treatment, sewage disposal, and water pollution; and tropical hygiene is given special attention—including a course at the Ross Institute of Tropical Hygiene, preceded by one on elementary entomology in the zoology department of Imperial College—for the benefit of students from overseas. The course is supplemented by numerous visits to works, etc., and the vacation work is arranged to give the students practical experience of the operation of plant. Enrolment is now proceeding for the 1952-53 course, particulars of which may be obtained from the Deputy Registrar, City and Guilds College Exhibition-road, London, S.W.7. Attention may be drawn, also, to the Rockefeller Foundation bursaries in public-health engineering, a notice of which appears on page 96 of this issue.

BRITISH AND AMERICAN STANDARDS FOR OIL CIRCUIT-BREAKERS.

The principles upon which oil circuit-breakers are rated and their performance is interpreted differ in this country from those in the United States; for instance, American practice assesses the rating on the asymmetrical breaking current, while in Great Britain the symmetrical breaking current is used. As a result, the American rating appears to be larger than the British for the same type of equipment. Although this difference is offset

to some extent by the American practice of assessing the fault megavolt-amperes of a system, so that only a proportion of the direct-current component (which is assumed to be present, after a time corresponding to the opening time) is included, the general tendency appears to be to instal circuit-breakers which, for a given duty, have a lower symmetrical breaking capacity than would be considered satisfactory by British standards. While the British specification requires both symmetrical and asymmetrical breaking capacities to be proved, the corresponding American document only requires proof of the latter value. The British specification lays down that the peak making current shall not be less than 2.55 times the root-mean-square symmetrical breaking current, but no specified value of making current is specified in America. The British specification stipulates that the recovery voltage on test shall not be less than 95 per cent. of the rated voltage for ratings up to 500 MVA, while American specifications permit a drop to 85 per cent. and, in calculating the megavolt-amperes broken, use the applied voltage in a way which may lead to optimistic results. The short-circuit tests and severity conditions laid down in the British specification are much more comprehensive than those of the American. These differences are discussed at length in a pamphlet entitled "Comparison between British and American Standards for the Short-Circuit Rating, Performance, Selection and Testing of Oil Circuit-Breakers," which has recently been published by the Association of Short-Circuit Testing Authorities, 36, Kingsway, London, W.C.2, at the price of 10s.; and the conclusion is reached that, unless due allowance is made for them, a circuit-breaker made to British standards may appear to compare unfavourably with one that complies with American standards. In fact, owing to greater stringency of the British Standards, the reverse may be true, a point that is worth emphasising.

THE PROFESSIONAL CLASSES AID COUNCIL.

As its name implies, the Professional Classes Aid Council—better known, perhaps, as the "P.C.A.C."—exists for the relief of distress among the professional classes and others who may be considered eligible—"people," to quote the preamble to the report for 1951-52, "who suffer as much as any, but are reluctant to disclose their difficulties." To quote the preamble further: "The Council is composed of representatives of almost all the great professional bodies, and it works in close association with their benevolent funds and institutions." How close this association is, we can testify from first-hand knowledge; but probably one of the most important functions of the Council arises from the fact (quoting the report again) that "because of the restricted scope of some of these funds, many professional people are ineligible for aid from them." In such cases, the Council can be, and is, of great assistance to many who otherwise would find themselves in circumstances of peculiar difficulty. The amount spent on relief during the past year was 12,357l., including 1,874l. which was administered for other societies; 262 families were given financial aid. During the year, 5,059l. was spent on education, 121 children being helped. The Council maintain a register, dating back to 1921, for the use of all societies, etc., dealing with the professional classes, to prevent overlapping in assistance. The office of the P.C.A.C. is at 20, Campden Hill-square, London, W.8. (Tel.: PARK 9191.)

PORT OPERATIONS PANELS.

Port Operations Panels, consisting of representatives of port authorities, shipowners, port employers and labour, have been set up at a number of the main ports of Great Britain, with the object of ensuring the most effective use of physical resources and of securing the full use of dock labour. Their appointment is one result of the work of the Ports Efficiency Committee, recently set up by Lord Leathers, Secretary of State for the Co-ordination of Transport, Fuel and Power. By meeting at frequent intervals, the Panels will keep in touch with the factors leading to delays to ships or cargoes at their ports and, where sufficient action to remove these factors cannot be taken locally, they will report the position to the Ports Efficiency Com-

mittee. Port Operations Panels have now been established at London, Liverpool, Manchester, Sunderland, Dundee, Hull, Newport, Cardiff, Barry, Port Talbot, Swansea, Middlesbrough and Hartlepool, their secretaries being accommodated at the offices of the respective port authorities. A parallel set of committees has been set up simultaneously at the ports, at the instigation of the Federation of British Industries, the Association of British Chambers of Commerce, the National Union of Manufacturers, the Chamber of Shipping, and the Liverpool Steam Ship Owners' Association. These committees are known as the Port Users' Committees and function in co-operation with a central Port Users' Committee in London. They serve to co-ordinate the "user" interest of ship-owners and traders generally in relation to the ports at which they are set up, though their scope extends beyond the ports themselves, to any delays in the movement of goods between inland points and the ports. The parts which these two sets of committees can play in improving turn-round are complementary, one approaching the problem from the point of view of the port operator and the other from that of the customer.

OBITUARY.

MR. A. B. SMITH.

It is with much regret, which will be shared by an unusually wide circle of friends, that we record the death, on July 7, of Mr. A. B. Smith, formerly chief mechanical engineer of the Vacuum Oil Company. Mr. Smith, who was 79 years of age, had been living in retirement for a number of years.

Aubrey Beckinton Smith was a Tynesider by birth and received his general education at a private school in Gateshead, at the Science and Art School in Newcastle-on-Tyne, and at Gateshead High School. He served an apprenticeship of seven years to engineering, first with Clarke, Chapman and Company; then with Carrick and Wardale, Limited, also of Gateshead; and finally with Rowland Barnett and Company, of Newcastle. He then went to sea, in 1894, in the Prince Line, and eventually joined the British India Steam Navigation Company, in which (having obtained a Board of Trade chief engineer's certificate) he rose to be second engineer. In 1905 he left the sea on being appointed district engineer for the Vacuum Oil Company in Newcastle. Seven years later, he was made assistant chief engineer to the company and, in 1917, chief engineer, which position he held until his retirement in 1938. He was a member of the Institution of Mechanical Engineers and of the Institute of Marine Engineers.

THE PANAMA CANAL.—The annual report, for the year 1951, of the Governor of the Panama Canal shows that, during the year, there was an appreciable increase (from 5,448 to 5,593) in the number of transits of the Canal, though the net tonnage of shipping passed through fell somewhat, from 28,013,236 tons to 27,180,425 tons. The amount of cargo was greater, however, being 30,073,022 long tons in 1951 as against 28,872,293 tons in the previous year; the cargo tonnage, in fact, was the highest total recorded since 1929. Of the 5,593 vessels which made transits, 2,203, of nearly 17 million tons gross, belonged to the United States and 1,004, or rather less than 7,645,000 tons, were British. The next highest totals were the 513 ships under the Norwegian flag and the 346 of Honduras. Many vessels, of course, made more than one passage through the Canal; actually the highest number of individual ships under any one flag to pass through consisted of those of British registry, numbering 490. The United States came second, with 461. In maintaining the Canal channel and the terminal harbours, and carrying out various small projects for local widening, etc., the Canal dredgers removed 7,514,500 cubic yards of material—a fairly large quantity, though 15 per cent. less than that recorded in 1950 and 28 per cent. less than in 1949. The percentage of rock excavated was larger than in the previous year, being 13 per cent. as against 11 per cent. The rapid growth of the water hyacinth still presents a problem; the report estimates that more than 55½ million plants were destroyed during the year, about 20 million by pulling them up and the rest by spraying.

LETTERS TO THE EDITOR.

ENGINEERING AND METALLURGICAL RESEARCH BY BABCOCK & WILCOX, LIMITED, AT RENFREW.

TO THE EDITOR OF ENGINEERING.

SIR,—Having been for some years intimately concerned with the application of ultrasonic methods of weld testing and the development of apparatus for this purpose, we were particularly interested in the article which appeared on page 797 of your issue of June 27, describing engineering and metallurgical research being carried on by Messrs. Babcock & Wilcox, Limited, at Renfrew. There are certain points in this article upon which we would like to express our opinions; but before doing so we would call attention to an earlier article which appeared on page 29 of your issue for January 5, 1951; this article, describing ultrasonic testing at Renfrew, followed a paper by Dr. H. Harris to the West of Scotland Iron and Steel Institute on November 17, 1950.

In the first paper, data were given covering the inspection of approximately a thousand weld areas both by X-rays and by ultrasonics. Broadly, the conclusion drawn was that with experienced operators ultrasonic methods would detect all defects which would be found radiographically, but that due to their greater sensitivity too much importance might be attached to many minute inhomogeneities, a proportion of which would not register radiographically. It is interesting, therefore, to learn from the subsequent article that the view now held is that ultrasonic methods, while giving good results with defects of large area, are of limited value for the detection of minute flaws—an apparently contradictory conclusion. Perhaps our experience may help illuminate this point.

When we approached the problem of weld inspection by ultrasonics some five years ago, we immediately encountered the difficulty that, with the amplifier set to give maximum sensitivity, all signals, whether large or small, were amplified roughly to the same extent—including those due to "valve noise." We found that considerable skill and experience were required of the operator to distinguish between signals coming from insignificant inhomogeneities and those from flaws of engineering importance. We accordingly designed amplifiers incorporating a reject or filter circuit at the penultimate stage so that small signals below a certain value—which could be varied at will—did not get through to the indicator unit, though the amplification of signals above that level was unaffected. We found this greatly simplified the task of the operator and our experience of subsequent practical application leads us to believe that the incorporation of some such device is essential if this method of testing is to become as widely practised as its potentialities would seem to warrant.

With regard to the detection of small flaws, we would say at the outset that out of hundreds of feet of weld seam which we have examined and which have also been X-rayed, we have never failed to detect any flaw shown radiographically. We would comment in passing, however, that in our experience the converse does not hold; fine cracks and oxide films, while sometimes eluding the radiographer, were readily detected ultrasonically. Currently, for the detection of the smallest flaws considered to be of engineering significance, we are using shear waves at a frequency of 4 mc. We have used frequencies up to 10 mc. for certain work in connection with the detection of fine oxide films in flash welds but so far have found 4 mc. to be sufficiently high for the detection of the smallest flaws which we have wished to find. We would therefore be interested to learn what is the highest frequency used at Renfrew and how small are the defects which are apparently considered to be at the limit of detectability.

Turning now to the development of a rapid multiple-crystal scanning method, and to the revival of interest in the suspended-particle image converter developed by the Germans, particularly during World War II, these would seem to be representative of current attempts to "make ultrasonics give a

picture like X-rays." We should like to put forward the view that while at the present state of development the permanency of the radiologists' shadowgraph has advantages over the conventional ultrasonic presentation, it does not necessarily follow that a visual impression of this kind is ideal; sometimes interpretation of shadowgraphs becomes the subject of debate between radiologists. We would suggest that a better aim might be to work towards the attainment of a permanent ultrasonic record without losing the fundamental advantage which interpretation by deductive reasoning based on observation of standard operations would appear to offer over interpretation by visual impression.

Your faithfully,

J. W. FOX,
E. M. LEWIS.W. S. Atkins and Partners,
158, Victoria-street,
London, S.W.1.
July 9, 1952.SOME LETTERS OF
ARTHUR WOOLF (1766-1837).

TO THE EDITOR OF ENGINEERING.

SIR,—A survey of the life and work of Arthur Woolf, an outstanding Cornish engineer of the early Nineteenth Century, has been recorded in vol. XIII of the *Transactions* of the Newcomen Society, in a paper by Mr. Rhys Jenkins. Since the publication of that volume, a number of letters written by Woolf, after he left Cornwall, have been found, and afford additional light on his subsequent career. The following extracts are self-explanatory.

The first, addressed to "Henry Harvey Esq. Hayle Foundry by Truro Cornwall," is dated November 10, 1834, and is from Delancey Hill, Guernsey. It reads: "Dear Sir, I have been applied to by a Gentleman for a Steam Engine for grinding Corn. He prefers the two cylinder engine about 10 or 12 Horse power to work with a beam supported by two pillars with Entablature plate across the House and a Cast Iron gallery from the plate to the end of the House over the cylinders, the cylinders to have the same length of stroke viz. 4 feet, length of the boilers, for 10 horse 20 feet and for 12 Horse 24 feet boilers 5 ft. 6 in. Diameter Tubes 2 ft. 9 in. diam.: I shall be glad of your Estimate for the Different Engines complete delivered on board at Hayle as soon as you can, I beg you to include in the estimate my fee £4 per horse power, I can assure you that the payment is certain at the same time I beg you would send a list of the millwork that was made for Gravesend with the diameter and weights of the different wheels and the prices. Neath Abbey Co. has erected one of my Engines with the millwork for 3 pair of stones it was ordered before I came to the Island the Engine is not amiss but the millwork is a complete failure not being at all proportioned and the consequence is that it must all be remade—waiting your reply Dear Sir, Yours Truly Arth. Woolf."

On April 6, following, Woolf again wrote: "When I wrote you in Nov. last I fully expected to get you an order for an Engine but was disappointed the party being then in treaty with Neath Abbey Co. and gave them the order. I am now applied to by a very respectable Gent. for a 10 Horse Engine on the plan I before proposed he is in possession of Estimates from several Engine makers and I have showed him yours, the lowest price is from Copper House Co. £430 or £10 under yours he wishes by all means that I will superintend its erection and I have recommended his having the Engine from you which he has determined on and I believe the payment will be in any way you wish . . ."

Subsequently, the engine was ordered, but it was not delivered until well on in 1836. Writing from "No. 22 Bridge street Southwark" on March 15, 1836, Woolf stated: "I am still in London I have heard this morning that Mr. Symes's engine is arrived at Guernsey I have not heard from Mr. Symes it was mentioned in a letter from Mrs. Woolf I don't know what state the Engine is in but I find that all my things is in a sad condition I have almost concluded my business here and expect to leave in about 10 days. Mr. Symes wrote me last

week that he had accepted Mr. Harvey's Bill for the amount of the Engine I shall be glad if Mr. Harvey will send me the amount of my Premium as I have been at great expense here and I cannot get clear out of London without it. I shall make a good bargain in the French concern with a respectable Compy. and shall want a great quantity of machinery one 63 Inch single for pumping one 40 In. Double with 80 inch blowing complete and one 40 In. Double for Mill and forge I understand that you are all so busy in Cornwall that you cannot take any more orders you can let me know if that is the case . . ."

Four days later, Woolf wrote to Nicholas Harvey: " . . . Do endeavour to persuade Mr. Harvey to send me a part if not the whole as I am entirely out of cash and depended entirely on it to clear me out of London. I want to get back to give directions about fixing the engine before I go to France. I have almost completed my arrangements about the Ironworks in France which will set me above the frowns of the world and I hope before the end of April I have been drove so short that I have been obliged to pawn my Gold watch not a very pleasant thing . . ."

Yours faithfully,

T. R. HARRIS.

5, Atlantic-terrace,
Camborne, Cornwall.BRITISH ELECTRICAL POWER
CONVENTION.

TO THE EDITOR OF ENGINEERING.

SIR,—The report of my paper, presented at the above Convention, which appears in the last column of page 29 in your issue of July 4, misinterprets one of the statements which I made. The paragraph of the paper, from which the third paragraph in your column is taken, refers not to the contribution of domestic comfort heating to winter morning peak load, but to the total load taken by the domestic consumer for all purposes, which includes at that time a very substantial lighting component as well as cooking, water heating, etc. If domestic comfort heating were responsible for such a large part of the total peak load as is implied by your paragraph, there would be more substance in some of the criticisms which have been directed against the use of electricity for household comfort-heating purposes.

Yours faithfully,

R. Y. SANDERS,

Deputy Commercial Manager (D),

British Electricity Authority.

Trafalgar Buildings,
1, Charing Cross, London, S.W.1.
July 10, 1952.

READING TECHNICAL COLLEGE.

TO THE EDITOR OF ENGINEERING.

SIR,—This College is developing under extremely difficult conditions in the field of engineering. We have had very good support from many sections of industry for the existing part-time day courses in mechanical engineering, both Ordinary National Certificate and craft (City and Guilds) subjects, but our progress in electrical work is not nearly so satisfactory. We propose not to offer further courses unless we have suitable apparatus for the practical work necessary, and the present supply position has handicapped us severely, in spite of fairly heavy financial expenditure by the Reading authority.

We should be most grateful if you could draw the attention of the engineering industry to our development, in the hope that some members may be able to offer us some practical assistance with equipment. We are hoping to be able to begin Higher National Certificate courses in mechanical and production engineering, but we are entirely dependent on the equipment involved.

