

THE INTERNATIONAL MACHINE TOOL EXHIBITION AT OLYMPIA.

(Continued from page 368.)

THE previous instalment of our report on the International Machine Tool Exhibition at Olympia, London, was prepared, of necessity, in advance of the official opening of this outstanding engineering display to the public, which took place on the morning of Thursday, September 18. Actually, the exhibition had been open since the previous day, which was the advertised date; but on September 18, when the customary exhibitors' luncheon was held, under the chairmanship of Mr. Robert W. Asquith, President of the Machine Tool Trades Association, the members of the Association were able to welcome, as their principal guest, the Rt. Hon. Duncan Sandys, M.P., the Minister of Supply. The President was supported by four past Presidents of the Association, and the Minister was accompanied by Sir Archibald Rowlands, G.C.B., Permanent Secretary of the Ministry of Supply, and by a number of its departmental heads. A particularly cordial, if informal, greeting was extended to Sir Herbert G. Williams, M.P., the first secretary of the Association and organiser of the inaugural exhibition in 1912.

The Minister, proposing the toast of "The Exhibition and the Machine Tool Trade," observed

demand abroad, had to be reserved for defence production. He thanked the industry sincerely for the way in which it had responded.

30-IN. TOOL-ROOM LATHE.

Four different types of tool-room lathe are included in the exhibits on the stand of the Holbrook Machine Tool Company, Limited, 44-48, Martin-street, Stratford, London, E.15. One of these, namely, their "A" 27-30 model, is illustrated in Fig. 58, on this page. It has a swing of 30 in. over the bed and can accommodate work up to 6 ft. in length between the centres. The bed is an iron-alloy casting and is provided with double V and flat ways; it is mounted rigidly on a steel base, which also contains the sump for the cutting compound. To reduce internal loadings to a minimum, the headstock is equipped with anti-friction bearings and the spindle, which is machined from a steel forging, is fitted with three sets of roller bearings, the forward set consisting of two opposed pre-loaded taper-roller bearings so as to control the end thrust in both directions. The spindle nose is provided with a Camlock securing device, thus ensuring easy

provided at each side of the operating nut. For convenience of the operator, the handwheel is mounted at the front of the tailstock and operates through spiral gearing. The tailstock is also provided with an easy-motion handle, which is arranged to operate in conjunction with a rack below the front bedway in the normal manner. The machines are available in three forms, namely: with internal slide or taper-turning equipment and normal top slide with a square turret; without the internal slide or taper-turning equipment, but with power feed to the top slide, the latter incorporating a clutch to permit hand setting of the tools; and with power feed to the top slide together with electronic profile equipment manufactured by the Metropolitan-Vickers Electrical Company, Limited.

HIGH-SPEED TOOL-ROOM LATHE.

The remaining lathes on the stand of the Holbrook Machine Tool Company, Limited, include that illustrated in Fig. 59, on page 394. Known as the Model "D" high-speed precision tool-room lathe, it is available in three sizes, namely: with a 13-in. swing and 24 in. between centres; with a 15-in.

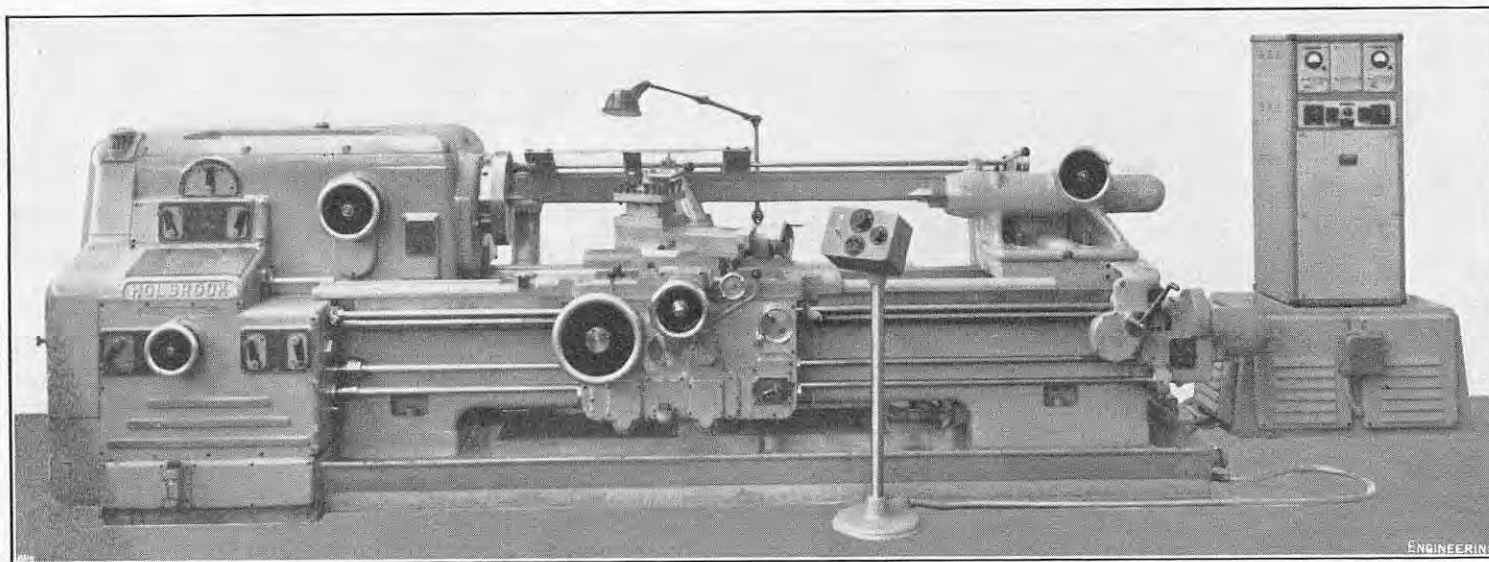


FIG. 58. 30-IN. TOOL-ROOM LATHE WITH ELECTRONIC PROFILE EQUIPMENT; HOLBROOK MACHINE TOOL CO., LTD.

that, while such highly technical exhibitions did not attract the attention of the public as much as did those devoted to motor cars or radio, the Machine Tool Exhibition was awaited with eagerness by industrialists throughout the world—an eagerness tempered, perhaps, by a certain amount of anxiety. The eagerness arose from the natural desire of every manufacturer to improve the efficiency of his works; the anxiety, from the knowledge that, if he was behindhand in buying the latest labour-saving machines, he might find, before long, that his prices were being undercut by his competitors. The 1952 Exhibition was, perhaps, more truly international than any of those which preceded it, nearly half of the exhibits coming from other countries; it included products from Belgium, Denmark, France, Germany, Italy, Holland, Switzerland and the United States of America. Britain, however, had built up a very fine machine-tool industry, and proof of its excellence was to be found in the large volume of orders received from overseas. The proportion of British machine tools now being exported was at least one-third higher than before the war and would have been higher still, but for the fact that large numbers, for which there was a ready

removal and replacement of chucks, faceplates, etc., without loss of accuracy. A hydraulically-operated change-speed mechanism provides 24 speeds in both directions of rotation, the range of speeds available extending from $3\frac{1}{2}$ r.p.m. to 700 r.p.m. All gears are hardened and ground on the tooth profile and the running gear is fed continuously with a copious supply of filtered oil. The main and the brake clutches run in oil, and, like the speed-change mechanism, are hydraulically operated.

The carriage is guided by a combination of raised V and flat surfaces, and is equipped with rapid power traversing gear for both sliding and surfacing, suitable interlocks being fitted to both handwheels. The feed reverse for right-hand or left-hand work is located in the apron. A quick-change gearbox enables a wide selection of feeds to be obtained ranging from 1 to 30 threads per inch, and 0.003 in. to 1.5 in., the feed-shaft being fitted with an accessibly-mounted adjustable multi-disc clutch to prevent overloading. The leadscrew is corrected to fine limits and is equipped with a special self-compensating thrust device arranged to run in an oil bath. A heavy-duty anti-friction centre is built into the tailstock and thrust washers are

swing and 30 in. between centres; and with an 18-in. swing and 42 in. between centres. That illustrated is the No. 13 model, i.e., with a 13-in. swing. The bed is built up from iron castings and incorporates double-V and flat ways which, to ensure accuracy, are finished in one setting on specially-designed surface grinders. It is provided with a heavy-gauge steel pan and integral sump, the cutting compounds being circulated by a separate motor-driven pump suitably protected by strainers. The driving motor is located in the base of the machine immediately below the headstock, the drive being transmitted to the headstock through multiple V belts. A gearbox is incorporated in the headstock and this is designed to give 18 speeds in geometrical progression ranging from 15 r.p.m. to 1,000 r.p.m. on models 15 and 18, and 12 speeds from 20 r.p.m. to 1,000 r.p.m. on the 13 model. Three bearings are provided for the main spindle, the front bearing consisting of two pre-loaded angular-contact ball-races arranged to withstand the thrust as well as accommodate radial loads. A quick-change gearbox gives a wide selection of feeds ranging from $1\frac{1}{2}$ to 92 threads per inch and 0.001 in. to 0.060 in. for the No. 13 machine and from 1 to

60 threads per inch and 0.001 in. to 0.062 in. for the No. 15 and No. 18 machines.

The carriage has long sliding ways and machined oil grooves, supplied with oil from the pump, provide adequate lubrication of the ways, which are protected against damage by covers. The internal slide is built into the carriage and for normal parallel turning is secured by a conical bolt which, for taper turning, is transferred to the top sliding plate of the taper-turning fitment, a standard item of equipment on the complete range of lathes. The slide swivels to any position and is fitted with an open-side toolbox which incorporates an elevating piece for raising or lowering the tool to the correct height; a square turret with automatic indexing, however, is available. The apron has two walls so as to provide two bearings for all shafts and the front is readily removed for access to the interior. Both the sliding and threading motions are easily engaged and a master clutch in the feed drive prevents the mechanisms from being damaged through excessive loadings or faulty operation.

UNIVERSAL MACHINE TOOL.

The universal machine tool illustrated in Figs. 60 and 61, on Plate XXIV, comprises a lathe, sensitive drilling machine, milling machine, universal grinder and a tool and twist-drill grinder. It is being shown by Thomas Ryder and Son, Limited, Turner-bridge Works, Bolton, who developed it originally to Admiralty specification for repair ships. It is exceptionally compact and should prove most useful in merchant ships and in the maintenance departments of manufacturing organisations. Both the lathe and milling machine are driven by the same 6-h.p. motor, the drive being transmitted by V-belts to a common shaft connected to the lathe and milling machine by multiple-plate clutches and identical nine-speed gear trains. These, together with the lathe feed and screwcutting gears, are located in the main body of the lathe headstock. The lathe spindle and the vertical and horizontal spindles of the milling machine are mounted in identical taper-roller bearings and each spindle is provided with a reverse gear and brake; stopping and starting are effected by lever-operated clutches.

The lathe admits 30 in. between centres and the gap bed allows a swing of 10½ in.; the swing over the bed is 6½ in. Nine spindle speeds and twelve feeds are available, the spindle speeds ranging from 21 r.p.m. to 533 r.p.m., and the feeds from 0.0056 in. to 0.0391 in. per revolution when sliding and from 0.0028 in. to 0.0195 in. per revolution when surfacing. Change wheels supplied with the machine enable a wide range of screw-cutting in both metric and inch threads to be accomplished and with even change wheels, twelve pitches ranging from 3½ to 24 threads per inch can be selected immediately by gear-change levers. The change-wheel compartment is situated on the front of the lathe headstock, but the wheels are readily accessible as their shafts lie at right angles to the lathe spindle. The design of the spindle permits quick removal and replacement of either the chuck or faceplate and the tailstock can be moved over for taper turning without losing rigidity. Any possibility of damage being caused by over-running of the carriage is prevented by an adjustable clutch in the feed drive.

As already indicated, the milling machine has both vertical and horizontal spindles. The vertical spindle is mounted in a swivel head that can be moved through any angle and permits, therefore, a wide variety of angular milling operations to be carried out without recourse to complicated rigs. The working surface of the table is 40 in. by 10 in. and its traverses are 23 in. longitudinally, 7 in. transversely and 13 in. vertically. Nine speeds and four feed rates are obtainable, the speeds ranging from 21 r.p.m. to 533 r.p.m., and the feed rates from ½ in. to 10 in. per minute. The knee of the milling machine is manufactured by Adcock and Shipley, Limited, Leicester, and is the same as that fitted to their No. 2AGU model.

The sensitive drilling machine is driven separately by its own 2-h.p. motor. Changes of speed and feed are obtained quickly through sliding gears, hand or automatic feed being available. The spindle and spindle head are counterbalanced by a helical spring and the table is elevated through

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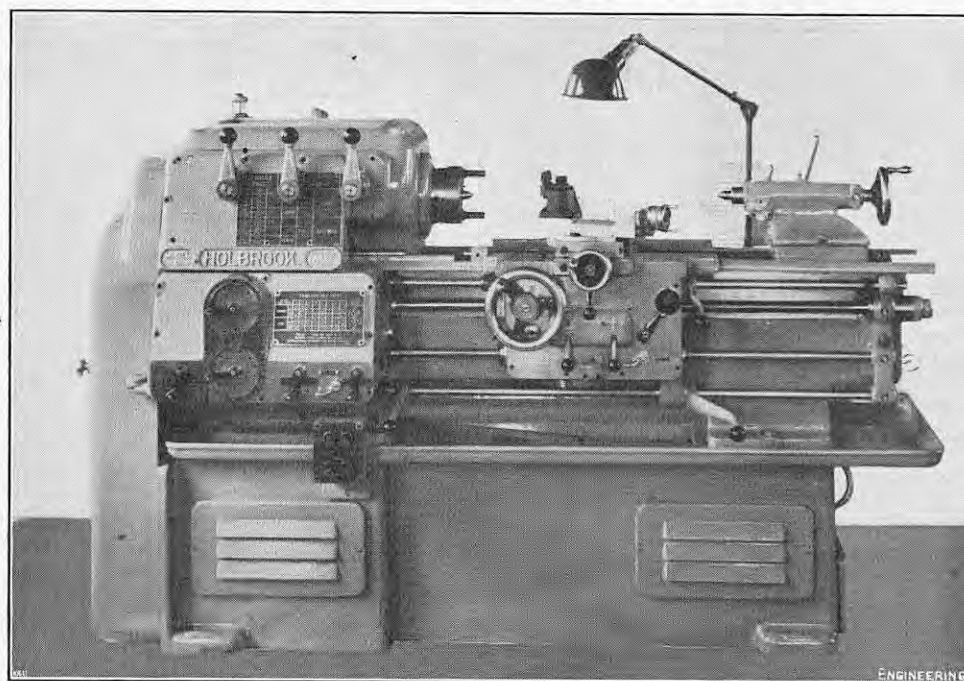


FIG. 59. HIGH-SPEED TOOL-ROOM LATHE; HOLBROOK MACHINE TOOL CO., LTD.

bevels and a screw operated by a hand lever, the design being such that it is self-sustaining in any position. Nine speeds and four feeds are available, the speeds ranging from 85 r.p.m. to 1,220 r.p.m. and the feeds from 0.0055 in. to 0.0162 in. per revolution. The maximum drilling capacity is 1½ in. diameter and the distance from the drill, or spindle, to the centre of the column is 12½ in. The maximum distance from table to spindle nose is 31 in.

The maximum capacity of the universal grinding machine is 10 in. diameter with a grinding length between centres of 24 in.; the traverses are 24 in. longitudinally, 7 in. transversely and 14 in. vertically. It is suitable for surface grinding, internal and external cylindrical grinding and taper grinding. A 2-h.p. motor drives the table through a gearbox and clutch, the gearbox being supported by a rubber mounting and connected to the grinder through a flexible coupling. The wheelhead and workhead are self-contained units driven by 3-h.p. and ¼-h.p. electric motors, respectively, both heads being made by the Churchill Machine Tool Company, Limited. To prepare the machine for use, the wheelhead-adaptor base, which normally is clamped to the grinder table, is transferred to the lathe bed, where it is coupled to a vertical shaft which transmits the feed motion to the head. The wheelhead can then be lifted from its base on the lathe headstock and mounted on the adaptor base; the lathe and the grinder, therefore, cannot be operated at the same time.

The tool and twist-drill bench grinder is a standard machine and this, together with the other components forming the universal machine, is carried on a fabricated-steel main bedplate which is used as a suds tank and contains cupboards for storing tools, etc. The suds system for the grinding machine is divorced entirely from that for the rest of the machine and incorporates means for settlement of abrasive matter in accessible compartments. Both suds systems are provided with baffle plates to reduce surging and consequent spillage during rough seas.

EIGHT-SPINDLE BAR AUTOMATIC.

The display arranged by Wickman, Limited, Coventry, is the largest ever to be staged by this firm, the exhibits covering over 80 British, American and Continental machine tools. Machines of the Company's own manufacture include a new eight-spindle bar automatic illustrated in Figs. 62 and 63, on Plate XXV, which is being shown for the first time. This has a capacity of 1½ in. and although of smaller capacity, the new machine is built in the same frame size as the larger machines and is, there-

fore, exceptionally heavy and rigid. As in the case of other multi-spindle automatics made by the same firm, it incorporates auto-setting mechanisms which enable alterations to tool-feed strokes and bar feed to be effected without changing the cams. The design permits bar feeding at two stations with double-indexing of the spindle drum, so that, if required, two dissimilar components can be produced for each machine cycle. A range of 24 spindle speeds extending from 96 r.p.m. to 1,243 r.p.m. is available and 50 feed-gear combinations provide an almost infinite range of cycle times between the limits of eight seconds and 16 minutes.

The standard bar-feed length is 5 in., but this can be increased to 10 in. by the addition of a special bar-feed cam. Feeds beyond this length are not necessary as the maximum turning length is 9 in. A total of 18 tooling faces is available, eight on the main tool block, two on independent slides at stations five and six, four on cross slides and four on two double-station auxiliary cross slides. The independent longitudinal slides and the rear auxiliary cross slide are optional extra equipment and alternative types of auxiliary cross slides are available to suit particular applications. All cross slides are fitted with micrometer adjusting screws and master stops engaging with stop screws in the spindle-drum stop ring to allow small sizing errors to be catered for. The tool feed strokes vary according to the station; those on the main tool block, for example, have a maximum of 5 in. whereas the maximum stroke for the fifth and sixth independent slides is 5½ in. The machine is driven by a 40-h.p. electric motor operating at 1,425 r.p.m., and without the electrical control gear and stock carriage the width is 4 ft. 11 in. and the length 12 ft. 6 in. When fitted with the stock carriage, the length is increased to 20 ft. 6 in.

OPTICAL PROFILE-GROUNDING MACHINE.

Other equipment being shown by Wickman, Limited, includes the optical profile-grinding machine illustrated in Fig. 64, on Plate XXV. This machine is designed to finish grind to fine limits any profile within its limits and is particularly suitable for the accurate grinding of irregularly-shaped contours on flat or circular form tools, male and female profile gauges, punches, die segments, etc., in any material, including tungsten carbide. It combines the functions of a universal tool-room grinding machine with a 50-to-1 pantograph and a projection unit, the latter being designed so that it may be used in conjunction with a screen or the microscope used as an inspection unit. In use, a 50-to-1 drawing of the required

EXHIBITS AT THE INTERNATIONAL MACHINE TOOL EXHIBITION.

(For Description, see Page 394.)

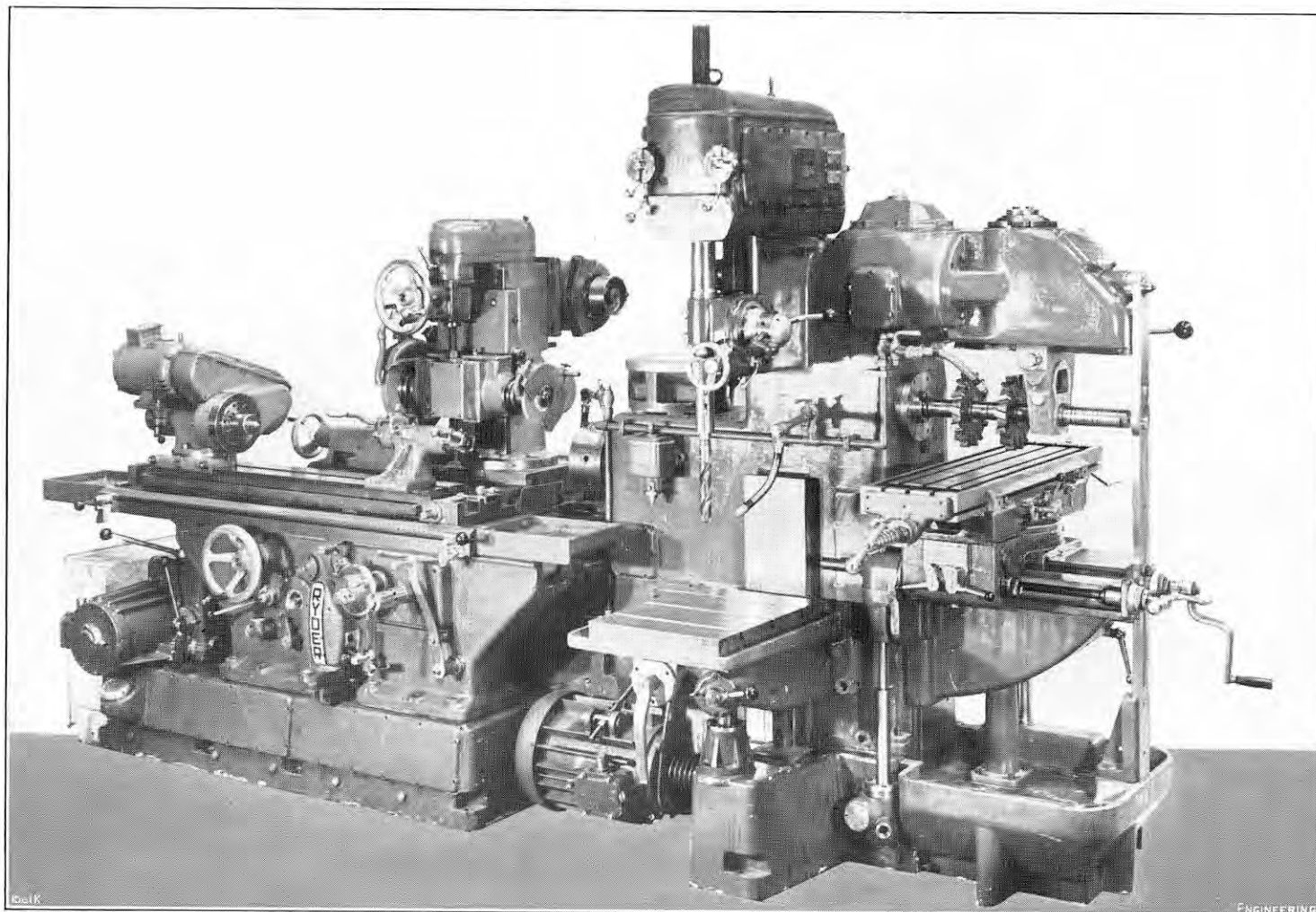


FIG. 60.

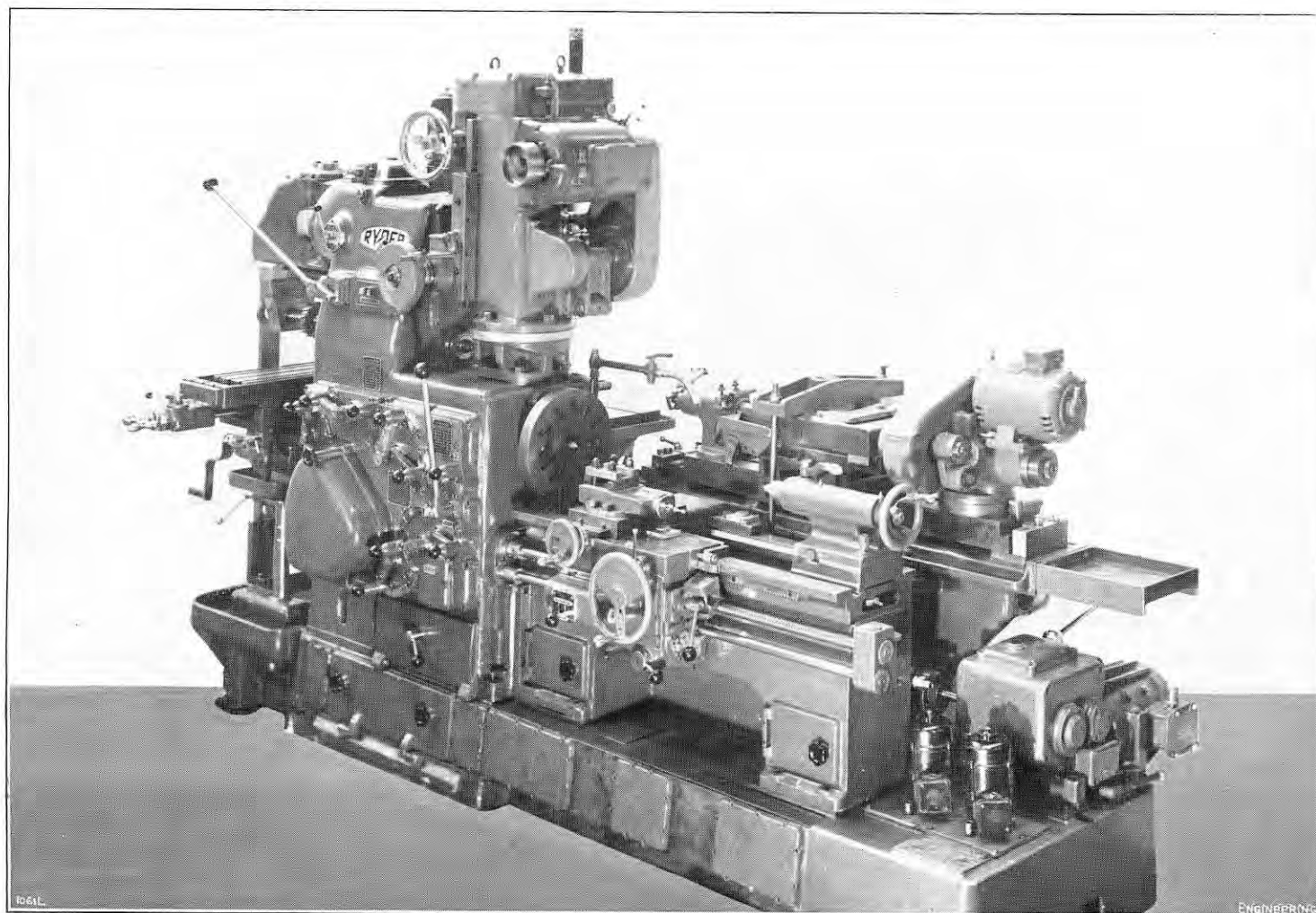


FIG. 61.

FIGS. 60 AND 61. UNIVERSAL MACHINE TOOL; THOMAS RYDER AND SON, LTD.

EXHIBITS AT THE INTERNATIONAL MACHINE TOOL EXHIBITION.

(For Description, see Page 394.)

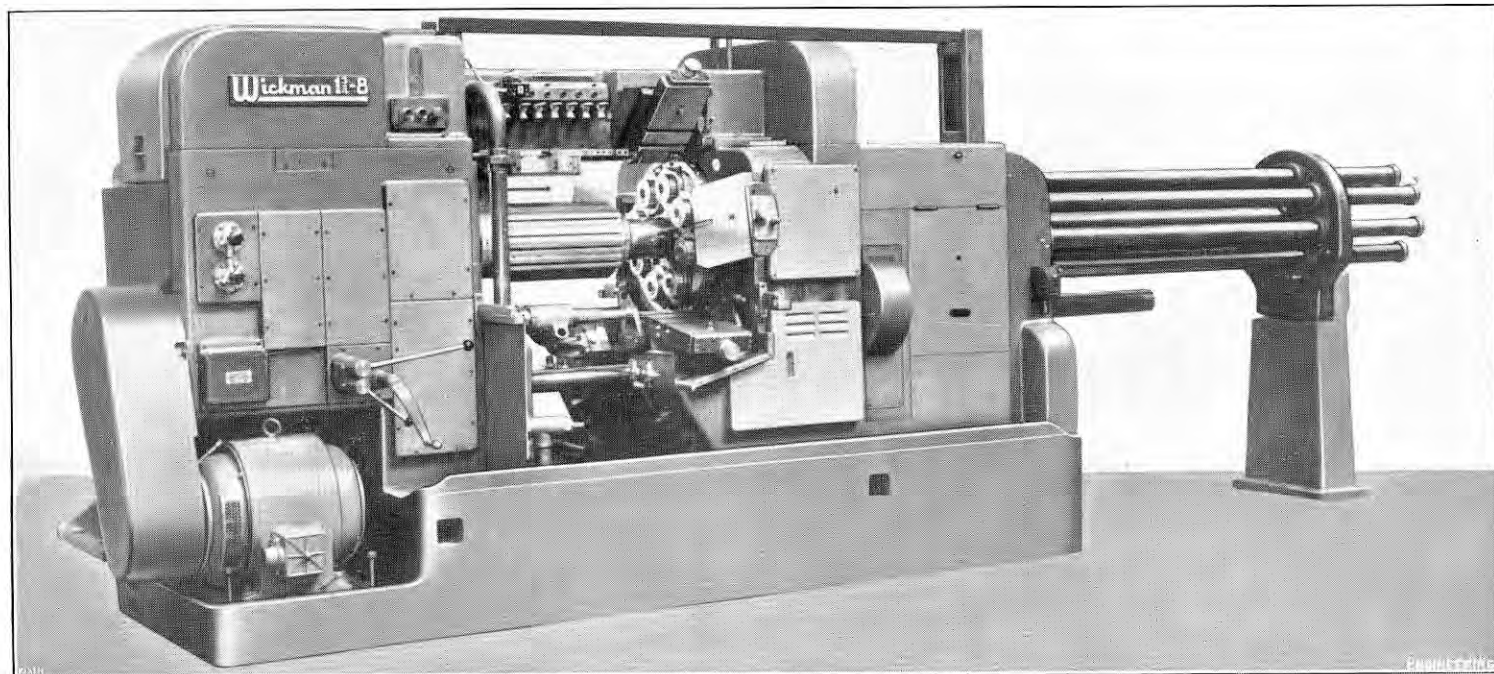


FIG. 62.

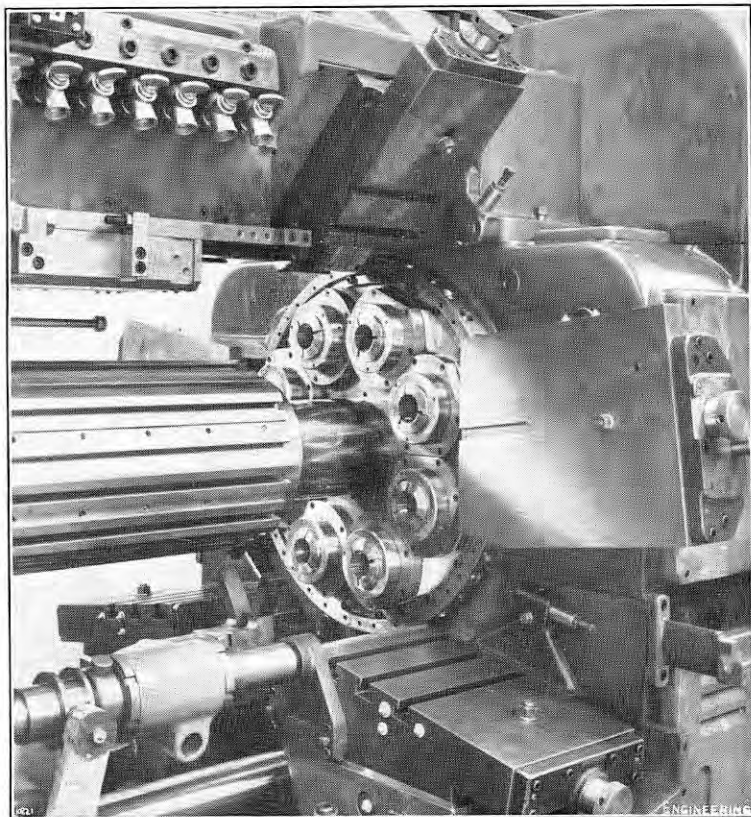


FIG. 63.

FIGS. 62 AND 63. EIGHT-SPINDLE BAR AUTOMATIC; WICKMAN, LTD.

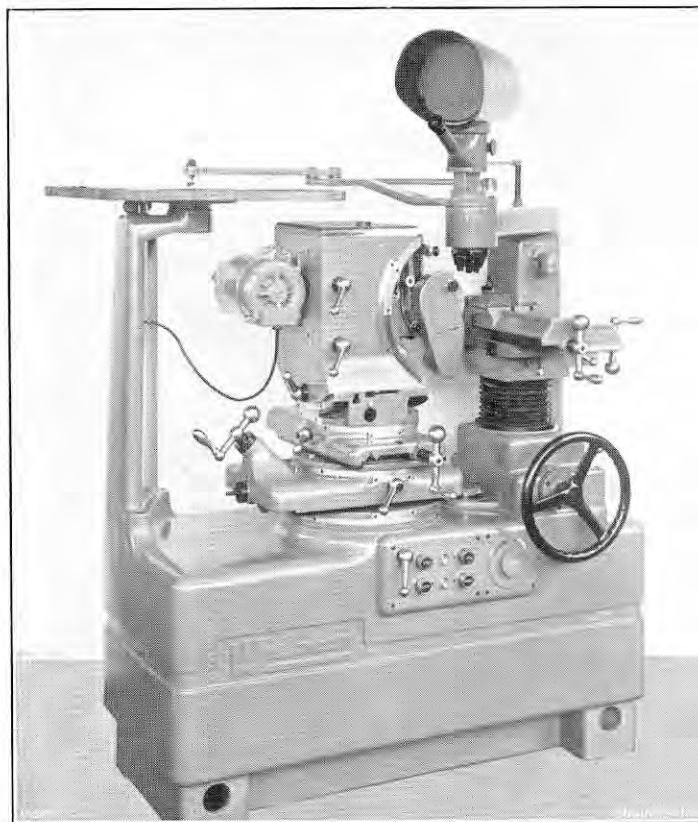


FIG. 64. OPTICAL PROFILE-GRINDING MACHINE; WICKMAN, LTD.

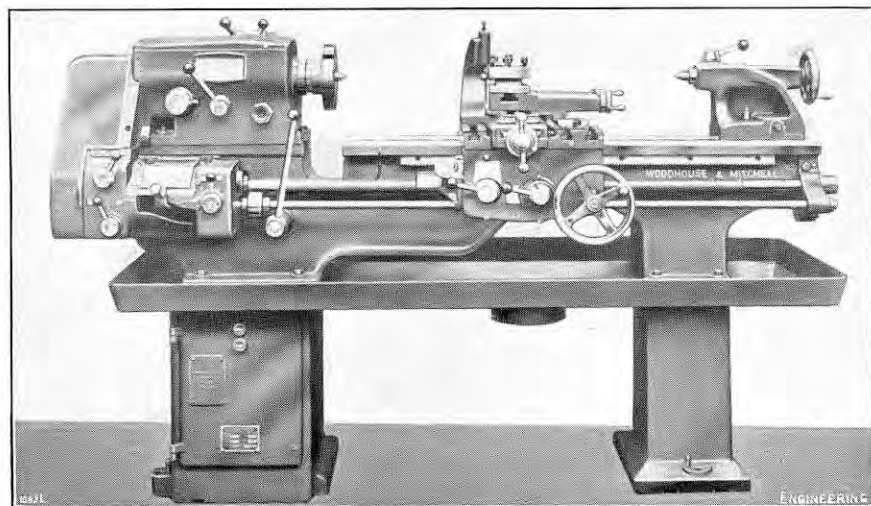


FIG. 65. WOODHOUSE AND MITCHELL 7-IN. LATHE; THOS. W. WARD, LTD.