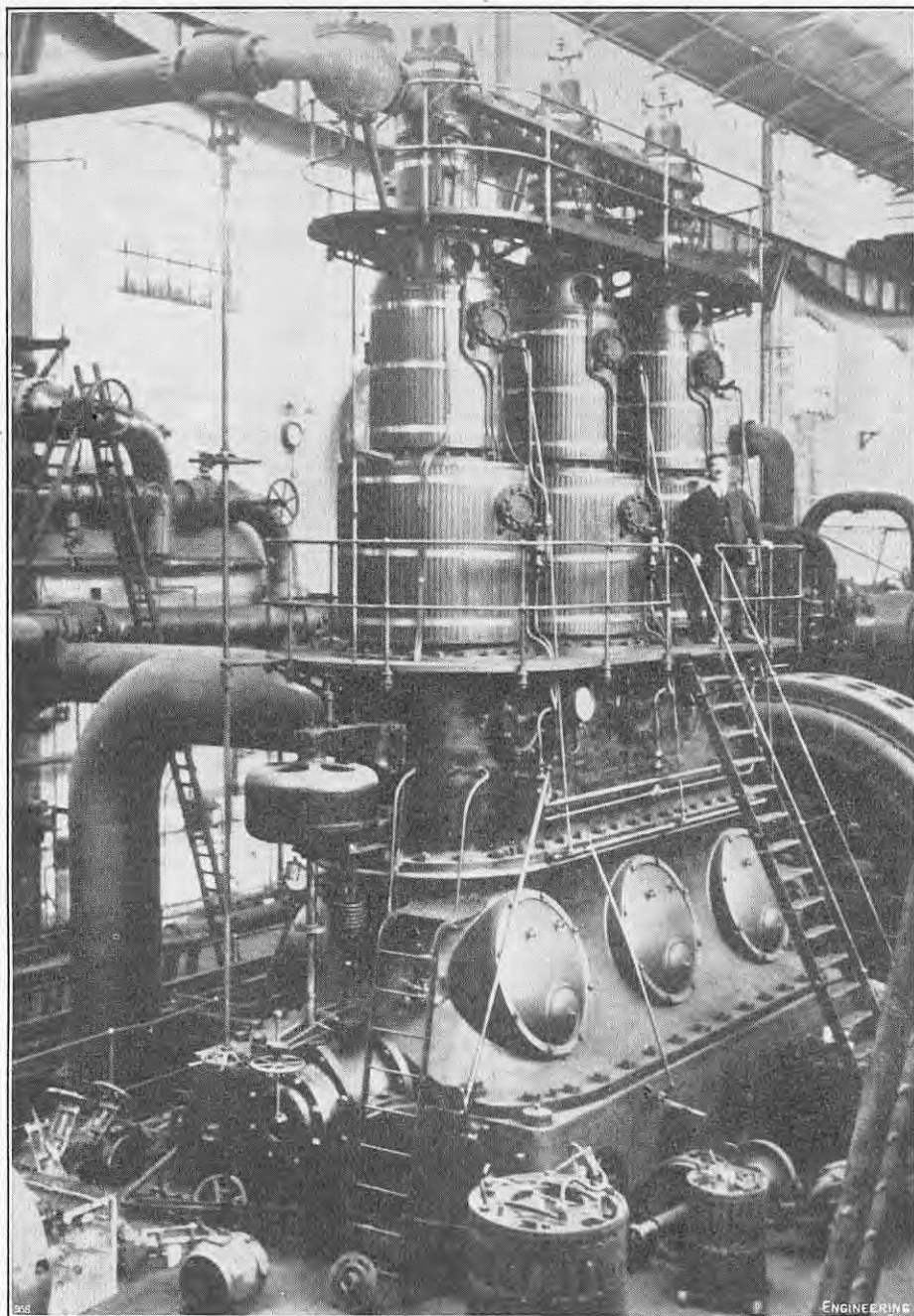
Yours faithfully,

P. E. HAWES,

Head of Department of Engineering.

2, London-road,
Reading, Berkshire.
July 16, 1952.

2,500-H.P. WILLANS ENGINE AT UPPER BOAT.



UPPER BOAT POWER STATION, SOUTH WALES.

THE history of the Upper Boat station near Pontypridd, in South Wales, the foundation stone of which was laid just over 50 years ago by Sir Frederick Bramwell, F.R.S., who was consulting engineer to the owners, the South Wales Electric Power Distribution Company, contains a number of points of engineering interest. The station began operation in 1904, the original plant including 14 Niclausse boilers, each of which evaporated 6,000 lb. of water per hour. These boilers, initially hand-fired, supplied steam at 200 lb. per inch to three Willans engines. Only four engines of this type, one of which is shown in the accompanying illustration, were built, and three were installed at Upper Boat. They were of the three-crank triple-expansion type with central valves and had an output of some 2,500 h.p. As their speed was only 150 r.p.m., they were of massive construction. Each engine was coupled to a 1,500-kW 11-kV Ganz alternator of the flywheel type, with an overhauling exciter and they must have been among the earliest machines to generate at that voltage.

These engines ran until 1908, when a 3,000-kW turbo-alternator was installed by the then British

Westinghouse Company. This was followed, in 1911, by a Willans-Dick Kerr set with an output of 3,000 kW, and in 1914 by a 5,000-kW set, supplied by the same makers. The steam-raising plant was increased in 1917 by two Babcock and Wilcox boilers, and in 1921 by two Niclausse boilers. Each of these units evaporated 30,000 lb. of water per hour at a pressure of 180 lb. per square inch, the former being fired by chain grates and the latter by Erith-Riley retort stokers. All this plant was in use until 1938.

In 1924, it was decided by the South Wales Electric Power Company to raise the steam conditions to 350 lb. per square inch and 750 deg. F., for future extensions, these conditions having been specified for an 18,750-kW Parsons set which had been installed in the original engine room and was commissioned a year earlier. At the same time, an extension was planned to house eight boilers, each evaporating 60,000 lb. of water per hour, and two 18,000-kW turbo-alternators with the necessary auxiliary plant. This extension was to be self-contained, so that the new plant could gradually replace the old. In 1927, there was, therefore, in addition to the Parsons set just mentioned, a 16,000-kW English Electric turbo-alternator in the old building, which generated three-phase current at

11 kV and 25 cycles, as well as two 1,000-kW auxiliary sets. The new boiler house contained eight 60,000-lb. boilers, which produced steam at 350 lb. per square inch and a temperature of 750 deg. F. In 1929, a further Parsons set, with an output of 25,000 kW, was installed.

In 1930, financial control of the South Wales Electric Power Company passed to the Shropshire, Worcestershire and Staffordshire Electric Power Company, a subsidiary of the Edmundson Corporation, and later to the latter concern itself. At about the same time the station was connected to the grid and the task of standardising the frequency was undertaken. The necessary change-over was completed in 1937, the 18,750-kW 25-cycle set being fitted with a 50-cycle alternator generating at 33 kV. In 1938, a Babcock and Wilcox boiler evaporating 182,000 lb. of water per hour was installed. This was fired with pulverised fuel and supplied steam at a pressure of 650 lb. per square inch and a temperature of 850 deg. F. Two similar boilers were added in 1939 and a fourth in 1940. In 1939, too, the generating plant was increased by a 30,000-kW English Electric set generating at 33 kV, a second similar set being added a year later. Owing to this increase in plant, it was also necessary to instal a cooling tower with a capacity of 2,250,000 gallons per hour, to supplement the water from the River Taff. Two years later, the steam-raising plant was again increased by the addition of a Babcock and Wilcox boiler, fired with pulverised fuel and having an output of 364,000 lb. of steam per hour, and a Mitchell stoker-fired boiler with an output of 182,000 lb. per hour. Both these boilers generated steam at a pressure of 650 lb. per square inch and a temperature of 850 deg. F. A further English Electric set with an output of 30,000 kW at 11 kV was also installed.

At present, therefore, the station comprises high-pressure and low-pressure sections, which are connected by two reducing valves. The high-pressure section contains one 364,000-lb. and five 182,000-lb. boilers, all generating steam at a pressure of 650 lb. per square inch and a temperature of 850 deg. F.; and the low-pressure section, eight boilers, each of which generates 60,000 lb. of steam per hour at a pressure of 350 lb. per square inch and a temperature of 750 deg. F. There are three 30,000-kW sets, which are supplied with steam at 625 lb. per square inch, and one 25,000-kW, one 20,000-kW, and one 18,000-kW sets, which operate at 325 lb. per square inch. Five of the six boilers in the high-pressure section are fired with pulverised fuel. Most of the electricity generated is transmitted at 66, 33 and 11 kV for local use in an area extending from Port Talbot in the west to Panteg and Pontypool in the east, and Aberdare and Merthyr in the north. Steam is also supplied at 350 lb. per square inch to the Wales and Monmouthshire Industrial Estates, Limited.

Investigations into the emission of grit from large boiler plant have recently been undertaken at Upper Boat, the results of which have enabled improvements in the efficiency of grit-collecting plant to be made. In addition, sample apparatus has been developed, in collaboration with the Fuel Research Station, which will facilitate the accurate measurement of the performance of pulverisers.

REPORT ON TRAIN DERAILMENT AT POLESWORTH.—The report of Colonel D. McMullen, an inspecting officer of railways, on the derailment which occurred on November 19, 1951, at Polesworth in the London Midland Region, British Railways, has been published by H.M. Stationery Office for the Ministry of Transport [price 6d. net]. The 10.30 p.m. up express passenger train from Glasgow to Euston, comprising a class 8P 4-6-2 locomotive and 12 coaches, passed through a crossover from the fast line to the slow line at the excessive speed of 55 m.p.h., owing to the driver's failure to observe the distant signal, which was at caution. Fortunately, the engine was prevented from overturning by striking the station platform. Two passengers were slightly injured. Colonel McMullen remarks that the accident "once again demonstrates the value of automatic train control of the warning type." He says that it is to be hoped that finality will soon be reached with the Railway Executive's development of a train-control apparatus which will meet all modern requirements.

FOURTH INDUSTRIAL PHYSICS CONFERENCE, GLASGOW.

(Concluded from page 55.)

Our report of the discussion on the education and training of industrial physicists in Scotland is continued below.

TRAINING OF PHYSICISTS.

The third speaker was Professor J. S. Rankin of the Royal Technical College, Glasgow, who began by saying that industrialists were often critical of the training given in technical colleges but seldom made constructive suggestions for its improvement. He wished to make clear that the training given at the Royal Technical College was not aimed at producing technicians and it was not a training in techniques, nor was it an extension of the course for the Higher National Certificate. Dr. Taylor had suggested that post-graduate courses in technology were required, but this meant extending the years of study. He saw no reason why it should not be possible to combine the technological studies with an adequate training in fundamentals within the normal period of study.

In his view, industry required pure scientists and technologists, including engineers, applied chemists and applied physicists. Small firms could not afford pure scientists, and there was more scope for them in light than in heavy industry. Engineering and applied chemistry had, for long, been recognised professions, but the same was not true of applied physics, and there were few opportunities in Britain for a university degree in this subject. In Scotland, a degree in applied physics could be obtained at St. Andrew's, but not at Glasgow, although a course in the subject was available at the Royal Technical College. The only other degree course of this kind in Britain was at the Manchester College of Technology. In America, however, the need for applied physicists was fully recognised and university degrees in engineering physics could be obtained. Similar developments in Britain were required urgently. If the proper courses were given and students were trained to meet industry's requirements, industrialists would be more likely to want applied physicists. The basic subjects of study should be mathematics, physics and chemistry, and there should be laboratory courses and opportunities for students to gain experience in industry during the summer vacation.

In the subsequent discussion, Professor Dee disagreed with Professor Rankin, and suggested that there was already a sufficient diversity of courses available to students. To institute degree courses in every application of science would inevitably result in unnecessary overlapping and costly duplication. The important matter was to produce graduates soundly trained in one subject and with minds disciplined to make the correct scientific approach to any problem. On the suggestion of another speaker that most honours graduates in physics did not want to go into industry, Professor Dee said this did not surprise him. The fault was not in the graduates or the training but in industry itself and the conditions of work which it offered. It was up to industry to improve these. Professor Rankin maintained that there were many students who were attracted to industry as well as physics, and who were deterred from embarking on an honours-physics course because it was too academic. Such students should have the opportunity of taking a course in which they could feel from the start that they were being trained for a career in industry.

SOUND REPRODUCTION.

On Wednesday evening, June 25, Mr. D. T. N. Williamson, of Messrs. Ferranti, Limited, Edinburgh, gave a lecture in the Berkeley Hall, Glasgow, on "Physics and Sound Reproduction," illustrating his talk by lantern slides and sound recordings. After reviewing briefly the main classes of sound-reproducing systems, and the requirements to be met under various conditions, the lecturer discussed at length the problems involved in high-fidelity sound reproduction. In the case of broadcasting, the cinema and the gramophone, said the lecturer, the aim was to create the illusion of perfect realism.

To achieve this result, a number of physical criteria must be satisfied, but not all of these could be observed in practice. A good sound-reproducing system was one in which first-class engineering was applied to design data arrived at by accurate calculation after a careful consideration of all the physical principles involved. Indifferent results were often attributable to a lack of appreciation of the finer points in the fundamental principles, or to lack of attention to detail in design and construction.

After discussing the problems of sound reproduction in large auditoria and mentioning that improved techniques for measuring acoustic properties had enabled accurate determinations of the acoustical characteristics of buildings and of speech and music to be made, the lecturer turned to the problems of domestic sound-reproduction. The equipment for this purpose normally consisted of three parts: first, a programme source, which was usually a radio receiver, supplemented by a means for reproducing gramophone records; secondly, an amplifier by which the power of the signals was increased; and, thirdly, a loudspeaker to convert the electrical signals into their acoustic counterparts. All these units were capable of distorting the original sound but, in general, the purely electrical links in the chain were far more nearly perfect than the electromechanical ones, namely, the gramophone pick-up and the loudspeaker. Until recently, the latter had received comparatively little attention and their design had by no means reached finality.

The various forms of distortion were then discussed and illustrated, including effects caused by the room as well as by the apparatus. As regards frequency distortion, the human ear could tolerate a wide departure from the original. Non-linear distortion, however, introduced sounds not originally present, and its tolerable amount varied inversely as the range of frequencies reproduced. Phase distortion, although not of great importance, was often noticeable in the case of sibilants, and transient distortion affected the reproduction of transient or percussive sounds. Other forms of distortion were introduced by equipment of limited dynamic range and by thermal and other noise. There was also an aural effect which varied with the difference between the volume of the original sound and that at which it was reproduced, and resulted from the sensitivity characteristics of the human ear. As regards gramophone-record noise, surface noise was considerable in the case of shellac recordings but was much less when modern micro-groove pressings made of homogeneous plastic were used. In the latter case, the noise was chiefly caused by dust and was not continuous. In the case of recordings on tape, the noise could be negligible.

Certain other forms of distortion, Mr. Williamson said, were beyond the control of the listener. One of the most serious causes of lack of realism in broadcasting was single-channel transmission. Stereophonic, or multi-channel, sound transmission and reproduction was markedly superior in realism, and the unpleasant effects of the various forms of distortion were masked considerably by its use. Disk-recording was unsuited to more than single-channel sound, but this limitation did not apply to tape-recording.

In the concluding part of his lecture, Mr. Williamson discussed the electromechanical parts of a sound-reproducing system. The design of loudspeakers inevitably involved a compromise between conflicting requirements and no perfect solution was possible, but guidance could be obtained from the analogy which existed between acoustic systems and electrical circuits. As regards gramophone pick-ups, the aim was to reduce the inertia of the moving parts to a minimum in order to avoid wear of the record, and to produce uniform response to all audible frequencies. Finally, the lecturer discussed the various methods of recording sound on magnetic tape and suggested that future developments would probably favour this type of recording.

NAVAL ARCHITECTURE.

The opening lecture on Thursday, June 26, was given by Professor A. M. Robb, of Glasgow University, who chose as his subject "Some Applica-

tions of Physics in Naval Architecture." The lecturer began by remarking that in elementary-physics classes it was customary to deal with hydrostatics and to derive a well-known formula for determining the height of the metacentre of a floating body. The student was then taught that the stability of such a body required that the metacentre be above the centre of gravity. Nevertheless, many ships had made long and safe voyages with a centre of gravity above the metacentre, as determined by the formula referred to above. The reason for this was that the simple formula applied only to infinitesimal displacements, and that an additional term, first derived in 1798 by Thomas Atwood, inventor of a machine to be found in every physics laboratory, took account of the change in the metacentric height which accompanied a finite angular displacement, and proved that the initial instability might be confined to a small range of angle of roll on either side of the zero.

The stability of ships, said the lecturer, could be properly understood only if the concept of the metacentre were associated with the formula derived by Atwood. If, however, Atwood's formula were used in studies of the dynamic stability of ships, the equations of motion became intractable. Some of the difficulty in dealing with oscillatory motion, however, resulted from the fact that the resistance of the water was not known with any high degree of accuracy. In fact, the nature and magnitude of the resistance to oscillatory motion were not nearly so important, in the case of a ship, as the resistance to steady ahead motion, which was comparatively little understood. Forty years ago, it had been thought that the calculation of the resistance of a hull moving at any speed through water was a comparatively simple matter, but this was now known to be untrue. In spite of a considerable amount of work on scale models in water tanks, the resistance could not be predicted accurately by such means. Fundamental knowledge was lacking and a completely fresh start on the problem of ship resistance was required.

The problem, in the case of a ship, said Professor Robb, was less simple than that for an aircraft since, with the latter, there was only one fluid. In the case of a ship, there were two, air and water, with a surface of separation between them, having a pattern of motion upon it. Lord Kelvin had thrown some light on the resistance associated with the latter by his mathematical investigation of the disturbance caused by a travelling pressure point. With a ship, there were generally two wave formations, one fore and the other aft. When the latter disappeared, there was usually a marked increase in the resistance, and this was probably explained by separation of the flow, although the phenomenon required much further investigation. Another matter requiring investigation was, under what circumstances did the flow along the hull change from laminar to turbulent?

PHYSICS IN RAILWAY WORK.

The second paper on Thursday, June 26, was given jointly by Mr. M. G. Bennett and Mr. T. A. Eames, of the research department of the Railway Executive. Their subject was "Some Applications of Physics in Transport." After referring to some of the ways in which physics affected transport, Mr. Bennett turned to the question of industrial efficiency and remarked that the success of an undertaking was commonly measured by the dividend which is paid on its share capital. In a transport organisation, efficiency was dependent on many factors and had a variety of forms. The time taken to make a journey, the frequency of a service, the efficiency of a vehicle, the mode of handling goods, the regulation of traffic, all had a bearing on the overall efficiency of a transport undertaking. It might, therefore, be advantageous to replace the dividend, as a measure of success, by a unit which would measure the physical efficiency. Such a unit might have the dimensions of mass multiplied by length divided by time.

Mr. Eames gave an account of the work of the Railway Executive research department and mentioned a number of activities which involved physics. His examples included the development of instruments for special purposes, such as the measurement

of low-intensity illumination during the war period, the determination of the humidity in wall cavities, the measurement of the electrical resistance of railway sleepers *in situ*, the testing of locomotives, the measurement of pulsating gas flow and gas temperature in locomotive boilers and the determination of the most economical running speed. He also discussed the ways in which physical phenomena affected working efficiency, mentioning the effects of noise, colour in relation to signals, temperature and humidity. An investigation into the causes of a high rate of breakage of glass water gauge tubes on locomotive boilers was also mentioned. This had been found to be due to the alkalinity of the boiler water, which resulted from water softening and caused erosion at the ends of the tubes. By arranging to keep the gauge tube full of condensed water, instead of boiler water, the average life of the tubes had been increased tenfold.

Mr. Eames then discussed refrigerated transport for perishable goods, mentioning that there was a considerable demand from commercial interests for the development of facilities of this kind. Advances had been made in the design and construction of heat-insulated containers and in the use of solid carbon-dioxide as a refrigerant, but there was room for further work. In the case of transport over long distances, a compromise had to be reached between the amount of goods carried, the weight of refrigerant carried and the amount of heat insulation provided. This problem offered scope for mathematical analysis, as an initial step. Other research work referred to by Mr. Eames included the investigation of stress and strain in locomotive frames and in railway tracks by strain-gauge and photo-elastic methods. Problems caused by fog and frost, particularly in relation to signalling and the icing of conductor rails, also offered opportunities to physicists.

AUTOMATIC CONTROL.

The first paper on Friday, June 27, the concluding day of the conference, was given by Mr. A. J. Young, of Imperial Chemical Industries, Limited. His subject was "Automatic Control of Industrial Processes." After remarking that the value of automatic as compared with manual methods of control had not been appreciated in the past, when automatic controls had frequently been looked upon as expensive luxuries, the lecturer discussed the advantages to be gained from their adoption. Every machine and industrial process must be controlled either by human agency or automatically. The choice between these must ultimately be made on economic grounds. It was not always appreciated, however, that not only was automatic control more consistent than control by a human operator, and thus saved plant and materials, but it also released skilled men who were enabled, in consequence, to make better use of their intelligence and judgment, which were largely wasted in routine operations. At the present time, when there was a scarcity of skilled man-power and a need to increase productivity, special attention should be paid to the possibilities of automatic control. Considerable research and development work on automatic controls had been done in recent years, indicative of the growing interest in such devices.

Even with automatic control, however, a man was still required to supervise the instruments, since such controls were not infallible; but he could supervise many more controls than he could operate unaided. In addition, he had far more time to study conditions in the plant under control and, hence, to determine the optimum conditions which the automatic controls could then be set to maintain. It was important that supervision should be as easy as possible; hence, attention should be paid to the method and form in which the information was displayed in the control room. The arrangement of the instruments, and the working conditions generally could have important physiological and psychological effects on the operators, and there was already a considerable amount of information available on the subject. In addition to the work being done in service departments and university research laboratories on these effects, which depended on the characteristics of the human operator, there was a parallel programme of research in industry and universities on the characteristics of the other

comparatively unknown components of control systems, namely, the parts under control. Machines were comparatively simple in this respect, but the performance of industrial plants was less predictable. There were very real problems in process control, though they were less difficult than those encountered in the analysis of human operators.

With a knowledge of the characteristics of an industrial plant, the selection of the most suitable type of automatic control and its matching to the plant could be effected simply and quickly and its action could be predicted with certainty by calculation. The ultimate aim, however, of all analysis of plant characteristics was to accumulate sufficient knowledge to enable designers to incorporate characteristics which made for easy controllability.

A problem in automatic control which was relevant to the transport and engineering industries as well as the process industries was that of controlling boiler plant, and a good example to illustrate the trend of thought on the subject was the automatic control of steam temperature in boilers serving turbo-generators. The ease, or difficulty, of control in this case depended largely on the design of the superheaters. A superheater, however, was only one form of heat exchanger, and considerable progress had been made by workers in several countries in analysing the factors which determined their controllability of heat exchangers. In conclusion, Mr. Young suggested that sufficient information on superheaters was already available for modifications in design to be tried, which would ultimately lead to better control of steam temperature. Improved control would permit the use of higher steam temperatures without endangering plant and would result in higher efficiencies.

In the discussion which followed, some particulars were given of the first fully-automatically-controlled open-hearth steel-making furnace in Scotland. This furnace is at Clydebridge Steelworks, Cambuslang, and was visited by a party of conference delegates in the afternoon.

SUPPRESSION OF NOISE.

The second paper in the morning session, which was also the last of the series, was on the subject of "Noise and its Suppression," and was given by Mr. N. Fleming, in charge of research on acoustics at the National Physical Laboratory, Teddington. After remarking that noise was a by-product of most industrial processes, was usually unwanted, often unpleasant, and sometimes even injurious, the lecturer said that the power wasted as noise in a machine was generally a very small fraction of that consumed in doing useful work. An aero-engine, however, might easily emit more noise than the entire population of a large city, such as Glasgow, could produce by shouting together. As examples of noise energy, the lecturer instanced the following: modern aero-engine, 50 kW; siren, 300 W; pneumatic drill, 2 W; trumpet, 100 mW; loud shouting, 1 mW; conversation, 10 μ W; whisper, 0.001 μ W.

Although prolonged and repeated exposure to loud noise might, in the course of years, permanently impair hearing, said Mr. Fleming, the latter was normally recovered completely if the exposure was of short duration. A reduction of noise might be effected in two ways, namely, by avoiding its production or by preventing it from reaching the listener. The first course, however, was not always practicable. Certain processes, such as riveting and metal chipping were inherently noisy, and the blow could not be softened without interfering with the efficiency of the process. The second course might involve applying sound-absorbing treatments to the room in which the sound was produced, in order to reduce the sound reflected from the floor, ceiling and walls, or applying sound-insulating treatments to these surfaces, to reduce the noise transmitted to other parts of the building or to the open air. Each case presented its own problems, the economical solution of which was assisted by a knowledge of the characteristics of the noise.

Mr. Fleming then reviewed the characteristics of the human ear, mentioning, in particular, the variation of its sensitivity over the range of audible frequencies. The effect on the ear of changing the intensity of a sound was discussed, reference being made to the thresholds of hearing and of pain, and to the phon, as the unit employed to measure

intensities relative to a standard intensity. The measurement of loudness, said the lecturer, was an essential preliminary to the reduction of noise but presented difficulties, since loudness was subjective. To determine the loudness of a sound it was necessary to compare it with another, which was generally a pure tone. In addition to the phon scale which was used to fix loudness levels, there was the sone scale, in which the scale was directly proportional to the loudness. In assessing relative loudness, it was customary to compare the independent estimates of a number of observers. The annoyance caused by a sound, however, was not always a simple function of its loudness, although loudness was a useful criterion. It had been found that random noise could often be tolerated more easily than a pure tone of uniform and lower intensity.

The concluding function on the Friday evening was a reception and dance for members and ladies, held in the City Chambers at the invitation of the Lord Provost and the Corporation of Glasgow.

SYNTHETIC RESINS IN THE FOUNDRY.

CERTAIN development work which has been undertaken in recent years has shown that synthetic resins have a number of technical and economic advantages for binding the sand cores used in foundries. Their hardening properties have also enabled new methods of sand shell moulding and the surface hardening of sand moulds to be employed, while the time necessary to dry such cores can be reduced from several hours to a few minutes by using dielectric heating.

The synthetic resins developed by the Plastics Division of Imperial Chemical Industries, Limited, Welwyn Garden City, Hertfordshire, for sand-core binding, are either of the urea-formaldehyde or the phenol-formaldehyde types. Both types can be made in a variety of forms with differing properties, depending on the use to which they are to be put, and both can be converted from liquid or powdered form to a final hardened state by the use of accelerators or of heat alone.

The breakdown temperature of the urea-formaldehyde resins is from 220 to 270 deg. C., compared with 450 to 500 deg. C. for those incorporating linseed oil, so that they are particularly recommended for use with non-ferrous metals, where low temperatures are employed, owing to the consequent freedom from faults in the castings due to insufficient core collapse. Experience has also shown that they are free from finning, while the economic advantages are that not only are the resin binders cheaper than the majority of the other materials used for this purpose, but that relatively low quantities of them are required. The mix is a little stickier than oil mixes, but this stickiness can be reduced by the addition of paraffin.

Generally speaking, the properties of the phenol-formaldehyde resins are similar to those containing urea-formaldehyde, the principal difference being that the breakdown temperature is from 400 to 450 deg. C., or a little lower than that when linseed oil is used. This makes them suitable for all types of ferrous castings. In addition, little gas is given off during burning out, so that there is comparative freedom from objectionable fumes. As cores bound with phenol-formaldehyde resins can be baked at similar temperatures to those used for drying oil-bound cores, the two sorts can be run simultaneously through the same oven, which is an advantage where cores of different types and characteristics have to be used. A typical mix consists of 100 parts of sand, two parts each of resin, cereal and water, half a part of bentonite and one quarter a part of paraffin.

As already mentioned, the introduction of dielectric heating, in combination with use of special resins as core binders, has enabled considerable saving in time to be effected over oven-drying. Dielectric heating, however, makes it necessary that the carriers, which support the sand core during drying, should have suitable electrical properties, so that loss of energy and overheating are prevented. They must also be robust, easy to manufacture, and have a good surface. Metals are

unsuitable for this purpose, owing to their electrical and heat-conducting properties, but it has been found that a carrier made of a polyester resin with sand and glass fibre, is most successful.

Another application of these resins is in the surface hardening of sand moulds, which contain little or no binder, and in certain cases tend to be washed away by the flow of metal. To overcome this drawback a mixture of urea-formaldehyde resin and an accelerator is sprayed on to the mould, the surface of which is then hardened either at normal temperatures or by heating. In the same way, a core can be given a case-hardened skin over a "green" interior, thus ensuring reduced fuming, improved breakdown and lower consumption of the starch or other binder.

Finally, sand moulds with thin shells can be produced by using a finely powdered phenol-formaldehyde resin, which is capable of softening rapidly and then hardening within a few minutes at about 450 deg. to 500 deg. F. This resin is mixed with about 6 per cent. to 8 per cent. of sand, and the dry mix is then allowed to fall on to the heated surface of a metal pattern, where it softens and forms a thin shell. This shell and the pattern to which it is adhering are transferred to an oven in which the shell hardens within a few minutes. It can then be removed from the pattern, which is available for further use. The total cycle time for making a finished shell mould is from 3 to 5 minutes, and the pattern is maintained at a constant temperature.

Two urea-formaldehyde resins are available for sand-core binding in the form of syrups with different resin contents. There are also three types of phenol-formaldehyde resins for ferrous casting, one of which has the rapid drying properties necessary when dielectric heating is employed. Other resins have been prepared for sand mould hardening, for sand shell moulding, and for making core carriers.

"AIR-SLIDE" CONVEYORS FOR POWDERED AND GRANULAR MATERIALS.

A METHOD of conveying powdered or granular materials in bulk which is well known in the cement industry but largely unknown elsewhere is being developed by Messrs. Doulton and Company, Limited, Doulton House, Albert Embankment, London, S.E.1. As makers of porous ceramic tiles, which are the chief components of the conveyors, they hope to issue reports on the development work from time to time. The "air slide," or fluidised-solids conveyor, consists of a trough which is divided into a closed lower trunk and an open (or closed—as required) upper trough by a bed of porous ceramic tiles. The material travels on top of the bed in the upper part of the conveyor. Normally, the conveyor would require to be set at a steep angle for powdered or granular material to flow freely due to gravity, the angle depending on the angle of repose for the material. Air under a slight pressure in the trunk, however, escapes through the porous tiles, and in so doing lifts the powder off the tiles, at the same time maintaining the particles in a state of very loose packing with air thinly distributed between them. Thus, friction is reduced to a minimum and the material can flow down a very shallow slope.

Raw cement is transported over considerable distances by air slides which are usually inclined at angles of less than 5 deg. to the horizontal. Sand which will not slide down a polished copper ramp inclined at 30 deg. will move readily along an air slide at an inclination of only 1 deg. The air stream through the tiles is generally obtained by blowing air into the lower compartment; alternatively, suction may be applied to the compartment above the tiles. There are no moving parts requiring maintenance, except, of course, the blower, which can be enclosed or otherwise protected from the material being conveyed. The air is filtered, using porous tiles, before it enters the lower compartment to ensure that the diffuser tiles do not act as filters, and, in certain circumstances, air leaving the system may be filtered.

Air slides will operate equally well with either continuous or intermittent feed. Moreover, pro-

vided the feed is correctly designed, the conveyor does not become overloaded when the take-off of the material at the delivery end is stopped, since movement along the whole length will cease automatically. This characteristic is of great value when the conveyor is used for filling sacks or packages. Messrs. Doulton and Company have carried out tests on a miniature slide and are now installing equipment which will enable them to obtain accurate data for many types of materials under various sets of conditions. They will welcome inquiries, though, of course, delay in completing preliminary trials will in many cases be unavoidable.

LABOUR NOTES.

EQUAL pay for both sexes for work of the same nature was discussed between Mr. R. A. Butler, the Chancellor of the Exchequer, and the economic committee of the Trades Union Congress at the Treasury in London, on Monday last, and Mr. Butler was urged to commence discussions with the Civil Service unions on the methods by which a start might be made on the gradual introduction of equal pay for Government employees. According to a Treasury statement, issued after the joint meeting, the Chancellor informed the economic committee that he had received a similar request from Mr. A. J. T. Day, the chairman of the staff side of the Civil Service National Whitley Council, to which he intended to give a considered reply at a very early date. He undertook to inform the economic committee of the nature of that reply. Mr. Lincoln Evans, the chairman of the committee, stated subsequently, that the committee had received nothing definite from the Chancellor, but that the discussion with him had been "very fruitful." Whether the report of the committee to the Trades Union Congress at its annual meeting in September was optimistic or not, Mr. Evans declared, would depend upon what happened between the present time and the delivery of the report.

A new high level of membership is recorded by the Transport and General Workers' Union in its annual report for 1951, which was issued early this month. At the end of last year, the union had a total of 1,337,060 members. This represented an increase of 8,794 on its previous peak figure of 1,328,266, which was reached in March, 1949. The union's income from all sources for the twelve months ended December 31, 1951, amounted to 2,414,192l. 9s. 6d., while the funds belonging to the union at the same date totalled no less than 7,747,185l. 4s. 2d. On the other hand, some benefits paid out during the year amounted to only small sums in comparison. The largest disbursement, in respect of sickness, totalled 124,370l. for the twelve months. Funeral, accident, and legal expenses paid by the union on behalf of its members were 63,909l., 42,657l., and 25,269l., respectively. The union also spent 20,178l., or considerably less than 1 per cent. of its income for the year, on educational projects. Affiliation fees to national and international bodies, joint industrial councils, conciliation boards, and similar organisations accounted for a further 51,791l. 11s. 3d.

The union's report includes a statement on the national and international economic situation, in which the opinion is expressed that the difficulties facing the country at the present time are not less than they were when the report for 1950 was issued. In fact, it is stated, the position has become in many respects even more difficult. The nation has had to contend with the recurring problem of the balance of payments and the decline in its gold reserves, and has had to make a very considerable effort to bridge the gap between imports and exports, in its endeavours to maintain such a position as to enable its people to buy the raw materials so urgently required to support their living standards and the country's export trade.

As the union's members look ahead and realise that Great Britain is passing out of a buyer's market into a seller's market, the union's statement continues, with Germany and Japan competing

against this country in a great number of export trades, such as the textile, steel and engineering industries, it becomes perfectly clear that all must increase their productivity and that costs over the whole field of British industry must be reduced. It is equally clear that if British workpeople are to live well they must work hard and develop, with foresight and imagination, the technical skill and efficiency which will enable them to make a still greater contribution to the national income. In other words, the statement concludes, if the members of the union are to enjoy greater prosperity, they must work to increase the size of the national income and see to it that they get their share.

Interesting references to the development of social welfare among British miners were made by Sir William Lawther, J.P., in his presidential address to the National Union of Mineworkers on July 7, at the union's annual conference at Scarborough. He said that, up to the time of nationalisation, the industry's welfare fund had built 366 pithead baths, which enabled some 450,000 men to leave the dirt where they acquired it—at the pit. As a result of the fund, the industry had 900 canteens, more than 1,500 welfare schemes, 15 convalescent homes and seven rehabilitation centres. Opportunities for the education of miners' children had also been provided. All this had been brought about by Acts of Parliament and, with the coming of the nationalisation of the mines, it was obvious that there must be a change in welfare arrangements.

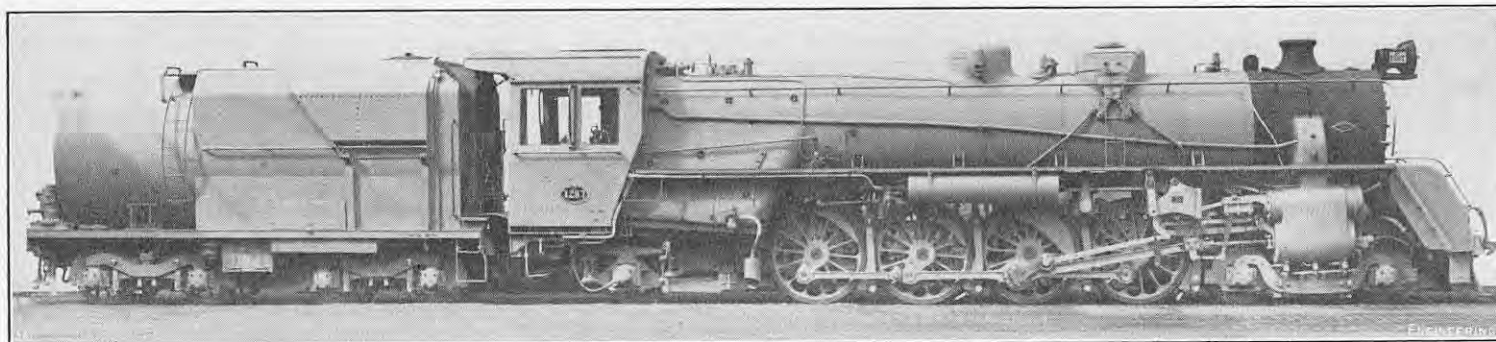
The Nationalisation Act required the National Coal Board to look after the welfare of its employees and, for a time, Sir William stated, the Board and the Miners' Welfare Commission worked side by side on welfare matters as the National Miners' Welfare Joint Council. This co-operation resulted in the Board adding six and a half million pounds to the amount available for the building of pithead baths and this helped to keep up the rate of building in spite of constantly increasing costs. The arrangement was a temporary one, however, and, on July 24, 1951, the N.U.M.W. signed an agreement with the Board, which was later given legal effect as the Miners' Welfare Act and came into force earlier this year. The Board therein undertook to accept full responsibility for all welfare at the pithead and, accordingly, the building of pithead baths would be no longer restricted by lack of money. Since April, 1947, the Board had met the full cost of operating these baths, and this meant that the miners no longer had to pay personal subscriptions, which, in some cases, had amounted to as much as a shilling a week.