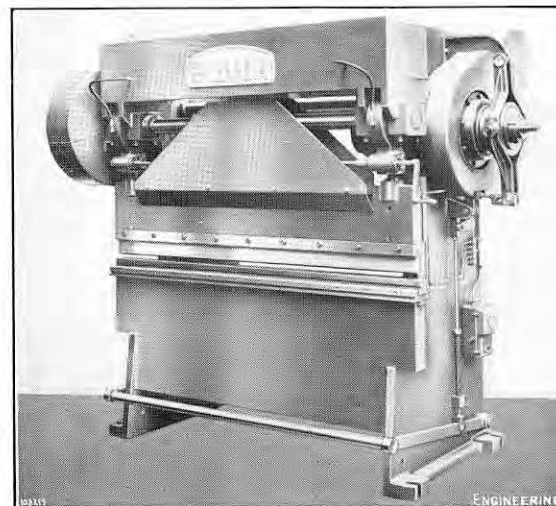


FIG. 66. ELDAIR PRESS BRAKE; THOS. W. WARD, LTD.

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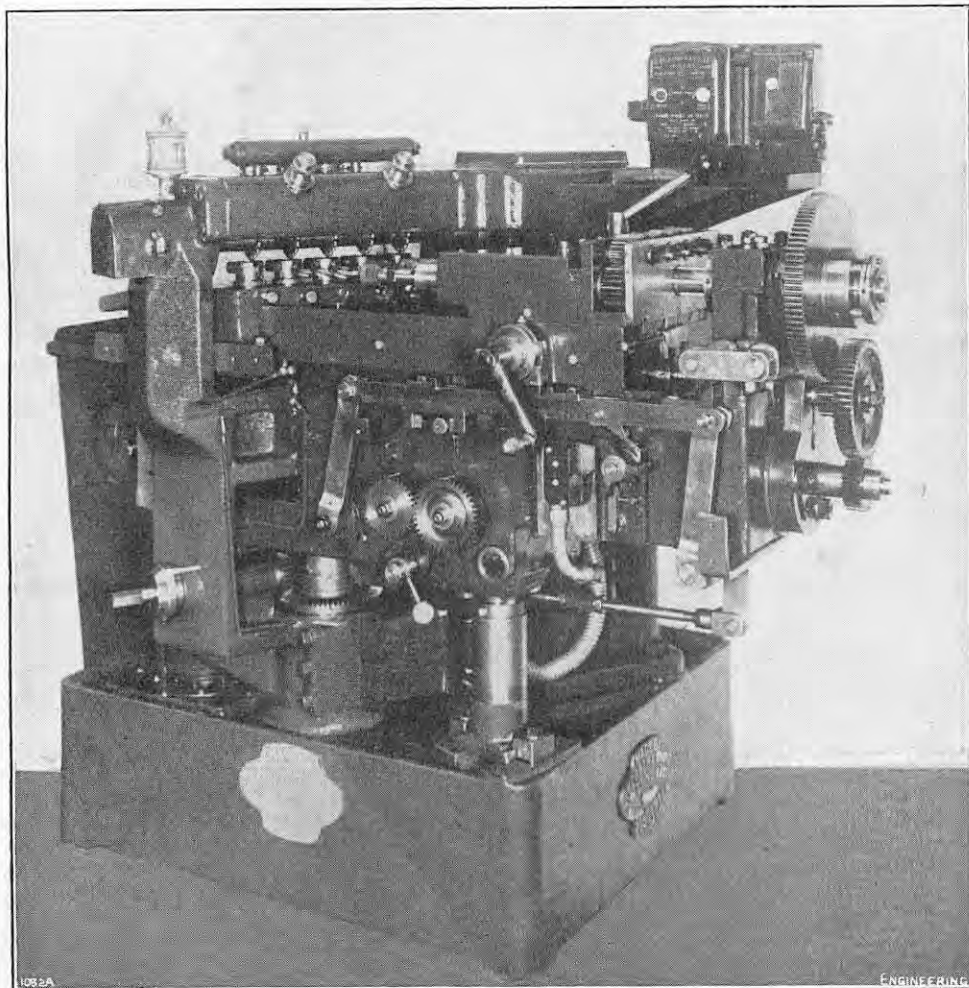


FIG. 67. TWIST-DRILL FLUTING MACHINE; HERBERT HUNT AND SONS, LTD.

profile is secured to the table of the machine and is then used in conjunction with the pantograph linkage which, as previously indicated, imparts a 50-to-1 reduction to the final arm, or follower. The projection unit is incorporated in the follower and in its field of vision are two crossed hair lines; these are superimposed on the image of the work and their point of intersection follows the path of the pantograph tracing point, thus outlining the correct profile.

The grinding-wheel head is mounted on a series of slides and circular guides designed so that the wheel and traversing slides can be set at almost any angle. For circular work, the wheel may be held stationary, but it can be reciprocated for straight work. Irregular shapes and curves with blending radii can be ground without difficulty and the accuracy of the work produced is not affected by wheel wear; furthermore, special shapes of wheel are not required. A $\frac{1}{2}$ -h.p. motor, incorporating anti-vibration features, is used to drive the wheel spindle and slide-oscillating mechanism, the motor being located on the grinding-wheel head and the drive transmitted by a thin woven-canvas belt. The slide oscillation is obtained through reduction gearing and a crank, two speeds, namely, 55 and 109 strokes per minute, being available. Cast aluminium with cast-iron inserts for the rubbing faces is used for the wheel slide, and the stroke of the slide can be varied between the limits of zero and 2 in. When using the pantograph the work range of the machine is limited to 0.4 in. by 0.4 in., but by using the work-table slides this can be increased to 5 $\frac{1}{2}$ in. by 2 $\frac{1}{2}$ in. The microscope used in the optical system has a magnification of 25 to 1 and the screen is 7 in. in diameter. A 12-volt 60-watt lamp is used in the projector and 12-volt 2.4-watt bulb for illuminating the surface.

WOODHOUSE AND MITCHELL 7-IN. LATHE.

In addition to the two machines illustrated in Figs. 65 and 66, on Plate XXV, and described here,

Messrs. Thos. W. Ward, Limited, Albion Works, Sheffield, are exhibiting a Bragonzi horizontal boring, facing, milling and drilling machine; a Riva universal milling machine and a vertical milling machine; an Eldair over-crank guillotine shearing machine and a portable alligator shear; and a universal nibble shearing machine. In addition to the Woodhouse and Mitchell lathe described here, there is also an 8 $\frac{1}{2}$ -in. sliding, surfacing and screwcutting lathe of the same make.

The principal features of the "70 Junior" 7-in. lathe (Fig. 65) are a diagonally-braced box-section bed, heat-treated nickel-steel gears on multi-splined shafts, a tubular forged main spindle of high-carbon steel, single-lever selection of sliding and surfacing feeds, inverted-V and flat guides for the saddle and tailstock, a tension-mounted leadscrew with ball thrust bearings, an oil-immersed multi-plate clutch, and the fact that the lathe is built throughout to Schlesinger limits. A half gap-piece is provided for the bed, allowing workpieces up to 1 in. thick and corresponding to the maximum swing of the lathe (22 in.) to be machined without removing it. The swing over the bed is 14 in., and over the saddle 7 in. The standard bed allows 36 in. between centres, but longer beds permit 45 in., 54 in., and 72 in. The headstock gives eight spindle speeds in geometric progression from 30 to 437 r.p.m., and the hole through the spindle is 1 $\frac{1}{8}$ in. in diameter. The bearings are of centrifugally-cast phosphor bronze and are mounted in tapered housings to provide adjustment for wear. Ball thrust bearings are fitted on both sides of the rear bearing. The headstock is totally enclosed and forms a sump.

The tailstock is provided with a set-over adjustment. The headstock, which is guided on a front V-way and a rear flat way, is provided with T-slotted right wings and a full-width T-slot at the front. A follower rest is mounted in the front T-slot and the saddle is drilled at the rear for a taper-turning attachment, which can be added without any alteration to the standard saddle. The feed box

normally fitted gives three surfacing and sliding speeds by means of sliding nickel-steel gears, and it is driven by a fixed end train so that the feeds are available irrespective of the leadscrew gears, which are fitted on a separate swing-plate end train. Change wheels are provided for cutting all standard threads, with an additional 127-tooth wheel for metric threads. A quick-change gearbox of the Norton type can be provided. The leadscrew is precision cut to give a pitch error not exceeding 0.002 in. in any 12 in.

ELDAIR PRESS BRAKE.

Fig. 66, on Plate XXV, shows the Eldair press brake type PBS/60, which is made by Weldall and Assembly, Limited, Stourbridge, and is being shown on Messrs. Thos. W. Ward's stand. It will deal with sheet metal up to 8 ft. in length, and as it has a large tool space a wide variety of work can be handled and such products as deep pans can be efficiently formed. The main features of this press brake are an all-steel welded frame, central-point lubrication, a multi-plate clutch, machine-cut steel gears, power-operated adjustment to the top beam, an automatic trip cut-out, and the right-hand crankshaft is fitted with an indicator, showing the bottom dead-centre, for ease of tool-setting. The end housings are of box section, connected together by a lattice girder. The bed is of two-plate welded construction, forming a rigid unit which ensures permanent alignment between the housings and the ram. The crankshafts, of forged alloy steel, have eccentrics located centrally between the four main bearings in end housings, one on each side of the eccentrics. The load is applied directly to the four plates comprising the end frame. The ram is adjusted by a reversing motor, governed by an over-run switch, through compound gearing, and final adjustment is effected by a handwheel. The flywheel and shaft are mounted in ball bearings, and a multi-disc clutch and self-releasing band brake permit the ram to be inched down slowly.

TWIST-DRILL FLUTING MACHINE.

The exhibits on the stand of Messrs. Herbert Hunt and Sons, Limited, Old Trafford, Manchester, 16, who specialise in machine tools for the production and maintenance of small tools, such as drills, taps and reamers, include a wide range of automatic and semi-automatic drill fluting machines, tap sharpening and manufacturing machines, and tap fluting machines. The most interesting machine on the stand is, possibly, their five-spindle automatic drill-fluting machine. This has a capacity of from $\frac{3}{8}$ in. to $\frac{1}{2}$ in., and is capable of fluting five blanks simultaneously by the climb-milling method. The machine, which is entirely new and on show for the first time, is illustrated in Fig. 67, on this page, where it is shown with the covers removed. The arbor for the cutters is supported by combined radial and thrust bearings and is driven by a 3-h.p. motor through a duplex chain arranged to drive a worm and worm-wheel assembly. The guide bushes are provided with means for slight adjustments to be carried out and the web taper is produced by an inclined solid bar. Changeable gears are incorporated to permit the helix angle to be varied between 25 deg. and 33 deg., and the rate of traverse can be altered by a further set of gears.

When in operation, the drill blanks are loaded in special collet holders, after which movement of a lever brings the slide carrying the blanks up to a stop, thus bringing the blanks to within $\frac{1}{16}$ in. of the cutters. A button is then pressed and the blanks move forward under the cutters at the correct rate of traverse, and on completion of the first flute, the table carrying the blanks drops so as to bring them clear of the cutters and subsequently returns at a faster speed to the starting position. On completion of the return stroke, the blanks are indexed automatically through 180 deg., the table elevated and then traversed forward to machine the second flute. After the second flute is machined, the table again drops to bring the drills clear of the cutters and returns to the starting positions, a cut-out switch automatically stopping the machine. A single movement of a lever then brings the drills into a convenient position for unloading and the subsequent loading of the next five blanks. The cutter arbor is 1 $\frac{1}{4}$ in. in diameter

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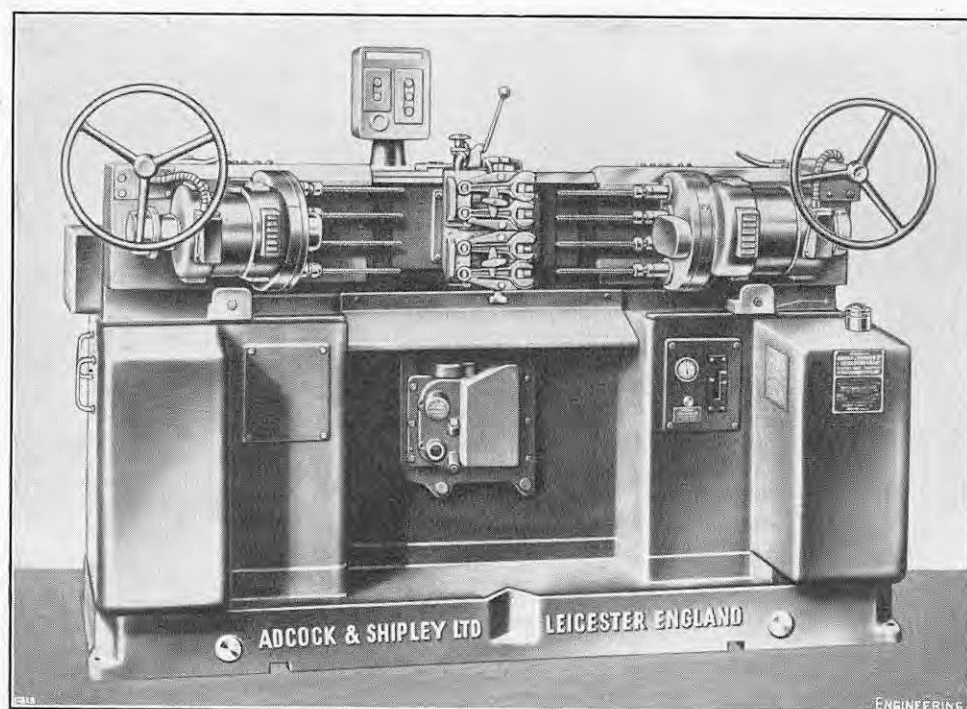


FIG. 68. DEEP-HOLE DRILLING MACHINE; ADCOCK AND SHIPLEY, LTD.

and the cutters 3 in. in diameter, with a $\frac{5}{16}$ -in. keyway. The spindle speed is 110 r.p.m. and the traversing speed may be varied between the limits of 1 in. per minute and 5 in. per minute. The output varies, of course, according to the size of blank, but 50 $\frac{1}{2}$ -in. diameter blanks can be dealt with in an hour, the output for other sizes varying in proportion. The machine is simple to operate and it is quite feasible for a single operator to attend to two or more machines.

VERTICAL MILLING MACHINE.

On one of the stands the exhibits are limited to two types of machines—millers and drilling machines. Messrs. Adcock and Shipley, Limited, Ash-street, Leicester, have on view nine models of their milling machines, four of which are horizontal types, two vertical and the remainder universal, together with three medium-heavy drilling machines. The largest of the millers is their model 4V, which is illustrated in Fig. 69, on this page, and is a vertical milling machine fitted with a table 60 in. by 15 in. It is equipped so that the spindle speeds may be infinitely varied between 20 and 1,400 r.p.m. This machine is controlled by a single lever on the front of the knee, thereby making the machine very suitable, not only for general-purpose work, but also for the milling of batches of components by mass-production methods. It is also fitted with direct-current electrical braking to both the tool spindle motor and the feed motor, in order to reduce change-over times.

DEEP-HOLE DRILLING MACHINE.

In Fig. 68, on this page, we illustrate Messrs. Adcock and Shipley's special deep-hole drilling machine, which they have developed for the step-by-step drilling of components with holes that are very long in comparison to their diameters. This particular machine is fitted with an indexing turret which enables loading and unloading of the workpiece to be carried out at one station while drilling operations are being carried on from another. The worth of these step-by-step deep-drilling machines has already been demonstrated in the production drilling of such components as connecting rods, crankshafts and swivel pins for the automobile and aircraft industries. Immediately the workpiece has been loaded and secured by mechanical, air or hydraulic clamps, the toolhead advances at a high approach rate of 300 in. per minute until the drilling position is reached, when the speed drops to the working rate of feed. At pre-determined

depths of drilling, work ceases and the drill withdrawn at high speed. The newly-drilled hole is flushed clean of swarf by coolant fluid applied under pressure. Re-drilling is then recommenced and the cycle repeated until the drilling is completed, when the tool heads retract rapidly to their original position.

DUPLEX AUTOMATIC ENDING AND CENTRING MACHINE.

The machine illustrated in Fig. 70, on page 397, is a duplex automatic ending and centring machine, which is being shown by Messrs. John Holroyd and Company, Limited, Milnrow, Lancashire. It is designed to mill to length and centre both ends of bars or forgings, and is especially suitable for preparing work for automatic copying lathes. Both ends of the work are machined simultaneously. The milling spindles are of high-carbon steel and revolve in taper-roller bearings at the front, and a parallel-roller bearing at the rear. A single speed (160 r.p.m.) suitable for tungsten-carbide cutters, is provided, and a flywheel is fitted to the spindle nose. The drive to the spindles is through hardened and ground gearing from flange-mounted motors, each head being an independent unit. The drilling spindles are fitted up the centre of the milling spindles and rotate in anti-friction bearings. Collet chucks are fitted for gripping the centre drills and means are provided for adjusting the drills so that the required depth of centre can be obtained. The spindles are driven at a constant speed of 500 r.p.m. The cutter spindles are eccentrically mounted in drums so that the action of rotating the drum feeds the cutters across the ends of the work. The drums are mounted in headstocks which contain the requisite feed gearing. Pick-off gears are provided to vary the rotary feed of the drum, and a constant quick rotation is provided. The feed to the drilling spindle is constant and is obtained by means of a cam which also provides a quick withdrawal of the drill spindle. One headstock is adjustable along the bed to suit the length of work, and means are provided for clamping it. Micrometer dials are fitted so that a setting can be repeated. The work vices are automatic and self-centring, and the closing and opening of the jaws are obtained by push button. The vices are clamped to the bed in the desired position, and are braced by over-arm supports from the headstocks. The milling and centring operations are automatic and are engaged by push-button. The drum rotates quickly until the cutter is just clear of the work, and then trips

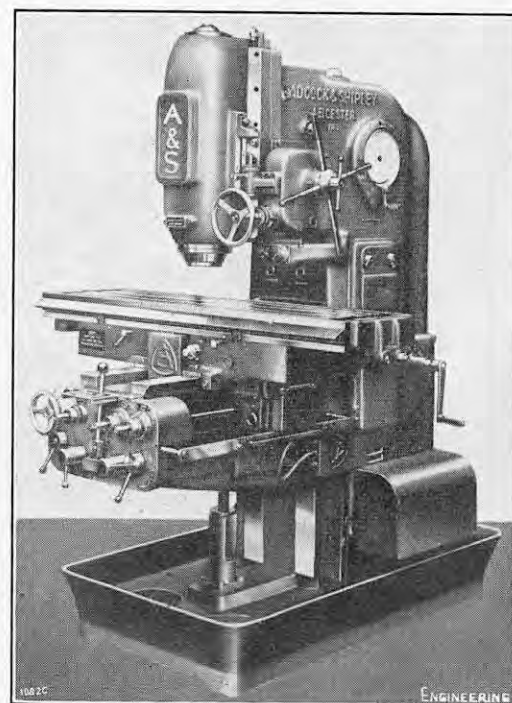


FIG. 69. VERTICAL MILLING MACHINE; ADCOCK AND SHIPLEY, LTD.

into the milling feed. On completion of the milling, the drum trips into quick rotation and then traverses until the drilling spindle is central with the work. The quick rotation and milling feed positions are controlled by trip dogs which are set to suit the diameter of work. When the drum has reached the central position, which is controlled by a dead stop, the rotary-feed motor cuts out and the cam feed to the drill starts. On completion of drilling, the drum returns quickly to its initial position. Pump lubrication to the headstock bearings and gears is provided. The maximum diameter of shaft that the vice will grip is 5 in., and the maximum and minimum lengths are 8 ft. and 10 in., respectively.

UNIVERSAL WIRE AND STRIP FORMING MACHINE.

Messrs. Heenan and Froude, Limited, Worcester, are exhibiting a large and comprehensive range of automatic wire and strip forming machines, one of which, the S 203A strip-forming machine, is illustrated in Fig. 71, on page 397. These machines are designed for the production of an almost unlimited range of wire and strip parts from coiled stock in a single pass through the machine, and the design permits many parts to be produced in pairs, or even four together, small parts like electrical components being produced in pairs or four together, and small parts like electrical components being produced at over 28,000 an hour. The general principle of operation is as follows. The wire or strip is progressively bent round a centrally-located mandrel by a number of reciprocating forming slides (usually four), each fitted with tools machined to the appropriate shape. A further slide feeds the machine regularly with a pre-set length of material, which is straightened and cut off in the machine. After forming, the component is stripped off the central mandrel and ejected. In the case of strip-forming, a press ram is introduced between the feed slide and the central tool, in which the strip can be pierced, blanked, lettered, etc., as necessary. Multi-stage tooling is sometimes used in the ram die-set, i.e., the strip is only partly blanked at the first stage, being blanked and pierced again and again as it progresses through the length of the die-set in a follow-on sequence. In some cases the motions of the four forming slides are insufficient to produce the final shape. This is overcome on Heenan machines by applying two-stage forming: after the first motion of the slides the partly-formed product is moved a short distance down the centre tool and is acted upon by a second set of forming

EXHIBITS AT THE INTERNATIONAL MACHINE TOOL EXHIBITION.

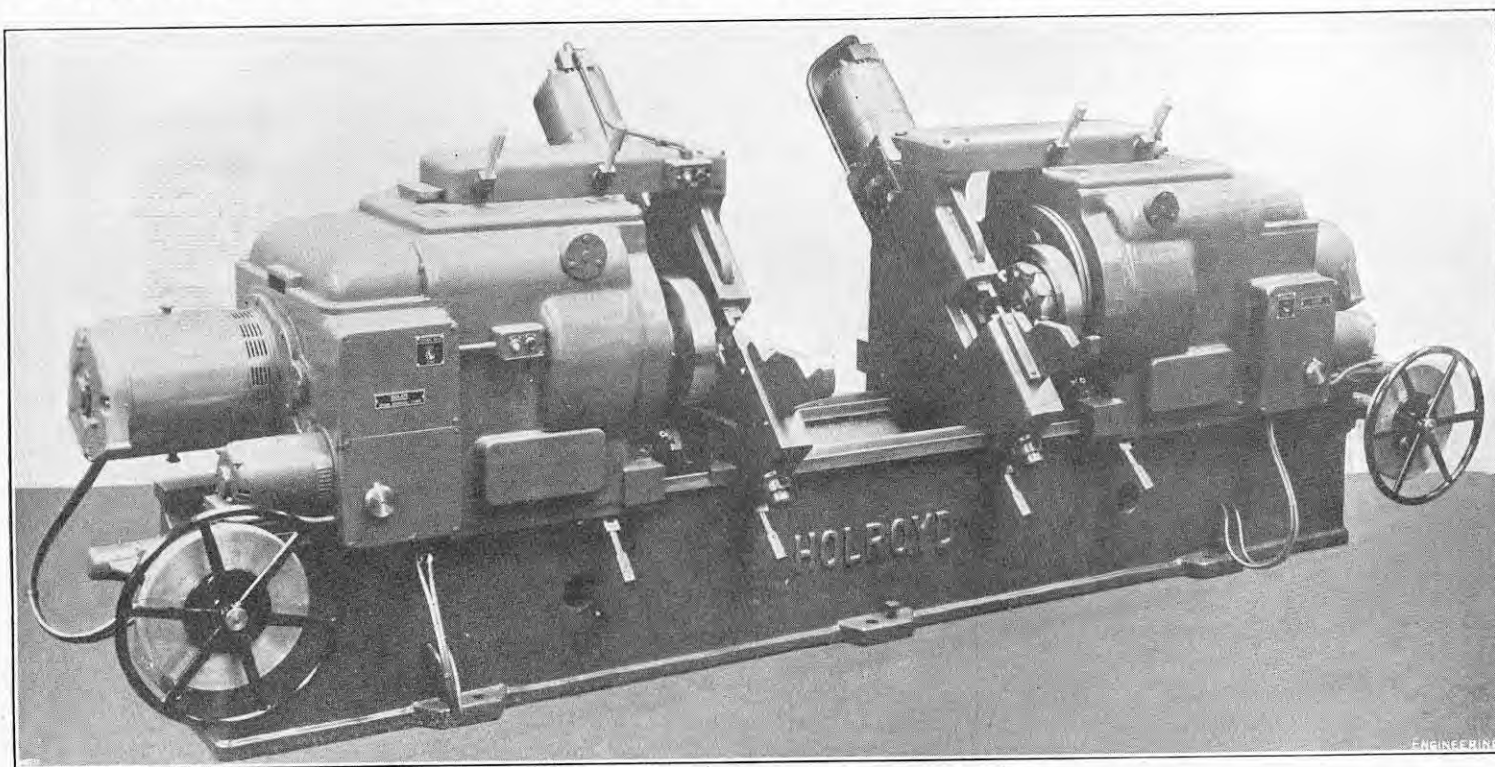


FIG. 70. DUPLEX AUTOMATIC ENDING AND CENTRING MACHINE; JOHN HOLROYD AND CO., LTD.

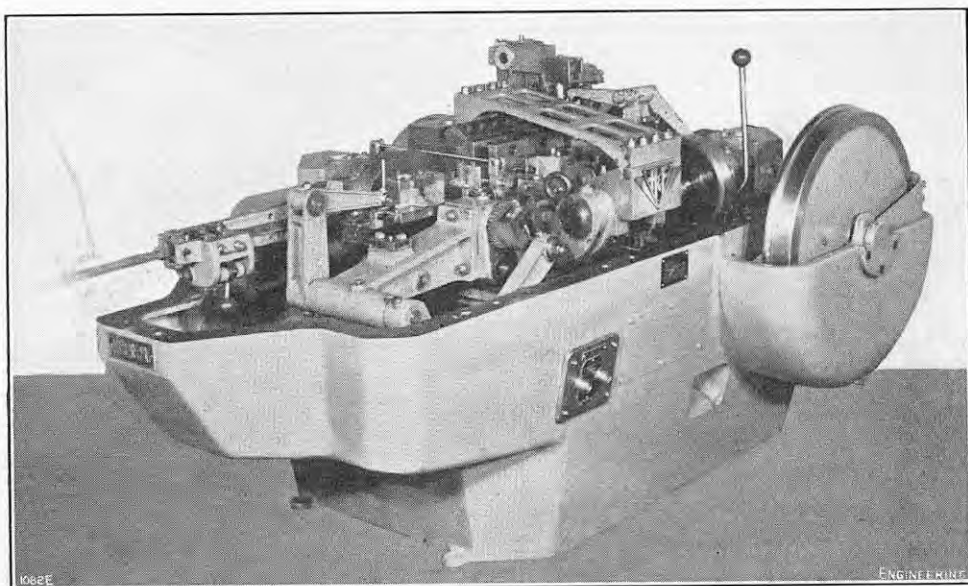


FIG. 71. UNIVERSAL WIRE AND STRIP FORMING MACHINE; HEENAN AND FROUDE, LTD.

tools mounted at a lower level on the same slides. Three-stage forming on similar lines can occasionally be applied.

Conversion parts are available for most Heenan machines which enable a strip machine to be modified for wire, and vice versa. Attachments for special operations can also be supplied, such as a seaming attachment for closing a joint in strip metal by means of a double lock seam or "can-seam," transfer mechanisms, ring-setting attachment for sizing rings or ferrules accurately to shape, twin-wire feeds, and others. These devices, allied to the general design and construction of the machine, make the range extremely versatile, and the high rate of output assures such low production costs that their employment on even comparatively short runs becomes economic. In many cases articles are produced, at one pass through the machine, which would normally require six or seven separate press operations, with individual handlings between each. Three sizes of wire and strip forming automatics are being shown, together with a chain-making machine and an automatic for the production of paper clips. Messrs. Wickman, Limited,

who are also exhibiting, are sole world agents for Heenan wire and strip forming automatics.

SWIFT-SUMMERSKILL PLANING MACHINE.

Messrs. George Swift and Sons, Limited, Halifax, are showing two machines which are illustrated and described here, namely, a planing machine which has a capacity of 16 ft. by 4 ft. by 3 ft. 6 in., and a heavy-duty centre lathe.

The Swift-Summerskill planing machine, illustrated in Fig. 72, on page 398, is an all-electric machine giving 80 feeds from 0.005 in. to 0.450 in. It takes tools 1½ in. by 1½ in. The cutting speeds and return speeds range from 25 to 200 ft. per minute. The machine shown carries three heads with a special drive by a reversing Ward-Leonard set. A patent feed motion applies the feed before the machine has finished reversing. Swift-Summerskill planing machines are provided with a helical-gear drive, which, together with the bearings, is lubricated by a mechanical pump. The walls of the bed are tied together with a continuous plate of metal, running the full length just below the slideways, as well as by other cross-bracings.

A double-wall construction is adopted round the gear chamber, thereby avoiding the weak spot found at this point in many planing machines. The standard guide-ways are of the flat type with adjusting strips, but beds of the V-guide type can be supplied. For securing the cheeks to the bed, full-length tongues cut from the solid, with taper gib keys and dowels, ensure rigidity and accuracy of alignment. The table rack is of high-tensile nickel iron, secured to the table by nickel-chromium screws and dowels. Particular attention has been paid to the design of the tool-boxes, to provide the utmost rigidity and accuracy of alignment, and, if required, automatic relief of the tool-boxes can be provided by means of built-in solenoids.

The makers draw attention specially to a new electric feed and quick power-traverse motion, which have been designed as a result of the advent of tungsten-carbide tools. The range of feeds is obtained simply by moving one handle when the machine is running or stopped. For reversing the table, only a light relay current is used, thus enabling a comparatively light reversing switch to be employed; this switch is operated directly by the table dogs, without connecting rods or links. Quick power traverse of the tool-boxes is obtained from the feed motor, interlocks being provided so that this feature cannot be operated when the machine is running. The electrical equipment of the machine includes a pendant push-button station and an accelerating device which enables the table to be speeded up to the return speed irrespective of the setting of the cut controller. This shows a great saving when machining faces which are situated some distance apart, and a further advantage is that the peak load at reversal is considerably reduced.

10½-IN. CENTRE LATHE.

The Swift-Sentinel centre lathe which Messrs. George Swift and Sons are also showing is one of their 10½-in. heavy-duty models with a wide bed, and is illustrated in Fig. 73, on page 398. It has a 12-speed reversing headstock driven by a two-speed motor, thus giving 24 speeds in all; the range can be from 7½ to 500 r.p.m., from 10 to 670 r.p.m., or from 15 to 1,000 r.p.m. The swing over the ways is 22½ in., and over the saddle 14½ in.; with a gap bed the swing in the gap is 33 in. by 9 in. The maximum length between centres is 5 ft. 6 in., 7 ft., or 8 ft. 6 in. The diameter of the hole through the spindle is 2½ in. A totally-

enclosed Norton feed-box gives 36 feeds from 29 to 400 cuts per inch, 36 English pitches of 2 to 28 threads per inch, and 36 metric pitches of 1 to 15 mm. Special pitches can also be cut.

The headstock has been designed for making the best use of either cemented-carbide tipped tools or high-speed steel tools. The hollow spindle, made from a solid steel forging, is mounted in three extra-precision anti-friction bearings. All gearing is of alloy steel, case-hardened and with profile-ground teeth. On the saddle apron the feed is engaged by a drop worm mounted on a hinge at right-angles to the axis of the worm; with this arrangement the worm-box cannot hang up under the heavy load in either direction of travel. A revolving-dial indicator is fitted for screwcutting. Automatic trips or positive stops can be fitted to either the sliding or surfacing motions. A taper-turning attachment of the tangent-bar type, which is carried along with the saddle and can be anchored at any point along the bed, is suitable for tapers up to 120 deg. included angle for a distance of 18 in. The machine is built to the limits laid down by Dr. Schlesinger.

13-IN. SWING CENTRE LATHE.

Messrs. Henry Milnes, Limited, Ingleby Lathe Works, Bradford, are showing two machines—a 13-in. swing centre lathe and a small vertical milling machine—which are illustrated in Figs. 74 and 76, on Plate XXVI.

The centre lathe is provided with eight forward and reverse speeds from 30 to 750 r.p.m. The range of feeds available is from 0.002 in. to 0.036 in. per revolution, by means of a Norton box, and any normal threads can be cut. By using an extra change wheel, an extra fine feed of 0.0011 in. can be obtained. The principal features of the lathe are as follows: a V-bed of deep section with diagonal ribs and a full gap piece; a high-speed helical-gear headstock; forward and reverse drives by plate clutches running in oil; the feed shaft has an adjustable knock-off stop; a foolproof interlocking sliding, surfacing and screwcutting mechanism; a screwcutting indicator; a hardened and graduated tailstock spindle; a square tool post with eight locking positions; a self-contained electric drive; fixed and travelling steadies; and a works test sheet to Schlesinger limits supplied with every machine. The swing over the saddle is 8½ in. and the distance between centres is 38 in. on the standard model and 72 in. on a model that has three-column support. The swing in the gap is 19½ in. and the width of the gap in front of the faceplate is 5 in. The spindle is bored 1½ in. in diameter.

VERTICAL MILLING MACHINE.

The other machine being exhibited by Messrs. Henry Milnes, Limited, is the vertical milling machine illustrated in Fig. 76, on Plate XXVI. The working surface of its table is 30 in. by 8½ in.; the automatic longitudinal movement of the table is 18 in.; the cross movement, by hand, is 6½ in.; the vertical movement, by hand, is 14½ in.; and the vertical adjustment of the spindle head, also by hand, is 2½ in. There are six spindle speeds, the standard range being from 75 to 750 r.p.m., and there are six feeds from 0.00066 in. to 0.066 in. per spindle revolution. The machine is driven by a 1½-h.p. motor and its gross weight is 2,440 lb.

The spindle, bored with a No. 3 Morse taper, is of case-hardened steel and runs at the forward end in two opposed Timken taper-roller bearings and at the other end in a floating ball race. It runs in a housing through which oil is circulated by centrifugal force. The head is located in a vertical position by a taper pin, and when the pin is removed the head can be turned through 360 deg. A motor in the lower part of the column drives the main gear shaft through a clutch, pulley and twin V-ropes. Sliding cluster gears transmit the drive to the spindle and the feed shaft, the spindle being splined to a spiral-bevel gear which meshes with a mating gear; the shaft of the latter is housed in a heavy cast-iron sleeve on which the head can be rotated. The vertical slide and spindle unit is moved by a hand-operated worm and wheel driving a pinion and rack. A micrometer depth stop, and an index collar graduated in thousandths of an inch on the

THE INTERNATIONAL MACHINE TOOL EXHIBITION.

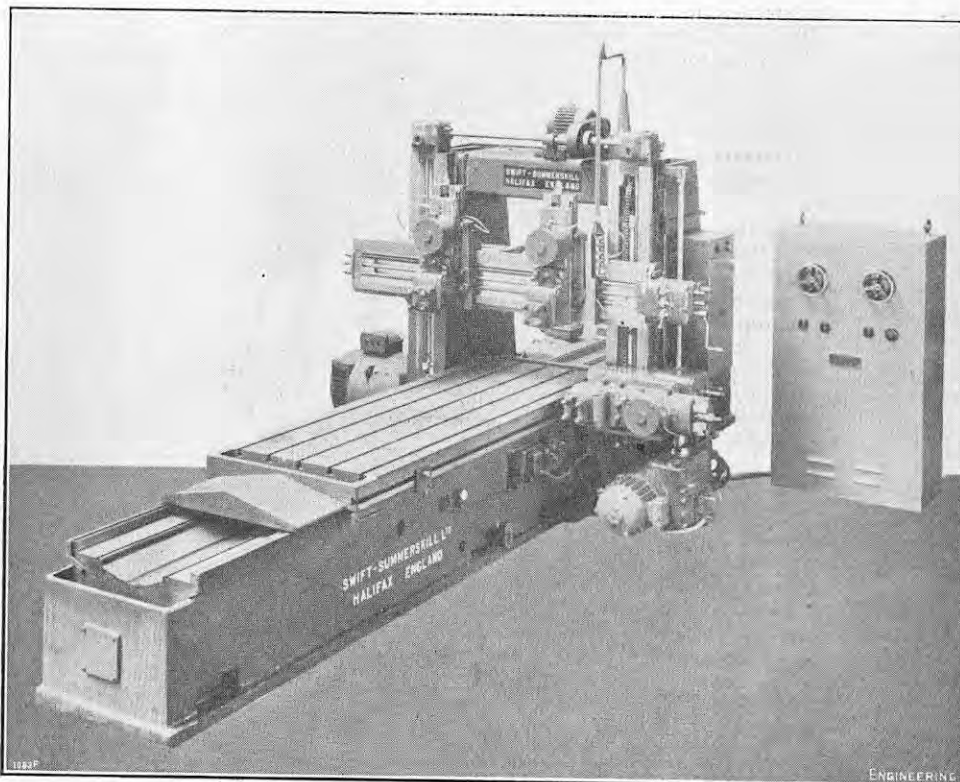


FIG. 72. PLANING MACHINE; GEORGE SWIFT AND SONS, LTD.