The cost of operating the baths alone was costing the National Coal Board, Sir William continued, over one and a half million pounds a year. The union would like to see the Board go one step further and provide free towels and soap, and perhaps a laundry service as well. The Board would also be responsible for the men's canteens. Most of these were constructed during the war and large sums would be needed to bring them up to the standard of the best industrial canteens. The provision of good meals at a reasonable cost to the miner was henceforth the full responsibility of the Board. To deal with the social side of welfare, a new organisation had been set up, known as the Coal Industry Social Welfare Organisation, which would be under the joint control of the union and the National Coal Board. The status of the miner as an industrial employee had been raised and, in many ways, his welfare was ahead of that of workpeople in other industries.

Returns issued by the Ministry of Labour and National Service on Monday last week disclosed a substantial improvement in the national employment situation. Persons registered with the Ministry as unemployed on June 16 numbered 440,100, compared with 467,500 on May 12, a decrease of 27,400 in five weeks. Of the total on June 16, 315,100 had been out of work for a period of less than eight weeks, leaving only 125,000 who had been disengaged for eight weeks or longer. The June unemployment figure represented 2.1 per cent. of the estimated total number of persons in work on that day.

4-8-2 OIL-BURNING LOCOMOTIVES FOR NEW ZEALAND.

NORTH BRITISH LOCOMOTIVE COMPANY, LIMITED, GLASGOW.



4-8-2 OIL-BURNING LOCOMOTIVES FOR NEW ZEALAND.

SIXTEEN 4-8-2 oil-fired locomotives have recently been completed by the North British Locomotive Company, Limited, Springburn, Glasgow, N. for the New Zealand Government Railways. They are for hauling mixed traffic on 3 ft. 6 in. gauge track, which is laid with 50-lb. rails, and the maximum axle-load is $11\frac{1}{2}$ tons. The tractive effort at 85 per cent. of the boiler working pressure (200 lb. per square inch) is 26,520 lb., the cylinders having a bore of 18 in. and a piston stroke of 26 in., and the coupled wheels being 4 ft. 6 in. in diameter. Baker valve gear, roller bearings and 4-in. thick frames are features of the design. The locomotives are a modified version of the existing "J" class, which was built by the North British Locomotive Company in 1939, and are therefore designated the "Ja" class. The streamlining of the earlier type has been omitted. Construction was under the supervision of the High Commissioner for the Dominion of New Zealand, London, and of Mr. Ronald J. Harvey, consulting engineer to the New Zealand Government. The locomotives were shipped fully erected to the Port of Wellington.

The boiler barrel consists of two rings, the internal diameter of the front ring being 4 ft. $7\frac{3}{4}$ in. and that of the rear 4 ft. 9 in. The distance between the tubeplates is 17 ft. 6 in. and there are 16 superheater flue tubes and 100 small tubes of $5\frac{1}{2}$ in. and 2 in. external diameter, respectively. The boiler tubes and the internal steam pipe in the boiler are made of Howell's Aquacidox steel. The inner firebox, of all-welded construction, is of Colvilles Double Crown steel and is stayed to the roof of the round-top outer firebox by direct steel stays with flexible stays at the front and sides. Flexible water-space stays are also fitted at the combustion chamber and sides and back of the firebox in the breaking zones. A 16-element Melesco superheater is fitted, and the regulator valve, which is situated in the dome, is of the New Zealand Railways' standard pattern. The heating surfaces are: large tubes, 403.2 sq. ft.; small tubes, 916.3 sq. ft.; firebox, 149.5 sq. ft.; superheater, 283.0 sq. ft.; total, 1,752.0 sq. ft.

The boiler, firebox and cylinders are lagged by means of asbestos, $\frac{3}{8}$ in. thick, sprayed on the insides of the clothing sheets and covered with aluminium foil. The firepan, of welded construction, is equipped with a double-outlet burner at the front and a damper door at the bottom, and is completely lined with firebrick. The grate area is 39 sq. ft. General steam fittings include Davies and Metcalfe's No. 8 $\frac{1}{2}$ class K Sellars-pattern live-steam injector and No. 9 class HJ exhaust-steam injector; two 2 $\frac{1}{2}$ -in. Ross pop safety valves; two sets of water gauges with water columns; an Ashton double-dial pressure gauge; and a steam heating valve. In addition, five of the 16 locomotives are fitted with A.C.F.I. blow-down equipment.

The main frames, 4 in. thick, are cut from rolled Ducoil steel slabs and are adequately stayed by steel castings and fabricated cross-stretchers. The cylinders, each of which is integral with a half smokebox saddle, are steel castings, and the barrels and steam-chests are fitted with renewable cast-iron

liners. The steam-chests and cylinder barrels are lubricated by means of a Wakefield "Double Seven" mechanical lubricator. The piston valves, $9\frac{1}{2}$ in. diameter, are actuated by Baker valve gear, which is controlled by Ragounet compressed-air reversing gear. The valve-motion pins are fitted with needle-roller bearings. Crossheads are of the Laird type. The connecting rods, coupling rods and crankpins are forged from manganese-molybdenum steel, and Skefko roller bearings are fitted to the connecting and coupling rods at the driving crankpins. All axleboxes throughout the engine and tender are fitted with Skefko roller bearings, the coupled-wheel boxes being of the cannon type. The engine bogie and tender bogie wheels (2 ft. $6\frac{1}{2}$ in. in diameter), axles and axleboxes are identical and interchangeable. The coupled axles are made from manganese-molybdenum steel. Laminated bearing springs of the overhung type are fitted throughout and compensation is arranged between the leading coupled and hind truck wheels. The latter are 2 ft. 9 in. in diameter. The coupled wheelbase is 14 ft. 3 in., and the total engine wheelbase is 33 ft. $1\frac{1}{2}$ in.

Westinghouse brake equipment is provided for the engine and tender, and actuates brake blocks on all coupled and tender wheels. Two brake cylinders are fitted on the engine and one on the tender. A large sand-box is situated on top of the boiler, and delivery of sand to the front of the leading and intermediate wheels is controlled by compressed air. Stone's electric lighting equipment is provided; it includes a turbo-generator, front and rear headlights, cab lights, and lamps for water gauges, speed indicator and bunker. The locomotives are fitted with Smith electric speed indicators, which are resiliently mounted on the cab front, and the generator is attached to the right-hand trailing-truck axlebox.

The tender is of the double four-wheeled bogie type and carries 4,000 gallons of water and 1,400 gallons of oil fuel. The Vanderbilt-type water tank and the oil tank are of welded construction with internal stays bolted in position. Longitudinal and cross channels are welded together to form the underframe, and a front drag-box of cast steel and a hind drag-box of fabricated construction are incorporated. The bogies are of the plate-frame type, with laminated bearing springs carried on spring beams to the axleboxes. The tender wheelbase is 15 ft. $10\frac{1}{2}$ in. The drawgear at the front of the engine and the rear of the tender is of Janney Yoke type, fitted with Spencer Moulton rubber springs. The combined wheelbase of the engine and tender is 58 ft. and the total length over buffers is 66 ft. $11\frac{1}{2}$ in. The weights, in working order, are 69.25 tons for the engine and 42.05 tons for the tender, giving a total weight of 111.3 tons.

UNITED KINGDOM PRODUCTION OF PIG IRON AND STEEL.—Statistics issued by the British Iron and Steel Federation, Tothill-street, London, S.W.1, show that in June the United Kingdom production of steel ingots and castings, which was affected by the Whitsun holiday, was at an annual rate of 16,252,000 tons, compared with a rate of 16,007,000 tons in June last year. The June, 1952, output of pig iron was at an annual rate of 10,384,000 tons, compared with a rate of 9,497,000 tons in June last year.

VENTILATION AND HEATING PROBLEMS IN ATOMIC ENERGY ESTABLISHMENTS*.

By W. L. WILSON, B.Sc., A M.Inst.C.E.

(Concluded from page 62.)

THE EXTRACT SYSTEM.

THE extract systems for radio-chemical work almost invariably must be designed to handle weak vapours of an acid and/or solvent nature, laden with radio-active particles. Generally, the ducts are housed in sizeable voids, which are warmed deliberately to a temperature of 60 deg. F. or so, to prevent deposition. On one or two occasions, the conversion of existing buildings to radio-chemical laboratories has necessitated the exposure of mild-steel ducting to the open air and the consequential internal corrosion has been rapid and well-nigh disastrous. It could be suggested that stainless steel might have been used, and I suppose it is true that it would have had a longer life. However, the commoner grades are allergic to HNO_3 and free chlorine, and it was felt in the particular cases that the short-term usage of the buildings in question did not warrant the expense.

Since the early days, much experimental work has been done on anti-corrosive paints for use in such situations, because it has been found that, whatever the attractions of other materials, steel has much to commend it. There has been considerable success in using a "strip" lacquer and I.C.I. Vinylite. Both of these paints provide a gloss finish that permits the erasure of activity deposited thereon. The former has the additional virtue that it can be easily stripped off in whole or in part, wherever adhesive activity exists.

Extract ducting may be quite large; on one particular project, it was some 10 ft. square at its greatest section. It is not altogether cheap if, for some reason, parts have to be replaced. Furthermore, replacements must be effected rapidly to prevent spreads of activity. To take care of both these points, large ducting (say, over 2 ft. 6 in. to 3 ft. square) is flanged on the vertical axis as in pipe-work practice, and the sections themselves are made from flanged plates; thus limited sections can be removed and replaced.

Smaller ducting is usually of welded construction, with flanged joints at every 3 ft. or more, dependent upon its dimensions. Whatever the ducting sizes, the tendency is to use metal gauges of 14 or so to increase its life if corrosion does develop and to facilitate making an air-tight job. This latter is essential to prevent the egress of activity, and particularly after filters, where the trunking may be running through a contaminated area. Extract ducting is pressure-tested during manufacture and after erection where the hazard warrants it.

Extract ducting, filters and fans are, wherever possible, contained in a working space given over solely to them. Where the hazard is great, all other services, and even fan motors, bearings, etc.,

* Paper presented at the summer meeting of the Institution of Heating and Ventilating Engineers, held at Torquay, June 14 to 17, 1952. Abridged.

are placed in a separate space so that they can be maintained conventionally. The filter, fan and duct room can then be regarded as a contaminated area and maintained accordingly. Generally, the extract system comprises arteries leading to the central discharge. The individual arteries may exist because of the varying intensities of radiation they carry, because of the use of different kinds of filter, or because different gases are carried in them and it is desired to keep these separate. In such circumstances, dampers are required for isolation purposes, in addition to those needed for regulation. Obviously, such dampers must be air-tight.

In earlier experiences, common single or multi-leaf dampers manufactured to close limits were used. They were not all successful and were improved by the provision of rubber-faced landing strips and edges. These were not completely successful. The next stage of development was the toggle-operated damper; this was much more successful. However, the form of construction—fabricated steel, and the “backlash” in the mechanical motion—militated against the objective, and in the end precision units were manufactured in quantity. These units eliminate all possible sources of leakage and, by virtue of the closing pressures that can be applied, seal against 12-in. w.g. air pressure without difficulty. This form of construction cannot be used economically on very large ducts, but the complete sealing-off of them has not yet arisen as a particular problem.

Air-flow measurement in extract ducts has become a necessity because of an increasing use of mechanical filters and the importance of knowing when to change them. It has also been desirable to bring the measuring unit or units to central points, often hundreds of feet away from the flow to be measured. It is believed that success is likely in this by using distant-reading velometers, up to 20 circuits being read individually by using a single velometer actuated by a selector valve no bigger than 7 in. or 8 in. in diameter.

The sole requirement of the extract fans used—apart from the desired capacity and the usual considerations—is that they shall have as smooth an internal finish as is possible. This is required in order that dust ledges and crevices be non-existent, and to facilitate the removal of activity deposited therein. Upon occasion, such fans may be at the bottom of chimneys. As these chimneys must not be provided with weather cowls, which would alter their dispersive characteristic, rain may reach the runners. Water-logging could become a nuisance, and hence water is normally run-off through a water seal. The liquor is radio-active, and problems arise in getting rid of it.

FILTERS.

The problems posed for the ventilation engineer in his choice of filters are capital and current expenditure, overall effectiveness, and what to do with the filters when they are dirty. He may have to contemplate these questions when examining how to filter quantities of air varying between 350,000 and 15,000 cub. ft. per minute. He must have a chimney about two and a half times the height of the building to give uninterrupted dispersion and this will reduce the activity concentration by several thousand times, dependent upon its height and atmospheric conditions.

In the early days, air quantities tended to be large owing to the fundamental research aspect of the buildings under construction. This eliminated the highly efficient replaceable mechanical filter because of the capital and running costs and the disposal problem. Attention was accordingly focused on the electrostatic precipitator, which had two particular virtues: it did not, with age, increase the overall pressure drop of the system and so upset balanced air flows; and the activity deposited on it could be washed off, contained in water and so controlled. Additionally, it possessed an overall efficiency (on blackness test) of considerable merit. Such units have been used with considerable success, the sole unusual refinement that has been added to them being an automatic washing device comprising a vertically moving sparge pipe, spraying hot water on to the cells. Electrical interlocks are provided to prevent washing

while the units are in operation. The washing cycle can be completed in half an hour.

Prospective processes are now forecast in their form and it is frequently the case that the engineer can plan air demand with something approaching accuracy, and certainly with economy. Air demands are, in consequence, getting less, and the capital and running expenditure for mechanical filters much more reasonable. The positive nature of such filters is, of course, an attraction not possessed by electrostatic precipitators. Some *ad hoc* use has been made of paper filters available from last-war stocks, but more attention has been directed to asbestos and resin-wool filters developed in later years.

It can be said, so far as the average problem is concerned, that both these filters, when new, are completely efficient, but whereas the former is entirely dependent on its mechanical action, the latter is dependent to a substantial degree on an inherent electrostatic charge. The asbestos-wool unit will handle less air at a greater pressure loss than a resin-wool unit for similar efficiencies. The capital cost in neither case is particularly low.

The resin-wool unit seemed, in particular circumstances, to be very attractive, but we were somewhat bothered about the permanence of its charge. We could not help but feel that the charges on the particles we wanted to filter out, coupled with high humidities, solvents, and acid vapours carrying them, could cause this charge to dissipate fairly quickly. Rapid improvised experiments showed that this could be the case. In consequence, the following conclusions have been applied in design: limited air flows from known sources of high activity must be filtered by a media of certain and high performance, and hence asbestos-wool filters are used, in such situations, their accepted performance being used to determine the efficiency of dispersal of the system. Air from sources of activity from which the air flow is high is filtered by resin-wool units, their efficiency as straight mechanical filters being used to determine the efficiency of dispersal of the system. Where higher efficiencies of filtration are required, the filters are used in series; and, to economise in running expenditure and to improve the efficiency of filtration, both resin-wool and asbestos-wool filters are often preceded by electrostatic precipitators.

Activity tends to spread, and it can be difficult to remove. Hence, once a building becomes “active” it can be regarded as perpetually so if the activity is long-lived, and if it is handled in quantities of any magnitude. It follows that, if such a building or plant is to be continually useful, the activity must not be allowed to spread due to any emergency that is likely to arise. The major protective feature against activity spread is air movement. Considerable steps are taken to ensure that essential extract fans, filters and associated equipment are maintained in service. Electrically, this has serious repercussions as, if the building is important enough, it might be essential to obtain duplicate supplies from the grid; to feed duplicate supplies to the building; to direct power to essential users through two separate routes inside the building; and to provide battery and Diesel generator supplies to the essential gear.

Standby mechanical plant will obviously be desirable. Fans may be in duplicate; motors and starters controlling those fans may also be arranged similarly, and spare banks of filters are invariably desirable. Even with such duplication, care must be taken to ensure that bearing troubles do not develop, and to this end temperature recording gear may be required. Essential duplicated plant must be designed to come into operation immediately on failure of a running unit. In providing such control, the governing mechanism is applied to the fan or pump rather than the prime mover.

Maintenance controls, i.e., bearing lubrication, temperature recording, filtered air-flow recording units, etc., are installed as near the plant as possible. Operational control, i.e., starting and stopping of plant, interlocks, flow and no-flow alarms, air-flow recording gear, etc., are centrally located on the general grounds that the system is too vital to be abused by *ad hoc* and unskilled action. If a damper control is placed in a working space, it is there purely for protection against a likely fire or, alternatively,

to give a limited flexibility that will not affect the system as a whole. Finally, the starting and stopping of plant is effected in sequence. The whole of the electrically-operated plant forming the plenum and extract systems is interlocked so that the vital extract plant is started first and stopped last. “Secret” bridges, key controlled, are provided to enable maintenance to be undertaken as desired.

HEATING.

Atomic establishments contain most of the buildings that are met in normal factories, in addition to the radio-active buildings of the general form described earlier. The heating problems have, therefore, been diverse, although not altogether unusual in most of their aspects. The demand for heat for domestic purposes has been considerable, the order of peak steam load being 60,000 to 70,000 lb. per hour. Not the least interesting exercise in this field has been that of maintaining supplies of steam for increasing constructional and occupational demands, while the central-heating station has been in the process of being built. A winter requirement is to prevent the freezing of sands and aggregate.