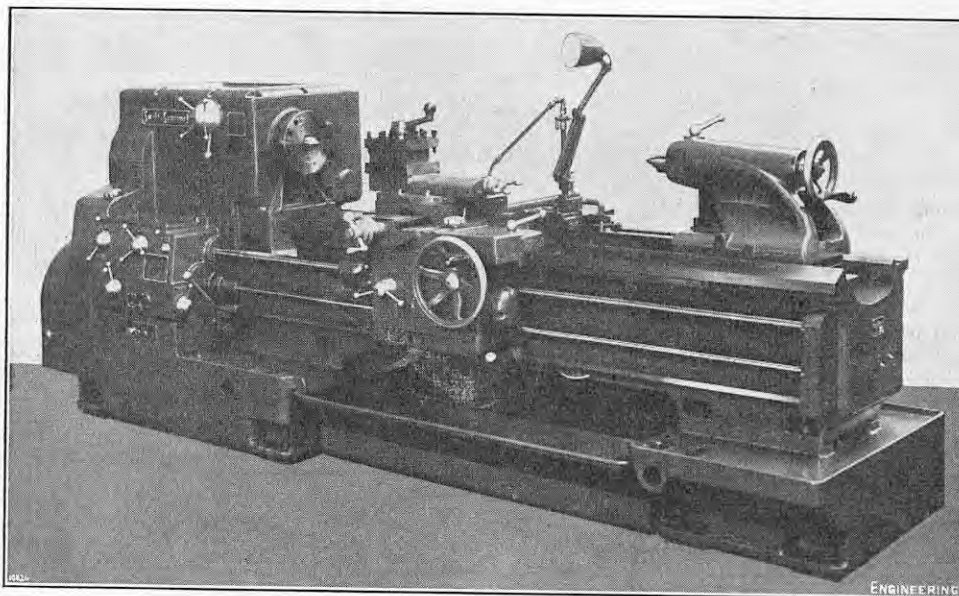


FIG. 73. 10½-IN. CENTRE LATHE; GEORGE SWIFT AND SONS, LTD.

worm shaft, are provided. The table feed is transmitted from the column feed shaft to the feed box through a roller chain, and from the feed box a telescopic shaft drives a worm and wheel, which in turn drive the bevels, for the forward and reverse motion of the table. The sliding clutch of the feed is controlled either by a hand lever or by adjustable knock-off dogs on the front face of the table.

THREAD-GRINDING MACHINE.

Newall Group Sales, Limited, Peterborough, are showing machine tools of the Newall Engineering Company, Limited, and Keighley Grinders (Machine Tools), Limited; and on an associated stand there are instruments from Optical Measuring Tools, Limited. The Newall Engineering Company's products on view include, apart from the thread-grinding machine shown in Fig. 75, on Plate XXVI, a fully-automatic cylindrical grinding machine, shown for the first time; a fully-hydraulic jig-boring machine; a redesigned No. 1 jig borer; a crankpin grinding machine for automobile crankshafts, also shown for the first time; a cam-shaft

grinding machine; a universal lapping machine for flat and cylindrical components; etc. The Keighley exhibits include a 24-in. by 96-in. universal grinding machine which incorporates a number of unique features; a duplex special-purpose grinding machine for grinding long bores; an automatic internal grinding machine for bores from ¼ in. to 2 in., which can also be arranged for profile grinding; and several other grinding machines. Among the products of Optical Measuring Tools, Limited, are an optical rotary table, a toolmaker's microscope, several Omtimeters, Pantometers for inspecting turbine blades, a surface projector with infinitely-variable magnification, and various gauges, etc.

The thread-grinding machine (Fig. 75) is being exhibited for the first time in this country. It is being shown grinding taps, with extremely rapid and accurate production, and a selection of auxiliary equipment is also on view, including an internal and hob-grinding attachment, a surface-grinding attachment, etc., together with a variety of wheel dressers. The latter include the Newall pantograph

EXHIBITS AT THE INTERNATIONAL MACHINE TOOL EXHIBITION.

(For Description, see Page 398.)

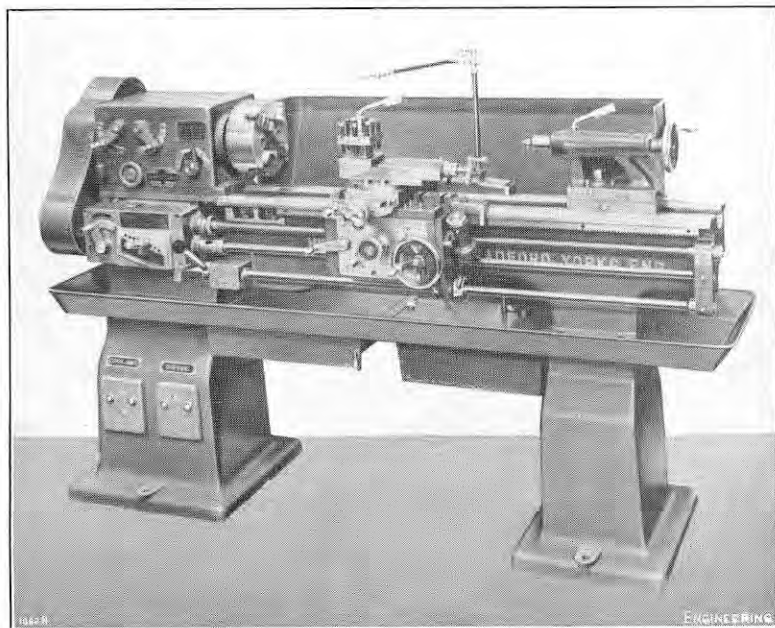


FIG. 74. 13-IN. SWING CENTRE LATHE; HENRY MILNES, LTD.

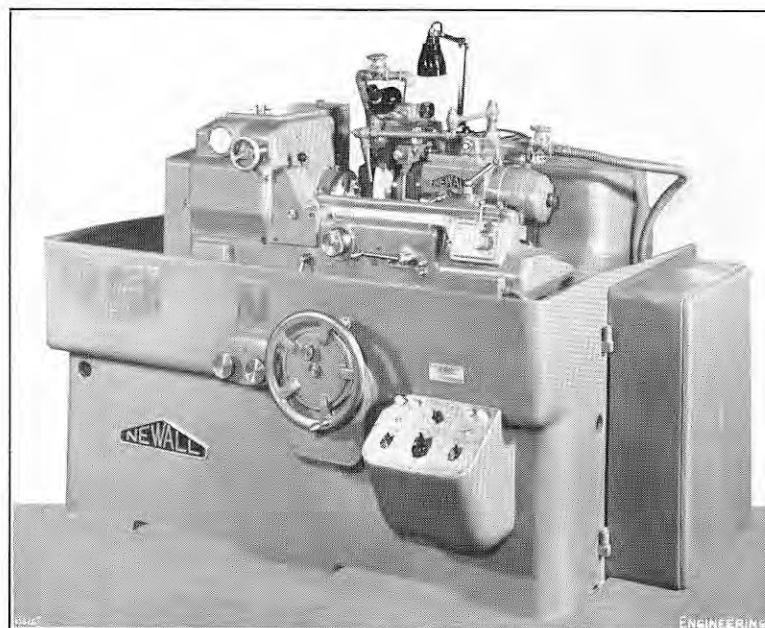


FIG. 75. THREAD-GRINDING MACHINE; NEWALL ENGINEERING CO., LTD.

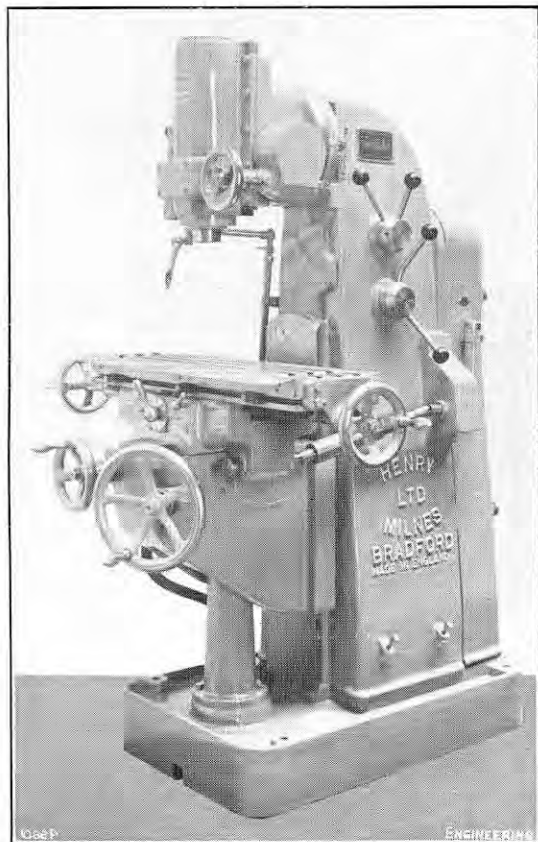


FIG. 76. VERTICAL MILLING MACHINE; HENRY MILNES, LTD.



FIG. 77. FRICTION DROP HAMMER; B. AND S. MASSEY, LTD.

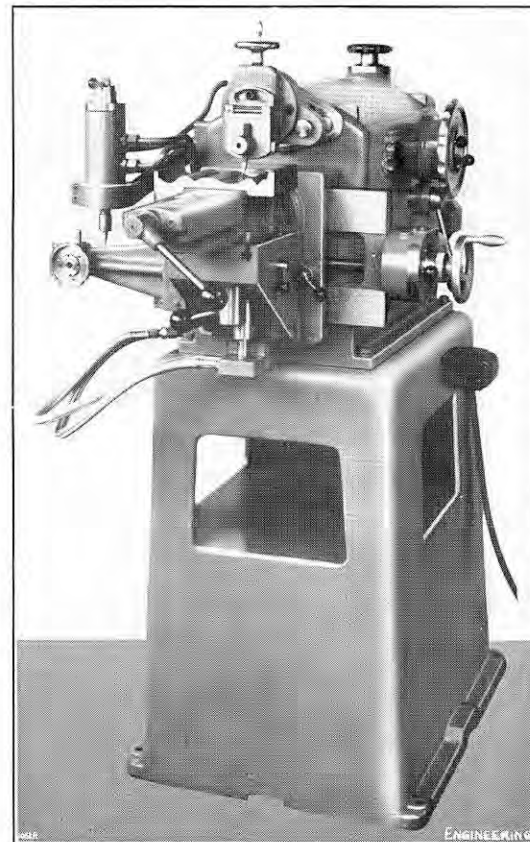


FIG. 78. BARTSCH COPYING SHAPER; SOAG MACHINE TOOLS, LTD.

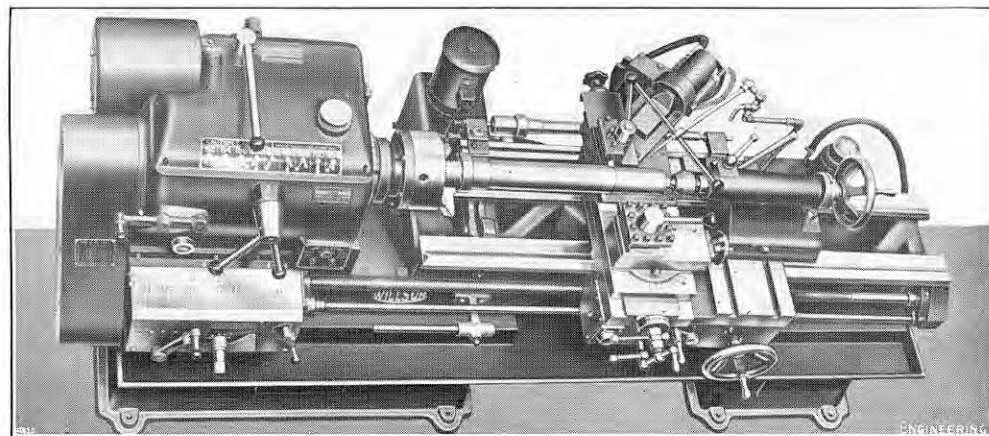


FIG. 79. HYDRAULIC TRACING LATHE; WILLSON LATHES, LTD.

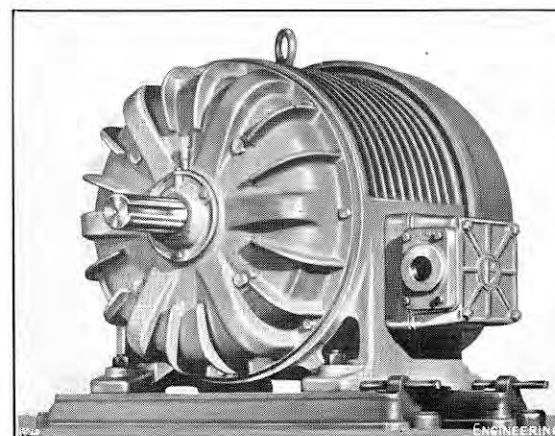


FIG. 80. TOTALLY-ENCLOSED FAN-COOLED MOTOR; BROOKS MOTORS, LTD.

EXHIBITS AT THE INTERNATIONAL MACHINE TOOL EXHIBITION.

(For Description, see Page 399.)

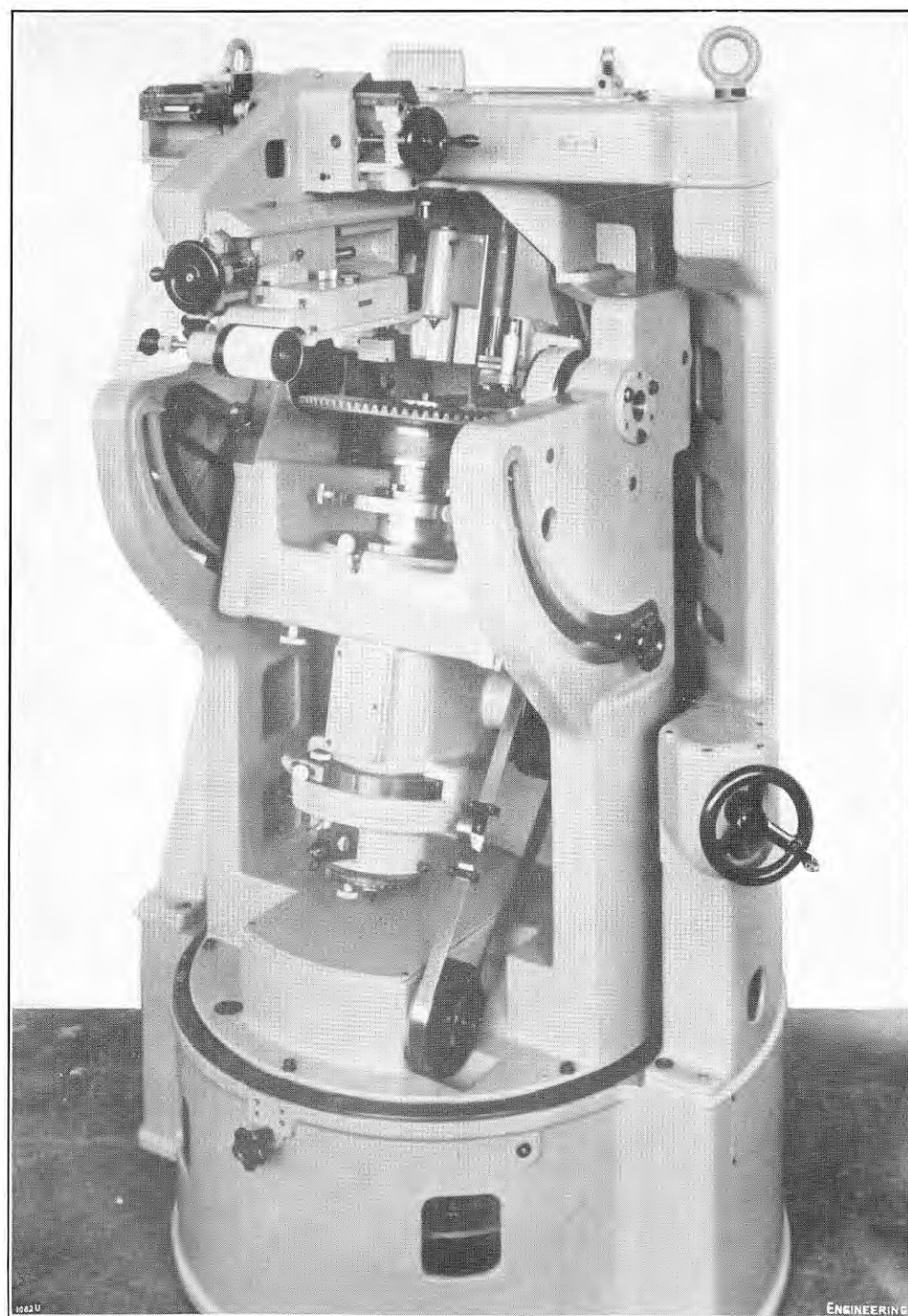


FIG. 81. MAAG BEVEL-GEAR TESTING MACHINE; BURTON, GRIFFITHS AND CO., LTD.

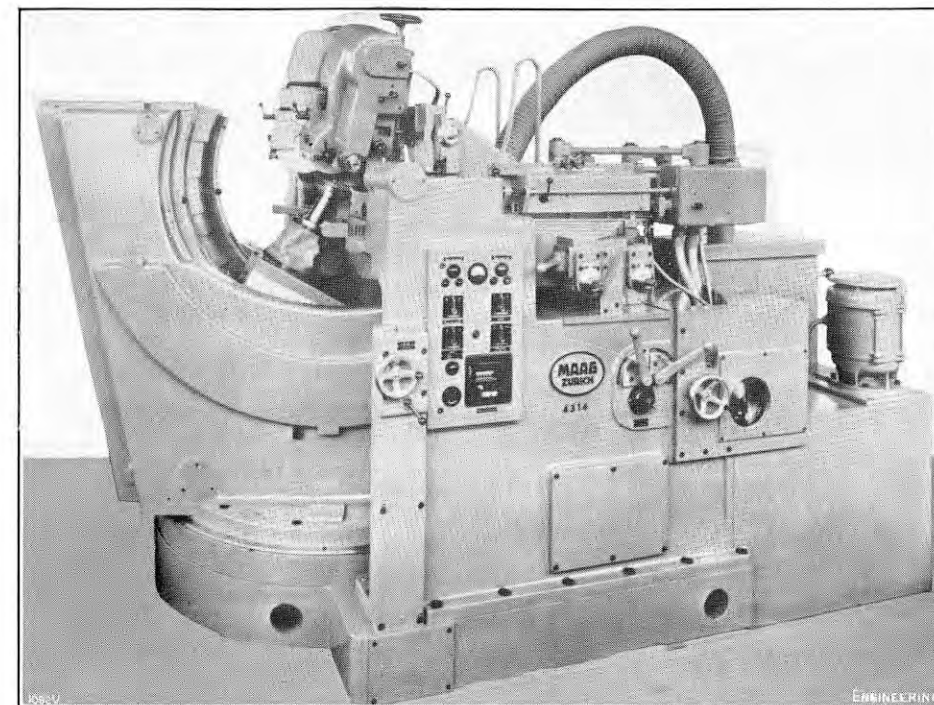


FIG. 82. MAAG BEVEL-GEAR GRINDING MACHINE; BURTON, GRIFFITHS AND CO., LTD.



FIG. 83. B.S.A. SINGLE-SPINDLE AUTOMATIC SCREW MACHINE; BURTON, GRIFFITHS AND CO., LTD.

FRICTION DROP HAMMER.

Messrs. B. and S. Massey, Limited, Openshaw, Manchester, 11, are exhibiting a 250-ton high-speed forging press of the type described in *ENGINEERING* for January 25, 1952; a 15-cwt. double-acting drop hammer; a 10-cwt. automatic friction drop hammer, shown in Fig. 77, on Plate XXVI, and described below; a 3-cwt. electro-pneumatic forging hammer; a 1-cwt. electro-pneumatic forging hammer; and a 60-ton trimming or clipping press. Models of a number of other Massey machines are also being exhibited.

The 10-cwt. friction drop hammer is one of a range of three new "Marathon" drop hammers. The weight of the tup (excluding the die) is 10 cwt., 15 cwt. and 20 cwt., respectively, and the maximum weight allowed for the top die is 4 cwt., 6 cwt. and 8 cwt. The maximum stroke, including fling, is 4 ft. for the three models, and the lifting speed is 480 ft. per minute except for the largest hammer, for which it is 470 ft. per minute. The space between the slides is 16 in., 18 in. and 20 in., and the depth of the tup, from back to front, is 15 in., 17 in. and 18½ in., respectively. The stamps have been designed to meet the conditions which prevail where mass-production methods are used and where intricate forgings of an exacting nature are made. New features include more accurate location of the standards on the anvil block, screw-adjusted slides, flexible anti-vibration mounting of the headgear, elimination of gearing by the adoption of a direct V-rope drive, and roller bearings for the lifter shaft and lifter arm.

Accurate alignment, which is essential in the production of first-class forgings, is provided by rigid attachment of the standards to the anvil block and by easy adjustment and close guiding of the tup. The standards are box-form steel castings with feet of large bearing area and overhanging lugs; each is secured to the anvil block by four large manganese-molybdenum steel bolts with spring shock-absorbers, and is securely locked against both front-to-back and side-to-side movement by deep keys which extend right across the block in both directions. These keys are lubricated and can be replaced easily and quickly when worn. The tup is guided by slides of a multiple-V form, providing a constant clearance in spite of the expansion and contraction of the tup which occurs when the temperature varies. The slides, which are separate steel forgings, have large wearing surfaces. Each slide can be adjusted laterally by a substantial tapered packing, arranged behind it, which is itself screw-adjusted. The anvil block, which weighs about 20 times the nominal size of the stamp, is normally of cast iron, although many users prefer steel, which is obviously better. A die-holder of forged alloy steel is secured by a large steel key in the dovetailed recess of the anvil block. It is not possible to provide the poppet arrangement.

The headgear, which is of welded steel construction, is flexibly mounted on the tops of the standards by large rubber mountings, and the transmission of vibration from the standards is therefore virtually eliminated. As this vibration is the primary cause of wear in the driving and lifting mechanism, the maintenance cost and loss of production resulting from "down time" have been reduced to a minimum. These rubber mountings also hold the tops of the standards in correct relation to each other, thus eliminating the usual tie-bolts and spreaders, or rigid tie-plate and wedges. A further source of wear has been removed by the use of V-ropes instead of gearing. The lifter shaft carries a Massey friction lifter consisting of a cast-iron friction drum encircled by a steel band lined with bonded asbestos, a combined guide pulley and lifter arm of welded steel construction to which the lifting belt is attached, and the usual operating mechanism. A buffer block is provided to act as a stop for the lifter arm in its extreme positions. Cooling water is circulated through the friction drum by means of the hollow lifter shaft, and swivel joints to which a convenient source of water supply and waste have to be connected are arranged at each end of the shaft. The lifter shaft runs in self-aligning roller bearings and the lifter arm is mounted on roller bearings. The tup is of forged manganese-molybdenum steel, and is secured to the main lifting belt by sling bolts and grip plates.

The standard method of control is by Simplex automatic gear actuated by a simple pedal; this enables the stamper to strike automatic blows of a constant predetermined stroke and force. The length of stroke can readily be altered to suit the work by an easy movement of a knurled sleeve on the Simplex unit, and the point of "pick-up" can be adjusted by altering the position of a second sleeve. When the foot-lever is released, the tup automatically rises to the top of the stroke and is held up there without consuming power. When desired, as for instance, in die setting, the automatic gear may be locked out of action and the stamp controlled by the hand-pulling cord.

BARTSCH HYDRAULIC COPYING SHAPER.

Soag Machine Tools, Limited, Juxon-street, Lambeth, London, S.E.11, are agents for a very wide range of foreign machines, representative examples of which are being shown at Olympia. Many of them are new to this country, including the hydraulic copying shaper illustrated in Fig. 78, on Plate XXVI. Other machines on show include a vertical boring mill, which can be supplied with an electronic copying device; a single-ended fine-boring machine, recommended for use with diamond tools; various types of grinding machines, including one for grinding valve cocks; a 16-in. shaper; radial drilling machines; various milling machines, including two for milling cams and a double-spindle vertical copying and profile milling machine; a horizontal broaching machine; a universal sheet-metal working machine suitable for flanging, upsetting, drawing, smoothing, bending, shearing, nibbling, etc.; a machine for cutting oil grooves; another for cutting internal key-seats; a heavy-duty gear-hobber; and an open-fronted power press.

The hydraulic copying shaper (Fig. 78) is made by Walter Bartsch, Berlin-Wittenau, and is fully hydraulic in principle, i.e., it has no crank or gearbox. It has thus been possible to design the machine so that all danger of the workpiece or the machine being damaged due to careless handling is eliminated. By using a sheet-metal template, any required profile can be shaped. The template and the workpiece are fixed relatively, but the lateral movement of the template relative to a tracer is controlled hydraulically and the workpiece moves correspondingly. The operation of the hydraulic mechanism is so simple that any machinist, tool-maker or die-maker can learn it in a few minutes. The length of stroke is 8 in., the transverse adjustment of the table is 8½ in., the vertical adjustment is 6 in., and the maximum distance between the table and the ram is 7½ in. The cutting speed is infinitely variable from zero to 65 ft. per minute.

HYDRAULIC TRACING LATHE.

An interesting hydraulic tracing, or copying, lathe is included in the exhibits of Willson Lathes, Limited, Ovenden, Halifax. This machine, which has been designated by the manufacturers the "Picop" hydraulic tracer lathe, is illustrated in Fig. 79, on Plate XXVI, from which it will be seen that the hydraulic-copying mechanism is mounted at the rear of the bed. This arrangement has been adopted so that the front slide is left free for operation in the normal manner and is available, therefore, for parting-off, forming small radii and other operations normally unsuitable for tracer control. Furthermore, by employing the front slide alone, the machine can be used as an ordinary lathe and, if necessary, the first off of a batch machined ready for use as a template for the remainder. Almost any combination of shoulders, tapers and curves can be cut, the only setting necessary being on the first diameter; setting-up times and the possibilities of errors being made are, therefore, reduced to a minimum. The machine is driven by a reversing motor, thus enabling downcutting to be performed by the rear, or tracing, slide with consequent increase in cutting strength over the more usual arrangement of inverted tools. This, in turn, allows the higher speeds normally associated with hydraulic profile turning to be used.

The height of the centres above the bed is 8½ in. and the length of the bed 8 ft. The swing in the gap is 28 in. and the width of gap 14½ in. Work up to a length of 3 ft. 10 in. can be accommodated between the centres, the swing over the bed being

17 in. and over the carriage 11½ in. It is driven by a 7½-h.p. reversing motor, the drive being transmitted by multiple V-belts to a multi-disc friction clutch mounted on the main drive shaft. To enable the correct belt tension to be obtained, the driving motor is installed on an adjustable platform arranged at the rear of the machine. The headstock assembly is designed to give nine speeds ranging from 52 r.p.m. to 954 r.p.m. All shafts are supported by ball bearings and the main spindle is fitted with Timken taper-roller bearings. To obviate any distortion when working under heavy loadings, the end of the drive shaft is held in an outrigger bearing. The feed and screw-cutting shafts are driven through a Norton-type quick-change gearbox designed to give 24 changes of screw and feed with one setting of the change wheels, the threading range being from 4 to 28 threads and the feed range from 48 to 336 cuts per inch. Conversion gears can be supplied, however, to give the full range of American threads and metric threads from 1 mm. to 10 mm. by 0.25 mm. increases. The sliding, surfacing and screwcutting motions are interlocked so that it is impossible to engage more than one action at a time and the operating levers are grouped conveniently on the front of the apron. One handle serves for the engagement of both sliding and surfacing feeds, the duties being altered by a change-over lever. Standard equipment supplied with the machine includes a sliding steady, a face plate, Morse-taper centres and change wheels for cutting all standard Whitworth and American threads.

FAN-COOLED MOTORS.

In addition to their normal range of electric motors for the machine tool user, Messrs. Brook Motors, Limited, Empress Works, Huddersfield, are showing prototypes of their new fan-cooled and fractional horse-power models. The former, of which an illustration appears in Fig. 80 has, after considerable research, been so designed that all the heat generated internally is dissipated through dust-free air passages to external cooling fins. It then passes through hollow ribs in the end shields and yoke and is finally exhausted by an external volute fan. The result is that the active material is more economically used. As regards construction the rotor bars are cast in aluminium and with the short-circuiting rings form a homogeneous and practically indestructible body. Alternatively, copper rods, which are inserted in slots, are used and are short-circuited by an end ring of the same material. In both cases the bars are staggered to give good starting characteristics. On the other hand, the slip-ring rotors are either former or bar wound for which purpose synthetic-resin covered wire inserted in insulated slots is used. The slip rings themselves are either of the moulded or assembled type, according to size, and are fitted with two brushes per ring with independent spring tension. Synthetic-covered wire is also employed for the stator windings, which are former wound, the slots being lined with micanite and leatheroid. After winding the stators are immersed in insulating varnish and baked.

Ball bearings are used at both ends on the smaller sizes of motor and ball and roller bearings on the larger sizes. To ensure silence and alignment they are an easy press fit into the housing. The accurate positioning of the rotor is ensured by using a spring thrust bearing. Two ratings are available for each frame size—continuous and machine rated, the latter allowing a greater output to be obtained in cases where the full load is not constantly employed.

The new fractional horse-power motor, which is also on view, incorporates several modifications in former designs, including pre-loaded bearings in cartridge housings to ensure quiet running. It is to be built with outputs of ½ h.p. for single-phase circuits and of 1½ h.p. for three-phase circuits. The stator and rotor units are of either the long or short core types to facilitate fixing the motors directly on machine tools.

MAAG BEVEL-GEAR TESTING MACHINE.

Messrs. Burton, Griffiths and Company, Limited, Marston Green, Birmingham, are exhibiting a great variety of machines and small tools on behalf of the B.S.A. Tools Group and principals. Apart from the three which are illustrated here and

described below, the products include, for example, a turret lathe, a multi-tool production lathe, a centreless thread grinder, automatic screw machines, a balancing machine, a vertical surface-grinding machine, a high-speed drilling machine, a high-precision lathe, a die-sinking machine, a die-forging hammer, an automatic copy milling machine, and a thread and form generator. They have prepared production cards for all the components produced on the various machines exhibited; these cards show the machine, component, material and cycle time for each job and serve as useful guides to the capabilities and capacities of the machines.

The Maag bevel-gear testing machine, type KP-42, shown in Fig. 81, on Plate XXVII, records the tooth alignment, tooth thickness, tooth profile and surface finish of bevel gears up to 16.5 in. in diameter at a ratio of 1 to 8. It is suitable for measuring the cone angle and the generating angle, as well as the lateral displacement in the case of oblique bevel gears. The accuracy is a few hundred-thousandths of an inch, or the corresponding angle thereof. All important data of a gear are thus obtained, with the exception of the pitch, for the measurement of which the T.M.S.K. instrument is recommended. The bevel-gear testing machine has been developed so as to correspond to the high grinding accuracy of the bevel-gear grinding machine, described below, and to facilitate mounting of bevel gears so that there is no doubt about their correct form and accuracy. Special attention has been given to ease of operation. The movements necessary for measuring correspond to those on the grinding machine, but are carried out by hand.

The generating motion of the bevel gears to be tested is obtained by means of rolling discs and steel bands and consists of a rotation around the axis of the workpiece and a rolling motion around a vertical axis passing through the apex. The desired rolling ratio is obtained by altering the diameter of one or two rolling discs. The recording device is carried on a movable horizontal slide, which is so designed that the points of contact of the feeler are on a line passing through the apex. The error magnification is adjustable between 400:1 and 1,000:1. For checking the tooth alignment, no rolling motion is given to the workpiece, i.e. the fixing head remains stationary; the feeler is moved along the tooth flank by turning a handwheel. For checking the profile, the slide carrying the feeler remains stationary. The fixing head is adjusted to the corresponding base cone when testing by means of a ball feeler, or to the pitch cone when testing by means of a conical feeler. The generating support of the machine is rotated around a vertical axis, passing through the apex, by means of a handwheel. The profile errors are recorded on a graph paper. Optical instruments are provided for reading the cone angle, the generating angle and the lateral displacement in case of oblique bevel gears. The instrument for reading the lateral displacement is removable and serves also for checking the generating angle of the fixing head of the machine. The accuracy of reading angles is 2 seconds, that for the lateral displacement 0.0004 in. The tooth thickness can be determined by contacting both flanks of a tooth with a special feeler and reading off the corresponding rolling angle. Thus interchangeability of bevel gears is ensured.

The Maag bevel-gear grinding machine, type KS-42, the second of the three Burton, Griffiths exhibits described, is shown in Fig. 82, on Plate XXVII. The increasing demand for high-precision bevel gears, and the fact that bevel gears of various designs would be used far more frequently if they could be obtained with higher accuracy, induced the Maag Gear-Wheel Company, about five years ago, to develop a machine for grinding bevel gears with straight and oblique teeth. The machine works according to the generating system and has the same high accuracy as Maag gear grinders for cylindrical involute gears. The design of the prototype, in service at Zurich since 1948, has been repeatedly improved and a small series of these machines is now being built. It is stated to be the only bevel-gear grinding machine which will grind economically individual bevel gears as well as a series of bevel gears with the highest accuracy. All motions are obtained by parts which simulate the theoretical motions, practically without deviation, and which

are not subject to wear. Any wear of the grinding wheels is automatically compensated. The machine is capable of grinding straight and oblique bevel gears with involute-tooth flanks up to a diameter of 16.5 in. at a ratio of 1 to 8 (work of smaller diameter at lower ratios). Working principle and design of the machine correspond to the Maag gear grinders of the same size for grinding cylindrical gears.

Two saucer-shaped grinding wheels having a diameter of 8.7 in. reciprocate along the tooth flanks in a straight-line motion. The generating motion, which is obtained by pitch blocks, rolling discs and bands, consists of a rolling motion of the workpiece round its axis, and a swivelling motion of the generating stand round the apex. The desired ratio of these motions is obtained by changing the diameter of both, or of only one, of the pitch-blocks. The speed of the rolling motion (feed) of the generating stand round the apex can be infinitely varied from 22 to 460 deg. per minute. Indexing takes place at both ends of the motion of the workpiece by means of change-wheels and index plates 13.5 in. in diameter, the latter having hardened and ground teeth. The two slides carrying the grinding wheels are hydraulically driven. Their speed can be varied infinitely from 0 to 50 ft. per minute, which gives tooth profiles of the highest accuracy. Grinding is performed dry, and the grinding dust is removed by a suction device built into the machine. The grinding spindle, indexing mechanism, pumps for hydraulic drive of the slides and for the lubricating oil, the generating stand and the fan all have separate driving motors. The grinder is fitted with an automatic counting and stopping device, which stops the machine as soon as the pre-set number of teeth are ground. A special tip and root relieving attachment with an adjustable cam is included in the standard accessories. The sturdy design of the machine bed ensures smooth running, free from vibrations. The guides are carefully scraped by hand and lubricated by pressure oil. All important roller bearings are specially selected and tested. Covers are provided for protecting the vital parts from dust.

B.S.A. SINGLE-SPINDLE AUTOMATIC SCREW MACHINE.

Fig. 83, on Plate XXVII, shows the B.S.A. single-spindle automatic screw machine. It is made in several sizes and for various cycles, the standard maximum capacity of round bar ranging from 1½ in. to 2 in. The L-type machines, as they are called, have been designed with particular attention to ease of operation and change-over from one job to another. High speeds can be maintained continuously and a fine finish on the workpiece is ensured. Maximum swarf clearance is achieved by the arrangement of the body of the machine. The number of spindle speeds ranges from 60 to 75, and the fastest speed ranges from 1,260 to 3,135. Two forward and two reverse speeds are obtained automatically by cone-type clutches, the various attachments that are available including those for feeding, screw slotting, end drilling, etc., as well as a third slide.

(To be continued.)

NEW GENERATING PLANT AT NOTTINGHAM POWER STATION.—The British Electricity Authority has received the consent of the Minister of Fuel and Power to the installation at Nottingham power station of a 60,000-kW turbo-generator set and two boilers, each to evaporate 300,000 lb. of steam an hour. The existing installed capacity of the station is 254,000 kW.

COLOUR LIGHTING SIGNALLING ON THE LONDON-BRIGHTON RAILWAY.—Another stage in the Southern Region of British Railways' scheme of equipping the line from London to Brighton with colour lighting signalling will be reached on Sunday, October 5, when this system will be introduced between Streatham Common and Selhurst. On the following Sunday colour light signalling will also be introduced between Battersea Park and Streatham Common, making a total distance of 14½ miles. As a result 11 mechanical signalboxes will be replaced by three new all-electric boxes at Clapham Junction, Balham and Streatham Junction. These boxes will contain a total of 225 miniature levers by which 125 multiple-aspect long range colour signals will be controlled. The new signalboxes will also be equipped with train describers. Further details of the scheme were given on page 436 of our 170th volume (1950).

THE TRAINING OF ELECTRICITY SUPPLY EMPLOYEES.

ONE of the obligations laid upon the British Electricity Authority and the Area Boards by the Electricity Act of 1947 was the provision of facilities for training their employees. To carry out this duty two residential training centres were established—one at Horsley Towers in Surrey and the other at Buxton, with accommodation for 100 and 60 students, respectively. The courses at these centres cover training in organisation, engineering and industrial relations and management; and since their inauguration in 1949 they have been voluntarily attended by some 10,000 of the Authority's employees. These employees it may be added, total nearly 180,000, of whom over 120,000 are manual workers. It may also be added that since their inauguration the courses have become increasingly popular and their value may be estimated from the fact that both the National Coal Board and the Steel Company of Wales have asked permission for their employees to attend the classes for boiler operatives.

The first courses at Horsley Towers were arranged for manual workers employed in the power-station boiler houses, the object being to give elementary technical instruction to men recruited from labourers who had learned to operate the plant on the job itself. The syllabus included instruction on the elementary principles of heat, temperature, fuel, combustion and boiler plant, the object being to assist students to understand not only how, but also why, certain operations were performed. In this way it was hoped to increase their interest in the work and thus to ensure that their various duties were carried out with maximum efficiency and the highest economy in combustion was achieved.

When the value of these boiler-house courses had been established, similar courses were introduced for those responsible for operating the turbines and auxiliary plant. In addition, specialist instruction to the technical staffs is given in such subjects as corrosion fatigue and crack detection, protective gear, American and European practice, and civil defence. There are also introductory or background courses for newly joined employees and graduate trainees. In the matter of industrial relations, too, there have been management courses for power-station superintendents and on joint consultation for members of the Local Advisory Committees.

Each course is carefully planned and includes a programme of talks. The speakers are, in the main, persons employed in the industry. A feature of all courses is the discussion group, at which topics relevant to the subject of the course are dealt with. All the normal educational media are used, including films, diagrams and simple laboratory experiments. Demonstration rooms have been established and are equipped with apparatus loaned by manufacturers who ensure that it is kept up to date. This apparatus includes models of power stations and examples of boiler fittings, turbine parts, circuit-breakers and cables and joints, as well as a number of instruments. A safety exhibition is now being built up. Suitable notes are provided as a supplement to the lectures and literature is supplied both by the Authority and the manufacturers.

"ACEC CHARLEROI."—The first 1952 number of a review, entitled "Acec Charleroi," which is published quarterly, has been received from Ateliers de Constructions Electriques de Charleroi, Charleroi, Belgium. It contains a long article on "The Problem of Motor Protection," in which the equipment available for that purpose is described, and a second article on checking the power rating of a standardised type of capacitor.

PROJECTED HIGH-SPEED INTER-CONTINENTAL AIR LINER: ERRATUM.—On page 344, *ante*, we published a paragraph giving preliminary details of a projected high-speed long-distance air liner, in which we stated that the aircraft would be capable of flying directly from London to New York, in the westward direction, in 17½ hours. This should, of course, have been 7½ hours, and we offer our apologies to the designers, Handley-Page Ltd., Cricklewood, London N.W.2.

CENTENARY OF GLENFIELD AND KENNEDY, LTD. THE BRITISH ASSOCIATION

MEETING IN BELFAST.

(Continued from page 371.)

VIBRATED CONCRETE.

WHILE the biological aspects of flying were being discussed, as previously reported, session B of the Section dealt with two papers, the first of which was by Mr. D. A. Stewart and was on the subject of "Vibrated Concrete." This paper was reprinted, under the title "Some Recent Developments in Concrete Technology," on pages 313 and 354, *ante*. Principal D. H. Alexander, O.B.E., of the College of Technology, Belfast, and Vice-President of Section G, occupied the chair. In presenting his paper, Mr. Stewart said he proposed to take the mathematical parts as read and to deal rapidly with the practical points. At the conclusion of his remarks, he showed a cinematograph film illustrating the construction of a large reinforced-concrete wind-tunnel in which a very fine finish was required for the internal surfaces. The tunnel had a maximum diameter of 50 ft. and the shell was 6 in. in thickness reinforced with a 6-in. mesh of $\frac{1}{2}$ -in. bars on both faces. The aggregate used ranged from $1\frac{1}{2}$ in. to $\frac{1}{2}$ in. and the sand passed a No. 14 sieve. The sand content was 28 per cent. of the combined aggregates and the water-cement ratio was 0.5. The film showed the methods adopted for mixing and placing the concrete and for testing batches before placing. In connection with the mixing operations, Mr. Stewart mentioned the difficulty experienced in removing the concrete from the mixers, owing to the fact that they were designed for a more "sloppy" mixture than he employed. The final results, however, were entirely satisfactory and after 18 months' service no craze marks could be found on the internal surfaces. About 3,000 tons of concrete were employed and the saving in cement amounted to about 300 tons. The strength of the concrete, however, was appreciably higher than the specified figure, so that an even greater saving in cement might have been effected.

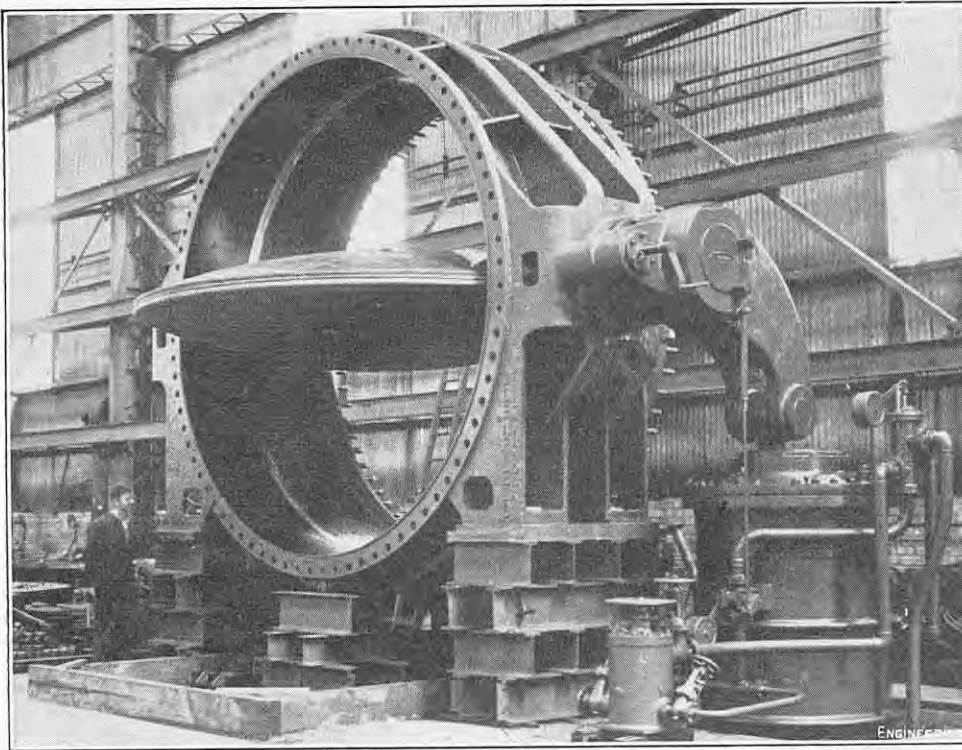
A brief discussion then followed, in which the first speaker, Mr. Donald Cuthbert, asked for information regarding the frequencies employed for vibration. To this the author replied that the frequency varied according to the conditions of compaction. When the concrete was introduced into the mould the particles were well separated, so that a large amplitude was desirable. At a later stage in the compaction, the amplitude was reduced. At first, therefore, a low frequency with a large amplitude was employed and later a high frequency was used with a small amplitude. The frequencies might range from 3,000 to 15,000 cycles per minute. Mr. M. Agar asked what increase in compressive strength was obtained by the author's method in comparison with ordinary methods. To this question, Mr. Stewart replied that he had obtained a strength of 7,000 lb. per square inch at seven days with a 7 to 1 mixture.

The time allowed for the paper having expired, the chairman adjourned the meeting for a short interval.

THE CALCULATION OF TRANSMISSION-LINE CONSTANTS.

When the meeting was resumed after the interval, the chairman invited Professor R. O. Kapp to deliver his paper on the above subject. Professor Kapp did not read his paper, which was reprinted on page 315, *ante*, but briefly explained the subject matter with the aid of blackboard diagrams.

Professor Kapp said the purposes of the paper were two-fold. Its first purpose was to discuss the physics of transmission. In doing this, he proposed to show that, instead of treating alternating-current power transmission as a development of direct-current transmission it could, if preferred, be treated as a development from the radiation of power in free space. The second purpose was to show that a fuller appreciation of the physics of power transmission led to the presentation of the formulæ in forms that were very much easier to handle than were the formulæ to be found in textbooks. The formulæ could never be simple, because in transmission-line calculations it was necessary to take into consideration a number of parameters—



THE CENTENARY OF GLENFIELD AND KENNEDY, LIMITED.

THERE can be very few engineering products of which it can be said that there has been no material change in their design over a quarter of a century or more, because there was no need for it. The pneumatic hammer is one, and, fundamentally, the Michell thrust bearing is another; but neither of these has yet been so long in service as the water meter of Thomas Kennedy, which was the subject of British Patent No. 214 of 1852. There is a special interest, therefore, in recording the centenary of the Kilmarnock firm of Glenfield and Kennedy, Limited, which was celebrated in that burgh on Friday last, September 19, by a luncheon in which some 400 of their friends participated.

In its present form, the company represents the result of four evolutionary stages: first, the establishment in 1852 of the Kennedy Patent Water Meter Syndicate by Thomas Kennedy in conjunction with Alexander J. Bruce, banker, William Taylor, a carpet manufacturer, and Robert Blackwood, secretary of the Kilmarnock Water Company. The next stage came in 1863, when the Syndicate was converted into a private company with the title of Kennedy's Patent Water Meter Company, Limited. In 1865, there was established the Glenfield Company, Limited, founders and general engineers, formed by a group of local men who were interested in the adjacent Townholm foundry for the purpose of supplying water-meter castings to the Kennedy Company; and in 1899 the two undertakings were amalgamated with the title, still retained, of Glenfield and Kennedy, Limited. The name "Glenfield," it may be remarked, is not that of an individual, but of the site—a field in which grew a profusion of "glens," a local term for daffodils; an origin which is now commemorated by a bunch of gilded daffodils on the handsome pair of new wrought-iron gates which have been set up at the works entrance as a permanent memorial of the centenary. There is also a relic of Stage III, mentioned above, in the wrought-iron sign which surmounts the main office building; for it bears the name "The Glenfield and Kennedy, Limited"—the "the" evidently having indicated initially "The Glenfield Company." Until 1899, the Kennedy Company made meters only, all the other products now associated with the firm's name, in water supply and regulation works throughout the world, being made by the Glenfield Company.

Now, however, the water-meter business is organised as a department of the combined works, the valve-making and other heavy-engineering activities having developed so very greatly in the present century. Typical of this development is a 13-ft. water-turbine inlet control valve illustrated above, which was one of the most imposing exhibits seen by the visitors on Friday last during the tour of the works which followed the luncheon in the Grand Hall, Kilmarnock.

At the luncheon, the chairman of the company, Mr. Hugh Cowan-Douglas, presided, being supported by the full board of directors—Sir Samuel R. Beale, K.B.E. (vice-chairman), Mr. R. A. Blakeborough, Mr. Algernon Denham, Dr. Alexander S. MacLellan, Sir Alexander L. McColl, Mr. Hugh R. Neilson, Mr. Iain M. Stewart, and the joint managing directors, Mr. E. Bruce Ball, M.A., and Mr. Henry Gardner. The speeches were few, but of a high order; it is to be hoped, indeed, that a verbatim record of them will be preserved among the firm's archives as an incentive to the organisers of the bicentenary celebrations in the year 2052. Mr. Cowan-Douglas, in extending a welcome to the guests, referred particularly to the presence among them of Mr. Thomas R. Kennedy, a great-grand-nephew of the founder; the Rt. Hon. the Earl of Home, P.C., Minister of State (Scottish Office); and the Rt. Hon. Lord Bilsland, M.C., D.L., LL.D., whose activities in the interest of Scottish industry had been so widely beneficial.

The Earl of Home, in proposing the toast of "Scottish Industry," said that, a century ago, there had existed "a restless scientific curiosity" in which Thomas Kennedy had shared. He had, moreover, the skill to put it into deeds, and a confidence that impressed others. The prosperity of the country still depended on the well-being of the heavy industries. The needs of the Twentieth Century were unlikely to be the same as those of the Nineteenth, and they must constantly ask themselves if they were, in fact, keeping abreast of the times. He was confident, however, that Scottish industry would make of the Twentieth Century an age of high promise and achievement.

Lord Bilsland, proposing the toast of "Glenfield and Kennedy, Limited," which was drunk with great enthusiasm, remarked on the great extent of the firm's present business, the products of which were to be found in practically every industry and, in 1951, were exported to 79 countries. Sir Alexander McColl, who responded, expressed the firm's keen appreciation of the many congratulatory messages that they had received from all parts of the world.

current and voltage at the sending end, the length of the line, and the capacitance, resistance and inductance per unit length. Therefore, calculations "without tears" could not be expected, but formulae could be derived that were easy to handle.

With regard to the physics of transmission, he said, electrical engineering, in its infancy, was direct-current engineering and consequently there was a tendency to approach alternating-current problems with what might be called a direct-current mind. We thus tended to think of alternating current transmitted along a transmission line as though a direct current that varied periodically were being transmitted. He invited the audience to imagine a planet on which radiation had been fully studied but no one had thought of using a wire. A wire might then be the subject or a patent with the title: "A device for giving the potential a small component in the direction of propagation."

The first speaker in the discussion on Professor Kapp's paper was Mr. L. Bainbridge-Bell, who expressed his admiration for the exceedingly simple formulae with which the paper concluded. He was not certain, however, whether the formulae would hold for audio frequencies. On this point, Professor Kapp said they would not hold; they would hold only if one quarter wavelength were not exceeded. The next speaker, Mr. D. S. McIlhagger, said the author had suggested that the limit of distance over which power could be transmitted was a quarter of the wavelength of the line, which was 900 miles. Professor Kapp had admitted, however, that the end equipment (generators, transformers, etc.) produced a considerable phase shift, so that a margin must be allowed. The speaker suggested that the actual limit was somewhere about 250 miles. In reply, Professor Kapp said that it was quite right to point out that the whole circuit had to be considered and not the line only. The line impedance was one-third of the total, as indicated by Mr. McIlhagger. The allowance on the line should not be more than about 30 deg. and this would limit transmission to 300 miles, or perhaps a little more, unless special steps were taken. The line could be compensated by series capacitors (of which practice Sweden provided the most notable instance) or special devices could be provided at the generators to increase the field as the load increased and reduce the phase angle—not in the line, but in the terminal apparatus. The latter method had been described and treated mathematically, but he did not know whether it had been adopted in practice.

Professor J. Greig, after expressing appreciation of the forms of mathematical expressions which had been developed by Professor Kapp, drew attention to the possibility of misconception in relation to the physics of the problem. It might be inferred from the wording of the paper that the magnetic field inside the conductor was not associated with loss of energy. The presence of any alternating magnetic field within the volume of a conducting body was, however, in one sense, the result of the conductor producing an ohmic resistance loss, for, if the resistivity of the conductor were to approach zero, the depth of penetration of the current would become vanishingly small and the internal flux would likewise vanish. Professor Kapp was in agreement with Professor Greig's remarks.

Mr. Bainbridge-Bell, who spoke again, referred to the use of wave guides for directing radiations of very short wavelengths. They were, however, very expensive and attention had recently been directed to the use of a single wire instead. For some applications of microwaves, great economy and flexibility could be obtained by using a wire, which had, however, to be covered by a certain amount of insulating material to prevent the field from spreading in all directions. Unfortunately, the guide wire was not a solution to all the problems of microwaves, because the transmission efficiency was greatly affected by the wire getting wet; it could not, therefore, be easily used out of doors.

No other member wishing to speak on Professor Kapp's paper the session was adjourned. In the afternoon, members of the Section visited the B.B.C. studios, the shipyard and engine works of Messrs. Harland and Wolff, Limited, and the Belfast Ropeworks.

PRESIDENTIAL ADDRESS.

On the morning of Friday, September 5, both sessions met in the Sir William Whitla Hall of Queen's University to hear the address of Sir Ben Lockspeiser, entitled "Progress in Aeronautical Science and Engineering." The address was printed, in slightly abridged form, on pages 317 and 357, *ante*. Wing-Commander T. R. Cave-Browne-Cave, C.B.E., occupied the chair. In the course of his address, the President showed some particularly interesting photographs and films, one of which showed the effects on the flow over an aerofoil surface of small excrescences, such as insects. In this photograph the effects of the resulting turbulence took the form of light-coloured isosceles triangles extending rearwards from each excrescence. A film showed the shock waves emanating from an aerofoil in flight at approximately the speed of sound, and also showed how the centre of pressure moved with small variations in the angle of incidence. At higher Mach numbers there was little movement of the centre of pressure with a change of incidence. Another film illustrated the effects of flutter on aircraft and showed the destruction of the Tacoma Narrows Bridge due to aerodynamic effects on the suspended roadway.

The address was not discussed, and after a vote of thanks to the President had been proposed by Wind-Commander Cave-Browne-Cave and carried by acclamation, the meeting was adjourned for a short interval.

SHIPS AND SHIPBUILDING IN BELFAST.

After the interval, the President invited Dr. Denis Rebbeck, C.B.E., Director of Messrs. Harland and Shipbuilding in Belfast, which we commenced to print on page 385, *ante*, and concluded on page 417 of this issue. Dr. Rebbeck gave his paper in a slightly abridged form, and at its conclusion made a particular reference to the assistance he had received from Mr. C. C. Pounder in preparing it.

The President then congratulated Dr. Rebbeck on his paper, and proposed a vote of thanks, which was duly carried. The meeting was then adjourned until the morning of Monday, September 8. In the afternoon of Friday, a visit was paid to the viscose works of Messrs. Courtaulds, Limited, at Carrickfergus, another group of members visiting the works of Messrs. Harland and Wolff, Limited, and of Messrs. James Mackie and Sons, Limited. On Saturday, September 6, a full-day excursion was made to the Silent Valley Reservoir of the Belfast Water Commissioners.

THE SHAPE OF WINGS TO COME.

When the meetings of Section G were resumed on the morning of Monday, September 8, Session A was devoted to the reading and discussion of two papers on aeronautical subjects, the first of which, by Mr. D. Keith-Lucas, was entitled "The Shape of Wings to Come." After introducing the author, the chairman, Wing Commander T. R. Cave-Browne-Cave, asked the audience to stand in silence for a few moments as a tribute to the memory of Mr. John Derry, the pilot of a D.H. 110 night-fighter aircraft, who was killed as a result of the aircraft breaking up in the air and crashing during a demonstration flight at Farnborough on Saturday, September 6. The observer, Mr. Anthony Richards, and 28 of the spectators, were also killed or subsequently died from their injuries. The accident was referred to on pages 343 and 346, *ante*.

Mr. Keith-Lucas then presented his paper, which was printed on page 349 of our issue of September 12. At its conclusion, the chairman invited members of the audience to put questions. In response to this invitation, several questions were asked and the author replied separately to each. The chairman then proposed a vote of thanks to Mr. Keith-Lucas, which was carried by acclamation, and the meeting was adjourned for a short interval.

FUTURE DEVELOPMENT OF THE FLYING-BOAT AIRLINER.

The interest in Mr. Keith-Lucas's paper was such that the accommodation of the room in which it was delivered was inadequate, and the next paper, that of Mr. H. Knowler, on the "Future Development of the Flying-Boat Airliner," was therefore

taken in the Whitla Hall of the Methodist College, which was also well filled. Wing-Commander Cave-Browne-Cave again occupied the chair and after a few introductory remarks, invited Mr. Knowler to read his paper. The author, after delivering the paper, showed some new and impressive photographs of the Princess flying boat in flight. This aircraft, it will be remembered, is currently being fully described in *ENGINEERING*, and Mr. Knowler's paper will be published in an early issue.

In opening the discussion, the chairman said he had been impressed by the fact that the passengers were such a nuisance to the designer, as, in addition to what they cost in weight, they had to be fed, made comfortable, and protected from noise. He jokingly suggested that they might be anaesthetised on embarkation and stowed in racks. Replying, in the same vein, the author said that drugging with opium might be tried.

As but little time remained for discussion, the chairman suggested that it should be used by members putting questions to the author. One member said he had been much impressed by the range and speed predicted for flying boats, but thought it would take nearly as long to get from the coast to the centre of a city as it did to travel from, say, New York to the English coast. He asked if the author had any solution to the problem of reducing the time occupied in the later stages of a journey. To this the author replied that he thought the solution lay in the helicopter, which would, however, require a speed of about 200 m.p.h. Another speaker pointed out that the author had dealt mainly with passenger transport, but remarked that the flying boat offered great scope for the carriage of freight, especially in the form of bulky articles. On the other hand, it would suffer severely from weather conditions. He inquired what would be done if the sea were too rough for the flying boat to alight. To this, Mr. Knowler replied that any harbour used for passengers, must be sheltered. Southampton was our national water base and the sea was never very rough there even in the worst weather. It would never prevent a flying boat of the size of the Princess from taking-off or alighting. In New York, also, there were suitable sites for flying-boat bases quite close to the city. He added that the development of flying boats of the size he had mentioned was proceeding largely because their use as freighters had been foreseen.

The time available having passed, the chairman thanked Mr. Knowler for his paper, in which, he said, the author had set out the present position in an interesting manner and had also predicted the likely trends of future development—as every British Association paper should do. He proposed a vote of thanks to the author, which was carried by acclamation. This concluded the programme of Session A for the morning.

(To be continued.)

ELECTRICITY SUPPLY STATISTICS.—According to the returns published by the Ministry of Fuel and Power, 4,034 million kWh were generated during August, 1952, in the stations under the control of the British Electricity Authority, the North of Scotland Hydro-Electric Board and the Lochaber Power Company, compared with 4,122 million kWh in August 1951, a decrease of 2.1 per cent. The total sent out during the first eight months of the year was 37,185 million kWh., an increase of 1.1 per cent. over the figure for the corresponding period of 1951. During August, 1952, 135 MW of plant were commissioned, bringing the overall increase to 1,417 MW during the past twelve months.

BRIXTON SCHOOL OF BUILDING.—A course of 24 weekly lectures (commencing on October 1 next) on Prestressed Concrete has been arranged at the School; a complementary tutorial and laboratory class (commencing on October 6) will be run in conjunction with the lectures. The principal lecturer will be Dr. P. W. Abeles. The fee for the lecture class will be 3l. 5s., and for the lectures and tutorial class 4l. A second course of 25 weekly lectures on the Design of Welded Structures (commencing on September 29) has also been arranged; principal lecturer, Mr. S. M. Reisser; fee, 2l. Applications to be made to the Secretary, L.C.C. Brixton School of Building, Ferndale-road, S.W.4.

ENGINEERING AND AERONAUTICAL INFORMATION SERVICES.

TECHNICAL information services for the engineering and aeronautical industries—particularly for the smaller firms—were the subject of considerable discussion and some decision last week-end at the 27th annual conference of the Association of Special Libraries and Information Bureaux (better known, among those who are mindful of the growing significance of such services, as Aslib). Professor T. U. Matthew, M.Sc., Ph.D., of the Department of Engineering Production, Birmingham University, reviewed the "Significance of Information in Present-day Industrial Society"; Dr. D. J. Urquhart, of the Department of Scientific and Industrial Research, and Mr. Leslie Wilson, M.A., Director of Aslib, gave "A Review of the Results of the Royal Society Scientific Information Conference, 1948"; and the work of the Aeronautical Group and the Engineering Group of Aslib were discussed at informal meetings. The conference was held at The Hayes, Swanwick, Derbyshire.

ENGINEERING INFORMATION.

Sir Stephen Tallents, K.C.M.G., took the chair at the meeting on Saturday, September 20, when Professor Matthew gave his paper. Reviewing contemporary industry, Professor Matthew observed that new knowledge and ideas travelled at a speed governed by the effectiveness of information services and means of publication and communication. Management could not assume that any of the technical factors in production were static. Long-term changes in the raw materials supply position, in production processes or equipment design, had to be kept constantly under review. Nor could management plan effectively without organising a constant flow of information on the current position, the immediate future and the long-term trend in relation to each major function, i.e., financial, accounting, technical (research, design, and plant engineering), production, purchasing and sales, and personnel.

Professor Matthew referred to some work carried out under his direction at the University by Mr. G. Gilfillan, on the use of scientific and technical information in Midland industries. In a number of companies, some employing up to 3,000 people, it was found that there were not more than one or two key men in each organisation who were actively engaged in the essential task of seeking for, and applying, technical information, although these firms were making engineering products. Only in exceptional cases was any significant amount of development work being done on production processes and products, the executives preferring to await the appearance on the market of a fully-developed competitive machine or product incorporating the results of research and development done elsewhere. However, a number of excellent examples of group information services existed in the Midlands and elsewhere, and in many cases they had been able to demonstrate the practical and economic advantages of a well-organised specialist service. In some, the information service, starting as an aid to the technical function with the emphasis on research information, had gone on to become a valuable source of guidance to all the other major functions of management, including production, purchasing and sales.

Henri Fayol, 50 years ago, had stated that all industrial organisations had six major activities or functions. A stage in the evolution of industry had now been reached, Professor Matthew continued, where six functions were no longer sufficient. The seventh function—the information function—had now to be added.

USING PUBLIC REFERENCE LIBRARIES.

The considerable resources of the better public reference libraries were described by Mr. R. L. W. Collison, F.L.A., of the Westminster Public Libraries. His own library, he instanced, could draw on nearly 500,000 non-fiction books in the area. He believed it would be useful if the libraries' holdings of periodicals were increased, so that they could serve as the first-line source of information for local

industry. Referring to the unique position of the Library of Congress in the United States, he suggested that Aslib would be doing a great service if they led a movement to increase the State's financial support of the British Museum Library. Mr. F. C. Francis, M.A., F.S.A., Keeper at the Department of Printed Books, British Museum, who took the chair at the meeting, mentioned a scheme for a new building for the Museum Library. In reply to a speaker in the discussion, Mr. Collison said that, in places where the reference library did not provide an adequate service, it was up to private citizens to press for more finance or staff.

RESULTS OF ROYAL SOCIETY SCIENTIFIC INFORMATION CONFERENCE, 1948.

Sunday morning was devoted to the review of the results of the Royal Society Scientific Information Conference, held in 1948. Mr. J. E. Cummins, M.Sc., F.R.I.C., of the Australian Scientific Liaison Office, was in the chair. Dr. Urquhart reviewed the results with particular reference to the part played by the Department of Scientific and Industrial Research (D.S.I.R.) in carrying out the Conference's recommendations. One of these was that ways in which scientists obtain information should be investigated. D.S.I.R. made an attempt to do this, but decided eventually that it would be more useful to discover what were the faults in the present system of recording and disseminating information. They issued at intervals a leaflet listing "Unanswered Questions," and it was found that, in fact, most questions could be answered, given time. The defects existing in the present information system—such as inadequate referencing of abstract bulletins—were less significant than the fact that the majority of industrial organisations made practically no use of the information services available.

As a result of the Conference, the Royal Society set up a standing Information Services Committee, which had been responsible for issuing a fair-copying declaration that had been accepted by many scientific journals. The Committee had also had published, by the Royal Society, a list of British abstract journals; a list of British scientific publications reporting original work or critical reviews; and some general notes for authors on preparing scientific papers. Other contributions to the Conference recommendation for the preparation of guides to sources of information included a "Brief Guide to the Research Activities of D.S.I.R. and the Research Associations," prepared by D.S.I.R., and a limited issue of "Scientific Research in British Universities," compiled by the British Council. The latter publication would shortly be on sale. The D.S.I.R. "Translated Contents Lists of Russian Periodicals" had made some contribution towards implementing the recommendation for procuring rare foreign periodicals. There had been general agreement at the Conference that the Science Library and the Patent Office Library should extend their collection to include every publication containing material of value to science or technology; as a result, this question was being considered by a committee of the Advisory Council on Scientific Policy.

Recommendations on which little had yet been achieved were the revision of the Copyright Act, under consideration at present by a Board of Trade Committee, and the question of educating science students at the universities in the use of information. Action on this was very necessary. The recommendation of the Conference that more use should be made of mechanical selection methods was, said Dr. Urquhart, a mistake. There were no completely satisfactory machines available. In conclusion, Dr. Urquhart emphasised the importance of making scientific information available to industry in a form which could be understood and used by the small industrial firm with no information or library facilities.

Mr. Leslie Wilson summarised Aslib's contribution to carrying out the recommendations of the papers. He cited the acquisition of machines for reproducing authors' papers by the litho-offset process; the formation of subject groups to foster the wider exchange of information; Aslib's educational courses for technical librarians; the institution of a consulting service which, among other activities, was investigating mechanised library

techniques; the revision of the Aslib directory of sources of information; and the maintenance of a register of approved translators. In conclusion, he suggested that Aslib should be an organisation representing those who needed information, whether they were aware of it or not; and that the scope of Aslib should extend beyond science and technology.

AERONAUTICAL GROUP.

On Sunday evening, some 20 representatives of the Aeronautical Group met to hear the reports of the Group's working parties, and to discuss future projects. The Aeronautical Group, it may be recalled, was formed in September last year, to work out ways of improving existing aeronautical information services, and of assisting the aircraft industry to make use of the services that are already available. At the inaugural group meeting, three working parties were set up, and in May this year a fourth party was formed to prepare revisions and extensions of the Universal Decimal Classification covering aerodynamics, aircraft engineering and related subjects, in co-operation with the British Standards Institution.

The working party on abstracting services have concluded, from replies to a questionnaire submitted to a number of organisations, that a slightly enlarged version of *Index Aeronauticus* would satisfy the industry's needs. This abstract journal is issued monthly by the Ministry of Supply Technical Information Bureau, but has a limited circulation and cannot be purchased. The working party have recommended that it should be placed on sale to the public, but there are, at present, administrative obstacles to this. They also recommend the establishment of an international aeronautical abstracting journal. The Group have, therefore, decided that the working party should remain in existence, in order to find ways for overcoming the present difficulties, and to foster co-operation with the Institute of Aeronautical Sciences in the United States.

One of the original working parties was set up to consider a comprehensive scheme, initiated by the National Luchvaart Laboratorium, Amsterdam, for indexing and classifying wind-tunnel reports, whereby all the significant data on the tunnel, techniques, test models and test conditions were to be presented on the catalogue card. The Dutch authors have now completed a revised scheme and will shortly issue a report on it. On Sunday the Group decided that the working party should remain in existence to study the new report, when issued, with great urgency, since the growing mass of wind-tunnel data renders it increasingly difficult for the aerodynamicist to locate the particular information he requires.

Among the new projects discussed by the Group was a proposal that all aeronautical research reports should include catalogue cards containing an abstract of the report. The Royal Aircraft Establishment will be adopting this practice in the near future, and it is hoped that other research organisations will follow. Another subject for consideration is methods of preparing data suitable for design-office use from research reports. It was agreed that a "Guide to Aeronautical Literature" should be prepared, possibly based on the questionnaire that Aslib are shortly to send out in connection with the revised edition of their "Guide to Sources of Scientific and Technical Information." Finally, the question of international relations was discussed. As a result of Group representation, the Advisory Committee for Aeronautical Research of the North Atlantic Treaty Organisation are to discuss the "systematisation" of aeronautical data at their next meeting. It was generally agreed that when the Aeronautical Group hold their next conference at the College of Aeronautics, Cranfield, at the end of March, 1953, a number of overseas guests should be invited to discuss international problems.

ENGINEERING GROUP.

At an informal meeting during the week-end, the preliminary work that is being done by the Engineering Group for the benefit of engineering firms, and projects for future work, were discussed. The formation and purpose of the Group were described on pages 210 and 211 of *ENGINEERING* for August 15, 1952.

THE MANUFACTURE OF ALUMINIUM-SHEATHED ELECTRIC CABLES.

LEAD has been employed as a sheathing material for underground electric cables for many years and has numerous advantages for that purpose. As, however, it also possesses the drawbacks, among others, of excessive weight and poor mechanical characteristics, it is not surprising that attempts have been made to find a substitute for it. Of the possible materials for this purpose, aluminium is the most obvious, since it is light and has a comparatively high mechanical strength. In turn, however, it suffers under the drawback of having a comparatively high softening temperature, so that it has been difficult to devise a suitable extrusion process for manufacturing the necessary sheaths. In fact, when, owing to a shortage of lead, attempts to solve this problem were made in Germany shortly before the 1939-45 war, the difficulties of extruding aluminium directly on to the cable core proved so formidable that, although ample supplies of soft pure-grade metal were available, only a few kilometres of indifferent quality sheath were produced. Failure also accompanied the attempt to use helically or longitudinally wrapped strips, owing to the absence at that time of an effective method of closing the seam.

Although experiments with aluminium sheathing were also made in this country, there was not much progress until early in 1946, when renewed interest was stimulated in the matter owing to the steep rise in the price and the acute shortage of lead. After an examination of the manufacturing methods just mentioned, Messrs. Johnson and Phillips, Limited, Charlton, London, S.E.7, directed their attention to the possibility of using a pre-extruded aluminium tube into which the cable core could be threaded, a seamless accurately fitting sheath being subsequently produced by swaging.

The initial experiments along these lines took place in November, 1946, at the Kynoch factory of Imperial Chemical Industries, Limited, who had undertaken to provide aluminium tube in the lengths required. So encouraging were the results of the tests* made on the samples produced that the difficult task of translating the successive operations of positioning the tube, inserting the core and forming the sheath into a mechanised process suitable for economic production was undertaken. This experimental stage was successfully concluded in August, 1947, and Messrs. Johnson and Phillips then began the design and installation of a permanent plant which was completed in May, 1948, the first lengths of aluminium-sheathed cable being manufactured to customers' orders two months later. During the first 12 months of operating this plant, production was confined to paper-insulated cable, but as lengths of smaller sizes of aluminium tube became available, the process was extended to rubber-insulated wires and a considerable length of high-frequency cable has also been sheathed. The original plant was extended in August, 1951, and up to the present time, we understand, a total of 2,100 miles of aluminium-sheathed cables of various types have been produced.