An opportunity for using high-pressure hot water on a large scale has not yet arisen, owing to either the necessity to generate electricity, the unknown nature or scope of the establishment in consideration, or because of the existence of expandable steam-producing plant. In consequence, steam has invariably been distributed and copper condensate return mains provided. The return of condensate, in long runs, has been effected by pumping from centralised stations. Much examination and application has gone into steam and condensate mains, and studies have been made of the relative merits of ducted, trench and overground runs. Into this consideration have gone the economies of running additional services—cables, compressed-air mains, and the like—in the common trench or duct and laid solid.

Many buildings of the hangar type, about 300 ft. long by 150 ft. wide and some 30 to 40 ft. high, have been heated successfully by floor-mounted high-velocity outlet blast heaters, fed by ducted fresh-air supplies giving an air change in the order of half per hour. Where circumstances have demanded it, propeller fans have been installed at high level to discharge the warmed air downwards to working levels. Buildings such as these have been invariably provided with office annexes which have been heated in a conventional fashion with hot water, flash steam from the “blast” heaters being used as the source of heat. Wall panels have been used to a considerable degree where fixed benching has not been prevalent, and it has also been provided with success on remote operating galleries in large buildings. In some cases, it has been built integral with prefabricated metal service casings carrying general piped services.

EXPORTS OF COKE TO DENMARK.—Official statistics issued recently show that United Kingdom exports of coke of all kinds (including breeze) to Denmark, from 1937 to 1939, averaged 993,000 tons a year. The total for 1949 was 941,000 tons and for 1950, 1,043,000 tons, but it was only 296,000 tons in 1951. All the above figures exclude manufactured fuel.

“KUNIFER” CUPRO-NICKEL ALLOYS.—The Metals Division of Imperial Chemical Industries, Ltd., has added Admiralty-quality 70-30 cupro-nickel to the “Kunifer” range of cupro-nickel alloys containing inclusions of iron and manganese. The I.C.I. trade name “Kunifer” originally referred to alloys having 5 per cent. and 10 per cent. nickel content, covered by the British Non-Ferrous Metals Research Association patent numbers 577065 and 578283; but, as the Division’s “AE Super-nickel” condenser-tube alloy has, for many years, contained inclusions of iron and manganese in accordance with Admiralty Specification 3T. 102, to bring it into the “Kunifer” range is an obvious measure of standardisation. The three alloys will be distinguished by numerical suffixes indicating the nickel content. Kunifer 5, in either tube or sheet form, is an alloy particularly suitable for sea-water trunking systems; Kunifer 10 is an alloy with a variety of special tube applications; and Kunifer 30 is the I.C.I. cupro-nickel condenser-tube alloy to British Admiralty requirements.

MECHANISMS FOR INTERMITTENT MOTION.

Fig. 45.

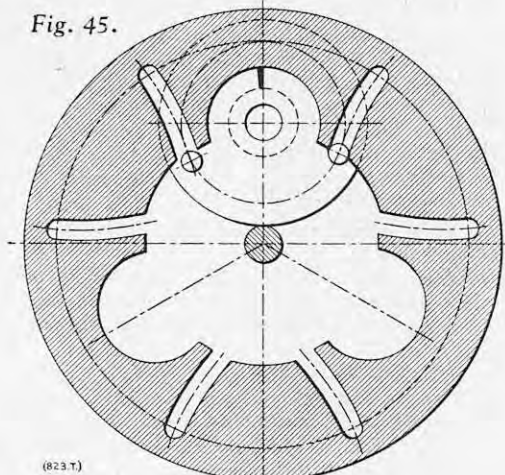


Fig. 46.

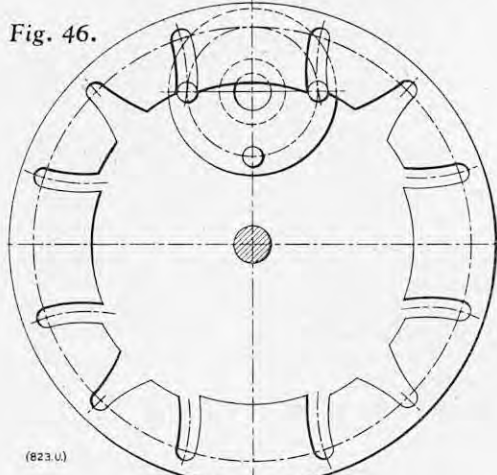


Fig. 47.

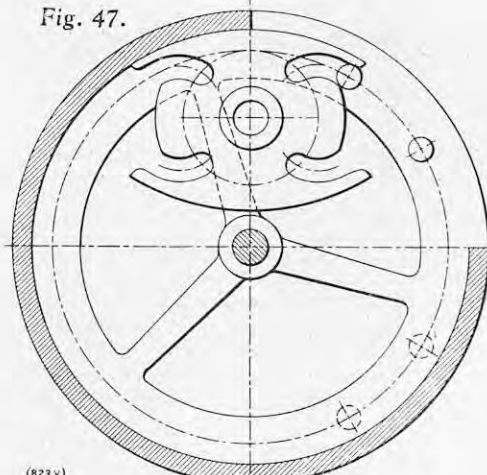


Fig. 48.

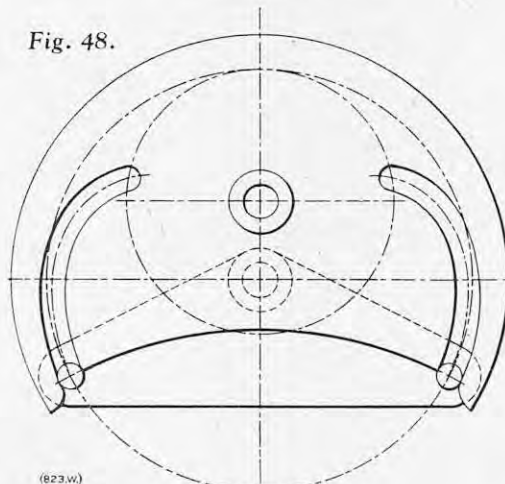


Fig. 49.

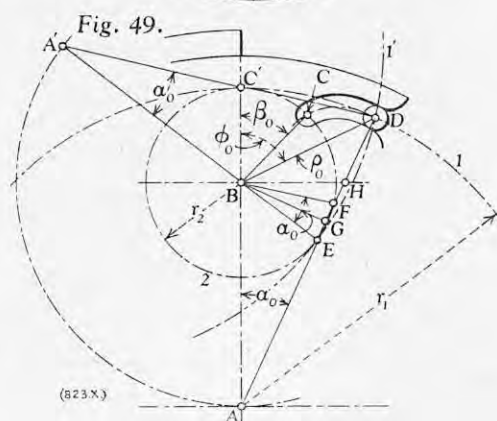
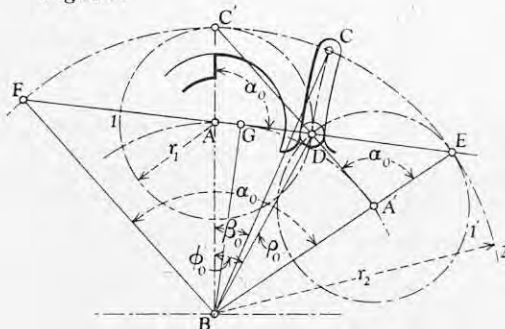


Fig. 50.



MECHANISMS FOR INTERMITTENT MOTION.

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

(Continued from page 59.)

INTERNAL STAR-WHEEL MECHANISMS.

It was shown previously that internal Geneva mechanisms cover other fields than external Geneva mechanisms, and that they have better kinematic properties. Internal star-wheel mechanisms can also be designed, but, as will be seen later, they do not cover other fields than their external counterparts. Their kinematic properties are only superior when the driven gear lies inside the driving gear. In many instances, however, internal star-wheel mechanisms are simpler to design and manufacture than external mechanisms, because the accelerating and retarding rollers frequently suffice to impart the uniform motion. Internal star-wheel mechanisms have the feature common to other internal gears that both gears rotate in the same direction, and they form a compact unit, particularly if the distance between the shaft centres is small.

As in the case of internal Geneva mechanisms, negative values of μ can be substituted in the formulae for external mechanisms in order to deduce the properties of internal mechanisms, but some of the results are liable to misinterpretation if this is done. A distinction must be drawn between mechanisms which have values of μ larger and smaller than 1, that is, between driven gears which are larger and smaller than the driving gears. In the former case, the driving gear lies inside the driven gear, as in Figs. 45 and 46, on this page; in the latter case, see Figs. 47 and 48, the situation is reversed. It will be found later that both groups of internal star-wheel mechanisms are separated by a range of μ on both sides of the value $\mu = 1$, a feature which has an analogy in ordinary types of internal gears. In their case, also, ratios in the neighbourhood of unity are not feasible because of interference between teeth which are not sup-

posed to be meshing. To simplify the analysis, the two groups of internal star-wheel mechanisms will be treated separately.

Geometry.—Fig. 49, herewith, shows an internal star-wheel mechanism, for which $\mu < 1$, in the position where the driven gear begins to move. The centre line CD of the accelerating slot is a part of a pericycloid, which is generated by a point on the pitch circle 1 when the latter is rolling, without sliding, on the pitch circle 2 in such a way that the centres of both circles lie on the same side of the point of contact. For reasons already known, the tangent to the pericycloid at the point D must also be a tangent to the circle 1. In order to make the many analogies with external mechanisms obvious, and justify a more concise derivation of the formulae, the same notation is used as in Fig. 31, on page 743 of the previous volume.

In the isosceles triangle ABF , Fig. 49 $AB = r_1 - r_2$, and $BF = r_2$, so that

$$\sin \frac{\alpha_0}{2} = \frac{\mu}{2(1-\mu)} \quad (20a)$$

$$\alpha_0 = 2 \sin^{-1} \frac{\mu}{2(1-\mu)} \quad (21a)$$

The angle HBF is $\frac{\alpha_0}{2}$, and the angle FBE is α_0 , so that the angle $C'BE$ is equal to $\left(\frac{\pi}{2} + \frac{3\alpha_0}{2}\right)$; the angle ϕ_0 which determines the point D , is

$$\phi_0 = \frac{\pi}{4} + \frac{3\alpha_0}{4} = \frac{\pi}{4} + \frac{3}{2} \sin^{-1} \frac{\mu}{2(1-\mu)} \quad (22a)$$

The arcs CE and DE are equal to $r_1 \alpha_0$; the angle $CBE = \frac{r_1 \alpha_0}{r_2} = \frac{\alpha_0}{\mu}$, and Fig. 49 shows that

$$\begin{aligned} \beta_0 &= \frac{\pi}{2} + \frac{3\alpha_0}{2} - \frac{\alpha_0}{\mu} = \frac{\pi}{2} - \frac{\alpha_0}{2} \frac{2-3\mu}{\mu} \\ &= \frac{\pi}{2} - \left(\frac{2-3\mu}{\mu} \right) \sin^{-1} \frac{\mu}{2(1-\mu)} \end{aligned} \quad (23a)$$

With a as the distance between centres, the radii of the driving and driven gears are

$$r_1 = \frac{a}{1-\mu} \quad (24a)$$

$$r_2 = \frac{a\mu}{1-\mu} \quad (25a)$$

The distance $s (= C'D)$ is

$$\frac{a\mu}{(1-\mu)^2} \quad (26a)$$

and it can be obtained graphically by describing a circle with centre at A and radius equal to AB , as far as the intersection F with the pitch circle of the driven gear. The line AF , when produced, intersects the pitch circle of the driving gear at the required point D .

The angle $B C' D = \frac{\pi}{4} - \frac{\alpha_0}{2}$, the angle $C' B D = \phi_0 = \frac{\pi}{4} + \frac{3\alpha_0}{4}$, and the angle

$$C' D B = \pi - \left(\frac{\pi}{2} - \frac{\alpha_0}{2} \right) - \left(\frac{\pi}{4} + \frac{3\alpha_0}{4} \right) = \frac{\pi}{4} - \frac{\alpha_0}{4}.$$

Using the sine rule,

$$\rho_0 : r_2 = \sin \left(\frac{\pi}{2} - \frac{\alpha_0}{2} \right) : \sin \left(\frac{\pi}{4} - \frac{\alpha_0}{4} \right) = 2 \cos \left(\frac{\pi}{4} - \frac{\alpha_0}{4} \right),$$

whence $\rho_0 = 2 r_2 \cos \left(\frac{\pi}{4} - \frac{\alpha_0}{4} \right)$, or

$$\rho_0 = 2a \frac{\mu}{1-\mu} \cos \left(\frac{\pi}{4} - \frac{\alpha_0}{4} \right) \quad (27a)$$

As in the case of external star-wheel mechanisms, the ratio of the angles of the driving and driven gears is

$$\epsilon = \left[2\alpha_0 + \mu \left(\frac{2\pi}{n} - 2\beta_0 \right) \right] \div \frac{2\pi}{n},$$

and so, by (21a) and (23a),

$$\epsilon = \mu + n \frac{4-3\mu}{\pi} \sin^{-1} \frac{\mu}{2(1-\mu)} - \frac{n\mu}{2} \quad (28a)$$

In the case $n = 1$,

$$\epsilon_1 = \frac{\mu}{2} + \frac{4-3\mu}{\pi} \sin^{-1} \frac{\mu}{2(1-\mu)} \quad (29a)$$

As in the case of external drives, the maximum value of ϵ is

$$\epsilon_{\max.} = n, \quad (30a)$$

and the value $\mu_{\max.}$ which corresponds to $\epsilon_{\max.}$ must satisfy the condition

$$\frac{4-3\mu}{\pi\mu} \sin^{-1} \frac{\mu}{2(1-\mu)} - \frac{1}{\mu} = \frac{n-2}{2n} \quad (31a)$$

As in the case of external drives, the minimum value of ϵ is

$$\epsilon_{\min.} = \frac{3n}{2\pi} \alpha_0 = \frac{3n}{\pi} \sin^{-1} \frac{\mu}{2(1-\mu)}, \quad (32a)$$

and the value $\mu_{\min.}$ which corresponds to $\epsilon_{\min.}$ must satisfy the condition

$$\frac{1-3\mu}{\mu} \sin^{-1} \frac{\mu}{2(1-\mu)} = \frac{\pi n-2}{2n}. \quad (33a)$$

The left-hand side of formula (33a) is a maximum when $\mu=0$, and has the value $\frac{1}{2}$. The corresponding value of n is $\frac{2\pi}{\pi-1} \approx 2.93$, a value which has already been met with in external star-wheel mechanisms. As the right-hand side of (33a) increases with increasing n , it follows that n cannot exceed 2.93. In consequence, n must be 1 or 2, and μ can be as small as desired. In the extreme case, in which $\mu=0$, the mechanisms are identical with those shown in Figs. 33 and 34, page 743, of the previous volume.

Although the results above are analogous to those for external mechanisms, there is a difference owing to the fact that $(1+\mu)$ is replaced by $(1-\mu)$. As μ increases, the value of $\sin \frac{\alpha_0}{2} =$

$\frac{\mu}{2(1-\mu)}$ also increases, and would ultimately exceed unity. A limit on μ , therefore, is imposed by the condition $\frac{\mu}{2(1-\mu)} \leq 1$, or $\mu \leq \frac{2}{3} = 0.6667$.

Another limit, however, is set by the condition that the driving gear must rotate through at least an angle $3\alpha_0$, for the same reason as in the case of external star-wheel mechanisms. Consequently $\frac{\alpha_0}{2}$ cannot exceed $\frac{360}{6} = 60$ deg., and

$$\frac{\mu}{2(1-\mu)} \leq \sin 60 \text{ deg.} = \frac{\sqrt{3}}{2}, \text{ or}$$

$$\mu \leq \frac{3-\sqrt{3}}{2} = 0.6340. \quad (52a)$$

In Table VII, herewith, which contains the extreme values of ϵ and μ , the maximum value of μ for $n=1$ is determined from (31a), and the maximum for $n=2$ by (52a). If the value of ϵ is specified, μ must be evaluated by means of (28a). Tables VIIIA and B, make the solution of the transcendental equations unnecessary in most cases. As in the case of external star-wheel mechanisms considered previously, it is advisable not to retain the evaluated value of μ , if it is an awkward decimal, but rather to approximate to it by a vulgar fraction.

TABLE VII.—Extreme Values for Internal Star-Wheel Mechanisms.

n	$\epsilon_{\max.}$	$\mu_{\max.}$	$\epsilon_{\min.}$	$\mu_{\min.}$	$m_{\max.}$
1	1	0.6302	0	0	∞
2	2	0.6340	0	0	∞
3	3	2.5420	2.8955	2.4399	1
4	4	3.4142	3.4056	2.7980	1
5	5	4.3011	3.9112	3.1676	1
6	6	5.1882	4.4154	3.5434	1
7	7	6.0748	4.9179	3.9219	1
8	8	6.9620	5.4201	4.3011	1
9	9	7.8479	5.9214	4.6830	1
10	10	8.7330	6.4227	5.0643	1

TABLE VIIIA.—Values of μ in Terms of n and ϵ for Internal Star-Wheel Mechanisms.

$\epsilon \backslash n$	1	2	$\epsilon \backslash n$	1	2
0.0	0.10810	0.09518	1.0	0.3980	0.3420
0.1	0.12320	0.10833	2.0	0.4618	0.3957
0.2	0.14318	0.12567	3.0	0.4766	0.4082
0.3	0.17085	0.14958	4.0	0.5000	0.4283
0.4	0.2116	0.18459	5.0	0.5422	0.4654
0.5	0.2773	0.2405	6.0	0.5646	0.4858
0.6	0.3089	0.2672	7.0	0.5781	0.5000
0.7	0.3275	0.2828	8.0	0.5802	0.5134

The duration of motion, expressed in fractions of a revolution of the driving gear, is the same as for external star-wheel mechanisms, namely,

$$v = \frac{\epsilon}{n}. \quad (35a)$$

so that when $n=1$

$$v_1 = \epsilon. \quad (36a)$$

$$v_{\max.} = \frac{\epsilon_{\max.}}{n}. \quad (37a)$$

$$v_{\min.} = \frac{\epsilon_{\min.}}{n} = 0. \quad (38a)$$

As in the case of external drives, the angle γ over which the locking drum extends, is

$$\gamma = 2 \left[\pi \left(1 - \frac{\mu}{n} \right) - \alpha_0 + \mu \beta_0 \right], \quad (39a)$$

so that when $n=1$,

$$\gamma_1 = 2 [\pi (1 - \mu) - \alpha_0 + \mu \beta_0]. \quad (40a)$$

The design data α_0 , β_0 , ϕ_0 , r_1 , r_2 , s and ρ_0 are contained in Table IX, herewith, in small steps of μ .