Turning to the details of the manufacturing process, the aluminium tube used as sheathing is laid out along a 350-yard gantry for the core to be inserted. The gantry is suspended from the roof trusses of an existing cable shop, its interior being shown in Fig. 2, and its arrangement being illustrated diagrammatically in Fig. 3. As will also be seen, Fig. 3, the intake of tube and core takes place at one end of the shop (the "feeding" end) and the sheathing and coiling of the finished cable at the other end (the "sinking" end). The long lengths of aluminium tube employed, which are produced by extrusion in sizes increasing in steps of $\frac{1}{8}$ in. up to diameters of 1 in. and in steps of $\frac{1}{4}$ in. for larger sizes, are brought to Charlton coiled on drums, where they are mounted on a stand at ground level, as shown on the left of Fig. 1 and also at *a* in Fig. 3. The leading end of the tube *b* is then drawn over the guide wheel *c* on to the plant gantry, where it is passed through the straightening rollers *d*, the size

ALUMINIUM-SHEATHED ELECTRIC CABLES.

JOHNSON AND PHILLIPS, LIMITED, LONDON.

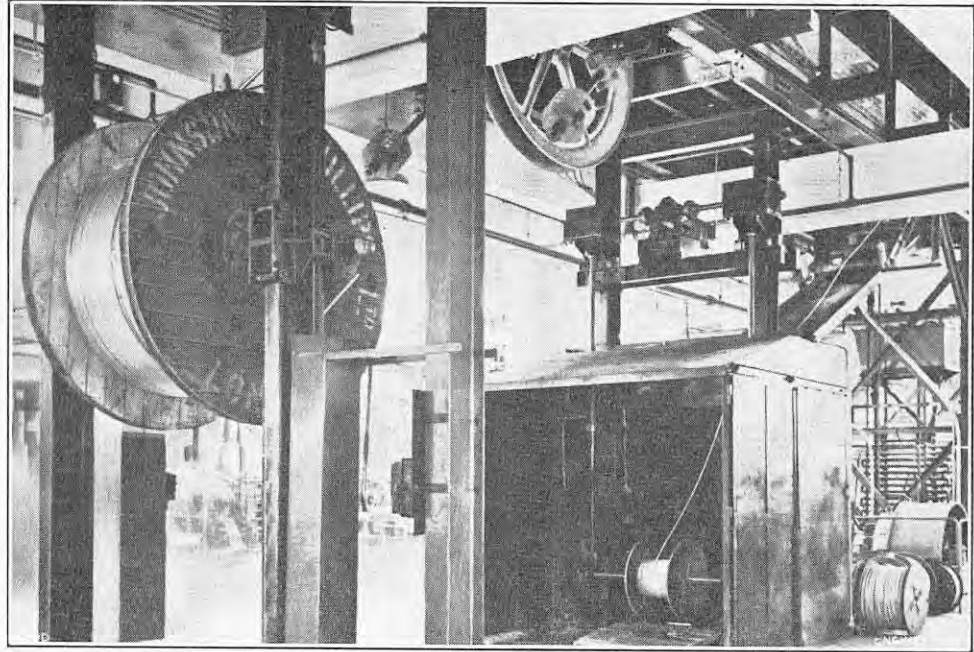


FIG. 1. DRUMS FOR ALUMINIUM SHEATH AND CABLE CORE.

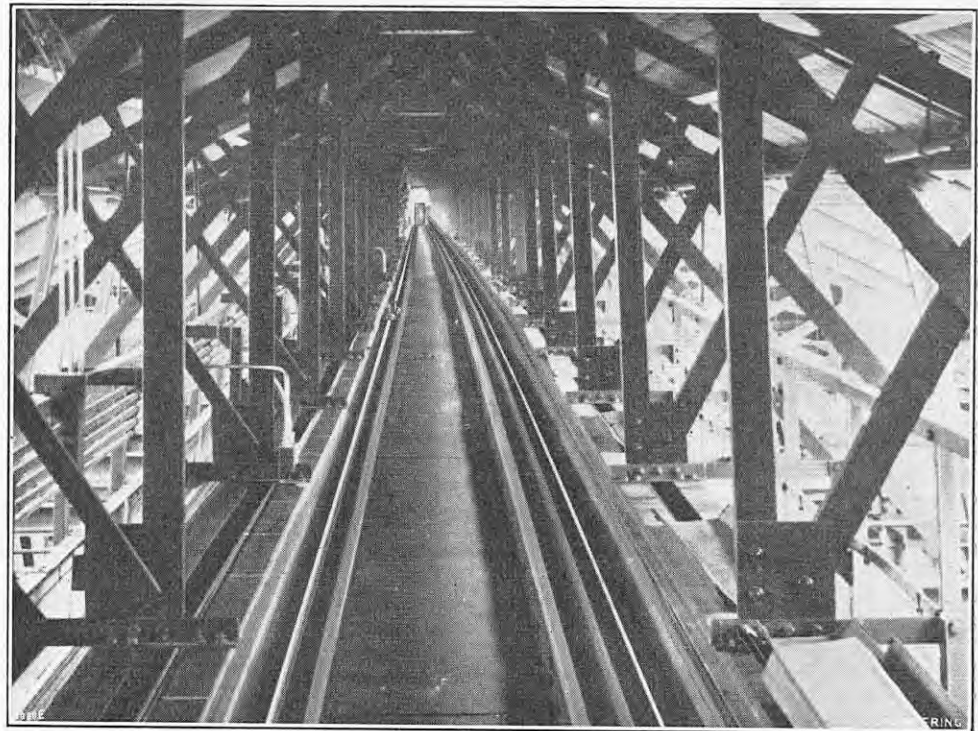
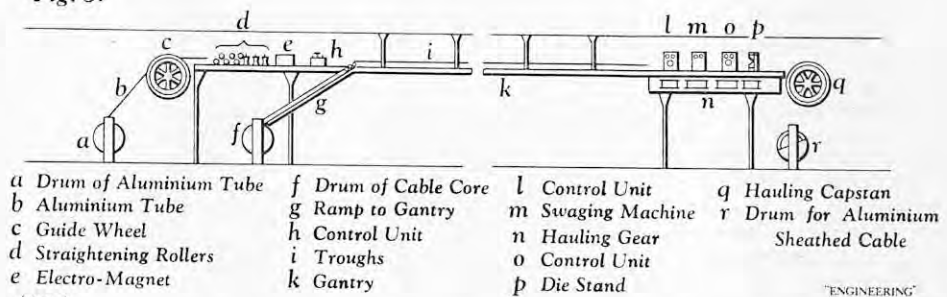


FIG. 2. PLANT GANTRY, SHOWING PROCESS TROUGH.

Fig. 3.



of which varies with the diameter of the tube. A photograph of these rollers is reproduced in Fig. 11, on page 408.

The tube is next passed through an electromagnet, which is shown at *e* in Fig. 3, and is also visible in

Figs. 11 and 12, on page 408. The movable core of this electromagnet is attached to a tow line which, in turn, is coupled to an electrically-driven variable-speed capstan at the sinking end of the plant. The position of this capstan is shown at *q*

* See ENGINEERING, vol. 165, page 404 (1948).

MANUFACTURE OF ALUMINIUM-SHEATHED ELECTRIC CABLES.

JOHNSON AND PHILLIPS, LIMITED, LONDON.

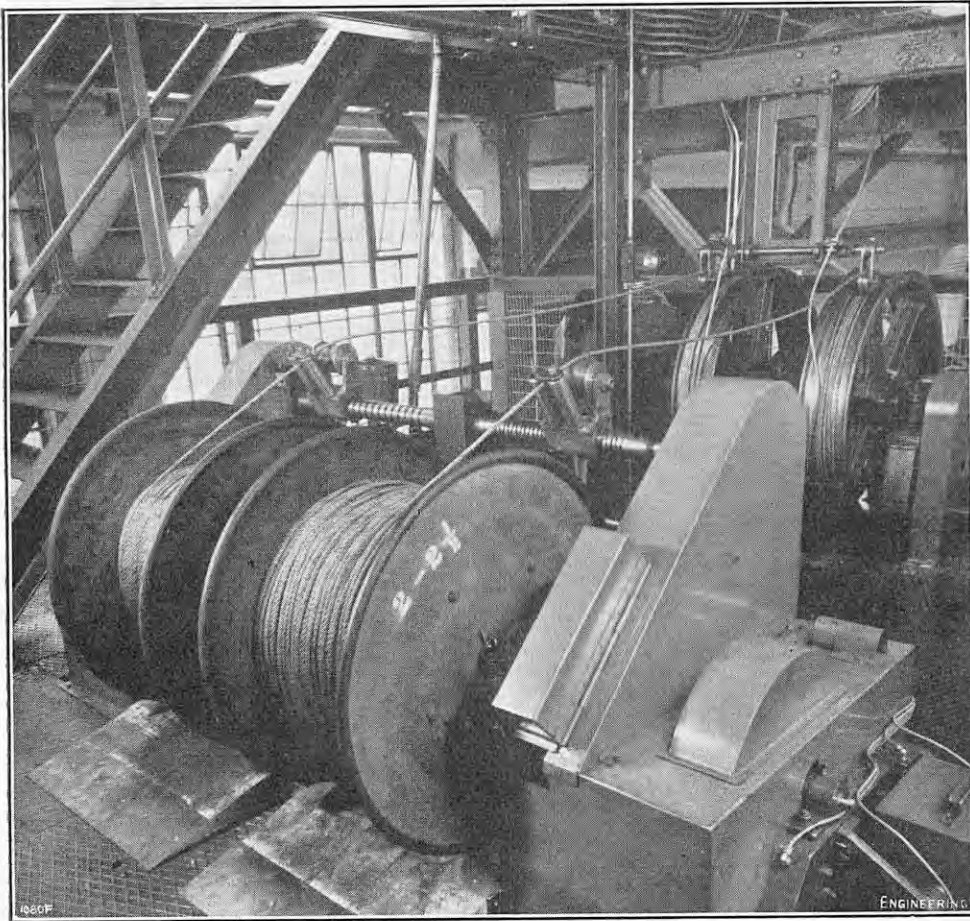
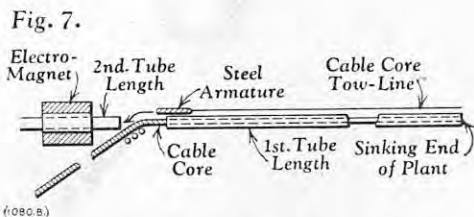
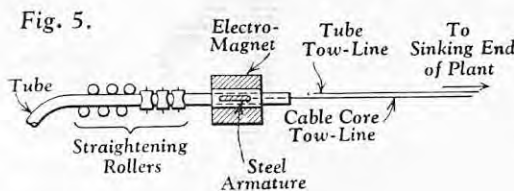
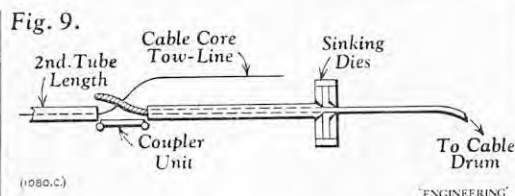
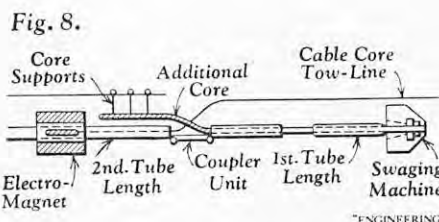
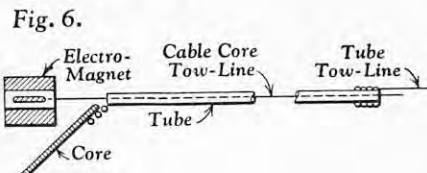


FIG. 4. TOW LINE HAULING GEAR AT SINKING END.



in Fig. 3, and the capstan itself in Fig. 4. Meanwhile, a second tow line, to which the cable core will subsequently be attached, has been drawn along a small trough which runs adjacent to the main trough, as can be seen in Fig. 2. This tow line is attached to the core of the solenoid and the core itself is inserted in the leading end of the aluminium tube, as shown in Fig. 12, on page 408, and is held by the magnetic field when the electromagnet is energised. The aluminium tube therefore passes over the tow line as it is drawn along the gantry by the capstan, as shown diagrammatically in Fig. 5.

When the required length of aluminium tube has been drawn over the tow line in this way, the electromagnet is de-energised and the line is made fast to the leading end of the cable core. The core is then drawn from the drum, shown at *f* in Fig. 3 and on the right of Fig. 1, up the ramp *g*, as shown in more detail in Fig. 6. The winch at the sinking end is set in motion and the cable core is drawn freely through the tube along the whole length of the gantry. As the process is semi-continuous, however, before the leading end of the first tube reaches the sinking end the leading end of a second tube is



drawn up on to the gantry, as indicated in Fig. 7, and is passed through the straightening rollers and electromagnet before being connected by a special coupling to the tail end of the first length, as shown in Fig. 8 and in Fig. 13, on page 408. Meanwhile the core tow line has been disconnected from the length of core at the sinking end of the plant and has been hauled back to the feeding end along a third trough. The solenoid core is then attached to it again and inserted in the second length of aluminium tube.

As will be seen from Fig. 13, at this stage in the process a considerable length of cable core protrudes from the tail end of the leading tube. This is ultimately sheathed, however, since the

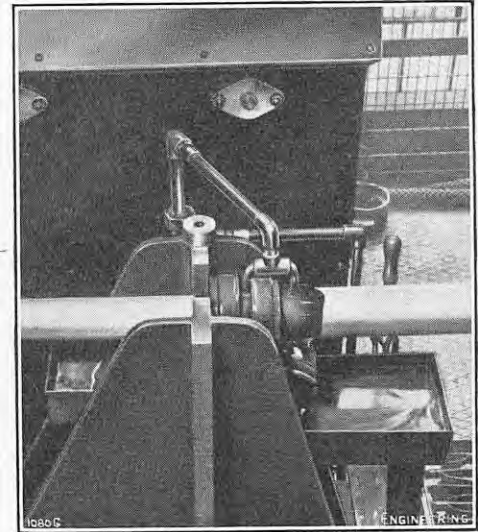


FIG. 10. SINKING DIES.

effect of sinking is to increase the length of the tube from 300 yards to between 333 and 440 yards, depending on the amount its diameter has been reduced. This core either lies in the trough or, in the case of the larger and heavier sizes of cable, is carried on a line of sliding supports which run on an overhead rail.

At the sinking end of the plant, the first length of aluminium tube with the core inside it is drawn forward into the swaging machine, shown at *m* in Fig. 3 and the leading 12 in. or so are swaged down so that the tube can enter the sinking dies, shown at *p* in the same diagram. The capstan *q* is then rotated and the complete tube is drawn through the dies, so that a tightly fitting sheath is formed accurately over the core, as shown diagrammatically in Fig. 9 and in Fig. 14, on page 408. As the sheathed cable emerges from the dies it passes round the capstan and then on to the drum shown at *r* in Fig. 3. During the sinking process on the first tube the second length is drawn along the plant gantry and the cable core tow line is inserted in it in the manner already described. The core is then drawn in so that it is ready for sinking as soon as the operation on the first length of tube has been completed.

Different sizes and types of cable can be dealt with, either by changing the straightening rollers at the feeding end of the plant or by altering the dies at the sinking end. It may be added that the two plants now installed at Charlton are completely independent in operation. The time taken to complete a sheath of course varies with the different types of cable, but an average of from 3,000 to 4,000 yards of power cable can be produced in a ten-hour shift.

It may finally be mentioned that another obstacle to the use of aluminium sheathing, in addition to those set out above, has been the difficulty of making soldered or sweated joints with that metal. A very large number of cable joints and terminations for low- and medium-tension cables, however, only require compound sealing and this method can be employed with aluminium sheaths, provided precautions are taken to prevent contact with other metals. For totally-sealed joints or terminations, Messrs. Johnson and Phillips have developed a mechanical type of union to replace the normal plumbing gland.* This consists essentially of a pair of rings which are coated to exclude any risk of galvanic action and between which the sheath is gripped. A lead or tinned copper sleeve is then passed over the joint and plumbed to the fittings in the normal way. Finally, the completed joint is enclosed in a concrete or metal box, which is filled with a suitable bitumen compound.

* See ENGINEERING, vol. 167, page 93 (1949).

NOTES FROM THE INDUSTRIAL CENTRES.

SCOTLAND.

SCOTTISH PIG-IRON AND STEEL PRODUCTION.—An expansion of around seven per cent. in the output of both pig iron and steel, as compared with a year ago, has been disclosed in the Scottish production figures for August. The output of pig iron averaged 16,470 tons a week against 15,310 tons in 1951. This, however, fell below the average of 17,090 tons achieved in the first half of the year. The production of steel ingots and castings arose to 43,780 tons a week compared with 40,820 tons in August last year. Over the first six months of the year the weekly average amounted to 42,920 tons.

SHIPBUILDING-STEEL DIFFICULTIES.—After the launch at Port Glasgow, on September 19, of the cargo motorship Tremayne for the Hain Steamship Co., Ltd., London, Mr. Horace Willson, chairman of Wm. Hamilton & Co., Ltd., the builders, referring to shipbuilding-steel supplies, said that not only was there a shortage by some thousands of tons a year, with on-cost charges going on at the same rate whether three or six ships were built in a year, but there was a lack of sequence in deliveries. Most shipbuilding firms had spent large sums of money in modernising their shipyards, and had worked out schemes of prefabrication, but now it was a case of working from hand to mouth and doing what they could with the steel available.

WATERWORKS CONFERENCE, EDINBURGH.—In his presidential address delivered in Edinburgh on September 10 to the 41st annual conference of the British Waterworks Association Provost A. Wallace, of Falkirk, said that the industry was continually progressing towards the solution of the twin problems of extending supplies in rural areas and finding water to meet the general overall increasing demand for domestic purposes. Because of the cheapness of public water supplies large industrial concerns were using enormous quantities for cooling purposes for which filtration and treatment were not necessary. He thought that some alternative method of providing cooling water should be sought. A resolution moved by Alderman Cresswell, of Coventry, affirmed the sense of urgency felt by the conference regarding the need for training and recruitment schemes to encourage more men to enter the water industry.

CLEVELAND AND THE NORTHERN COUNTIES.

TEES-SIDE STEEL INDUSTRY.—Addressing Middlesbrough Rotary Club, Mr. E. T. Judge, director and chief engineer of Dorman Long & Co., Ltd., referred to the fact that Tees-side produced one-fifth of Britain's steel output and one-quarter of her iron output. Although he agreed with the bringing of new industries into the area to make it less dependent upon steel, he commented that the outlook would be grim indeed if they could not look forward to a confident future for iron and steel. Dealing with works extensions, Mr. Judge said that in these days of modern transport facilities it would cause no hardship if the centre of employment were moved a few miles away from Middlesbrough.

THE LATE LT.-COL. H. M. STOBART.—The death has taken place at his home at Gainford, near Darlington, of Lt.-Col. Hugh Morton Stobart, a prominent North-East industrialist. He was 69 years old. Lt.-Col. Stobart was chairman of the Wearmouth Coal Co., Ltd., and the France Fenwick Tyne and Wear Co., Ltd., and a director of William France Fenwick & Co., the Newcastle coal exporters. He was also a former chairman of Richardson Westgarth & Co., Ltd., West Hartlepool. Lt.-Col. Stobart had been a Durham County magistrate for 45 years.

TYNE EXPORTS AND IMPORTS.—Coal and coke shipments from the Tyne during August amounted to 612,248 tons, bringing the total for the first eight months of the year to 6,152,268 tons, an increase of 9 per cent., or 507,716 tons, on last year, but 26½ per cent., or 2,214,901 tons, less than the pre-war figures of 1938. Exports of general merchandise for the seven months ended July were 222,551 tons. The chief items included 51,417 tons of oil-fuel cargo, 52,153 tons of sulphate of ammonia, 22,127 tons of machinery, and 22,264 tons of tar and pitch. Imports of general merchandise for the same period amounted to 1,553,325 tons. The chief items were 403,263 tons of iron ore; 380,992 tons of oil fuel and other oils; 107,344 tons of timber (excluding pit props); and 198,438 tons of grain.

THE SITUATION IN SHIPBUILDING.—The belief that the steel-supply situation would improve in the not-too-distant future was expressed at the launch of the 32,500 tons deadweight capacity tanker World Enterprise built by Vickers-Armstrongs Ltd., Walker-on-Tyne, for Mr. Stavros S. Niarchos of New York. Speaking after the launch, Sir Ronald Weeks, chairman of Vickers Ltd., referred to the fact that two tankers of 44,000 tons each were under construction at the firm's Barrow yard for Mr. Niarchos. Both the firm's yards had several years' work in hand, and it was unfortunate that there were clouds on the horizon which threatened the industry. He hoped something could be done concerning the unions' decision to ban overtime and piecework, an action which would interfere with the national effort to restore Britain's place in the world economy. Major-General C. A. L. Dumphie, managing director of Vickers-Armstrongs engineering works and shipyard, said there were signs of better supplies of steel not far ahead.

NORTH-EAST METALLURGICAL SOCIETY.—The newly-formed North-East Metallurgical Society held its first annual meeting at Middlesbrough, on September 16. Mr. W. W. Stevenson, chief metallurgist of Dorman Long & Co. Ltd., Middlesbrough, presided. The Society has 120 members and the honorary secretary and treasurer is Mr. J. W. Gailer, head of the Metallurgical and Pure Science Department of Constantine Technical College, Middlesbrough.

LANCASHIRE AND SOUTH YORKSHIRE.

METALLURGICAL EDUCATION ON MERSEYSIDE.—In 1950, the Liverpool Metallurgical Society carried out an inquiry into the need for part-time metallurgical education in their area and the response showed that there were many potential students who wished to take National Certificate Courses or qualify for the Diplomas of the Institution of Metallurgists. A start has now been made towards meeting this need. The Birkenhead Technical College offers first- and second-year courses leading to the Ordinary National Certificate in Metallurgy. These courses began on September 15. The first-year course comprises teaching in chemistry, physics and mathematics, and is held on Tuesdays, from 9 to 12 a.m. and from 2 to 5 p.m. Classes in engineering drawing are held on Wednesday evenings from 7 to 9. In the second-year course, inorganic chemistry and physics are taught on Thursdays, and mathematics and metallurgy at times to be arranged. Persons interested in the above courses should get in touch with the Principal—Mr. C. V. Vinten Fenton, M.Sc., A.M.I.Mech.E., A.M.I.E.E., Birkenhead Technical College, Leighton Road, Birkenhead.

YORKSHIRE COAL OUTPUT.—In the week ended September 13, when Doncaster Races were held, the output of coal in Yorkshire fell by nearly 50,000 tons short of the weekly target of a million tons. By consent, the Doncaster-district pits did not open on the St. Leger day and production in that week was 23,926 tons less than in the previous week. In consequence, supplies have been short, but all industrial concerns and the gas and electricity undertakings have satisfactory reserves of fuel.

COURSE ON ADMINISTRATION FOR APPRENTICES.—About 20 apprentices have been attending a course, at Unstone Grange Hostel, near Sheffield, which was designed for young men who may become foremen, works managers, personnel officers or even managing directors. Talks have been given by industrialists and executive officers explaining their duties and responsibilities and the apprentices have made searching questions. The scheme has been inaugurated by the Economic League, and the course gives apprentices an insight into works organisation.

EMPLOYMENT OF GIRLS.—For the first time since before the war, girls leaving Sheffield schools are finding that there are no jobs available for them. Some have been placed by the Youth Employment Bureau, but there is a considerable surplus of girls wanting clerical jobs. The only section in which employment has not declined is in local-government office work. Vacancies for boys have declined in number only slightly.

THE MIDLANDS.

NEW FACTORY AT DUDLEY.—The Talbot-Stead Tube Co., Ltd., a subsidiary of Tube Investments, Ltd., have recently taken over a small factory at Tipton-road, Dudley. The factory, which is newly built, will be opened in October as a branch of the company's main works at Walsall, and will produce a variety of light-alloy components.

TRADE CONDITIONS IN THE MIDLANDS.—At a Press conference held by the Midland Regional Board for Industry in Birmingham on September 16, figures were given showing that unemployment in the area had increased from 18,313 in July to 19,825 on August 11. Mr. Barry Kay, Midland Regional Controller for the Board of Trade, said, however, that there were signs that conditions were improving in both the North American and European markets. Increased sales in the United States and Canada had been reported by several industries during the past few weeks.

THE EFFECT OF LAND DEVELOPMENT CHARGES.—A meeting is to be held in Birmingham on October 9 to discuss the effect of land development charges on industry. The meeting, which is under the auspices of the Midland Industrial Development Association, is to be attended by representatives of Chambers of Commerce, the National Union of Manufacturers, the Federation of British Industries, and local authorities. Special consideration is to be given to the problems of the small manufacturer. The Association is collating evidence of the delay and frustration caused by development charges, and the co-operation of Midland industrialists is sought in preparing an outline scheme for modifying the existing legislation. In due course the scheme will be presented to the Government for consideration.

RESTORATION OF HELICOPTER SERVICE.—Dr. G. Hislop, of the British European Airways Corporation, announced during a visit to Birmingham on September 16 that the Corporation's helicopter passenger service between Birmingham and London, which was withdrawn last April, is to be restored. The Corporation expect to operate the service from next June, but the date will depend upon delivery of new four-seater aircraft from the Bristol Aeroplane Company. It is not expected that the 14-seater twin-engined machines, which will eventually be used on the route, will be ready for operation until 1954.

NEW SEWAGE WORKS.—Stafford Borough Council have received permission from the Minister of Housing and Local Government to spend 52,000*l.* on machinery for a new sewage disposal works, and hope that construction will start next January. The eventual cost of the scheme will be 300,000*l.*

SOUTH-WEST ENGLAND AND SOUTH WALES.

EXPERIMENTAL SEA-WALL WORK.—New experimental work being carried out by John Morgan Ltd., contractors, Cardiff, on the sea wall at Goldcliffe, near Newport, has been inspected by the drainage board. The new work consists of a bed of bitumen laid at the foot of the sea wall on a base of stone. Concrete beds were previously used and it is stated that the new type has been used with considerable success on the large South Breakwater at the Hook of Holland, where it has resulted in great saving in maintenance costs and man-power. An area measuring 1,800 square yards and 900 ft. in length is being laid and will need 250 tons of bitumen. If it should prove satisfactory it is anticipated that the River Board will carry on with the work.

BUILDING ACTIVITIES IN GLAMORGAN.—The Glamorgan County Architect, Mr. L. R. Gower, states in his annual report that building projects in the planning stage, under construction or recently completed by his Department cost well over 2,000,000*l.* Never before in the history of the authority, he states, have so many schemes been brought to the building stage within the very limited time allowed by Government departments for the preparation of sketch designs, working drawings, bills of quantities, etc.

COKE-OVEN DUST AT PORT TALBOT.—Smut and grit from the coke ovens at the Margam Steelworks are causing a problem which so far has defied all attempts to find a solution. It has been reported to a meeting of the Port Talbot sanitary committee that dirt is falling on the Taibach area of the town at the rate of 459.8 tons a square mile each month—the highest deposit in the country. In the town centre the amount is 28 tons. Mr. C. A. Morgan, the chief sanitary officer, has told the committee that the problem has not been solved anywhere in this country or in America. Engineers in Germany have been consulted also without success.

MINERS' OPINIONS ON WAGE RESTRAINT.—Delegates representing 18,000 miners in the Swansea and Neath areas have decided to protest to the national executive of the National Union of Mineworkers against their action in supporting the wage-restraint policy of the General Council of the Trades Union Congress.

NOTICES OF MEETINGS.

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

ILLUMINATING ENGINEERING SOCIETY.—*Leicester Centre*: Monday, September 29, 6.30 p.m., Offices of the East Midlands Electricity Board, Charles-street, Leicester. "Horticultural Lighting," by Mr. J. J. French. *Cardiff Centre*: Tuesday, September 30, 5.45 p.m., Offices of the South Wales Electricity Board, Cardiff. Chairman's Address, by Mr. A. J. Dalton. *Newcastle Centre*: Wednesday, October 1, 6.15 p.m., Minor Durrant Hall, Oxford-street, Newcastle-upon-Tyne, 1. Chairman's Address, by Mr. G. Kingsley-Lark. *Edinburgh Centre*: Wednesday, October 1, 7 p.m., 357, High-street, Edinburgh. "Lighting for Inspection," by Mr. H. E. Bellchambers. *Nottingham Centre*: Thursday, October 2, 6 p.m., Offices of the East Midlands Electricity Board, Smithy-row, Nottingham. Chairman's Address, by Mr. P. L. Ross. *Glasgow Centre*: Thursday, October 2, 6.30 p.m., 39, Elmbank-crescent, Glasgow, C.2. "Lighting for Inspection," by Mr. H. E. Bellchambers. *Birmingham Centre*: Friday, October 3, 6 p.m., "Regent House," St. Philip's-place, Colmore-row, Birmingham. Chairman's Address, by Mr. E. H. Norgrove. *Bath and Bristol Centre*: Friday, October 3, 7 p.m., Offices of the South Western Electricity Board, Old Bridge, Bath. "Lighting for the Prevention of Industrial Accidents," by Mr. E. W. Murray.

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS.—*Bournemouth Branch*: Monday, September 29, 8.15 p.m., Grand Hotel, Firvale-road, Bournemouth. "General Tariff Problems," by Mr. H. E. White. *South London Branch*: Thursday, October 2, 8 p.m., Café Royal, North End, Croydon. Film on "A Concrete Proposition." *Liverpool Branch*: Friday, October 3, 7.30 p.m., Liverpool Engineering Society, 9, The Temple, 24, Dale-street, Liverpool. "Television," by Mr. B. P. Atkinson.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—*Scottish Branch*: Tuesday, September 30, 6.30 p.m., Engineering Centre, 351, Sauchiehall-street, Glasgow, C.2. Annual Meeting. *Institution*: Wednesday, October 1, 6 p.m., Institution of Mechanical Engineers, Storey's-gate, St. James's Park, S.W.1. "Industrial Radiant Heating," by Mr. F. R. L. White. *East Midlands Branch*: Wednesday, October 1, 6.30 p.m., College of Technology, Leicester. "Burning of Coke by Down-Jet Method," by Mr. G. C. Sharpe. *North-East Coast Branch*: Tuesday, October 7, 6.30 p.m., Neville Hall, Newcastle-upon-Tyne, 1. Annual General Meeting. "Heating and Hot-Water Service for Moderate Rental Flats," by Mr. A. F. Myers.

SOCIETY OF INSTRUMENT TECHNOLOGY.—Tuesday, September 30, 7 p.m., Manson House, 26, Portland-place, W.1. "Some Practical Aspects of Fluid Flow Through Sharp-Edged Orifice Plates," by Dr. W. J. Clark.

INSTITUTE OF BRITISH FOUNDRYMEN.—*Slough Section*: Tuesday, September 30, 7.30 p.m., Offices of High Duty Alloys, Ltd., Slough. "Non-Ferrous Ingot Production," by Mr. W. G. Mochrie. *West Wales Section*: Friday, October 3, 7 p.m., Technical College, Llanelly. "Some Practical Considerations of Liquid Shrinking in Cast Iron," by Mr. H. Balme. Also at the *Wales and Monmouth Branch*: Saturday, October 4, 6 p.m., South Wales Institute of Engineers, Park-place, Cardiff. *Sheffield Branch*: Monday, October 6, 7.30 p.m., Sheffield College of Commerce and Technology, Pond-street, Sheffield, 1. (i) Branch President's Address on "Men and Moulds," by Mr. F. A. Martin. (ii) Film Display.

NORTH-WESTERN FUEL LUNCHEON CLUB.—Wednesday, October 1, 12.45 p.m., Engineers' Club, Manchester. Luncheon Meeting. "The Processing of Coal," by Mr. Ernest West.

INSTITUTION OF ELECTRICAL ENGINEERS.—*Southern Centre*: Wednesday, October 1, 6.30 p.m., British Electricity House, 111, High-street, Portsmouth. Chairman's Address, by Mr. C. J. Turnbull. Wednesday, October 8, 6.30 p.m., Dorset Technical College, Weymouth. "Illumination," by Mr. S. S. Beggs. *South Midland Centre*: Monday, October 6, 6 p.m., Grand Hotel, Birmingham. Annual Meeting and Conversation. Chairman's Address, by Dr. K. R. Sturley. *Merseyside and North Wales Centre*: Monday, October 6, 6.30 p.m., Royal Institution, Colquitt-street, Liverpool. Chairman's Address, by Mr. W. A. Hatch. *East Midland Centre*: Tuesday, October 7, 6.30 p.m., Loughborough College, Loughborough. Chairman's Address, by Mr. H. E. Knight. Thursday, October 9, 7.30 p.m., Corn Exchange, Spalding. "Review of Overhead Lines," by Mr. N. G. Simpson. *North-Western Centre*: Tuesday, October 7, 6.30 p.m., Engineers' Club, Manchester. Chairman's Address, by Mr. J. Prince. *District Meeting*: Wednesday, October 8, 7 p.m., Offices of Southern Electricity Board, 37, George-street, Oxford. "Short-Circuit Testing Technique," by Mr. J. G. P. Anderson. *Institution*: Thursday, October 9, 5.30 p.m., Savoy-place, Victoria-embankment, W.C.2. Inaugural Address, by the President, Colonel B. H. Leeson.

INSTITUTE OF ROAD TRANSPORT ENGINEERS.—Wednesday, October 1, 6.30 p.m., Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Annual Meeting. *Scottish Centre*: Monday, October 6, 7.30 p.m., 39, Elmbank-crescent, Glasgow, C.2. Discussion on "Welding Methods." *Eastern Centre*: Tuesday, October 7, 7 p.m., Albert Hall, Cowdray-avenue, Colchester. "The Running Maintenance of Fuel Injection Equipment," by Mr. R. W. Preece.

JUNIOR INSTITUTION OF ENGINEERS.—*Midland Section*: Wednesday, October 1, 7 p.m., James Watt Memorial Institute, Birmingham. Annual Meeting. *Institution*: Friday, October 3, 7 p.m., Townsend House, Greycourt-place, S.W.1. Film Evening. Friday, October 10, 7 p.m., Townsend House, S.W.1. "Electricity and Productivity," by Mr. H. J. Gibson.

INSTITUTION OF PRODUCTION ENGINEERS.—Wednesday, October 1, 7.15 p.m., Wolverhampton and Staffordshire Technical College, Wolverhampton. "The Development of Engineering Metrology," by Mr. F. H. Rolt. *Leicester Section*: Thursday, October 2, 7 p.m., Bell Hotel, Leicester. (i) Address by Mr. J. Radcliffe. (ii) Discussion on "Is the Production Engineer Playing His Part?" *Luton Section*: Thursday, October 2, 7.15 p.m., Town Hall, Luton. "An American View of Machine Tools," by Mr. H. T. Johnson. *Reading Section*: Thursday, October 2, 7.15 p.m., Great Western Hotel, Reading. "Jobbing Foundry Work To-Day," by Mr. A. Talbot. *Lincoln Section*: Thursday, October 2, 7.30 p.m., Ruston Club, Lincoln. "Measurement of Productive Efficiency," by Mr. W. C. Puckey.

INSTITUTION OF ENGINEERING INSPECTION.—*Birmingham Branch*: Wednesday, October 1, 7.30 p.m., Chamber of Commerce, 95, New-street, Birmingham. Film Evening. *Institution*: Thursday, October 2, 5.30 p.m., Royal Society of Arts, John Adam-street, Adelphi, W.C.2. "The Inspection Organisation at U.K. Time," by Mr. Robt. S. Murray. *Coventry Branch*: Tuesday, October 7, 7.30 p.m., Technical College, Coventry. "Jet Propulsion from the Pilot's Viewpoint," by Group Captain L. R. Stokes.

INCORPORATED PLANT ENGINEERS.—*Southampton Branch*: Wednesday, October 1, 7.30 p.m., Polygon Hotel, Southampton. "Materials Handling and National Recovery," by Mr. J. R. Sharp.