As an example, consider the design of an internal star-wheel mechanism which imparts half a revolution to the driven gear during a 90-deg. rotation of the driving gear.

The arrangement is shown in Fig. 47. Let the distance between centres be $a=5$ in. The ratio $\epsilon = \frac{90}{180} = 0.5$, and Table VII indicates that $\mu = 0.3420$ for $n=2$. This value may be re-

placed by $\mu = \frac{13}{38} = 0.342105$, in order to obtain rational dimensions of the pitch diameters.

By (20a), $\sin \frac{\alpha_0}{2} = 0.26$. Hence, $\frac{\alpha_0}{2} = 15$ deg. 4 min., and $\alpha_0 = 30$ deg. 8 min.

By (22a), $\phi_0 = 45$ deg. $+\frac{3}{4}\alpha_0 = 67$ deg. 36 min.

By (23a), $\beta_0 = 47$ deg. 7 min.

By (24a), $r_1 = 7.6$ in.

By (25a), $r_2 = 2.6$ in.

By (26a), $s = 3.952$ in.

By (27a), $\rho_0 = 4.127$ in.

All these values can also be interpolated from those in Table IX.

By (28a), $\epsilon = 0.49783$. This value differs only slightly from the intended value 0.5, and means that the motion occupies 89 deg. 37 min., instead of 90 deg.

By (35a), $v = 0.248915$ instead of 0.25.

By (39a), $\gamma = 270$ deg. 23 min., which can be made 270 deg. as originally intended.

It is interesting to carry out the calculations for $\epsilon = \frac{2}{3}$ and $n=1$, or $\epsilon = \frac{5}{8}$ and $n=2$. In these cases, μ assumes the round value 0.5, and all angles

TABLE VIIIB.—VALUES OF μ IN TERMS OF n AND ϵ FOR INTERNAL STAR-WHEEL MECHANISMS.

$\epsilon \backslash n$	3	4	5	6	7	8	9	10
0.3	2.5420							
0.4		2.8953						
0.5		3.4142						
0.6			3.2609					
0.7			3.7832					
0.8			4.3011					
0.9				3.6329				
1.0				4.1558				
1.1				5.1882				
1.2					4.0082			
1.3					5.0491			
1.4					6.0748			
1.5						4.9080		
1.6						5.9398		
1.7						6.9620		
1.8							4.7652	
1.9							5.8042	
2.0							6.8291	
2.1							7.8479	
2.2								5.6664
2.3								6.6957
2.4								7.7168
2.5								8.7330

TABLE IX.—INTERNAL STAR-WHEEL MECHANISMS.

μ	α_0	ϕ_0	β_0	$\frac{r_1}{a}$	$\frac{r_2}{a}$	$\frac{s}{a}$	$\frac{\rho_0}{a}$	$\left(\frac{d\beta}{da}\right)_0$	$\left(\frac{d^2\beta}{da^2}\right)_{\alpha_0}$	$a_{\max.}$	$\left(\frac{d^2\beta}{da^2}\right)_{\max.}$
	deg. min.	deg. min.	deg. min.	1.0	0	0	0	∞	∞	deg. min.	∞
0.00	0 0	45 0	32 42	1.0204	0.02041	0.02082	0.02901	50.00	242.5	0 39	-3051
0.02	1 10	45 52	33 17	1.0417	0.04167	0.04340	0.05953	25.00	587.6	1 20	780.5
0.04	2 23	46 47	33 53	1.0638	0.06383	0.06790	0.09170	16.67	252.9	2 2	339.2
0.06	3 39	47 44	34 31	1.0870	0.08696	0.09452	0.12563	12.50	137.6	2 45	187.0
0.08	4 59	48 44	35 11	1.1111	0.11111	0.12346	0.16147	10.00	85.13	3 29	116.9
0.10	6 22	49 47	35 52	1.1364	0.13636	0.15496	0.19933	8.33	57.08	4 14	79.25
0.12	7 49	50 52	36 34	1.1628	0.16279	0.18929	0.2394	7.14	40.44	4 50	57.03
0.14	9 20	52 0	37 19	1.1905	0.19048	0.2268	0.2819	6.25	29.82	5 46	42.69
0.16	10 55	53 12	38 5	1.2120	0.2120	0.2677	0.3270	5.56	22.67	6 34	33.01
0.18	12 36	54 27	38 53	1.2500	0.2500	0.3125	0.3749	5.00	17.64	7 23	26.06
0.20	14 22	55 46	39 44	1.2821	0.2821	0.3616	0.4260	4.55	13.98	8 13	21.03
0.22	16 13	57 10	40 37	1.3158	0.3158	0.4155	0.4806	4.17	11.25	9 5	17.24
0.24	18 10	58 38	41 33	1.3514	0.3514	0.4748	0.5389	3.85	9.179	9 58	14.31
0.26	20 14	60 11	42 32	1.3889	0.3889	0.5401	0.6011	3.57	7.542	10 52	12.03
0.28	22 25	61 49	43 33	1.4286	0.4286	0.6122	0.6678	3.33	6.256	11 48	10.21
0.30	24 45	63 34	44 38	1.4706	0.4706	0.6920	0.7396	3.13	5.225	12 45	8.725
0.32	27 13	65 25	45 46	1.5152	0.5152	0.7806	0.8171	2.94	4.387	13 44	7.516
0.34	29 51	67 24	46 59	1.5625	0.5625	0.8789	0.9006	2.78	3.699	14 46	6.522
0.36	32 40	69 30	48 16	1.6129	0.6129	0.9886	0.9908	2.63	3.128	15 49	5.685
0.38	35 41	71 46	49 37	1.6667	0.6667	1.1111	1.0887	2.50	2.652	16 53	4.979
0.40	38 56	74 12	51 3	1.7241	0.7241	1.2485	1.1953	2.38	2.250	18 1	4.376
0.42	42 27	76 50	52 36	1.7857	0.7857	1.4030	1.3115	2.27	1.910	19 10	3.860
0.44	46 16	79 42	54 15	1.8519	0.8519	1.5775	1.4385	2.17	1.619	20 22	3.417
0.46	50 25	82 49	56 1	1.9231	0.9231	1.7752	1.5785	2.08	1.370	21 37	3.034
0.48	54 58	86 14	57 56	2.0000	1.0000	2.0000	1.7321	2.00	1.155	22 54	2.699
0.50	60 0	90 0	60 0	2.0833	1.0833	2.2570	1.9018	1.92	0.9679	24 14	2.405
0.52	65 36	94 12	62 15	2.1739	1.1739	2.5519	2.0910	1.85	0.8048	25 38	2.148
0.54	71 53	98 54	64 42	2.2727	1.2727	2.8926	2.3021	1.79	0.6614	27 6	1.921
0.56	79 3	104 17	67 25	2.3810	1.3810	3.2880	2.5392	1.72	0.5342	28 37	1.719
0.58	87 20	110 30	70 25	2.5000	1.5000	3.7500	2.8057	1.67	0.4200	30 12	1.539
0.60	97 11	117 53	73 48	2.6316	1.6316	4.2937	3.0955	1.61	0.3149	31 52	1.379
0.62	109 20	127 0	77 39	2.7321	1.7321	4.7321	3.3464	1.58	0.2439	33 5	1.277
0.634	120 0	135 0	80 43								
2.44	115 49	41 52	36 16	0.6944	1.6944	1.1767	0.9370	0.410	0.8410		
2.6	108 41	36 31	31 13	0.6250	1.6250	1.0156	0.9951	0.385	0.7359		
2.8	102 7	31 35	26 42	0.5556	1.5556	0.8642	1.0371	0.357	0.6494		
3.0	97 11	27 33	23 23	0.5000	1.5000	0.7500	1.0606	0.333	0.5880		
3.2	93 19	24 59	20 49	0.4545	1.4545	0.6612	1.0742	0.313	0.5407		
3.4	90 12	22 39	18 46	0.4167	1.4167	0.5903	1.0820	0.294	0.5024		
3.6	87 38	20 43	17 6	0.3846	1.3846	0.5326	1.0862	0.278	0.4705		
3.8	85 28	19 6	15 42	0.3571	1.3571	0.4847	1.0881	0.263	0.4431		
4.0	83 37	17 43	14 32	0.3333	1.3333	0.4444	1.0887	0.250	0.4193		
4.2	82 2	16 31	13 31	0.3125	1.3125	0.4102	1.0882	0.238	0.3982		
4.4	80 38	15 29	12 38	0.2941	1.2941	0.3806	1.0873	0.227	0.3794		
4.6	79 25	14 34	11 52	0.2778	1.2778	0.3549	1.0859	0.217	0.3624		
4.8	78 20	13 45	11 11	0.2632	1.2632	0.3324	1.0843	0.208	0.3471		
5.0	77 22	13 1	10 34	0.2500	1.2500	0.3125	1.0826	0.200	0.3331		
5.2	76 30	12 22	10 2	0.2381	1.2381	0.2948	1.0807	0.192	0.3202		
5.4	75 42	11 47	9 32	0.2273	1.2273	0.2789	1.0789	0.185	0.3084		
5.6	74 59	11 15	9 6	0.2174	1.2174	0.2647	1.0770	0.179	0.2974		
5.8	74 20	10 45	8 41	0.2083	1.2083	0.2517	1.0752	0.172	0.2872		
6.0	73 44	10 18	8 19	0.2000	1.2000	0.2400	1.0734	0.167	0.2778		
6.2	73 11	9 54	7 59	0.19231	1.1923	0.2293	1.0716	0.161	0.2689		
6.4	72 41	9 31	7 40	0.18519	1.1852	0.2195	1.0699	0.156	0.2607		
6.6	72 13	9 10	7 23	0.17857	1.1786	0.2105	1.0682	0.152	0.2529		
6.8	71 47	8 50	7 7	0.17241	1.1724	0.2021	1.0666	0.147	0.2456		
7.0	71 22	8 32	6 52	0.16667	1.1667	0.19445	1.0651	0.143	0.2387		
7.2	71 0	8 15	6 38	0.16129	1.1613	0.18730	1.0635	0.139	0.2322		
7.4	70 38	7 59	6 25	0.15625	1.1563	0.18066	1.0620	0.135	0.2260		
7.6	70 18	7 44	6 12	0.15152	1.1515	0.17447	1.0607	0.132	0.2202		
7.8	70 0	7 30	6 1	0.14706	1.1471	0.16868	1.0594	0.128	0.2147		
8.0	69 42	7 16	5 50	0.14286	1.1429	0.16326	1.0581	0.125	0.2094		
8.2	69 25	7 4	5 40	0.13889	1.1389	0.15818	1.0568	0.122	0.2044		
8.4	69 10	6 53	5 31	0.13514	1.1351	0.15340	1.0556	0.119	0.1997		
8.6	68 55	6 41	5 21	0.13158	1.1316	0.14890	1.0545	0.116	0.1951		
∞	60 0	0 0	0 0	0	1.0	0	1.0	0	0		

and almost all other dimensions appear as round figures. In the case of $\varepsilon = \varepsilon_{\max.}$, there is no locking drum as the driven gear is periodically brought to a standstill without remaining at rest. A gear of this kind is shown in Fig. 48.

For internal star-wheel mechanisms in which the driving gear lies inside the driven gear, or for which $\mu > 1$, the distance between centres is $r_2 - r_1$, in contrast to the mechanisms considered above in which the centre distance is $r_1 + r_2$. It will not be surprising, therefore, to find that $1 - \mu$ in the various formulæ is replaced by $\mu - 1$. The formulæ can readily be derived from Fig. 50, on page 96, in which the same references are used as in Fig. 31 on page 743 of the previous volume and Fig. 49, on page 91.

$$\sin \frac{\alpha_0}{2} = \frac{\mu}{2(\mu - 1)} \quad (20b)$$

$$\alpha_0 = 2 \sin^{-1} \frac{\mu}{2(\mu - 1)} \quad (21b)$$

$$\phi_0 = \frac{3\alpha_0}{4} - \frac{\pi}{4} \quad (22b)$$

$$\beta_0 = \frac{3\mu - 2}{\mu} \sin^{-1} \frac{\mu}{2(\mu - 1)} - \frac{\pi}{2} \quad (23b)$$

$$r_1 = \frac{a}{\mu - 1} \quad (24b)$$

$$r_2 = \frac{a\mu}{\mu - 1} \quad (25b)$$

$$s = \frac{a\mu}{(\mu - 1)^2} \quad (26b)$$

The last result may be found graphically by a construction analogous to that for mechanisms in which $\mu < 1$.

$$\rho_0 = 2a \frac{\mu}{\mu - 1} \cos \left(\frac{\pi}{4} + \frac{\alpha_0}{4} \right) \quad (27b)$$

$$\varepsilon = \mu + n \frac{4 - 3\mu}{\pi} \sin^{-1} \frac{\mu}{2(\mu - 1)} + \frac{n\mu}{2} \quad (28b)$$

$$\varepsilon_{\max.} = n \quad (30b)$$

The corresponding maximum value of μ satisfies

$$\frac{3\mu - 4}{\pi\mu} \sin^{-1} \frac{\mu}{2(\mu - 1)} + \frac{1}{\mu} = \frac{n + 2}{2n} \quad (31b)$$

$$\varepsilon_{\min.} = \frac{3n}{\pi} \sin^{-1} \frac{\mu}{2(\mu - 1)} \quad (32b)$$

The corresponding minimum value of μ satisfies

$$\frac{3\mu - 1}{\mu} \sin^{-1} \frac{\mu}{2(\mu - 1)} = \frac{\pi n + 2}{2} \quad (33b)$$

$$\varepsilon_{\min.} = \frac{3(n + 2)\mu_{\min.}}{2(3\mu_{\min.} - 1)} \quad (34b)$$

$$\nu = \frac{\varepsilon}{n} \quad (35b)$$

$$\nu_{\max.} = \frac{\varepsilon_{\max.}}{n} \quad (37b)$$

$$\nu_{\min.} = \frac{\varepsilon_{\min.}}{n} \quad (38b)$$

$$\gamma = 2 \left[\pi \left(1 - \frac{\mu}{n} \right) - \alpha_0 + \mu \beta_0 \right] \quad (39b)$$

Here again, $\sin \frac{\alpha_0}{2} = \frac{\mu}{2(\mu - 1)}$ must be ≤ 1 ; thus $\mu \geq 2$.

Another limit, however, is set by the requirement

that $\frac{\alpha_0}{2} \leq 60$ deg., so that $\frac{\mu}{2(\mu - 1)} \leq \frac{\sqrt{3}}{2}$, or

$$\mu \geq \frac{3 + \sqrt{3}}{2} = 2.3660. \quad (52b)$$

It will be shown later that the practical minimum value of μ is still higher, namely, 2.4399. The left-hand sides of equations (31b) and (33b) increase as μ decreases, so that the lowest value of μ corresponds to the highest value to which the left-hand sides of these equations can amount. The right-hand sides of equations (31b) and (33b) are proportional to $\frac{n + 2}{n}$, which increases as n decreases. The minimum value of μ , namely, 2.3660, therefore, corresponds to the minimum value of n .

If $\mu = \frac{3 + \sqrt{3}}{2} = 2.3660$ is substituted for $\mu_{\max.}$ in (31b), or for $\mu_{\min.}$ in (33b), n is in both cases $12\sqrt{3} - 18 = 2.7846$. The smallest practical value of n , therefore, is 3.

In the case of internal star-wheel mechanisms,

the choice of $\mu > 1$ or < 1 depends on the number of locking shoes n . If n is 1 or 2, μ must be < 1 ; if n is 3 or more, μ must be > 1 . The corresponding mechanisms are distinguished in Tables VII to IX.

A comparison between Table IV, on page 742 of the previous volume, and Table VII, opposite, reveals that external and internal star-wheel mechanisms have, for any value of n , a common upper limit of ε ; the lower limit, however, is higher for internal mechanisms. Internal drives, therefore, do not offer possibilities exceeding those of external star-wheel mechanisms. It has been found that, for $n = 2.7846$, the upper and lower limits of μ coincide. As Table VII shows, there is a small margin between the two limits for $n = 3$. This difference increases with increasing n ; but as low values of n are most likely to be required, internal star-wheel mechanisms generally leave little latitude for the choice of μ .

Tables VIII A and B indicate the values of μ when the value of ε is specified. It is interesting to check by means of (28b) the values of n , ε , and μ for $n = 4$ and $\varepsilon = 4$ (Fig. 46). In spite of the transcendental form of the equation, $\frac{\alpha_0}{2}$, in this case is

45 deg., and $\mu = 2 + \sqrt{2} = 3.4142$. A similar, although less obvious case, occurs for $n = 10$ and

$$\varepsilon = 8; \frac{\alpha_0}{2} \text{ is } 36 \text{ deg.}; \sin 36 \text{ deg.} = \frac{\sqrt{10 - 2\sqrt{5}}}{4}$$

$$\text{and } \mu = \frac{5 + \sqrt{5} + 2\sqrt{5} + 2\sqrt{5}}{2} = 6.6957.$$

Table IX contains the data for designing internal star-wheel mechanisms. It has been found that, for $\mu > 1$, the minimum value of μ is 2.3660 which would imply $n = 2.7846$ locking shoes. The practical minimum of μ is thus the value corresponding to $n = 3$, namely, $\mu = 2.4399$, and Table IX, therefore, shows a gap between the values 0.634 and 2.44.

Another gap in the possible range of μ is between the maximum value for $n = 3$, namely, 2.5420, and the minimum value for $n = 4$, namely, 2.7980. The value 2.6 of μ in Table IX is included only for interpolation purposes.

The values against $\mu = \infty$, in Table IX, confirm the obvious fact that in this case the internal mechanism is identical with the external for $\mu = \infty$ (Figs. 35 and 36, on page 743 of the previous volume).

(To be continued.)

MECHANISATION IN BRITISH COLLIERIES.*

By E. H. BROWNE.

(Concluded from page 61.)

DESIGN AND SPECIFICATION.

THE mining industry has been one of the most backward in drawing up specifications of its requirements. As opportunity affords, the National Coal Board will gradually remedy this. For highly specialised equipment, it is obviously unfitting for the Board to do more than specify the general type and kind of performance that is needed; for instance, it would be unthinkable for the Board to design and specify a coalcutter. At the same time, there does seem to be a wide field within which the industry should tighten up its specifications.

In big constructional jobs on the surface, we must advance farther towards complete design and specification, with quantities, for civil engineering works. In this, the use of civil engineering consultants seems to be the right answer, though seldom adopted in the industry in the past. These surface constructional works are more difficult to handle on orthodox lines than those for power stations, factories, oil refineries, etc. Complete plans can seldom be drawn up for a new sinking, and then the whole executed as one job: reconstruction schemes often involve a close degree of integration with equipment

which has to be kept in use during the reconstruction, which adds complication. But the mining industry needs to obtain properly competitive estimates for building and constructional work, like other industries; and the practice of getting contractors, or design-contractors, to submit schemes and estimates, and leaving them to do practically the whole of the design work, cannot be regarded as satisfactory except under the special conditions for which the "selected" contract has been designed. In an industry desperately short of planning staff, it is surely good sense to make use of outside help in the one field where it is available—the civil engineering consultants.

For the specialised mining equipment, like winding engines, the whole corpus of technical knowledge is the exclusive property of the Board and the manufacturers. There are no consultants (as there are in the field of electrical generation) who can help us to design and specify our specialised plant. In this field, then, we must ourselves participate to a greater extent than in the past, while, at the same time, continuing to make the fullest use of the makers' experience and skill. The Board would not wish to design a winding engine in detail, but there are certain broad features which ought to be specified so that a fair comparison between different tenders can be made, and to ensure that the best and most economical plant is purchased. For equipment of this kind—and even for more comprehensive plant, such as washeries—the mining industry is still apt to broadcast inquiries without saying what it really needs. Tenders are sometimes put forward with widely different characteristics in the equipment offered, because a sufficiently precise specification has not been predetermined. This leads to revisions, new designs and fresh tendering; and it puts manufacturers to immense trouble and cost (which, no doubt, ultimately falls back on the Board) and causes delay in the execution of the project. The heart of an Engineering Department is its drawing office. Most Area drawing offices need strengthening.

CENTRAL WORKSHOPS.

The Reid Report was categorical in its recommendation that central workshops should be provided for groups of collieries, and the Board have adopted a policy to build central shops, normally for each Area, though this is not rigid. It is anticipated that ultimately about 40 shops will be required, but the implementation of this policy has so far advanced very slowly. It is not a question of rigging up bad old workshops and calling them "central"; what is intended is modern layout and equipment. The mining industry is practically without expert knowledge in this subject, and we have much to learn from the experience gained in the outer world.

If we are to look in the future to central workshops doing repairs, overhauls and testing, some manufacture (though it is not the intention to embark on making specialised machinery at these shops), and providing the capacity for furnishing erection squads and for undertaking special jobs, it is important to study the effect of this on mechanical and electrical engineers and their work and on the training of newcomers. When a central works has been established it will carry out a large amount of the overhauls of colliery equipment. Portable plant should come in at fixed intervals, according to its kind; and central shops and stores between them must provide a replacement service which will win the confidence of management and encourage them to regard portable plant as being on a pool basis for the Area as a whole, rather than belonging to a particular colliery. Work at the pits will become more and more inspection, detection and anticipation of weaknesses, day-to-day maintenance and first-aid repairs. These are the jobs most difficult to do well. How, then, shall we give young men entering the engineering service, the all-round training which they need to have in order to perform these important tasks at the pits?

Close contacts between the central shops and the collieries are essential; there should be regular intercourse between them, and promotion from one to the other. Apprenticeship will normally be better given at central workshops, at least in part,

* Address by the Director-General of Production, National Coal Board, to the Annual Conference of the Association of Mining, Electrical and Mechanical Engineers, delivered at Blackpool on June 17, 1952. Abridged.

than at a pit; but this is not without its difficulties, which the Board recognised when they formulated their central workshops policy. There are problems of distance, and apprentices may be reluctant to go to the pits after a spell at the shops. These problems must, however, be overcome. It is desirable to recruit many of the apprentices from the pits themselves and to bring on boys, after their initial general training, by temporary transfer to the central shops; they should then return to the pits. Proper training is the basis on which the rest must be built.

The Board welcomes the approach of statutory qualification of electricians, to be followed later by similar qualification for mechanics. Because of the special circumstances of the mining industry, statutory qualifications are necessary. They can however, provide only the basic minima; they cannot in themselves raise the standards all round. It is for the Board to see that comprehensive training is available and that qualifications for different places in the engineering world are properly established. Three groups are required for collieries, as for other industries. First, there are the craftsmen; secondly, for want of a better word, the "technicians"; and, thirdly, what are described as the qualified "professional" engineers.

The conception of craft training is firmly established, having its roots in mediaeval apprenticeship. At the other end, the training of "professional" engineers has received much attention in recent times. The intermediate group has had no well-established system of training, and, in my view technical education in the country has placed too little emphasis on this extremely important section. There seems to have been much more attention devoted to the limited numbers of students who go some distance in their studies than to the larger numbers who are destined to remain part-way up the ladder. This has meant, I fear, that many students of real, but limited, academic capabilities have embarked on courses only to find themselves unable to keep up, and have abandoned technical education altogether.

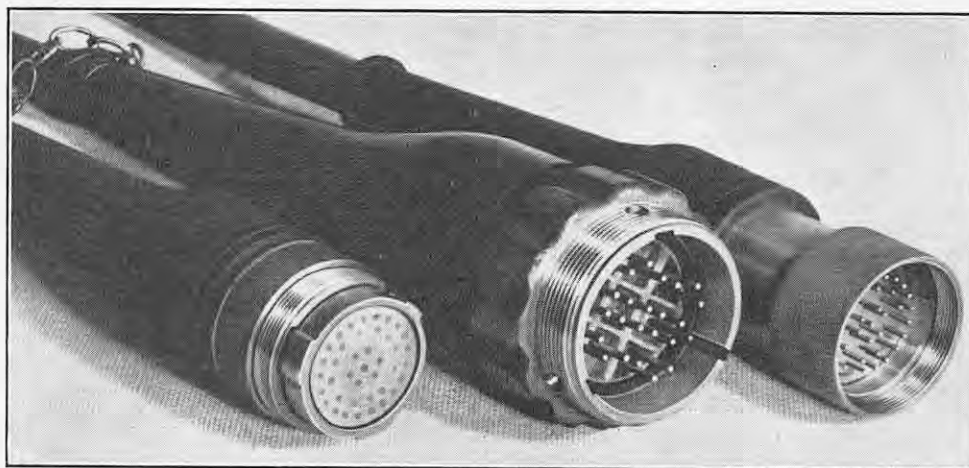
For the "technicians," there is a need for technical education which is of a more practical kind, but which does give them enough theoretical background. This has been recognised in the country generally by the development of courses of the City and Guilds type. This is not, of course, to under-rate the importance of higher technical education. There is a need now, and there will be an increasing need, for the most highly qualified engineers for senior posts. There should be no falling off in the candidates for the Higher National Certificate. We must also get our share in mining of the graduates from engineering departments of universities; we are not doing so now.

I have not hidden my view that mechanical and electrical engineering should be given better status and more scope than it has had in some places in the coalfields; and that there is need to recognise it as a functional branch within the technical control of the industry. It is for mechanical and electrical engineers to justify that recognition by giving the service, and by meeting the new demands of the day and the greater demands still of the future. This is an underground industry; the mining engineer's heart is really at the face, the focal point of operations. The mechanical or electrical engineer should dispose his energy accordingly, and should devote the time and trouble justified for the development and design of underground plant and its efficient maintenance.

SPECIFICATIONS FOR RADIO EQUIPMENT.—The Radio Industry Council, 59, Russell-square, London, W.C.1, have issued Sections 1 and 2 of specifications dealing with dolly-operated switches, wafer rotary switches and electronic receiver type valve holders. These specifications are temporarily intended for internal use within the industry, but it is hoped to submit them to the British Standards Institution by the time that the respective requirements of the industry and the services have been co-ordinated. The price of the first two of these specifications is 6s. each, and of the third 5s. 6d. Section 3 of the specifications on non-insulated wire-wound fixed resistors, and of composition track variable rotary resistors, and on fixed capacitors with Grade I ceramic dielectric have also been published. The first two of these can be obtained at 1s. 6d., and the third at 3s. per copy.

CABLE FOR TELEVISION CAMERAS.

BRITISH INSULATED CABLES, LIMITED, LONDON.



TELEVISION CAMERA CABLES.

THE B.I.C.C. Polypole television camera-cable system introduced in 1949 by Messrs. British Insulated Cables, Limited, 21, Bloomsbury-street, London, W.C.1, provided for the first time a high-performance single-strand cable in unit lengths, each with integrally moulded-on couplers. Without such couplers the virtual impossibility of obtaining a strong termination has usually involved the use of large multi-strand conductors throughout the cable, with consequent loss of electrical performance. In the B.I.C.C. Polypole system, the couplers are moulded integrally with the cable in the factory. The connections are permanently made, and the mechanical strength of the termination is as good as that of the remainder of the cable.

The success of this system in service with the British Broadcasting Corporation has now encouraged the company to introduce further improvements. A new design, known as Polypole 111, has now been introduced and a laboratory prototype was shown at the exhibition of the Radio and Electronic Components Manufacturers' Federation this year; it is illustrated herewith, together with its predecessor. Compared with the latter, the Polypole 111 coupler is smaller, lighter and more compact and provides for up to 36 circuits.

The cables are of unusually small dimensions, due partly to the use of single-strand conductors and to the special high-accuracy extrusion processes evolved for applying the polythene dielectric. The overall diameter of the latest 36-circuit cable, for example, is only 0.82 in. This cable consists of a centre of three screened circuits, each of which may be coaxial or balanced twin, and three triplets of insulated conductors. The outer layer contains 21 single insulated conductors. The cables are screened overall and sheathed with P.V.C. or tough rubber. They are light and easily handled, and it is claimed that kinking is eliminated; they can be bent in a small radius without injury.

The couplers consist of male and female connectors, enabling unit lengths of cable to be built up as required. The 36 contacts are so arranged that the circuit passes through the coupling in the same geometrical formation as in the cable. Each coaxial or balanced-twin unit has two contacts, the screen in the former case being isolated from adjacent coaxial screens and from other screens in the cable. Although the couplers are integrally moulded to the ends of the cable, the aluminium-bronze housings can be readily replaced if damaged. Even when the casing is removed, the moulded interior is waterproof.

REMOVAL OF PRICE CONTROL ON PARAFFIN WAX.—The Ministry of Fuel and Power have announced that, as paraffin wax is now in abundant supply, its price will no longer be subject to control. A further statement from the Ministry is that the removal of the control took effect as from July 1.

THE INSTITUTION OF METALLURGISTS: PRESIDENTIAL ADDRESS*.

By PROFESSOR HUGH O'NEILL, M.Met., D.Sc.

As the first of your Presidents who is not directly engaged in the metallurgical industries, you may expect me to take a different line from that of my predecessors. I would therefore direct your attention towards two of our objects, selected from the Memorandum of Association as follows: 3 (c) To promote the better education and training of metallurgists. . . .; and 3 (e) To adopt any lawful means conducive to the setting up and maintenance of a high standard of professional conduct among metallurgists. I am very interested in these two objects, and propose to consider some of the cultural and professional aspects of metallurgical training.

Whether our founders, in 1945, intended it or not, the Institution is a company, showing a strong resemblance to the craft guilds of Britain which developed during the Twelfth Century. Our three grades of membership and our objects point this way, and the resemblance is all the stronger when we learn that the Anglo-Saxon word *gild* means "payment, sacrifice." G. K. Chesterton expressed the old arrangement as follows: "The highest grade in the guild system was a Master, and it meant a mastery of the business. The other grades were the journeyman and the apprentice: but like the corresponding degrees at the universities, they were grades through which every common man could pass. They were not social classes; they were degrees and not castes."

The masters were recognised as being skilled, and they employed the journeyman—provided the latter could satisfy them as to competence to do the work. The apprentice was in an intermediate class between the two, for he frequently paid a premium to be trained. A guild was a union of employers and employees, but conflicts of interests frequently arose, and the tendency later developed for guilds to be controlled by the merchant or financial groups. For example, the 1422 Charter of the Cutlers Company of London empowered the commonalty to elect the officers of the company, but the constitution adopted in 1607 deprived them of this right, and vacancies were filled by the nominees of officers only. At first, apprenticeship and practical experience were conditions of membership, but by 1624 one could join the company after paying 20l. It is not surprising that these changes led to the decay of the organisations.

UNIVERSITY TRAINING.

Informal discussions with a few of our members have revealed an element of dissatisfaction with the type of training at present given to many

* Delivered in London on June 26, 1952, at the eighth annual general meeting of the Institution. Abridged.

students of metallurgy. Somebody wrote to me to say that, after recently interviewing several hundred science graduates, he concluded that in all British universities insufficient attention was directed to the underlying science and philosophy of the subject. He believed that teaching in the history and philosophy of science, plus an account of scientific method, with further philosophical teaching on the nature of truth, were essential ingredients in the training of any scientist who wished to describe himself as well educated.

Since then we have had the 1951-52 Report of the Advisory Council on Scientific Policy (Cmd. 8561), which finds that science graduates tended to lack a sufficiently broad education, not only in the general sense, but also in the field of science. A further criticism of current training is contained in the following statement: "The educated scientist knows that his science is derived only from a part of experience, and that it does not and cannot concern itself with the most important aspects of human life—personal relationships and the highest mental integrations of our inner life. The universities are deeply to blame: they have betrayed their trust. They were instituted to give an education, but to their science students they are giving little more than a technical training. They are, in general, expending far less effort in making wise men and good citizens than in turning out good employees for commerce and industry. This can be remedied in part at least by insistence that the study of the nature of Science should be a necessary part of the training of scientists, and should enter into every final examination in the sciences—a reform long overdue." In a paper contributed to the *Bulletin* of the Institution, of May, 1944, I tried to set out some views about metallurgical education which are not inconsistent with the motto of the University College of Swansea. This is an old Welsh proverb which may be translated as "Technical skill is sterile without the gift." University teachers are not satisfied that enough of their graduates are as good as they might be, and, judging by Press reports of a recent speech by a well-known metallurgist in Birmingham, they still leave much to be desired. Perhaps a straw in the wind from that great city indicates the direction of thought, for one of our members chose as his presidential address to its Metallurgical Society the unexpected subject of "Metaphysics, not Metal Physics."

"THE CRISIS IN THE UNIVERSITY."

The condition of most of our centres of higher learning to-day is sufficiently confused and utilitarian in principle to have prompted Sir Walter Moberly to write a book entitled *The Crisis in the University*. Proletarian and technological influences have produced a new type of climate and culture, so that our universities are "not asking the really fundamental questions." Materialistic Victorian science, reacting with Victorian religion, led to the adoption of religious neutrality as the best way of handling a difficult position. In this atmosphere we concentrated on science. Some writers claim that science is an adequate basis for the life of a university or a nation, especially because of its sociological developments. On the other hand, I must mention an hilarious "debunking" essay† written in this connection by a serious scientist, which concludes as follows: "We can, and should, laugh out loud at scientists and this will be the very best way to prevent them from regulating us, or averaging us, or conditioning us to synthetic happiness. For what are they doing? The most laughable thing in the world. They are all crowding round and bowing low before a Sacred Cow." Now, without being cynical about science we need not become worshippers, for while it "delivers the goods" it is always ebbing and flowing in its teachings.

Moberly asks how the universities should attempt to implant a wide culture and an education in the art of living. Should it be by reduced specialisation and activated development along the lines of classical-humanism, or alternatively, by adopting

ideas derived from science and technology? He is not in favour of this latter approach. Intense specialisation at the undergraduate stage is to be avoided. In the words of Professor Woodward, no one should receive an honours degree without showing "that minimum of general understanding which differentiates education from technical skill."

Fortunately, in Britain, with its independent universities, the teaching body is an intellectual community which possesses the freedom and responsibility to form the academic policy of the college or the department. The professor can try to educate as he thinks best, within the limits of propriety and trust which he accepts as a professional person. So far, we have largely avoided what an American professor, W. D. Nutting, has sadly described in the following words as the assembly line technique: "the part affixed in this industrial process is the course. . . . The course is a neat unit of knowledge, complete in itself, duly fastened to the student's mind, inspected, passed—forgotten. Once it is on, it is on, and we do not have to worry about it any more. When a student has had all the courses bolted on, we look him over to see that nothing has been forgotten, we add up the credits that the courses are worth, and if what we find agrees with the specifications . . . we give him a degree which signifies that he has a college education."

The requirements of a good science teacher, in the sense that I am advocating, received attention in 1949 by the Commission for University Reform in Germany. Their report states that each lecturer in a technical university should possess the ability to see the limits of his subject matter, and in his teaching to make the students aware of these limits and to show them that beyond these limits forces come into play which are no longer entirely rational, but arise out of life and human society itself; and to show in every subject the way that leads beyond its own narrow confines to broader horizons of its own.