ROYAL STATISTICAL SOCIETY.—*Industrial Applications Section*: Thursday, October 2, 6 p.m., New Arts Building, University College, Swansea. "Statistics Research," by Mr. A. W. Swan. Friday, October 3, 6 p.m., Lighting Service Bureau, 2, Savoy-hill, W.C.2. "The Design and Analysis of 2ⁿ Factorial Experiments with Fractional Replication," by Mr. G. W. Sears.

BRITISH INSTITUTION OF RADIO ENGINEERS.—*Scottish Section*: Thursday, October 2, 7 p.m., Department of Natural Philosophy, The University, Edinburgh. "Recent Developments in Television," by Mr. H. McGhee.

ROYAL SANITARY INSTITUTE.—Friday, October 3, 10 a.m., Public Library, Grace-hill, Folkestone. Various papers, including "Cross-Channel Port Health Control," by Dr. R. F. H. McElligott.

INSTITUTE OF FUEL.—*South Wales Section*: Friday, October 3, 6 p.m., South Wales Institute of Engineers, Park-place, Cardiff. "Coal Measures as a Source of Methane," by Mr. L. T. Minchin.

IRON AND STEEL INSTITUTE.—Tuesday, Wednesday and Thursday, October 7, 8 and 9. Special Meeting in Swansea. Various visits and excursions. For programme, see page 247, ante.

INSTITUTION OF MECHANICAL ENGINEERS.—*Automobile Division*: Tuesday, October 7, 5.30 p.m., Storey's-gate, St. James's Park, Westminster, S.W.1. Annual Meeting and Address by the chairman of the Automobile Division.

INSTITUTION OF CHEMICAL ENGINEERS.—*South Wales Graduates' and Students' Section*: Tuesday, October 7, 7 p.m., University College of South Wales and Monmouthshire, Museum-avenue, Cathays Park, Cardiff. "Non-Metallic Corrosion Resistant Material," by Mr. N. Monks.

INSTITUTION OF WORKS MANAGERS.—*Sheffield Branch*: Tuesday, October 7, 7.30 p.m., Grand Hotel, Sheffield. "Magnetism in Industry," by Mr. T. G. Hawker.

INSTITUTE OF PETROLEUM.—Wednesday, October 8, 5.30 p.m., Manson House, 26, Portland-place, W.1. "Methods of Atomising Liquid Fuels," by Mr. J. R. Joyce.

INSTITUTION OF ENGINEERS-IN-CHARGE.—Wednesday, October 8, 6.30 p.m., St. Bride Institute, Bride-lane, Fleet-street, E.C.4. "The Use of Unusual Fuels," by Mr. C. E. Newman.

INSTITUTE OF WELDING.—Wednesday, October 8, 6.30 p.m., Institution of Civil Engineers, Great George-street, Westminster, S.W.1. Presidential Address, by Mr. A. Robert Jenkins.

SOCIETY OF CHEMICAL INDUSTRY.—*Corrosion Group*: Wednesday, October 8, 6.30 p.m., Chemical Society's Apartments, Burlington House, Piccadilly, W.1. Discussion on "Filiform Corrosion and Related Phenomena."

PERSONAL.

VISCOUNT KNOLLYS, G.C.M.G., M.B.E., D.F.C., has been appointed an additional member of the board of directors of Vickers Ltd., Vickers House, Broadway, London, S.W.1.

MR. R. H. S. TURNER, M.A., M.I.P.E., has been appointed assistant works manager, Main Works, Metropolitan-Vickers Electrical Co. Ltd., Manchester, 17. **MR. A. PATERSON**, B.Sc., A.R.T.C., A.M.I.P.E., in addition to his duties as superintendent, motor department, is appointed assistant works manager, Mosley Road Works, including Leonard Works. **MR. J. S. WRIGHT**, B.Sc.(Eng.), A.M.I.E.E., has been appointed superintendent, plant department, and **MR. J. A. BROOKS**, B.Sc.(Eng.), A.M.Inst.W., superintendent, Leonard Works. **MR. R. M. A. SMITH**, B.Sc.(Eng.), M.I.E.E., is now assistant sales manager, instrument and meter department.

MR. G. T. H. SPURLING, B.Sc., A.M.I.Mech.E., has resigned his position as commercial manager, turbine division, The Brush Electrical Engineering Co., Ltd., to take up that of chief assistant to **MR. I. V. ROBINSON**, Wh.Sc., M.I.C.E., M.I.Mech.E., head of the turbine and allied-plant sections of the British Electrical and Allied Manufacturers' Association, 36 and 38, Kingsway, London, W.C.2. **MR. B. L. GOVER** has succeeded to Mr. Spurling's position at the Brush Co.

Canadian Pacific Steamships Ltd. have announced that they have appointed **MR. J. R. Y. JOHNSTON**, M.I.N.A., naval architect, with headquarters in Liverpool.

MR. F. S. BOWEN, of Manchester, has been elected President of the Engineer Surveyors' Association, 19, Atlantic Chambers, 7, Brazennose-street, Manchester, 2, for the year 1952-53. **MR. J. G. F. CARROL**, of London, has been elected vice-president.

MR. E. V. HAINSWORTH, chairman and managing director of Edward Elwell Ltd., Wednesbury, has been appointed deputy chairman of Edge Tool Industries Ltd., Wolverhampton, of which firm Edward Elwell are a subsidiary company. Mr. Hainsworth remains chairman of Messrs. Elwell, but will relinquish the office of managing director on October 1.

MR. J. E. MERCER, general manager of the steel foundries of Head, Wrightson and Co. Ltd., Stockton-on-Tees, is retiring at the age of 68. Mr. Mercer commenced his career at Sheffield with Vickers Ltd., and moved to Stockton in 1922.

MR. T. W. MILLS, who for the past 12 years has been manager of Trimdon Grange Colliery coke-ovens and by-products plant, County Durham, has been appointed manager of the Stella Gill coke and by-product works, Pelton Fell, Chester-le-Street, County Durham. **MR. R. CHAMBERS**, under-manager at Trimdon Grange, has been appointed under-manager at Derwenthaugh coke-works, Blaydon-on-Tyne.

MR. WILLIAM FERGUSON, B.Sc., has been appointed to the Colonial Engineering Service in Nigeria. He is a graduate of the Institution of Mechanical Engineers and graduated at the University of Edinburgh.

MR. A. R. CROFT, divisional accountant, at Middlesbrough, for the Northern Gas Board, has been appointed general manager of the Western Group of the Board at Carlisle. The area includes the Carlisle, Penrith and Workington divisions.

MR. A. ST. H. AUBREY, blast-furnace manager to the Skinningrove Iron Co. Ltd., Saltburn-by-the-Sea, Yorkshire, has been appointed works manager to the Sheepbridge Coal and Iron Co., Ltd., Chesterfield, where, at one time, he was blast-furnace under-manager.

MR. A. F. RIDLEY, F.L.A., has been appointed librarian at the National College for Heating, Ventilating, Refrigeration and Fan Engineering, Borough Polytechnic, London, S.E.1.

MR. ORLANDO OLDHAM is joining Oldham and Son Ltd., manufacturers of storage batteries and portable mine-lighting equipment, Denton, Manchester, on September 30. He is the only son of the chairman, Mr. John Oldham, O.B.E., J.P.

MR. R. J. PAINTER has been promoted to the position of executive secretary and **MR. R. E. HESS** to that of associate executive secretary and editor in chief of the American Society for Testing Materials, 1916, Race-street, Philadelphia 3, Pennsylvania, U.S.A. Both promotions became effective on September 16.

THE BRITISH ALUMINIUM CO. LTD., Norfolk House, St. James's-square, London, S.W.1, have opened a new branch office at 20, Brunswick-place, Southampton. (Telephone: Southampton 76780.) **MR. W. H. MARSTON** has been appointed area representative.

New district offices of **METROPOLITAN-VICKERS ELECTRICAL CO. LTD.**, and the **EDISON SWAN ELECTRIC CO. LTD.**, have been opened at 10-12, Hospital-street, Birmingham. **MR. A. F. BOCK** is the district manager for Metropolitan-Vickers and **MR. A. H. ADEY** the district manager for Ediswan.

MANUFACTURE OF ALUMINIUM-SHEATHED ELECTRIC CABLES.

JOHNSON AND PHILLIPS, LIMITED, LONDON.

(For Description, see Page 404.)

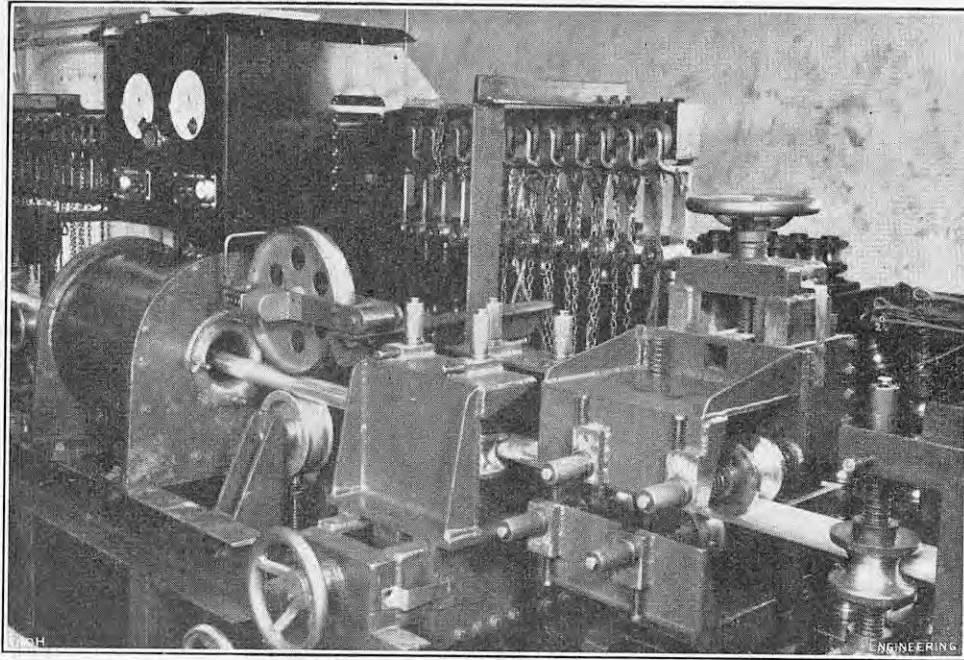


FIG. 11. STRAIGHTENING ROLLERS AND ELECTROMAGNET

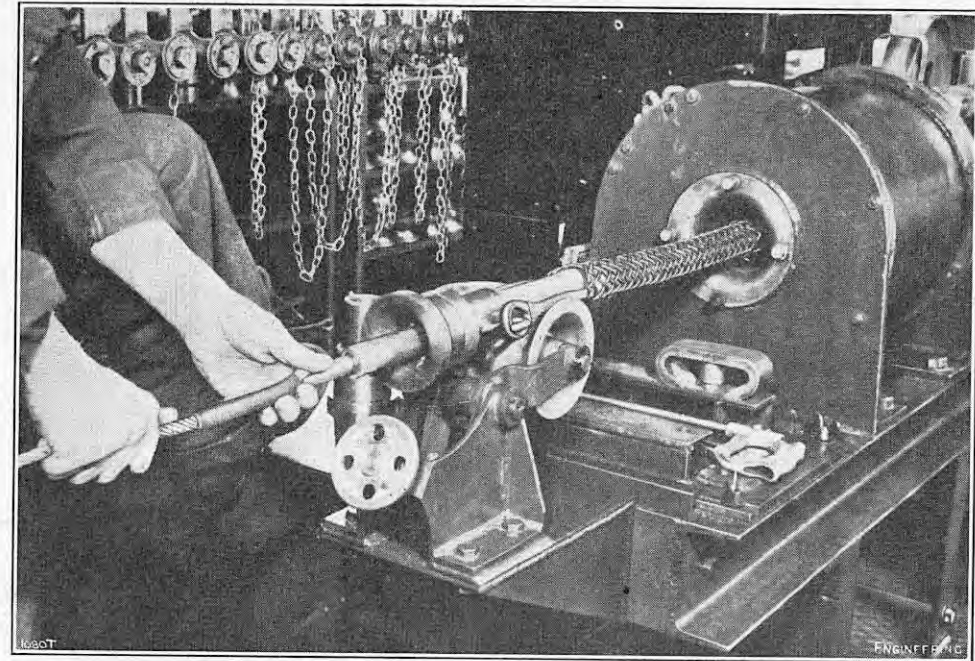


FIG. 12. STEEL MAGNET CORE AND TOW LINE.

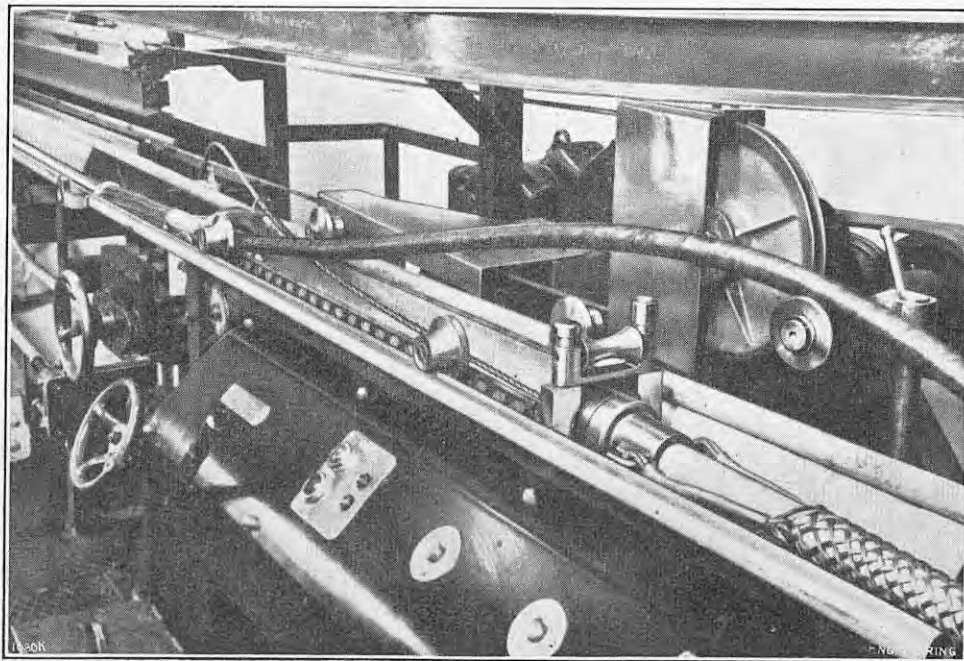


FIG. 13. SECOND LENGTH OF TUBE AND PROTRUDING CORE.

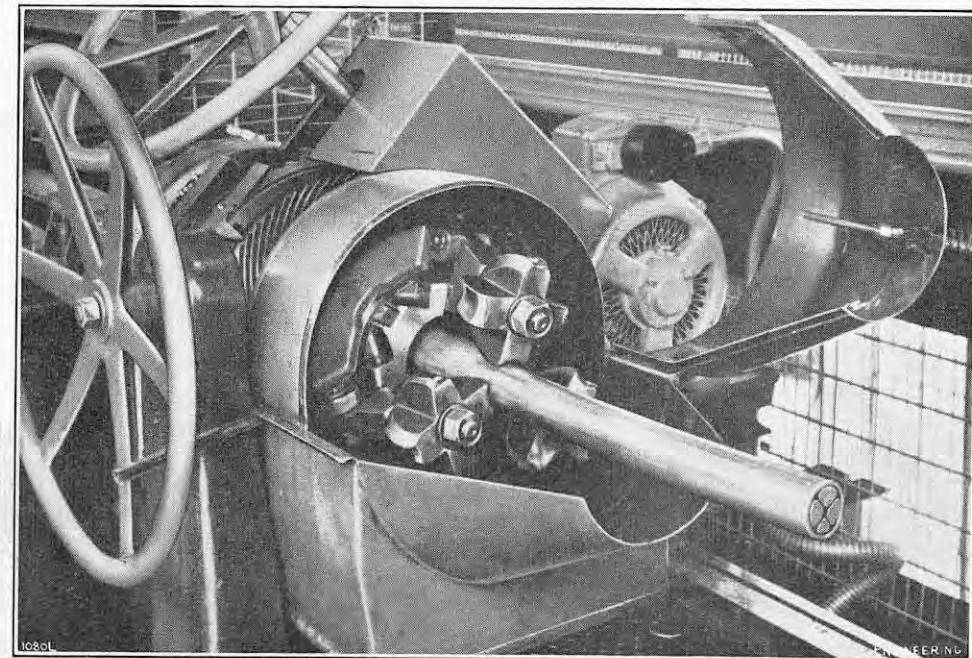


FIG. 14. SWAGING MACHINE.

ENGINEERING

35 & 36, BEDFORD STREET, STRAND,
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ADVERTISEMENT RATES.

Terms for displayed advertisements can be obtained on application to the Manager. The pages are 12 in. deep and 9 in. wide, divisible into four columns 2½ in. wide. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

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

TIME FOR RECEIPT OF ADVERTISEMENTS.

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

"Copy" instructions and alterations to standing advertisements for display announcements must be received 14 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, SEPTEMBER 26, 1952.

Vol. 174.

No. 4522.

INFORMATION.

SOME months ago 3,000 manufacturing firms in the Midlands were invited to submit, in confidence, to a voluntary panel of engineers, librarians and information officers, any technical problems for which an answer had not been found through any of the existing sources of information known to them. Forty questions came in. Ever if allowance is made for those firms—perhaps 50 per cent.—where the invitation went straight into the waste-paper basket, and a further allowance is made for those who preferred not to divulge, or even hint at, their future intentions, it is surprising that only 40 questions were submitted. If, as seems probable, some firms sent more than one question each, the number who took advantage of the gratuitous offer was even less than 40. Some firms, of course, would have their own efficient sources of information, but the proportion was probably very small.

The explanation—though not the justification—of this indifferent response is to be found in a paper given by Professor T. U. Matthew at the Aslib conference (reported on page 403) last week-end, from which the details of the experiment reported above are also taken. Studies conducted at the University of Birmingham, he said, suggested that the technical managers of many British firms were content to rely on the research associations to keep them advised of technical developments affecting their interests. Furthermore, in spite of the considerable national expenditure on research and development, many firms were not prepared to spend time and money on development work, and preferred to buy innovations in the fully developed form. To anyone who is primarily concerned with research, or with the publication and application of technical information, these observations will be surprising and disturbing; but to the anonymous technical managers whose indifference is imputed, they will appear simply as evidence that businesses exist to

be commercially successful, not to use technical information for its own sake. The truth probably lies somewhere between these two extremes.

Newspapers are read to-day and forgotten to-morrow. Technical publications on the other hand, flowing in a continuous stream of periodicals, institution papers, reports and the like, constitute a vast storehouse of information which can be drawn on at any time, and it is only when they are considered and used in this way that their full value is realised. It follows that any technical publication describing a new material or technique, or giving a new theory, could interest far more readers in the course of, say, ten years, than it does at the moment of publication. With increasing specialisation, the individual reader finds that only a fraction of the articles and papers which pass through his hands are of immediate interest to him, but in the course of time, with new problems arising in design and production, articles which meant nothing to him when he first glanced at their titles, may become significant. Meanwhile, however, he has almost certainly forgotten them. It is at this point that the system breaks down—if that can be called a system which serves those engineers who have ready access to technical librarians and information officers but makes no provision for those, probably far greater in number, who have to rely on their memory and rather meagre files of technical literature.

The problem facing industry, as well as librarians and information officers, is how to ensure that a search for information is easily and economically carried out. No industrialist will be won over to the idea of making good use of technical information unless he is confident that it is an economic proposition. On the other hand, the undoubted usefulness of librarians and information officers, and of the type of work that they undertake in some of the larger establishments, cannot be extended to any great extent until the significance of the subject is more widely recognised. The two aspects go hand in hand, and there is evidence that they are progressing, albeit slowly. In military circles there is a useful mnemonic for the essential parts of an operation order. Using the letters of the date, in French, 11 Mai (and regarding the figures 1 as letters I), the parts, in their correct order, are information, intention, method, administration and inter-communication. In industrial circles a new operation too often starts with "intention," and goes on to "method" without first considering "information."

Professor Matthew expressed the trend towards technical information services when he called for the recognition of a seventh function of management—the information function. The existing six functions, which he enumerated, are well established because they are indispensable, but the seventh can be, and is, neglected. In small and medium-size firms, where it would not be practicable to establish a full-scale service, a senior executive could be charged with the responsibility, as Professor Matthew advocated, "of reviewing and reporting upon, and maintaining, the essential key information services required by the organisation at all levels," and with seeking for "means of educating and training his existing staff to make use of the information services provided." There are, as he said, great possibilities for the future progress of industry in this proposal for the development of the information function of management in the individual company. He suggested, as a first step, further experiments of the type conducted in the Midlands, in which the Birmingham Chamber of Commerce collaborated. When he spoke of the submission of 40 questions, from the 3,000 firms who were approached, as "a most encouraging response," he was no doubt stressing the potential value of this notable experiment, rather than suggesting that it revealed a situation that could be regarded with

complacency. As "a positive informal means of bringing information services into touch with an ever-widening circle of industrial engineers and managers," it is the most constructive step that has been taken for some time. It is work such as this—much of it voluntary—that promises to extend the scope and utility of the existing information organisations.

Of these organisations, Aslib is the best known, and probably represents most closely the true interests of industry, since it is supported by contributions from industrial firms, with a grant from the Government. The precise manner in which Aslib should continue to function in the future is not easily defined. Since most member firms are represented at its meetings by their librarians or information officers, there is a danger of too much consideration being given to professional status and interests. Nevertheless, it was fairly evident at the conference that the consensus of opinion is in favour of ensuring that the Association continues to take the widest possible view of its functions. That implies, for example, that in bridging the gap between the storehouse of technical information and those who could use it, the initiative must come from Aslib and its members as much as from the potential users. Professional status and interests will follow automatically.

Of the good work that has been done in furthering these objects, much could be reported. The Aeronautical Group of Aslib is active in prosecuting a number of practical schemes. The Engineering Group, more recently established, is at present formulating its preparatory stages. In relation to similar work being done overseas, particularly in the United States, it may be possible to achieve some co-operation, which would reduce the amount of basic work that has to be carried out. In a few areas of this country, co-operative schemes are active which overcome, to some extent, the difficulties that the smaller firms have to face. There seems to be no reason to doubt that, in the fulness of time, no firm need think twice about the cost of using the best available information.

RESPONSIBILITY FOR ELECTRICAL ACCIDENTS.

THE latest report on electrical accidents*, issued by the Factory Department of the Ministry of Labour and National Service, contains a section headed "The Chain of Responsibility." It gives details of two accidents. In the first, a workman using a portable extension light consisting of an unskirted screwcap lampholder on a long flex, received a severe electric shock and narrowly escaped death. The extension had been made up by a fitter on instructions from the manager, neither of these individuals having sufficient electrical knowledge to appreciate the danger of using such a lampholder as a portable light. A firm of electrical contractors asking for a portable light were told the appliance was available and instructed a boy labourer to collect and plug it in. The boy evidently had sufficient electrical knowledge to realise that the unearthed lampholder was dangerous as he covered it with insulating tape, but his experience was not sufficient to make him realise that the screwcap was equally dangerous and he did not cover it.

In the second case, the proprietor of a small works obtained a secondhand portable electric tool. The plug was broken, causing the earth wire to come into contact with one of the live pins. The tool was handed over to the working manager with instructions to put it in the store until the plug had been changed. The repair, however, was not made and the manager handed the tool to some

workmen and told them to use it. A young man in the department called the attention of the foreman to the broken plug and asked "if it was all right." He was told it seemed to be and to get on with the job. As a result, he received an electric shock and was rendered unconscious. The manager was prosecuted for breach of duty, and fined.

At first sight, it might appear that no lesson is to be drawn from the fact that, in both these cases, the only people to realise the potential danger were juniors occupying minor positions in the chain of responsibility. The fact that they could not have had long experience in handling electrical apparatus, however, may have been the reason why they exhibited greater awareness of its possible danger: they had not attained the familiarity which breeds contempt. The report contains a table relating the number of reportable electrical accidents to the status of the individuals to whom they occurred. Excluding cases of eye-flash from electric welding, for which the necessary data are presumably not available, there was a total of 611 non-fatal and fatal accidents. Of these, 309 occurred to skilled workmen and 302 to unskilled. To be fully informative, these figures would have to be related to the total number of workmen of each class who were exposed to the possibility of accidents. This figure is not given; probably it is not known.

Apart from this, however, it is unsatisfactory that 309 accidents occurred to skilled men who should have been well aware of any possible danger from the material and plant they were handling. Some of the accidents were not due to the actions of the individuals concerned but to defective apparatus. If, however, an attempt is made to trace a chain of responsibility it must lead back to some individual who should have ensured that the apparatus was not defective. Some failures of material occur which it may fairly be claimed could not have been foreseen, but most accidents due to defective apparatus are due not to material itself but to the way in which it is assembled. The report gives details of 81 cases of failures of explosive violence and/or causing fire. By far the majority of these were due to incorrect actions, either by assembly electricians or operators. One example was a case in which three men were burned, two severely, when pushing a cable into a live 'bus-bar chamber, an old piece of fuse wire left in the chamber became dislodged and caused a fault. A second was a case in which a switch-fuse exploded, shattering the oil tank, owing to the operator connecting a new transformer without phasing out, thus paralleling two systems out of phase.

The table lists various cases of circuit-breaker explosions due to the oil level being too low; these are examples of defective maintenance. It also lists cases of circuit-breakers failing because these were of inadequate rupturing capacity. There is no question here of inadvertence or slack maintenance. The provision of oil switches adequate for their job is a task for those who occupy leading positions in the chain of responsibility. The situation is often difficult. Owing to development in the size of systems and the growing demands for supply, much gear adequate when installed is now too small. The report states that Area Boards "owing to the limited funds available," may "tend to relegate switchgear replacements to positions of low priority, even though inadequacy is known, and the risk of explosive failure realised." It is not suggested that nothing is being done. In some cases, it has been possible to reduce the short-circuit kVA by sectionalising; in others, old circuit-breakers have been protected by fuses of high rupturing capacity, but this is a matter which occupies a position of some importance in the list of causes of electrical accidents.

Of the 309 accidents to skilled workmen, 212 happened to electricians and jointers. The reason for this high proportion is that this class of trades-

man is frequently required to work on, or near, live gear. The report states that such accidents occur particularly with switches and fuses. As "only a minority of switchgear accidents are due to defective design and construction" it must be concluded that the majority of such accidents are due to oversight or over-confidence of the men themselves, as in the case in which an electrician applied an earthing lead to the live contact of an isolating switch. It is difficult to suppose that qualified electricians are not acquainted with the dangers associated with live gear; too frequently, however, they either ignore or forget them. The report suggests that many men would profit by instruction on safe methods of work on or near live gear. This is no doubt true, but no instruction will ever eliminate human fallibility which may affect every link in the chain of responsibility.

It is certainly the business of everyone concerned with the layout and maintenance of electrical plant to do everything possible to provide against human vagaries, although some accidents have been due to erratic behaviour which no one could have been expected to foresee. A proportion of accidents due to carelessness can, however, be provided against by interlocking arrangements, and it is highly desirable that those concerned with both design and maintenance should study this detailed and informative report. It will tell them what can, and does, happen. The chain of responsibility begins on the drawing board, and although the best provisions made by designers may be rendered nugatory by inadequate maintenance, that is no reason why constant effort should not be made to provide for every possible contingency. The designer must reconcile himself to the fact that at times his best intentions will be defeated by neglected maintenance. For instance, certain 33,000-volt cellular-type switchgear installed in 1942, was provided with numbered keys and locks for various cells. The keys became so worn that, in 1950, a junior shift engineer was able to insert one in the wrong lock, open an isolating switch still on load, and cause short which resulted in the shut-down of the whole station.

NOTES.

BRITISH OVERSEAS AIRWAYS CORPORATION.

THE year 1951-52 was a gratifying one for British Overseas Airways Corporation. For the first time in their history, the Corporation made a surplus of 274,999l., after paying interest on issued capital, it is recorded in the *Annual Report and Accounts for the Year Ended 31st March, 1952*, published by H.M. Stationery Office, price 3s. net. This surplus compares with a deficit of over 4l. million for the year 1950-51; the total revenue has increased from 24,252,115l. to 33,567,862l.; the operating cost has been reduced from 39.5d. to 38.8d. per capacity-ton-mile; and the load factor (i.e., the ratio of the load carried to the load that could be carried) required to break even has been reduced from 75 per cent. to 65 per cent. Four factors have contributed to the progress of the Corporation. Firstly, it was the first complete year in which they were operating with a fleet of four-engined pressurised aircraft—Argonauts, Stratocruisers, Constellations and Hermes; since the year 1947-48, the output per aircraft has risen from 562 to 1,399 capacity-ton-miles per flying hour. Secondly, over the past five years there has been a drastic reorganisation of staff, and the average output per employee has risen from 3,790 capacity-ton-miles a year, in the year 1947-48, to 11,865 in 1951-52. The other factors are an increased sales drive and the adoption of modern business and accountancy methods. Thus, in the five years under discussion, operating costs have been reduced from 56.6d. to 38.8d. per capacity-ton-mile. During 1951-52, development work was carried out on the introduction of the Comet service, and the start of tourist services across the North Atlantic. It is satisfactory to know that all aircraft now on

**Electrical Accidents and their Causes*, 1950. H.M. Stationery Office. (Price 3s. net.)

order for the Corporation are of British design and construction—the de Havilland Comet for high-speed first-class services, and the Bristol Britannia for slower tourist services. With the introduction of the Comet into service, the report states, the Corporation is confident that it has achieved a lead for a considerable period. There are long-term plans for jet-transport aircraft with greater capacity and range than the Series II Comets powered by Rolls-Royce Avon engines, which are on order for operating over longer stage distances than the Comet I aircraft now in service. The excellent safety record of the Corporation has been maintained; there have been no accidents involving fatalities or serious injuries to passengers during the last four years, and in recognition of this accomplishment, the Cumberbatch Trophy of the Guild of Air Pilots and Navigators has been awarded to the Corporation's No. 3 line "for their outstanding contribution to safety in the air since commercial operations were resumed across the Atlantic after the War." Among the other matters dealt with, the report states that the policy of concentrating aircraft maintenance at London Airport cannot be fully realised until the new engineering maintenance building is completed. (At present, Constellations and Stratocruisers are based on Filton.) The new building, the construction of which is organised by the Ministry of Civil Aviation, will comprise four hangar pens, with an area between them housing the main workshops, stores and offices, canteens, and a training school. The building will be completed, it is hoped, during 1954. The engine and propeller overhaul factory at Treforest, it is reported, has made an effective contribution to the development of engines and propellers. The partial silencing of the engine test beds, in compliance with an order made under the Town and Country Planning Act, is proceeding. Plans for converting some of the test beds for the overhaul of jet engines have been approved.

LABOUR CONDITIONS IN GREAT BRITAIN IN 1951.

Industrial life in Great Britain in 1951 presented a general picture of continuity and stability, according to the *Annual Report of the Ministry of Labour and National Service for 1951* (Cmd. 8640, H.M. Stationery Office, price 6s. net), published last Friday. The total working population, the report states, expanded in that year, as it had done for several years, and the number of persons in the Armed Forces and in civil employment both increased. In the autumn of 1951, the total of persons in work reached a peak figure of 23,500,000, the highest total on record during peace time. Unemployment in July of that year was at its lowest level since the middle of 1945, with fewer than 200,000 persons out of work. In the same month, also, there were more than 500,000 unfilled vacancies. The year bore the first impact of three important industrial and political developments, the expansion of the re-armament programme, the calling up of Z-class reservists and the replacement of the Conditions of Employment and National Arbitration Order No. 1305 by the Industrial Disputes Order, for the settlement of industrial disputes. In this connection, it is recorded that the cancellation of Order 1305 had no adverse effect on industrial relationships. Indeed, fewer working days were lost during the second half of the year than in the first half and fewer than in the corresponding months of 1950, but other factors doubtless contributed to this result. The main consequence of the growth of the re-armament programme was its stimulus to the working population to increased output. As the year passed, more and more contracts were placed by the Government for naval, military and air equipment and supplies, and for building and civil-engineering work essential to the re-armament plans. Nevertheless, the check to the expansion of production which was experienced, owing to shortages of materials and a decline in the demand for the products of such industries as the textile, began to be reflected in the man-power situation towards the end of the year. After July unemployment rose appreciably, until, at the close of 1951, it had reached almost the same level as at the opening of the year, with just over 300,000 persons out of work, or an average of approximately 1.4 per cent. of the total number of employees in Great

Britain. During the twelve months, the 1,151 local offices of the Ministry, aided by the youth employment offices of certain local authorities, were successful in placing over 2,400,000 persons in employment, although the number of notified vacancies unfilled totalled nearly 313,000. The Ministry's technical and scientific register filled 2,569 vacancies during the year. At the middle of December last, there were 5,219 persons on that register, of whom 1,292 were unemployed and 3,927 were in work, but seeking a change of occupation. While the placing of older people in professional or managerial positions was a continuing problem, employers were less inclined than formerly to specify upper age limits when notifying vacancies to the Ministry. Officials of the Ministry assisted in the settlement of 330 disputes during the year, but it is noted that it remains the policy of the Government to leave wages and working conditions to be settled by negotiation between employers and workpeople and their representatives. Employers continued to take increasing advantage of the advisory service which the Ministry provides on problems of personnel management.

CALVERTON COLLIERY.

The Rt. Hon. the Lord Leathers, P.C., C.H., Secretary of State for the Co-ordination of Transport, Fuel and Power, opened the new colliery and railway branch line at Calverton, Nottinghamshire, on Wednesday, September 24. Lord Leathers paid tribute to B.A. Collieries, Ltd., and their chairman Colonel C. G. Lancaster, M.P., who initiated the project in 1937 as an extension to the Bestwood Colliery, and to the Midland Region of the National Coal Board and the Midland Region of British Railways who had completed the works which he described as the most up-to-date colliery in Europe. He concluded by restating the need of the country for coal and pointing out the value of the 130 million tons of coal thought to be available in the seams, which it was intended to raise at the rate of 1½ million tons a year. Sir Hubert Houldsworth, chairman of the National Coal Board, added his tribute to the previous owners for the valuable asset that had been handed over to the Board. Mr. John Benstead, deputy-chairman British Transport Commission, described the work involved in the construction of the seven-mile branch line from the main line passing through Nottingham. Lord Leathers then pressed a master switch to put the new plant into operation, and was then inspected by the Minister and other guests who had travelled in a special train from London or Nottingham. The party then returned to Nottingham for lunch, which was followed by the presentation to Lord Leathers, by Mr. R. Ringham, J.P., Chairman, Midland Region, N.C.B., of a cigarette box in the form of a model of the new 24½-ton railway wagons which are to be used for removing the coal from the colliery. A description of the plant and works will be given in *ENGINEERING* at a later date.

BRITISH ELECTRICITY CONSUMPTION.

The monthly statistics setting out the amount of electricity sold by the British Electricity Authority to the Area Boards and sent out by the Boards to their consumers show that the downward trend of consumption, noted in the earlier returns, continued during August. The actual sales amounted to 3,631 million kWh, compared with 3,732 million kWh in August, 1951, a reduction of 2.8 per cent. During the year ended August 31, 1952, however, 54,930 million kWh were sold, an increase of 1.7 per cent. over the figure for the previous 12 months. When these figures are adjusted to normal weather and standard working days, they become — 0.7 per cent. and 3.6 per cent. respectively. The total electricity sold in the "mainly industrial" areas during August, 1952, was 2,304 million kWh, a decrease of 5.4 per cent. from the figures of August, 1951, while in the "mainly non-industrial" areas it was 1,266 million kWh, an increase of 2.1 per cent. The largest decrease (—12.9 per cent.) occurred in the "mainly industrial" North Western Area and the largest increase (+4.5 per cent.) in the "mainly non-industrial" Southern Area. It may be pointed out that in collating these figures no account is taken of the Area Boards' purchases from other sources. These are, however, small,

and are unlikely to have any material effect on the percentage changes. The increase in the Southern Area may be partly ascribed to the load on the new refinery at Fawley and that in the South Wales Area (0.7 per cent.) to the connection of the new steelworks at Margam and Trostre, though the effect of these upon the monthly figures, as might be expected, is becoming less. The decreases of 9.6 per cent. in the Mersey and North Wales Area and of 9.4 per cent. in the North Eastern Area, are said to be partly due to the reductions of energy interchange, which have followed the extension of some large private generating plants operated in conjunction with public supply. An increase of 1.6 per cent. in the twelve months total in the North Western Area is the result of a large new industrial load, but as already noted, the figures for August, 1952, were 12.9 per cent. less than those in August, 1951.