This is part and parcel of the view so frequently expressed just now, that the humanities must be associated with the technical courses. The dilemma arises, however, about distribution of time for all the work to be done. Some professor will take the view that the life of Britain depends upon the discovery, development and export of high-quality specialties which are associated in the mind with words like atom-splitting, radar and penicillin. For this work, first-class scientists are needed and perhaps the others could be produced by the technical colleges. It seems to me, however, that we should maintain the broad basis for the bachelor's degree, and intensify the required specialisation in post-graduate work. I would draw your attention to the 3rd Report of the Joint Committee on Metallurgical Education, which is about to be published. This deals with the education and training of metallurgists, and proposes a most important role for our Institution. It is suggested that the associateship of our Institution should be the ultimate goal and award of all metallurgical technologists, and that the Institution should co-operate in a Board of Metallurgical Studies and Examinations and by acting as a kind of external examiner.

PURE AND APPLIED SCIENCE.

Various qualifying adjectives are being attached to the word metallurgy, and there is a danger of these being misunderstood in different English-speaking countries. In Britain, we use the term "extraction metallurgy," but in Australia (and, I believe, South Africa), this means "primary metallurgy." Having produced primary ingots or pigs of metal, they are converted to the finished product by "process metallurgy." In Australia, the word "secondary" is used instead, but in the homeland this suggests recovered or reclaimed metal, as in the case of secondary aluminium alloys. In the United States, the term "adaptive" has been employed for this second stage of the operations. Physical metallurgy, as coined by Rosenhain, has met with general acceptance, and it is hoped that variations of these adjectives will be kept at a minimum, for which purpose the Institution may be able to act as a clearing house. Is there such a thing as "cultural metallurgy"? In a lecture before the Royal Society of Arts in 1950, entitled

"Chemistry as an Instrument of Culture," Professor John Read developed an earlier opinion that "Chemistry itself may become a cultural and humanistic instrument of high value." To that may be added the statement of Lord Waverley (Sir John Anderson) in his 1951 May Lecture to the Institute of Metals: "I wish it could be universally recognised that scientific studies no less than the humanities have a cultural value, and that applied science is not inferior academically to pure science."

Professor Polanyi crossed swords with Sir John in 1945, and "recalled that applied science is merely an instrument for procuring welfare, whereas the advancement of pure science, the progress of discovery, is part of welfare itself." More recently, Professor R. F. Mehl, in a letter to the *Journal* of the Institute of Metals of September, 1949, stated that universities should teach "pure" metallurgy, which he describes as principles, with industrial techniques used only as illustrations. For metallurgy to have any humanistic qualities it would probably have to include the history of the subject, and this was the main point of Professor Read's lecture mentioned above.

PROFESSIONAL CONDUCT AND MUTUAL ASSISTANCE.

How are we to set up and maintain a high standard of professional conduct as set out in Object 3 (e) of our Memorandum of Association? This is a moral matter, and increasingly one hears the expression that there is no morality or culture without religion. In the United States, the Engineers' Council for Professional Development has succeeded in publishing a "Canon of Ethics for Engineers," and its Committee on Professional Recognition issues an annual report. If we pursue the analogy with the craft guilds mentioned earlier, we find a general understanding that guild conduct should be based on definite religious principles. Regulations enforced between 1360 and 1557 in many companies prevented a craftsman from turning the casual needs of his neighbour to his own benefit. Most guilds were friendly societies for mutual assistance, and this aspect finds its counterpart in appointments bureaux and in the benevolent funds of several present-day organisations.

There would, of course, be hostility from some quarters at attempts to bring Christian principles directly into the question of professional conduct. A writer to *ENGINEERING** for September 3, 1948, page 231, attributed a certain altruistic maxim to the early Christian Church, and roundly stated that "American engineers are not the only ones who do not accept the doctrine to-day." He referred to Lord Stamp's book *The Christian Ethic as an Economic Factor*, and remarked that "... one must feel comforted in these times to know that the practicable limits of Christian ethics in industry are apparently as well recognised in America as in Britain." One cannot help noticing that representatives of the British, French, German and Italian steel industries, assembled at Caux, emphasised the great need for absolute moral standards in industry.

It may well be the job of the universities to advise about everything pertaining to Object 3 (e). Perhaps the teaching of Sir Walter Moberly is having an effect. I would like to conclude by a quotation from a letter entitled "What do we in the Universities believe?" It is signed by "A Professor," who is presumably American, for the letter appeared in *Metal Progress* for February, 1952. It runs: "... Underneath our devotion to the fictitious reality, which the physicist at the Einstein level has destroyed, lies sleeping a faith in the existence of a moral universe; in the existence of a natural law which gives to man certain inalienable rights; in a Divine Creator, of which we are each a tiny spark. . . . But we are scarcely aware of these foundations far beneath our everyday lives. . . . Only when man-made laws challenge man's inalienable rights do we realise whence comes our belief in these rights. Even the university is beginning to face these fundamental questions. . . . Watch the university for ten years—a most significant change is coming." Whether this anonymous professor is a prophet or not remains to be seen.

* In a letter to the Editor on "Professional Recognition of Engineers."

* *Man and Matter*, by F. Sherwood Taylor, London, 1951.

† *Science is a Sacred Law*, Standen, New York, 1950.

LAUNCHES AND TRIAL TRIPS.

M.S. "LONDON MAJESTY."—Single-screw oil tanker built by the Furness Shipbuilding Co., Ltd., Haverton Hill, County Durham, for London and Overseas Freighters, Ltd., London, W.1. Second vessel of a new series for these owners. Main dimensions: 525 ft. between perpendiculars by 71 ft. by 39 ft. 3 in.; deadweight capacity, 18,070 tons on a summer draught of 30 ft. 5½ in. N.E.M.-Doxford six-cylinder opposed-piston single-acting two-stroke oil engine, developing 6,800 b.h.p. at 119 r.p.m. in service, constructed by the North-Eastern Marine Engineering Co. (1938), Ltd., Wallsend-on-Tyne. Speed, 15 knots. Trial trip, June 25.

S.S. "EUGENIA."—Single-screw cargo vessel, built and engined by William Gray & Co., Ltd., West Hartlepool, for Mr. N. G. Livanos, Piræus, Greece. Main dimensions: 431 ft. between perpendiculars by 57 ft. 6 in. by 38 ft. 3 in. to shelter deck; deadweight capacity, 10,000 tons on a draught of 26 ft. 7 in., but, when operating as a two-deck ship, can carry 11,000 tons on a draught of 28 ft. 6 in. Triple-expansion steam engine, working in conjunction with a Bauer-Wach exhaust turbine, and three oil-fired boilers. Service speed, 11½ knots. Launch, July 7.

M.S. "FLOWERGATE."—Single-screw cargo vessel, built by the Burntisland Shipbuilding Co., Ltd., Burntisland, Fife, for the Turnbull Scott Shipping Co., Ltd. (Managers: Turnbull, Scott and Co.), London, E.C.3. Fifth vessel built for these owners. Main dimensions: 441 ft. 3 in. by 56 ft. 8 in. by 38 ft. 3 in. to shelter deck; deadweight capacity, 9,450 tons on a draught of 25 ft. 9½ in.; gross tonnage, 4,894. Kincaid-Harland-B. and W. four-cylinder two-stroke single-acting heavy oil engine, developing 3,300 b.h.p. at 125 r.p.m. in service, constructed by John G. Kincaid & Co., Ltd., Greenock, and installed by the shipbuilders. Trial trip, July 7.

M.S. "DAGLAND."—Single-screw oil tanker, built by Swan, Hunter, and Wigham Richardson, Ltd., Wallsend-on-Tyne, for Aktieselskabet Ocean (Managers: John P. Pedersen and Son), Oslo, Norway. Main dimensions: 500 ft. between perpendiculars by 65 ft. 6 in. by 37 ft. 6 in.; deadweight capacity, about 15,000 tons on a draught of 29 ft. 1 in.; gross tonnage, about 10,000; oil-cargo tank capacity, 700,000 cub. ft. Wallsend-Doxford five-cylinder two-stroke opposed-piston oil engine, developing 5,100 b.h.p. at 105 r.p.m. in service, constructed by the Wallsend Slipway and Engineering Co., Ltd., Wallsend-on-Tyne. Service speed, 13 knots. Launch, July 7.

TRADE PUBLICATIONS.

Current-Limiting Reactors.—Details of the reactors made by them for limiting the fault current and maintaining stable operating conditions on transmission systems are given in a pamphlet received from Hackbridge and Hewitt Electric Co. Ltd., Walton-on-Thames, Surrey.

Steam-Raising and Coal-Handling Plant.—A well-illustrated survey of the steam-raising and coal-handling plant installed in the Poole power station of the British Electricity Authority is given in a pamphlet received from International Combustion Ltd., 19, Woburn-place, London, W.C.1.

Mosaic Diagrams.—A bulletin describing the mosaic diagrams which they have designed for the supervision of electric power networks has been received from Automatic Telephone and Electric Co. Ltd., Strowger Works, Liverpool, 7. These enable operating changes to be effected easily and quickly, and facilitate the recording of extensions. Remote or direct control is possible.

Electric Switches and Accessories.—Messrs. J. A. Crabtree & Co. Ltd., Lincoln Works, Walsall, have published a new catalogue giving full details of the switches and accessories made by them. It includes certain new designs as well as some changes in their standard finishes.

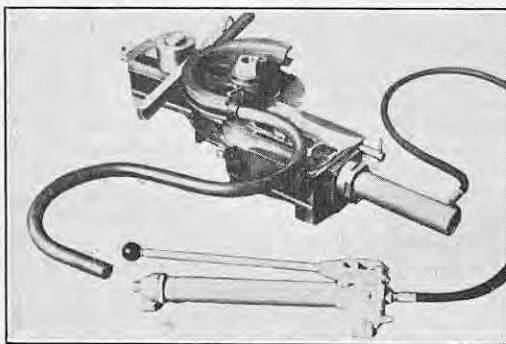
Mercury-Vapour Lamps for Photographic Copying.—A leaflet received from Hackbridge and Hewitt Electric Co. Ltd., Walton-on-Thames, Surrey, deals with the mercury-vapour lamps manufactured by them for photographic copying.

Supporting Poles for Electric Cables.—We have received from British Insulated Callender's Cables, Limited, 21, Bloomsbury-street, London, W.C.1, a catalogue of "P.B." poles, for overhead electric transmission lines. The "poles"—actually fabricated steel structures—are made by Painter Brothers, Limited, Hereford, and are designed to be light, easily handled and erected and unobtrusive. Details of load-carrying capacity, dimensions, etc., are given in tables.

Concrete Compactor.—Holman Bros. Ltd., Camborne, have issued an illustrated catalogue S.1 describing their pneumatic concrete compactor and pneumatic vibrated finishing screed for use in concrete-road construction. Both tools are made in four sizes suitable for placing the concrete in bays of 5 ft., 9 ft., 12 ft. and 15 ft. 6 in. width.

BENDING THIN-WALLED TUBES.

WE have received from Messrs. Chamberlain Industries, Limited, Staffa Works, Leyton, London, E.10, particulars of the pipe-bending attachment illustrated herewith, which they have developed for the purpose of bending light-gauge steel tubes for motor-car exhaust systems. It was produced primarily for the use of repairers who wish to bend their own tubes because of difficulty in obtaining replacements for certain makes of car at the present time and is, in essence, a power-operated version of the well-known ratchet type of tube-bender, designed to be used in conjunction with the same makers' Hydroram pump or their two-stage pump unit, and equally suitable for copper or other thin-walled tubing. In conjunction with the centre former, a knife-edge back former is used which fits inside the overlapping flange of the centre former



and is held in position by the roller on the bending arm, thus supporting the tube and preventing distortion of its cross-section. The grooves of the formers are accurately machined to fit the tube.

It is stated that bends may be commenced from within an inch from the end of the tube and may be continued through a maximum angle of 180 deg. One complete stroke of the lever provides a bend of 60 deg., so that three strokes suffice to complete the semi-circle. At the end of each stroke, a pawl detains the bending arm, thus preventing the tube from springing back. An angle-indicator plate on the top of the machine enables the amount of the bend to be regulated. Bends may be made in different planes, and directly-connecting bends of 90 deg. and 180 deg. can be formed without waste of the tube. The machine will deal with light-gauge seamless tubes of 1 in. to 2½ in. outside diameter, with a wall thickness of 16 to 19 gauge, and formers are stocked for these inclusive sizes, in steps of ½ in.

ROCKEFELLER FOUNDATION BURSARIES IN PUBLIC-HEALTH ENGINEERING.—The Institution of Civil Engineers has accepted an invitation from the Rockefeller Foundation (Division of Medicine and Public Health) to administer during the next three years certain moneys for providing bursaries for post-graduate study and research in public-health engineering in universities in the United Kingdom. Each bursary, of approximately 450l. per annum, would normally be tenable for one year, but may be renewed at the discretion of the Awards Committee. The amount of the award may be appreciably increased in special circumstances, to older applicants of experience. Applicants must hold an engineering degree of a university within the Commonwealth, acceptable to the Awards Committee. Awards will be made to individuals who wish to take a course of study or research in public-health engineering at a university in the United Kingdom having suitable facilities. Applications will be considered from graduates who have just completed their degrees, or from graduates who have had practical experience in public-health engineering. Awards may also be made to graduates wishing to undertake research on a specific subject, and in special circumstances, grants-in-aid may be made to senior engineers to assist them to carry out specific research at a university or in the field. A successful candidate may not undertake work other than his course of study without the permission of the Awards Committee, and will be expected to submit an account of his work to the Institution at the conclusion of the course. Applications for the 1952-53 bursaries should be made to the Secretary of the Institution of Civil Engineers, Great George-street, London, S.W.1, as soon as possible, and in any case not later than August 31.

BOOKS RECEIVED.

Classification of Copper and Copper Alloys. The Copper Development Association, Kendals Hall, Radlett, Hertfordshire. [Gratis.]

Boulton, Watt and the Soho Undertakings. By W. K. V. GALE. City of Birmingham Museum and Art Gallery, Department of Science and Industry, Newhall-street, Birmingham. [Price 2s. 6d.]

Mechanics and Properties of Matter. By PROFESSOR REGINALD J. STEPHENSON. John Wiley and Sons, Incorporated, 440, Fourth-avenue, New York 16, U.S.A. [Price 6 dols.]; and Chapman and Hall, Limited, 37, Essex-street, Strand, London, W.C.2. [Price 48s. net.]

Theoretical Aerodynamics. By PROFESSOR L. M. MILNE-THOMSON. Second edition. Macmillan and Company, Limited, St. Martin's-street, London, W.C.2. [Price 40s. net.]

United States National Bureau of Standards. Circular No. 520. Mechanical Properties of Metals at Low Temperatures. Proceedings of the semicentennial symposium held on May 14 and 15, 1951. The Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., U.S.A. [Price 1.50 dols.]

The Cold Working of Non-Ferrous Metals and Alloys. A symposium on metallurgical aspects of the subject held in London, 14 March, 1951. The Institute of Metals, 4, Grosvenor-gardens, London, S.W.1. [Price 15s.]

Associação Brasileira de Cimento Portland. Funções Ortogonais na Resolução de Problemas da Teoria da Elasticidade. By PROFESSOR TELEMACHO VAN LANGEN-DONCK. Vol. I. Generalidades e Torção. Offices of the Association, Caixa Postal 8071, São Paulo, Brazil.

Physique et Technique du Bruit. By DR. A. MOLES. Dunod, 92, Rue Bonaparte, Paris (6e). [Price 960 francs.]

Forging and Forming Metals. By PROFESSOR S. E. RUSINOFF. American Technical Society, 848, East 58th-street, Chicago, Illinois, U.S.A. [Price 4 dols.]; and The Technical Press Limited, Gloucester-road, Kingston Hill, Surrey. [Price 32s. net.]

National Union of Manufacturers. Descriptive and Classified List of Members. Offices of the Union, 6, Holborn Viaduct, London, E.C.4. [Gratis to members, price 20s. to others.]

Productivity Team Report. Steel Construction. Report of a visit to the U.S.A. in 1951 of a Productivity Team on constructional steelwork, fabricated platework, mechanical handling plant. Anglo-American Council on Productivity, 21, Tothill-street, London, S.W.1. [Price 3s., post free.]

An Engineer's Approach to Corrosion. By C. F. TRIGG. Sir Isaac Pitman and Sons, Limited, Pitman House, Parker-street, Kingsway, London, W.C.2. [Price 15s.]

Colliery Rope Haulage and Rope Splicing. By JOHN KIMBER, JR. The Colliery Guardian Company, Limited, 30 and 31, Farnival-street, London, E.C.4. [Price 30s. 6d., post free.]

Ministry of Transport. Railway Accidents. Report on the Derailment which Occurred on 19th November, 1951, at Polesworth in the London Midland Region British Railways. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 6d. net.]

Port of Cochín. Administrative Report for 1950-51. The Administrative Office, Port of Cochín, India.

Power Factor Correction. Federation of British Industries, 21, Tothill-street, London, S.W.1. [Price 3s.]

CONTRACTS.

MARCONI'S WIRELESS TELEGRAPH CO. LTD., Chelmsford, Essex, are supplying to the order of H.M. The Imam of the Yemen, wireless equipment to form the basis of the country's first permanent internal and external communication system. The main installations will be at Taiz, an inland town, and at Hodeida, on the coast. A 100-watt transmitter at Hodeida will permit of constant communication with shipping passing through the Red Sea to and from Suez. Also at Hodeida will be two all-frequency receivers for incoming messages from other countries. At Taiz, a 200-watt transmitter has been installed and two receivers of the type of those put in at Hodeida will be provided. A high-frequency receiver is to be installed for internal communications and two 100-watt high-frequency transmitters will be placed at other centres to provide subsidiary internal services.

HEAD WRIGHTSON ALUMINIUM LTD., Thornaby-on-Tees, have been appointed, by the Ministry of Civil Aviation, to be sub-contractors to W. and C. French Ltd., for the supply and erection of four main hangar doors for London Airport. The doors which will be constructed entirely of aluminium alloy, are electrically operated and of the folding-leaf type. The doors are designed to cover an opening 300 ft. wide by 46 ft. high.