INTERNATIONAL ELECTROTECHNICAL COMMISSION.

Nineteen countries were represented by a total of 428 delegates at a series of meetings of Committees of the International Electrotechnical Commission, which were held at Scheveningen, Holland, from Wednesday, September 3, to Saturday, September 13. The technical subjects dealt with at meetings lasting from one to five days, included the dimensions of electric motors, methods of declaring the efficiency of rotating machinery, graphical symbols, turbo-alternator sets, voltages, mercury-arc rectifiers, capacitors, batteries and insulators. The results of these meetings will eventually be published in the form of recommendations, which serve as a model for the drafting or revision of national standards. All the participating countries are pledged to adopt the recommendations in so far as national conditions permit. During the conference a number of technical visits were paid, including one to inspect the dams which are now being built for the reclamation of the Zuyder Zee. At a meeting of the Council, Dr. H. S. Osborne, president of the United States National Committee, was elected president and Dr. P. Dunsheath was re-elected treasurer. An invitation from the Yugoslav National Committee to hold a series of meetings in that country in June, 1953, was accepted, after an assurance had been given that the delegates from all member countries of the Commission would be able to obtain the necessary visas.

LETTER TO THE EDITOR.

PRODUCTION OF COMBUSTIBLE AND FERTILISING SLUDGE AT MAPLE LODGE SEWAGE WORKS.

TO THE EDITOR OF *ENGINEERING*.

SIR,—Mr. Willians, in his letter to you published on page 308 of your issue of September 5, is surely not exaggerating in speaking of the criminal waste in our sewage disposal. The fertility that is constantly being sent out to sea is something that no engineer or technologist can synthesise. May I take the matter a stage farther?

We have in our cities elaborate paraphernalia for dealing, quite independently, with two kinds of waste—excreta, and household refuse (with which may be included organic industrial wastes); handled separately, these are unpleasant nuisances. Yet Nature intended nothing concerned with life to be wasted. These so-called wastes are actually raw material for something else, and they are mutually complementary. Acting together with a vast army of unpaid yet indefatigable fungi and bacteria, they yield a substance, organic compost, of greater value to soil fertility than anything else we have; better even than good old farmyard muck. It is well within the capabilities of engineers to devise convenient new plant for dealing with refuse and sewage together. A number of municipal authorities both here and abroad (notably, I believe, in South Africa) are already practising composting with success. The sale of well-made compost might be a useful offset to the municipal running costs.

Yours faithfully,

MAURICE CARD.

Mill-road, Rearsby,
Leicester.
September 17, 1952.

INTERNATIONAL COMMERCIAL MOTOR SHOW.

THE International Commercial Motor Show, which is due to open at Earl's Court, London, to-day, is the third exhibition of its kind to be held since the end of the war and the 16th of a biennial series instituted in 1907, five years after the organisers, the Society of Motor Manufacturers and Traders, was founded. The show this year coincides, therefore, with the jubilee of the organisers and it is, perhaps, only appropriate that it should be the largest and most comprehensive to be held so far. Altogether, well over 400 firms are represented at the exhibition, comprising 37 commercial-vehicle manufacturers, 74 body and trailer builders, 220 accessory and component manufacturers, 54 transport-service equipment producers, 14 tyre manufacturers and 21 associations and information services. Of these, the commercial-vehicle bodies and trailer exhibits are on the ground floor and cover 433 different vehicles, a greater number than ever before. All the other products are on view on the first floor, the space available having been extended this year. These latter exhibits cover an extremely wide variety of products ranging from heavy garage equipment to the smallest components used in the manufacture of vehicles, and it is probably fair to say that no other such exhibition in the world covers so effectively the many facets of the commercial-vehicle industry. In general, there are no striking innovations and, for the most part, the vehicles on view follow the trends evident during the previous post-war exhibitions. There are, however, a number of new chassis fitted with under-floor engines, so that it may be appropriate to commence our review of the exhibits by describing one of these.

44-SEAT 'BUS CHASSIS WITH UNDER-FLOOR ENGINE.

A good example is furnished by the Tiger Cub, a new Diesel-engined under-floor engined passenger chassis being shown by the manufacturers, Leyland Motors, Limited, Leyland, Lancashire, for the first time. This machine is illustrated in Figs. 1 and 2, on this page, Fig. 1 showing the chassis equipped with a prototype 44-seat body made by Metropolitan-Cammell-Weyman Motor Bodies, Limited, and Fig. 2 illustrating the bare chassis. Considerable trouble has been taken with the design of this vehicle to reduce weight to a minimum without sacrificing strength; as a consequence, fuel consumptions giving about 16 miles per gallon have been obtained, undoubtedly a remarkable figure and one normally associated with large private cars. The chassis has an overall length of 29 ft. 4½ in., a width of 7 ft. 8 in. and a wheelbase of 16 ft. 2 in. The front overhang is 5 ft. 8½ in., the rear overhang 7 ft. 5½ in. and the turning circle 60 ft. When "dry," that is, without fuel, oil or water, the weight of the chassis is just over 3 tons 11 cwt., and when fully equipped, 3 tons 14 cwt. 3 qr. That considerable thought has been expended on obtaining this low weight is emphasised by the fact that the clutch and main transmission units incorporated in the chassis were designed originally for use in heavier vehicles.

The engine fitted in the Tiger Cub chassis is a horizontal version of the 351-cub. in. vertical unit used in the Leyland Comet "90" cruiser-weight range of trucks and commercial vehicles; it is illustrated in Fig. 3, opposite. Several improvements and refinements have, however, been incorporated in the horizontal unit: it has, for example, an automatic advance and retard mechanism designed to give optimum timing to the fuel-injection system. This unit operates on the bob-weight principle and is incorporated in the drive from the inlet Venturi through a large diaphragm, and governs progressively throughout the speed an all-pneumatic governor operated by vacuum from the inlet Venturi through a large diaphragm, and governs progressively throughout the speed range of the engine. In general, however, the design of the engine remains the same and apart from a re-designed 4½-gallon sump with an elongated filler, the only major changes from the vertical

EXHIBITS AT THE COMMERCIAL MOTOR SHOW.



FIG. 1. "TIGER CUB" WITH 44-SEAT BODY BY METROPOLITAN-CAMMELL-WEYMAN MOTOR BODIES, LIMITED; LEYLAND MOTORS, LIMITED.

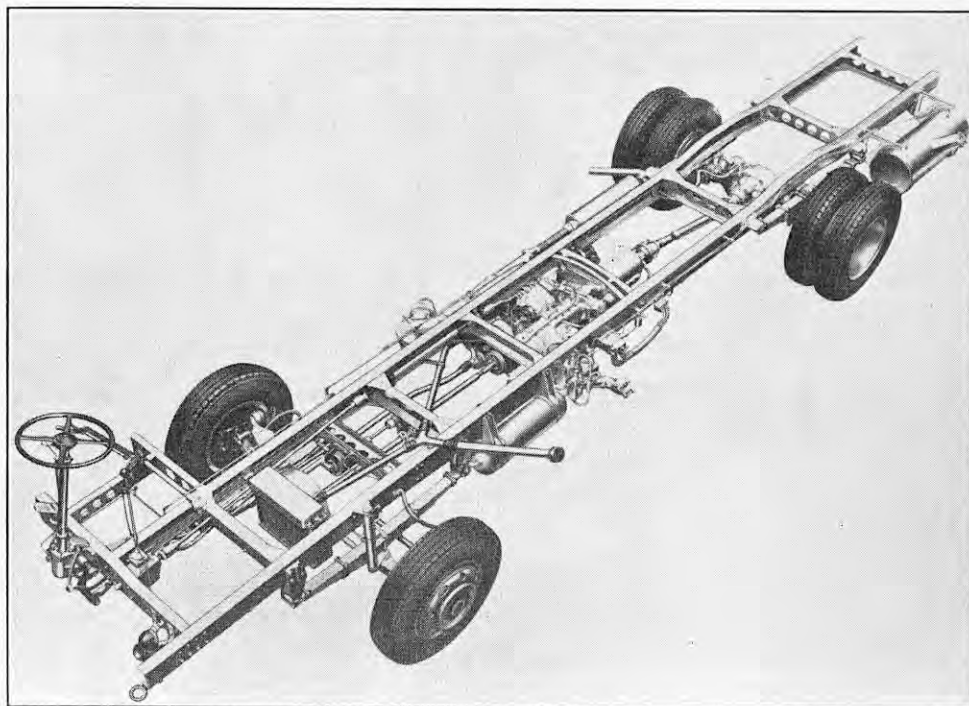


FIG. 2. "TIGER CUB" CHASSIS; LEYLAND MOTORS, LIMITED.

engine are a rearrangement of the auxiliaries and the complete elimination of all belt drives, the centrifugal water pump now being driven through a helical gear meshing with the camshaft gear. The auxiliaries have been arranged so that the filters for the fuel and lubricating oils are now mounted externally on the left-hand side of the engine, the compressor for the brakes at the front left-hand side and the fuel-injection pump on top of the engine where it is easily accessible through a trap door in the body floor.

The engine is built integrally with the gearbox and the complete assembly is mounted well below frame level. In common with other Leyland passenger vehicles, the assembly is suspended from rubber-bushed flexible links. These constrain the engine to oscillate on an axis between its centre of gravity and the front joint of the propeller shaft, the vibration transmitted to the chassis, in consequence, being almost negligible. At the front of the engine, a propeller shaft coupled to the forward end of the crankshaft transmits the drive to a gearbox mounted on one of the cross-members. Two shaft-drives extend forward from this gearbox, one of which drives a 7-in. diameter dynamo suspended from a cross-member and the other an 18½-in. diameter radiator fan. In the latter case, the drive shaft is extended over the front axle in close proximity to the radiator. The size of the bell housing at the rear of the engine has been

increased to take the larger 16½-in. diameter heavy-duty clutch which, as previously mentioned, replaces the unit normally fitted to the Comet "90" engine. It has a flexible centre carried on a hub with involute splines which can easily be removed from the combined input shaft and pinion of the gearbox. Non-metallic ¼-in. thick liners are fitted, and a four-stage adjustment incorporated in the withdrawal mechanism permits the full thickness of the liners to be used before renewal becomes necessary. Adequate cooling is provided by currents of air which pass through slots formed in the liners and the flywheel.

The gearbox is a modified version of the manufacturers' standard unit as fitted to their Tiger and Titan 'bus chassis immediately after the war. It employs constant-mesh gears for top, third and second speeds, engagement being effected by dog clutches. All gears are of the single-helical type and the ratios in the various speeds are: first, 4.78 to 1; second, 3 to 1; third, 1.74 to 1; and top, 1 to 1. The selector mechanism is located on the cover and the linkage from the change-speed lever is by light tubular shafts and universal joints. A single tubular propeller shaft fitted with heavy-duty Hardy-Spicer universal joints transmits the drive to the rear axle. This is an Eaton two-speed unit, the gear change being effected by an electric motor mounted on the axle casing and controlled through a push-pull switch at the driving position.

EXHIBITS AT THE COMMERCIAL MOTOR SHOW.

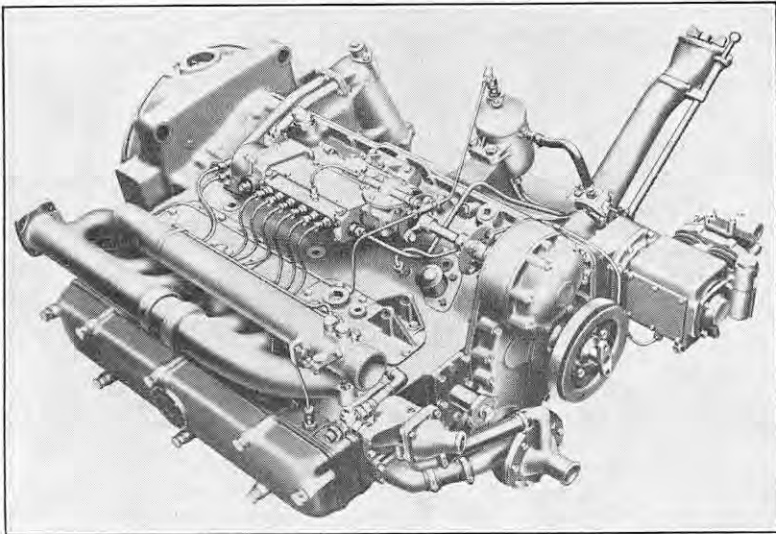


FIG. 3. ENGINE FOR "TIGER CUB"; LEYLAND MOTORS, LIMITED.

Three alternative sets of ratios are available, namely: 4.8 and 6.8 to 1; 5.62 and 7.81 to 1; and 6.14 and 8.52 to 1. With the first set of ratios, the manufacturers state that a fully-laden 'bus will accelerate up to 38 miles an hour in low ratio and up to 52 miles an hour in high ratio.

An outstanding feature of the chassis is the compressed-air braking system. This incorporates a single reservoir fitted with an unloading valve and charged to a maximum pressure of 100 lb. per square inch by an engine-driven compressor. Air is released from the reservoir to the brake chambers through a special type of control valve designed so that it has a progressive action to give straight-line braking characteristics, the brakes, as a consequence, having an exact response to pedal pressure. Furthermore, as the brake pedal is depressed, it makes contact with a spring-loaded buffer, the height of which can be adjusted to give the required braking characteristics. For normal service operation, the pedal is depressed as far as the stop, but for an emergency stop, the driver exerts additional pressure on the pedal to overcome the resistance of the buffer spring, in which event the full force of the air inside the reservoir is made available for brake application. It is claimed that by this means retardations up to 24 ft. per second per second are made available. In place of the more usual pistons, the brake chambers are actuated by diaphragms; these operate the brake cam shafts through short push-rods and levers which incorporate Bendix-Westinghouse slack adjusters. The total area of the foot-brake linings is 623 sq. in., this figure being made up from 4½-in. wide linings for the front wheels and 7-in. wide linings for the rear wheels, both of which operate in 15½-in. diameter drums. Moulded linings are used and the drums are provided with deep fins to assist cooling.

The frame has a width of 34 in. and consists of parallel side members tapering in depth to the front and rear in accordance with normal practice. Use of a narrow frame has made it possible to employ outriggers for the spring anchor brackets, thus enabling the height of the frame to be reduced. The right-hand frame member narrows at the mid-section to give clearance for the engine and at this point it is reinforced with a further length of channel-section steel. The maximum section of the side members is 8 in. deep by 3½ in. thick and the flanges are 3 in. wide. Steering and springing are conventional, the steering system incorporating a Marles cam-and-double-roller steering box, which is rigidly mounted on the foremost cross-member. A 22-in. diameter steering wheel, somewhat larger than usual, is fitted, the ratio being 28.5 to 1. Semi-elliptical springs are fitted to both axles, those at the front being 3 in. wide and 60 in. long, and those at the rear 3 in. wide and 62 in. long. To increase resistance to fatigue, the tension side and edges of the top leaves are shot-peened. Hydraulic shock absorbers are fitted at the front and, when laden, the springs have

a pronounced reversed camber. The standard chassis is fitted with a 24-volt lighting and starting system of Simms manufacture. A 7-in. dynamo is used and this has an output of 1,390 watts. All lighting controls, together with the indicator lamps for dynamo charging, oil pressure and the trafficators, are installed in a combined switch-board and terminal box. The instruments comprise a clock, a combined water-temperature and air-pressure gauge and a speedometer. An alternative electrical system of C.A.V. manufacture is available, the dynamo in this case having an output of 1,320 watts. The batteries are of C.A.V. or Exide manufacture with capacities of 116 and 113 ampere-hours on a ten-hour rating or of Oldham manufacture with a capacity of 120 ampere-hours.

TRACTOR FOR USE WITH SCAMMELL TRAILERS.

Other vehicles on the stand of Leyland Motors, Limited, include the new short-wheelbase Comet "90" tractor illustrated in Fig. 4, herewith. This vehicle has been produced specifically as a prime mover for Scammell articulated semi-trailers. In general, the tractor chassis is similar to others in the Comet range and is fitted with the makers' 90-h.p. six-cylinder Diesel engine, a five-speed gearbox and a two-speed Eaton back axle. The length overall is 14 ft. 4 in. and the width 7 ft. 5 in.; a wheelbase of 8 ft. 7 in. allows the vehicle to turn in a circle of 35 ft. It is fitted with a 10-ton semi-trailer built to the order of British Insulated Callender's Cables, Limited, which has an inside body space of 7 ft. by 20 ft. The side members and rear cross-member are made from rolled-steel channel sections and there are three tubular cross-members, the forward one of which carries the turntable and retractable undercarriage. The Scammell automatic semi-trailer coupling gear, consisting of two runways bolted to the tractor frame, takes the flanged wheels of the trailer's coupling gear, the two parts being locked together automatically by two claws which engage with the oscillating beam of the trailer turntable. Coupling and uncoupling is entirely automatic.

The trailer brakes are operated by means of a servo mechanism on the tractor unit, the control valve being so designed that the initial pressure on the foot-brake pedal opens the valve to the servo and applies the brakes on the trailer. Further movement of the pedal increases the braking effort on the trailer and at the same time applies the brakes on the four wheels of the tractor. With this system, the trailer brakes must be applied before those on the tractor, thus adding considerably to safety in operation, particularly on wet roads. The system also dispenses with the need for fitting separate servos to each trailer and has the added advantage of dispensing with the air pipe line from the tractor to the trailer necessary to operate the servos. An additional feature is that the valve controlling the servo for the trailers is of the reaction

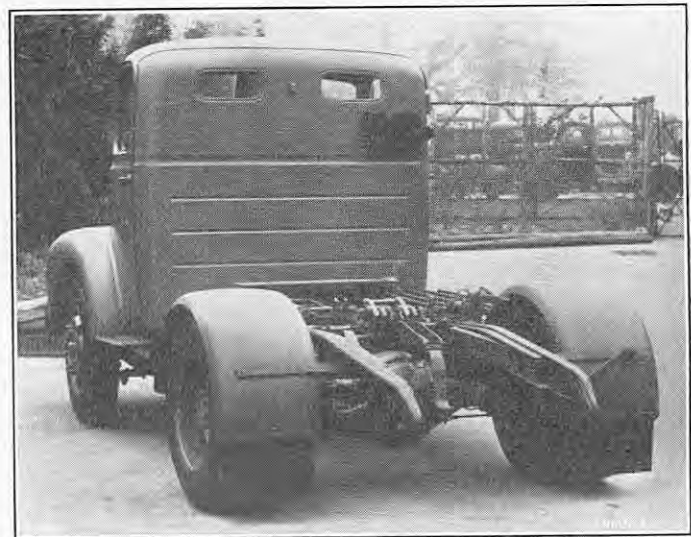


FIG. 4. COMET "90" TRACTOR; LEYLAND MOTORS, LIMITED.

type; this automatically adjusts itself, the braking pressures thus providing compensation between the tractor and trailer brakes. A large-capacity vacuum reservoir is installed on the tractor and the equipment provided includes a vacuum gauge. Two hand-brake levers are fitted to the tractor, one of which applies the brakes to the rear wheels of the tractor while the other operates the trailer brakes through a king pin in the centre of the turntable. A separate parking brake is fitted to the trailer for use when uncoupled from the tractor.

HEAVY-DUTY EXPORT CHASSIS.

Leyland Motors are also showing one of their range of vehicles designed specially for heavy-duty haulage under the arduous conditions frequently encountered overseas. Known as the Super-Hippo, Model EH.4AL, it is a bonneted-type rigid six-wheeler with two rear driving axles which incorporate heavy worm final drives and differential gears. It has a wheelbase of 17 ft. 9 in. and provides a platform length of 20 ft. 9 in., the maximum gross laden weight being 47,600 lb. The engine is a six-cylinder direct-injection Diesel unit having a capacity of 597 cub. in. and developing 125 h.p. at 1,800 r.p.m. The engine, clutch and five-speed gearbox are built as a unit which is mounted flexibly at the front end and held by a banjo-type cross-member at the rear. A step-down auxiliary gearbox having a ratio of 1.0 to 1.328 is fitted as standard. A three-man cab is installed which, to provide good insulation in various climates, is of double-skin construction, the space between the two skins being filled with Isoflex. Equipment supplied with the vehicle includes a Clayton-Dewandre large-capacity heater, ventilator and windscreen-demisting unit, leather upholstery with rubber filling and a large locker for use by the crew. Glazing throughout consists of toughened-plate glass and sun visors are fitted to both the exterior and interior of the cab.

(To be continued.)

FILMS ON WHITE LEAD PAINT.—Associated Lead Manufacturers, Ltd., 14, Finsbury-circus, London, E.C.2, have sponsored two films, entitled "White Lead" and "Magnet—a White Lead Paint," which they intend to show to paint users and specifiers to encourage the use of white-lead paint. The first of these films, which describes the mining of lead ore and the conversion of purified pig lead into white lead, is suitable for showing to technical schools and general audiences. It is available in the 35-mm. and 16-mm. sizes, and has a running time of 20 minutes. The other film is a 16-mm. Kodachrome, and has a running time of 16 minutes; it shows how white lead is used in making Magnet paint, and demonstrates the advantages of the latter paint. Both films were made by World Wide Pictures Ltd., in collaboration with Cecil D. Notley Advertising Ltd. They are available on application to any of the offices of Associated Lead Manufacturers Ltd.

THE INSTITUTE OF METALS.

As stated on page 379, *ante*, the autumn meeting of the Institute of Metals opened in Oxford on the evening of Monday, September 15, with the delivery of the Autumn Lecture, entitled "On the Foothills of the Plastic Range," by Professor H. W. Swift, which we commenced to print on page 383, *ante*. On Tuesday morning the meeting was continued in the Clarendon Laboratory, Parks-road, and the chair was taken by the Chairman of the Reception Committee, Dr. H. M. Finnis. At the outset of the proceedings, the Mayor of Oxford, Councillor W. C. Walker, O.B.E., and the Vice-Chancellor of the University, Sir Maurice Bowra, M.A., D.Litt., welcomed the Institute to the City. In the course of his speech, Mr. Walker said that he was glad to note that, in addition to their scientific discussions, members of the Institute were to visit works and other establishments in Oxford and its vicinity. Sir Maurice Bowra, in his address of welcome, expressed gratitude to the Institute for the manner in which they had helped, in past years, and were still helping, members and students of the University in their studies and researches. In reply, the President of the Institute, Dr. C. J. Smithells, M.C., thanked the City and the University for their hospitality and for the trouble their staffs had taken in making preparations to ensure the success of the meeting. After the official welcome, Dr. Smithells took over the chair and the meeting passed on to the reading and discussion of technical papers. Two simultaneous scientific sessions were held, the first, session "A," being devoted to the discussion of papers of industrial interest, and the second, session "B," to papers on physical metallurgy.

WROUGHT COPPER-ALUMINIUM-NICKEL-IRON ALLOYS.

The first paper taken at session "A" was by Dr. Maurice Cook and Messrs. W. P. Fentiman and Edwin Davis, of the Metals Division, Imperial Chemical Industries, Limited, Birmingham, and dealt with "The Structure and Properties of Wrought Copper-Aluminium-Nickel-Iron Alloys." It was presented by Mr. Davis. The authors stated that they had made a study of the structure and properties of complex aluminium bronzes containing from 8 per cent. to 12 per cent. aluminium and from 4 per cent. to 6 per cent. each of nickel and iron. Four phases, namely, α , β , δ and κ , had been identified and, structurally, the alloys could be divided into three classes. In the first class were alloys containing from 8 per cent. to 9 per cent. of aluminium, which, consisting of α and β at 1,000 deg. C., changed to α and κ at lower temperatures. In the second class were alloys containing 10 per cent. of aluminium, consisting of β at 1,000 deg. C., α , β and κ between 800 deg. and 900 deg. C., and α and κ at lower temperatures. In the third class were alloys containing from 11 per cent. to 12 per cent. of aluminium, consisting of β at 1,000 deg. C., changing from $\beta + \kappa$ to $\alpha + \beta + \kappa$ over the range 800 deg. to 600 deg. C., and finally changing to $\alpha + \kappa + \delta$.

The mechanical properties of alloys containing 8, 10 and 12 per cent. of aluminium with 5 per cent. each of nickel and iron, representative of the three main structural classes, had been determined in the quenched, quenched and tempered, hot-rolled, and hot-rolled and annealed conditions, and these properties had been related to the structures. In general, optimum properties had been obtained with the 10/5/5 alloy. The effect of cold rolling on the mechanical properties of this alloy had shown that plate hot-rolled to $\frac{3}{16}$ in., and annealed at 750 deg. C., could be initially reduced in thickness by cold rolling to the extent of about 30 per cent., before edge-cracking began, but cracks developed on subsequent cold working after annealing at 750 deg. C. To obviate this difficulty, it was essential, before cold rolling, to anneal the hot-rolled stock at 825 deg. C. and slowly cool it to 750 deg. C. Plate so treated could be cold rolled with successive reductions of about 25 per cent., with intermediate annealing at 750 deg. C. The effect of the cold rolling was to

increase the ultimate tensile strength, diamond-pyramid hardness and 0.1 per cent. proof stress, and to reduce the elongation. After an initial drop, the limit of proportionality also rose. The properties of extruded and annealed rod of the 10/5/5 alloy had also been studied. It had been found that maximum elongation values were obtained by annealing the extruded rod at 825 deg. C., followed by slow cooling to 750 deg. C. Even under these conditions, however, the ductility was lower than that of hot-rolled plate.

The discussion was opened by Mr. W. A. Baker, who stated that the paper was timely, as the type of alloy under discussion was being adopted to an increasing extent. Work on quaternary alloys of copper-aluminium-iron-nickel, containing 5 per cent. each of iron and nickel was being carried out by the British Non-Ferrous Metals Research Association, and many of the authors' results had been confirmed. The phase fields which the authors had drawn constituted good guides to users of the commercial alloys. The authors had also shown that the 10 per cent. Al, 5 per cent. Ni and 5 per cent. Fe alloy was brittle after being quenched in water from annealing temperatures ranging from 800 deg. to 1,000 deg. C., and that the same alloys, when furnace-cooled, were comparatively ductile and soft. He would like to ask what happened at intermediate rates of cooling.

Professor A. J. Murphy agreed that the importance of the authors' findings, from the point of view of the non-ferrous industrial metallurgist should be stressed. He added that, although, in certain special fields, these alloys were well established, their use was spreading, and detailed information regarding them was particularly welcome as large quantities were now being handled by persons who possessed only a fragmentary knowledge of their structure and methods of heat treatment. The next speaker, Mr. Z. Stokowiec, referred to aluminium bronze cast to specification D.T.D. No. 412. He said that unless manganese, to the extent of 1 per cent. or more, were added it was impossible to get the Brinell hardness up to 350. Moreover, this addition of manganese increased the tensile strength from 40 tons to 48 tons per square inch, and the proof stress of sand-cast material from 16 tons up to as much as 30 tons per square inch.

Dr. H. Sutton considered that the Metals Division of Imperial Chemical Industries Limited had been generous in making public valuable information on these alloys; information which was of great service to users of the materials. He asked the authors for further data regarding the influence of the aluminium content on the hot-working properties. He also drew attention to the small scale on which some of the diagrams had been reproduced and thought that this made them very difficult to read. Mr. Christopher Smith, who spoke later, asked the authors how they ensured that large pieces of these alloys were free from quenching cracks and what steps they took to produce 6-in. diameter extruded bar or other large pieces free from internal stresses.

In a brief reply, Mr. Davis told Mr. Baker that they had very little more information to give him regarding the properties of the alloys at rates intermediate between water quenching and furnace cooling. The effect of manganese was a controversial issue at the present time. Many manufacturers asserted that they could not produce alloys without making considerable additions of manganese, while others said that they had found the presence of the metal of little or no advantage. He agreed regarding the practical difficulties of quenching large masses without getting cracking and distortion.

FLOW OF LIQUID METALS ON SOLID METAL SURFACES.

The only other paper considered at session "A" on Tuesday morning was a communication from the British Non-Ferrous Metals Research Association, entitled "The Flow of Liquid Metals on Solid Metal Surfaces and Its Relation to Soldering, Brazing and Hot-Dip Coating." It was by Dr. G. L. J. Bailey and Mr. H. C. Watkins, and was presented by Dr. Bailey. The authors stated that they had carried out experimental investigations of

the behaviour of several liquid metals, including a wide range of conventional and "tin-economy" solders in contact with various solid metals, such as electropolished and oxidised copper surfaces, mild-steel sheet and tin-plate. Most of the work had been conducted using hydrogen as a flux, but a few experiments with liquid fluxes had been done. The forces of particular importance in soldering, brazing, and hot-dip coating were those due to gravity and to surface tension. The surface-tension forces acting on the liquid metal were characterised by the value of the surface tension of the liquid metal and by the angle of contact between the liquid and the solid surfaces at the line in which they met. It was found that the contact angle in the case of the metals examined was not, in general, zero. Its true value in given circumstances was obscured by the effects of roughness of the solid surface, which could not be allowed for. The development of the particularly low contact angles which were formed against copper by tin-lead alloys having compositions in the range preferred for practical soldering, appeared to be preceded by the formation of an alloy layer in the surface of the copper over which the liquid metal spread. The alloy layer might be formed relatively slowly by diffusion through the surface layers of the copper from the bulk of the liquid metal, or it might be formed relatively quickly as a result of the transfer of metal ions through suitable liquid fluxes. The observation that the receding contact angle of lead upon nickel was very low had led to a successful attempt to produce lead coatings upon copper and iron by the addition of a small proportion of nickel to the lead.

Dr. J. C. Chaston, who opened the discussion, stated that an assumption underlying the paper was that metal "wetting" and adhesion were not the same thing, and, in this, he was inclined to agree. According to the authors' results a tin-lead alloy containing some 60 per cent. of tin spread most easily on a copper surface and this raised the question of why the eutectic alloy was preferred for soldering purposes; one reason, of course, was that it had the lowest melting point of the series and that it made the joint more quickly. The next speaker, Mr. R. G. Harper, stated that soldering was so complex that the greatest care should be exercised, when applying the authors' experiments in a practical field, to avoid giving undue weight to any particular factor. The experiments had been directed, not so much to the making of comparisons between alloys, but to ascertain the influence exercised by certain particular factors.

Mr. R. Chadwick said that the paper dealt chiefly with the questions of flow and "wetting" characteristics. The authors were not concerned with adhesion or whether the eutectic alloy was the easiest to employ for soldering purposes. Fundamentally, the contribution was not a metallurgical paper; most of the authors' results were in physical terms. The authors had said that a micrographic study of alloy layers with the object of obtaining supporting evidence for some of their conclusions might prove to be difficult. Sections through alloy layers, however, could be taken and microphotographed and they could yield most valuable information. The authors had described experiments in which liquid solders were in contact with copper for 30 minutes. No real industrial soldering occupied such a long time; the process was usually accomplished in a matter of seconds or even in fractions of a second.

Mr. W. E. Hoare said that, in soldering, a joint must be filled quickly and completely. The joint should therefore be designed accurately from an engineering standpoint. He had found the spreading test to be a good test, not so much perhaps from a research viewpoint but for day-to-day technological purposes. For the evaluation of variations in "solderability" of metal surfaces the spreading test was a valuable tool.

In the course of a brief preliminary reply Dr. Bailey said that the eutectic alloys were preferred for soldering purposes not only on account of their lower melting points but also because their angle of contact was low. Mr. Watkins also briefly replied and the President then adjourned the meeting until the following morning.

(To be continued.)

NIMONIC 80A ALLOY.

Fig. 1. 700 DEG. C.

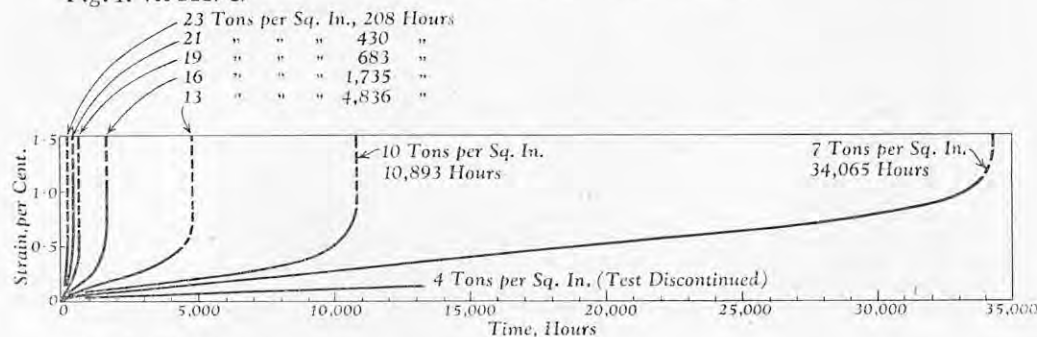
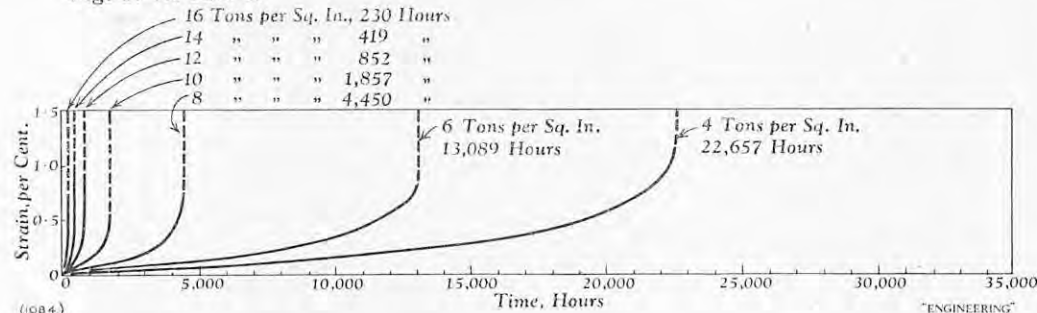


Fig. 2. 750 DEG. C.



CREEP TESTS ON NIMONIC ALLOYS.

AMONG the alloys specially developed to meet strict limitations on permissible creep under particularly arduous conditions of stress and temperature, the Nimonic series of the Mond Nickel Company, Limited, are now well established and have found numerous applications in the gas-turbine and other high-temperature fields. At intervals in the past we have published data concerning these alloys as they have been made available, and we now quote some results of long-time creep tests which have just been issued. In Figs. 1 and 2, above, are shown, graphically, series of long-time creep tests conducted at 700 deg. and 750 deg. C., respectively, on Nimonic 80 A. This alloy contains 80 per cent. of nickel, 20 per cent. of chromium, from 1.8 to 2.7 per cent. of titanium, from 0.5 to 1.8 per cent. of aluminium, and a maximum of 5 per cent. of iron and of 2 per cent. of cobalt. The corresponding Ministry of Supply specification for the alloy is D.T.D. No. 736. It will be noted from Fig. 1 that the creep curve for the alloy at 700 deg. C., under a load of 7 tons per square inch, has now been completed, the specimen fracturing at 34,065 hours, giving a strain of approximately 1.15 per cent. Fig. 2, showing creep data at 750 deg. C., has already been published by the firm; it indicates that the specimen, under a load of 4 tons per square inch, fractured at 22,657 hours. It is concluded that although Nimonic 80 A was primarily designed for use at high temperatures for short times, these data show that this alloy is also suitable for use for long periods at these temperatures. The firm state that the curves were all obtained on material as heat treated for aircraft service and that investigations are at present in hand to develop the best possible long-time creep properties of the alloy. They add that the properties shown in Figs. 1 and 2 should be taken, therefore, as an indication of the minimum properties which can be developed.

In a newly-revised edition of a pamphlet published by Henry Wiggin and Company, Limited, Wiggin-street, Birmingham, 16, and entitled "The Nimonic Alloys," from which the above data have been taken, some brief notes are also given regarding Nimonic 95, the latest addition to the series of the firm's creep-tested wrought alloys. The information merely states that acceptance creep tests are carried out for this alloy at 870 deg. C., with a load of 9 tons per square inch, and a minimum life to rupture of 100 hours. General descriptions of the recently-introduced DS and DT modifications of the Nimonic D alloy are also given in the pamphlet. The DS alloy, which is essentially a nickel-chromium-iron

alloy containing nickel 37, and chromium 18, per cent., with approximately 2 per cent. of silicon, is stated to be a useful heat-resisting material for adoption in oxidising conditions at temperatures of up to 950 deg. C. Work is in hand on the DT alloy, which is to be a stiffened alloy of the same basic composition, for the manufacture of flame tubes and turbine blading operating within the temperature range of 500 to 700 deg. C.

CHEMICAL RESEARCH LABORATORY.

As has been the case for a number of years past, the Chemical Research Laboratory of the Department of Scientific and Industrial Research, at Teddington, Middlesex, held several "open days" this week to enable visitors to inspect the apparatus and plant, and see some of the work in progress. The exhibits were so numerous that we must limit ourselves to giving brief data on a few of the new items and novel presentations on view. In the corrosion of metals group a new cylindrical totally-enclosed and automatically-controlled corrosion testing apparatus was shown in action. It is built up of Perspex and stainless steel, and enables the accelerated weathering of flat metal specimens, mounted on a slowly rotating turntable, to be carried out by the agency of sprays, ultra-violet light and infra-red drying. We have described several pieces of apparatus of this type in our columns and readers may recall that they are particularly suitable for the testing of paints and other protective coatings on metal surfaces, as well as corrosion-resistant alloys. Other exhibits in the corrosion section included applications of corrosion inhibitors and examples of "filiform" corrosion, a relatively new name for the early stages of corrosion on polished metals when the corrosion products take the form of thread-like or worm-like tracks spread over the metal surface. Among the corrosion-inhibitor schemes shown, the protection afforded to a steel surface by the brushing on of a Bentonite potassium chromate paste was judged to be particularly promising. A new apparatus for experiments on the behaviour of alloys under high-temperature oxidation conditions has recently been constructed. In this, metal samples are exposed to a synthetic flue-gas atmosphere and the oxidation is recorded by weighing the samples *in situ* at suitable intervals. Analyses and microscopical examinations are conducted when the samples have been exposed for periods of the order of 1,000 hours.

The research on the steel fire tubes of the Scotch marine boilers of trawlers and similar craft, described in our columns at its inception on page 7 of vol. 170

(1950) and conducted on behalf of the British Shipbuilding Research Association, is proceeding actively, although no results are as yet available for publication. Experiments using 50 per cent., 100 per cent., and even 300 per cent. sea water have been conducted, sometimes with the injection of oxygen or with the addition of various alkalis or other reagents. Some tests have been carried out in which the pH value of the water is controlled. Among other new apparatus installed in the laboratories of the inorganic group are a spectrum projection-comparator and a non-recording microphotometer, for use in spectrographic analysis. Both instruments have been supplied by Messrs. Adam Hilger and Company, Limited. In the microbiology group a continuous process for the culture of sulphate-reducing bacteria has been devised and the apparatus installed is utilised in bacterial-corrosion investigations. The radio-chemical group is now housed in the new Radio-chemistry Building, which has been occupied for about six months. This has an overall length of some 200 ft. and is about 50 ft. wide over most of its length. Here the treatment and analysis of various minerals and ores and the measurement of radio-active carbon and other radio-chemical research operations are conducted.

FORTHCOMING EXHIBITIONS AND CONFERENCES.

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

INTERNATIONAL MACHINE TOOL EXHIBITION.—Wednesday, September 17, to Saturday, October 4, at Olympia, London, W.14. Organised by the Machine Tool Trades Association, Victoria House, Southampton-row, London, W.C.1. (Telephone: HOLborn 4667.) See also pages 321, 361 and 393, *ante*.

COMMERCIAL MOTOR SHOW.—Friday, September 26, to Saturday, October 4, at Earl's Court, London, S.W.5. Organised by the Society of Motor Manufacturers and Traders, Ltd., 148, Piccadilly, London, W.1. (Telephone: GROsvenor 4040.)

16TH METZ TRADE FAIR.—Saturday, September 27, to Monday, October 13, at Metz. Agents: Home and Overseas Trade Fairs, 40, Gerrard-street, London, W.1. (Telephone: GERrard 5947.)

FOURTH INTERNATIONAL CONGRESS ON INDUSTRIAL HEAT AND APPLIED THERMODYNAMICS.—Saturday, September 27, to Saturday, October 4, in Paris. Apply to the general secretary of the Congress, 2, Rue des Tanneurs, Paris, 13e.

18TH INTERNATIONAL NAUTICAL EXHIBITION.—Saturday, September 27, to Sunday, October 12, in Paris. Agents: Home and Overseas Trade Fairs, 40, Gerrard-street, London, W.1. (Telephone: GERrard 5947.)

SECOND NATIONAL TELEVISION AND 16TH NATIONAL RADIO AND ELECTRONIC EXHIBITION.—Monday, September 29, to Sunday, October 12, in Paris. Organised by the Salon de la Radio, de la Télévision et de l'Électronique, 23, Rue de Lubeck, Paris.

IRON AND STEEL EXPOSITION.—Tuesday, September 30, to Friday, October 3, at the Public Auditorium, Cleveland, Ohio, U.S.A. Organised by the Association of Iron and Steel Engineers. Apply to Mr. Albert W. Erickson, Junr., at the Association's offices, 1010, Empire Building, Pittsburgh 22, U.S.A. See also our issue of April 18, 1952, page 486.

SIXTH PACKAGING, HANDLING, PRESENTATION AND DISTRIBUTING-TRADES EXHIBITION.—Thursday, October 2, to Sunday, October 12, in Paris. Organised by the Salon International de l'Emballage, du Conditionnement, de la Manutention, de la Présentation et des Techniques de Distribution, 40, Rue du Colisée, Paris, 8e.

PARIS INTERNATIONAL MOTOR-CAR, CYCLE AND SPORTS EXHIBITION.—Thursday, October 2, to Sunday, October 12, in Paris. Organised by the Chambre Syndicat des Constructeurs d'Automobiles, Grand Palais, 111, Avenue Alexandre, Paris, 8e.

SEVENTH INTERNATIONAL BOTTLING EQUIPMENT EXHIBITION.—Thursday, October 2, to Sunday, October 12, in Paris. Organised by the Salon International du Matériel d'Embouteillage et Industries Connexes, 28, Rue Louis le Grand, Paris.

PARIS EXHIBITION OF BUSINESS MACHINES AND OFFICE EQUIPMENT.—Wednesday, October 8, to Sunday, October 19, in Paris. Arranged by the Salon International de l'Équipement de Bureau, 6, Place de Valois, Paris.

PLASTICS EXHIBITION.—Saturday, October 11, to Sunday, October 19, at Düsseldorf. Organised by the

Nordwestdeutsche Ausstellungs G.m.b.H. (Nowea), Ehrenhof 4, Düsseldorf, Germany. Agents: John E. Buck & Co., 47, Brewer-street, Piccadilly, London, W.1. (Telephone: GERrard 7576.)

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

INSTITUTION OF WORKS MANAGERS; NATIONAL CONFERENCE.—Friday and Saturday, October 17 and 18, at the Town Hall, Birmingham. Applications to be made to the secretary of the Institution, 67-68, Chandos-place, Strand, London, W.C. (Telephone: TEMple Bar 8324.)

NATIONAL METAL EXPOSITION.—Monday, October 20, to Friday, October 24, at Philadelphia, Pennsylvania, U.S.A. Organised by the American Society for Metals. Apply to Mr. W. H. Eisenman, secretary of the Society, 7301, Euclid-avenue, Cleveland 3, Ohio, U.S.A.

"THE MODEL ENGINEER" EXHIBITION.—Monday, October 20, to Wednesday, October 29, at the New Horticultural Hall, Vincent-square, London, S.W.1. Apply to the offices of the Exhibition, 23, Great Queen-street, Kingsway, London, W.C.2. (Telephone: CHAncery 6681.)

EXHIBITION OF MACHINERY AND APPARATUS FOR FOOD-PROCESSING, CHEMICAL AND PHARMACEUTICAL INDUSTRIES.—Tuesday, October 21, to Wednesday, October 29, at Rotterdam. Organised by the Royal Netherlands Industries Fair, Rotterdam, Holland. Agent: Mr. W. Friedhoff, 10, Grosvenor-place, London, W.1. (Telephone: WELbeck 9971.)

MOTOR SHOW.—Wednesday, October 22, to Saturday, November 1, at Earl's Court, London, S.W.5. Organised by the Society of Motor Manufacturers and Traders, Ltd., 148, Piccadilly, London, W.1. (Telephone: GROsvenor 4040.)

THIRD INTERNATIONAL PAPER, PRINTING AND ALLIED TRADES EQUIPMENT EXHIBITION.—Thursday, October 23, to Friday, October 31, in Paris. Held under the auspices of the Salon des Techniques Papetières et Graphiques, 40, Rue du Colisée, Paris, 8e.

PUBLIC WORKS AND MUNICIPAL SERVICES CONGRESS AND EXHIBITION.—Monday, November 3, to Saturday, November 8, at Olympia, London, W.14. Organised jointly by the Municipal Agency, Ltd. and the Congress Organising Council. Applications to the Municipal Agency, Ltd., 68, Victoria-street, London, S.W.1. (Telephone: VICtoria 9132.) See also page 143, *ante*.

BUSINESS EFFICIENCY EXHIBITION, GLASGOW.—Tuesday, November 4, to Friday, November 14, at Kelvin Hall, Glasgow. Organised by the Office Appliance and Business Equipment Trades Association, 11-13, Dowgate-hill, Cannon-street, London, E.C.4.

TOOL AND EQUIPMENT SHOW.—Tuesday, November 11, to Friday, November 14, at the Show Mart, Montreal. Organised by the Montreal Tool and Equipment Show, 4585, Sherbrooke-street West, Montreal, Canada.

24TH ROYAL AGRICULTURAL WINTER FAIR.—Friday, November 14, to Saturday, November 22, at Toronto. Apply to the offices of the Fair, Royal Coliseum, Exhibition Park, Toronto 2b, Canada.

27TH INTERNATIONAL CYCLE AND MOTOR-CYCLE SHOW.—Saturday, November 15, to Saturday, November 22, at Earl's Court, London, S.W.5. Organisers: British Cycle and Motor Cycle Manufacturers' and Traders' Union, Ltd., The Towers, Warwick-road, Coventry. (Telephone: COventry 62511.)

BREWERS' EXHIBITION.—Monday, November 24, to Friday, November 28, at Olympia, London, W.14. Particulars obtainable from the organisers, Trades, Markets and Exhibitions, Ltd., 623, Grand Buildings, Trafalgar-square, London, W.C.2. (Telephone: WHItchall 1371.)

20TH NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING.—Monday, December 1, to Saturday, December 6, at the Grand Central Palace, New York. Organised by the American Society of Mechanical Engineers, 29, West 39th-street, New York 18.

CONFERENCE ON PREVENTION AND SUPPRESSION OF DUST IN MINING, TUNNELLING AND QUARRYING.—Monday, December 1, to Wednesday, December 17, at Geneva. Arranged by the Industrial Safety Division, International Labour Organisation, Geneva, Switzerland.

SYMPOSIUM ON LIGHT-METAL HEAVY FORGINGS AND EXTRUSIONS FOR MODERN AIRCRAFT.—Tuesday, December 2, at New York. Organised by the American Society of Automotive Engineers. For further information, apply to the secretary of the Society, 29, West 39th-street, New York 18, U.S.A.

SMITHFIELD SHOW AND AGRICULTURAL MACHINERY EXHIBITION.—Monday, December 8, to Friday, December 12, at Earl's Court, London, S.W.5. Details obtainable from the Smithfield Show Joint Committee, 148, Piccadilly, London, W.1. (Telephone: GROsvenor 4040.)

LABOUR NOTES.

HIGHLY-SKILLED employees in engineering and merchant-shipbuilding occupations, or engaged on certain categories of work of particular importance to the export trade, will be able to obtain a deferment of their calling up for national service under a new scheme, the terms of which were announced by the Ministry of Labour and National Service on Monday last. The new arrangements are an extension of those already in existence for former apprentices employed on specified re-armament undertakings of special priority, such as the production of tanks, military aircraft, radar equipment, and plant for atomic-energy projects. In future, applications will also be considered from engineering and shipbuilding establishments with a good export performance, or which are able to produce definite proofs of their ability to achieve a high level of exports at an early date, provided that they are firms which train apprentices and can show that they require to retain some of these men to maintain and improve their export performances.

Engineering firms engaged in servicing other branches of the industry, such as manufacturers of machine tools, the principal contributions of which to the export trade is indirect only, will also be able to apply. In accordance with existing arrangements, deferment will be for two years, and will be granted solely to men whose skill is being fully used in connection with designated export work, who agree to accept deferment, and where the position cannot be met by the provision of a substitute. The granting of deferments will be limited, however, by the needs of the Armed Forces for time-expired apprentices, whose services are required as skilled tradesmen, and who can be fully employed in that capacity. It is expected that, under the new arrangements, some 2,000 ex-apprentices will be granted temporary deferment, out of the 23,000 called up each year from engineering and metal-working occupations.

Establishments which come within the scope of the new arrangements will be notified, by the Ministry of Supply and the Admiralty, of the procedures they should follow when they wish to apply for the deferment of individual employees. Each application will be fully investigated by a technical officer of the Ministry of Labour and the final decision will be taken at the headquarters of that Ministry. All cases where deferment is granted will be reviewed at six-monthly intervals to ensure that the men concerned are being used to the full extent of their skill. Among the many categories of engineering products affected are steelworks plant, mining machinery, locomotives, cranes and conveyors, aircraft, electronic apparatus, marine engines, printing machinery, and heavy electrical plant. The scheme also applies to such products as machine tools, ball and roller bearings, air and gas compressors, and scientific instruments, mainly on account of their indirect contribution to the export trade.

The possibility of averting the enforcement of restrictions on overtime and piecework in the engineering industry was discussed on September 18 at a meeting in London between Sir Robert Gould, chief industrial commissioner, and other officials of the Ministry of Labour, and representatives of the Engineering and Allied Employers' National Federation. The meeting had been arranged by the Ministry in the hope of bringing the two sides of the industry together, to negotiate on the claim of the Confederation of Shipbuilding and Engineering Unions for a wage increase for all male engineering employees. The existing form of the demand is a request for an all-round advance of 40s. a week. The employers' representatives adhered to their previous decision that it would be contrary to the best interests of all sections of the industry for wages to be increased in the present economic circumstances.

They expressed their willingness, however, to accept the decision of any arbitration tribunal which might be set up to investigate the claim,

provided that the unions affiliated to the Confederation would give a similar undertaking. Discussions took place between Sir Robert and representatives of the Shipbuilding Employers' Federation on Tuesday on the Confederation's claim for a "substantial" increase for men in the shipbuilding industry. In this case, also, the employers declined to go back on their previous decision, but expressed their willingness to go to arbitration. Reports of both discussions were considered at a meeting of the Confederation's executive council on Wednesday, when it was decided that the restrictions should come into force on October 20.

Although equal pay for both sexes for the same work was endorsed in principle by all parties in the House of Commons on May 16 last, there is, apparently, no prospect of its early introduction, owing to the country's present financial and economic difficulties. A deputation from the staff side of the Civil Service National Whitley Council met the Chancellor of the Exchequer, Mr. R. A. Butler, in London, on September 17 to discuss the position with him. The trade-union leaders pressed Mr. Butler to approve the holding of negotiations in the near future between the two sides of the Government service, on the means by which equal pay for women civil servants might be introduced on a gradual basis, and urged the immediate application of any scheme which might be agreed to as a result of these joint discussions.

The Chancellor re-affirmed the determination of the Government to commence the introduction of equal pay in the Civil Service, but added that he could hold out no hope of a beginning being made in the immediate future. Mr. Butler promised the deputation, however, that he would let them have his considered opinion shortly on what arrangements might be made to provide for exchanges of views between the two sides of the Civil Service National Whitley Council on the merits of alternative schemes by which equal pay might be introduced by gradual stages, when the national circumstances permitted.

Appeals for higher outputs per man-hour were made by Mr. H. Watkinson, the Parliamentary Secretary to the Ministry of Labour and National Service, in a speech at Leeds on September 17, at the close of a three-day tour of engineering, wool-textile and clothing establishments in Yorkshire. He considered that employers would have to take their workpeople much more into their confidence than they were now doing, if improved efficiency and increased outputs were to be attained. The only risk of mass unemployment, Mr. Watkinson stated, was the mass loss of foreign orders and foreign markets through inefficiency. It had to be remembered that Britain now had to fight in overseas markets for the orders necessary to keep its industries going.

Respecting the increases in unemployment which occurred recently in Yorkshire and Lancashire, Mr. Watkinson urged that they should be regarded as a warning, by every industry engaged in export trade, that the days of fulfilling "easy" orders were gone. What was happening to the industries of those two counties, was going to happen to other industries. Even the engineering industry was going to encounter similar adverse conditions, but good-quality productions and efficient salesmanship could overcome the country's selling problems. A good start would be made if it could be forgotten that there were two sides of industry. It was essential that the Government, workpeople, and employers all worked together as a team.

A further favourable turn has been taken in connection with the Scottish printing-trade dispute. With a view to improving the chances of a favourable settlement of the one remaining matter at issue, that of the reinstatement by Messrs. D. C. Thomson and Company, Limited, of the men dismissed when they went on strike some months ago, the trade unions concerned have been recommended by the Printing and Kindred Trades Federation to take such action as may be necessary to end any ban imposed on supplies and distribution affecting the firm.

SHIPS AND SHIPBUILDING IN BELFAST.

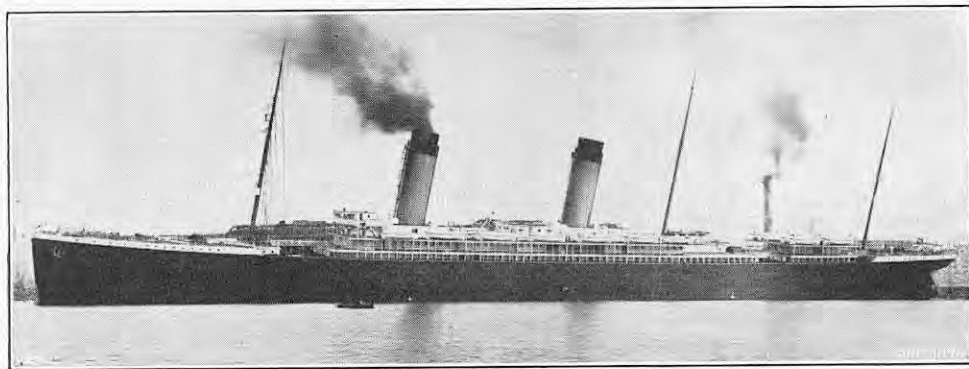


FIG. 11. THE SECOND "OCEANIC," 1899.

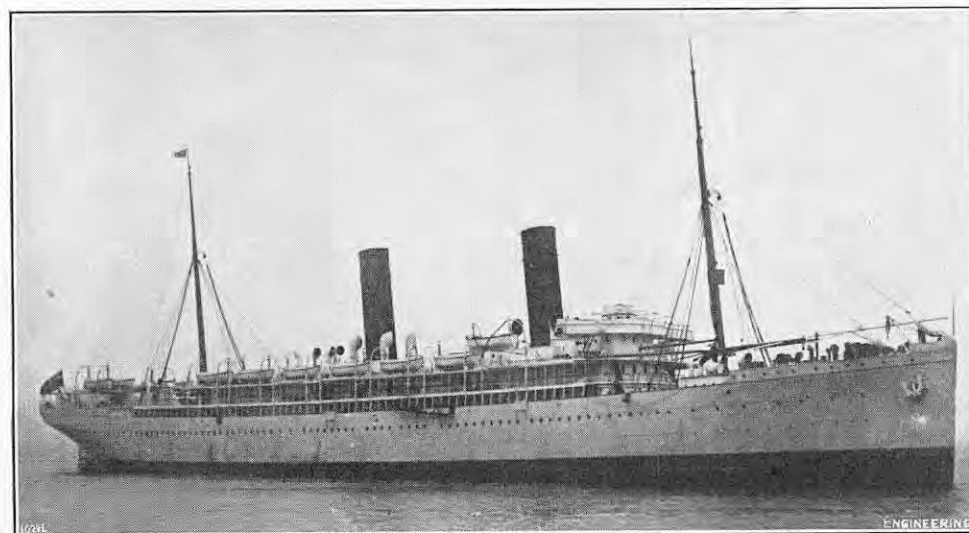


FIG. 12. UNION-CASTLE LINER "WALMER CASTLE," 1902.

SHIPS AND SHIPBUILDING IN BELFAST*.

By DR. DENIS REBBECK†, C.B.E., M.A., M.Sc.,
B.Litt., J.P., M.I.C.E., M.I.Mech.E.

(Concluded from page 388.)

BEFORE the close of the Nineteenth Century another important commercial link was forged between Harland and Wolff and a shipping company of some repute, namely, the Union Steamship Company, which later merged with the Castle Line to form the world-famous Union-Castle Mail Steamship Company, Limited. The first Union Steamship Company's ships to be built by Harland and Wolff were the Gaul and the Goth, in 1893, twin-screw steamers 400 ft. long, and the first Union-Castle liner built at the Queen's Island was the Walmer Castle (Fig. 12), 570 ft. long, powered by twin-screw quadruple-expansion engines, and launched on July 6, 1901. It is a well-known fact that the great Union-Castle fleet has been built, almost exclusively, at Belfast, and at this very moment there is a Union-Castle passenger liner—the Braemar Castle—fitting out, and a cargo liner building, as well as a further cargo liner to be laid down. In addition, there is a cargo vessel building for the King Line, a subsidiary of the Union-Castle Company. It is perhaps not inappropriate that one of these Union-Castle vessels should bear the number 1500 in the Harland and Wolff building programme. Two other important shipping companies who have had long and strong connections with the Queen's Island, and who came to Belfast for their first ships around the turn of the century, are the Pacific Steam Navigation Company, whose Orellana, a 400-ft. steamer, was launched on December 7, 1892, and the Royal Mail Steam Packet Company's 375-ft. steamer Pardo, launched on June 30, 1904.

The greatest achievement of the Queen's Island in the Nineteenth Century was undoubtedly the building of the second Oceanic (Fig. 11). At her launch on January 14, 1899, she was referred to as the finest vessel ever produced, and the crowning success of the century in naval architecture and marine engineering. Undoubtedly, this vessel represented a most outstanding advance in steam propulsion, with her two four-crank triple-expansion engines, having a designed total output of 28,000 indicated horse-power at 77 r.p.m. Steam at 192 lb. per square inch was provided by no fewer than 15 double-ended Scotch boilers. The vessel was 685 ft. long, had a gross tonnage of 17,000, and a service speed of 21 knots. It was perhaps fitting that the Oceanic was the first ship which exceeded in length that remarkable product of the mid Nineteenth Century—the Great Eastern.

The closing years of the Nineteenth and the early years of the Twentieth Century saw many large passenger liners built at the Queen's Island. Space does not permit of reference to these giants of their day, but the demand for large passenger carriers on the North Atlantic led eventually to the mammoth White Star liners Olympic and Titanic, followed by the slightly larger Britannic being laid down at Belfast. The Olympic and Titanic, 850 ft. long, 92 ft. beam and 64 ft. 6 in. depth, with a loaded draught of 34 ft. 6 in., and a gross tonnage of 46,000, were indeed remarkable achievements in the sphere of shipbuilding, when we remember that the first of them—the Olympic—was launched over 40 years ago, on October 20, 1910. A long and useful life of a quarter of a century ended on October 13, 1935, when the Olympic was taken to Jarrow to be broken up. The Titanic, it will be remembered, had a tragic end, striking an iceberg on her maiden voyage, on the night of April 14, 1912, and sinking within a period of four hours. The Olympic and Titanic were triple-screw ships, each wing propeller being driven by one set of reciprocating engines and the centre propeller by a large direct-coupled low-pressure turbine into which the

reciprocators exhausted. Owing to the great size of the units, it was found necessary to place the turbine in a separate compartment abaft the reciprocating engine room and divided from it by a watertight bulkhead; 24 double-ended and five single-ended boilers delivered steam at a pressure of 205 lb. per square inch by gauge. The slightly larger Britannic (Figs. 13 and 14, page 418) (gross tonnage 48,000) was launched on February 26, 1914, but her completion was interfered with by the outbreak of the first World War, and she was eventually converted into a hospital ship. She was torpedoed by the enemy in the Aegean Sea—the largest individual loss suffered by the British mercantile marine during the 1914-18 conflict.

The Belfast yards of Messrs. Harland and Wolff, Limited, continued to be improved and enlarged from time to time. The construction of the Olympic, Titanic and Britannic had necessitated the erection of a very large steel gantry in the Queen's Yard, and the purchase of a 150-ton floating crane for fitting-out purposes. The engine works, too, were expanded and modernised. The first geared-turbine vessel to be built by Messrs. Harland and Wolff was the Vedic, which had been started before the war, and was completed in 1918. The gearing was single-reduction, and the total shaft horse-power for the twin screws was 3,600. In the early 1920's, double-reduction geared turbines were built at Belfast, some of which are still running.

During the first World War, Lord Pirrie (who had succeeded Sir Edward Harland when the latter died in 1895) was Controller-General of Merchant Shipbuilding. Pirrie was responsible for the laying down at Belfast of an entirely new and extensive shipyard with six large slips for building standard merchant ships. This yard—the Musgrave Yard—which increased the potential output of the firm to a considerable extent, has been the birthplace of large vessels for many of the premier shipping companies. During the second World War, the Musgrave Shipyard was devoted entirely to the production of large vessels for the Royal Navy, and it proved to be, together with the rest of the huge Queen's Island works, a national asset of the greatest importance. The Musgrave Shipyard will also be long remembered by the people of the City of Belfast as the yard where the keel of a 1,000-ft. Diesel-electric passenger liner was laid down for the White Star Line in the late 1920's (Figs. 15 and 16, page 418). The total power of the ship was designed to be 200,000 shaft horse-power on four screws, and there were to be 47 six-cylinder supercharged four-stroke Diesel engines, coupled in pairs. Unfortunately, due to the depressed state of shipping at that time, the construction of the vessel had not gone very far before it was brought to a halt. As a result, the Queen's Island was denied the honour of building the first vessel to have a length of 1,000 ft. and completing what would have been a truly remarkable achievement in the sphere of shipbuilding and marine engineering. Nevertheless, the fact that such a bold design was ever contemplated suffices to prove how far Messrs. Harland and Wolff had by then progressed along the path of Diesel engine development for marine propulsion.

As far back as 1912, the Burmeister and Wain Oil Engine Company had been established at Finnieston, Glasgow, on a site which Messrs. Harland and Wolff had then recently acquired. One-third of the new oil engine company's capital was owned by Messrs. Harland and Wolff, and two-thirds by Messrs. Burmeister and Wain, of Copenhagen. The outbreak of war in 1914 led to Messrs. Harland and Wolff becoming the sole proprietors of the company at Finnieston, and from those early beginnings great strides were soon made in the application of the Diesel engine to marine propulsion. The construction of marine Diesel engines was also commenced at the Queen's Island, and notable among passenger-ship installations in the mid-1920's (as opposed to purely cargo-ship prime movers which marked the early application of the Diesel) may be mentioned the large double-acting four-stroke engines of the twin-screw ships Asturias and Alcantara for the Royal Mail Company, and the Carnarvon Castle for the Union-Castle Company. The two former vessels were 630 ft. long, with a gross tonnage of 22,000, and had a total shaft horse-power of 14,500 per ship, while the Carnarvon

* Paper read before Section G of the British Association at Belfast on Friday, September 5, 1952.

† Director, Harland & Wolff, Ltd.

SHIPS AND SHIPBUILDING IN BELFAST.

Fig. 13. WHITE STAR LINER "BRITANNIC," 1914.

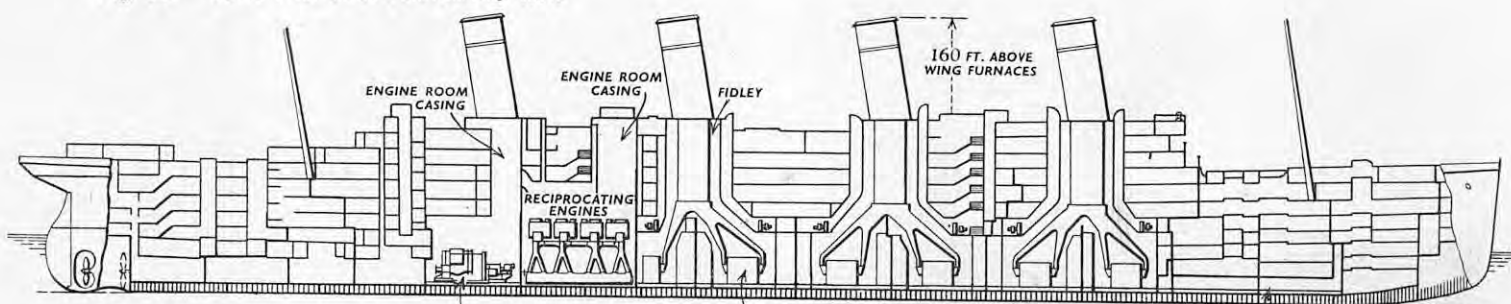


Fig. 14.

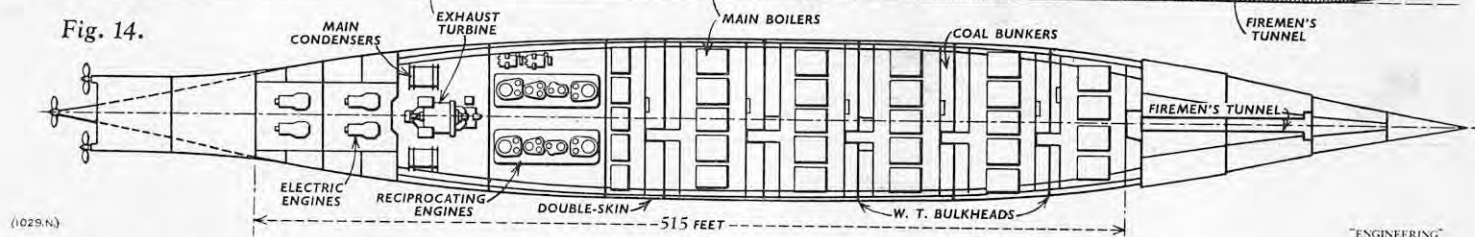


Fig. 15. PROJECTED DIESEL-ELECTRIC LINER, 1927

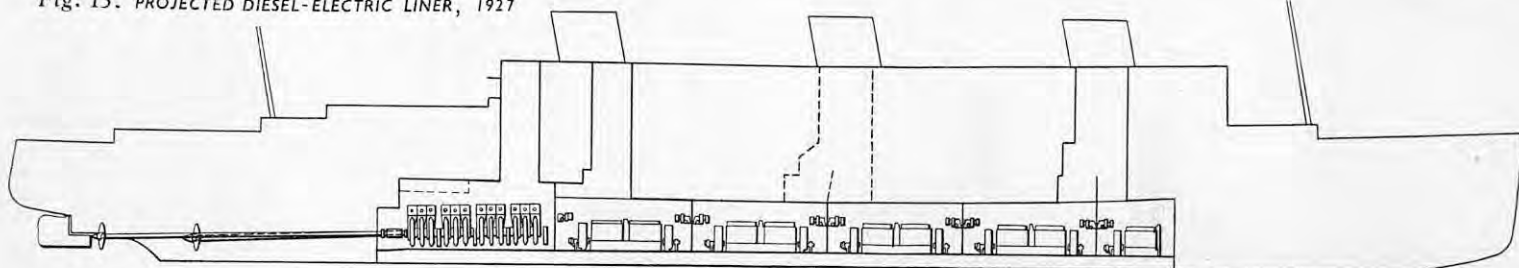
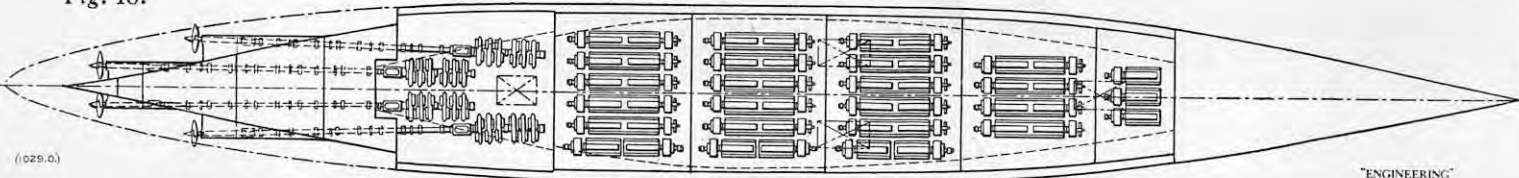


Fig. 16.



Castle, though also 630 ft. long, had a gross tonnage of 20,000 and engines of 11,200 shaft horse-power.

Space does not permit of reference to the numerous passenger vessels built at Belfast with this double-acting four-stroke Diesel machinery, of which the 27,000-ton *Britannic* and *Georgic*, for the White Star Line, were two outstanding examples, nor of the later developments with double-acting two-cycle Diesel units which reached a peak with the sets installed in the Union-Castle Company's *Capetown Castle*, completed in April, 1938. This ship, with her twin-screw ten-cylinder Diesels developing a total in service of 24,000 shaft horse-power at 102 r.p.m. (80 per cent. of the full designed power), together with her very slightly smaller consorts, *Stirling Castle* and *Athlone Castle* (completed in February, 1935, and May, 1936), marked a great advance in sea travel to the Cape. Fig. 17, on Plate XXVIII, shows one of the two 10-cylinder main Diesel engines of the third *Britannic*, built in 1930. The engine is of the double-acting four-cycle type with blast-injection and develops 9,250 brake horse-power at 102 r.p.m. The engines of the *Capetown Castle* are shown in Fig. 18, on Plate XXVIII. They are of the double-acting two-cycle type with solid injection.

Those members who visited the Queen's Island Engine Works during the meeting of the British Association were able to see examples of the latest two-stroke single-acting Harland B. and W. marine Diesel engine, of which a large number are being built for British and foreign owners. The advantages of these latest units are simplicity of construction, quietness in running, and ease of overhaul. Fig. 19, on Plate XXIX, shows the erecting bay of the engine works with a marine two-stroke single-acting Diesel engine in the foreground.

Parallel with all this activity in the world of Diesel engines for ship propulsion, there were many important vessels built at the Queen's Island which were powered with steam turbines. One of

the outstanding examples in the immediate pre-war period was the Royal Mail liner *Andes* (Fig. 20, on Plate XXX), completed in September, 1939. A most successful geared-turbine installation of 30,000 shaft horse-power propelled this 26,000-ton passenger ship, 630 ft. long, which is regarded as one of the finest ships built at Belfast. In the post-war period reference must be made to the 700-ft. *Union-Castle* liners *Pretoria Castle*, shown being launched in Fig. 21, on Plate XXX, and the *Edinburgh Castle*, the propelling machinery of which is comprised of double-reduction geared turbines of Parsons reaction type, and Babcock and Wilcox boilers of the latest integral-furnace design, operating under high-pressure and high-temperature conditions. The machinery marked a definite advance over any previous installation of this size and power in a British merchant ship. Passing reference must also be made to some of the powerful steam-turbine installations which have been built at the Queen's Island Engine Works in recent years and installed in several aircraft carriers, as well as in a number of other naval vessels. The outstanding example is, of course, H.M.S. *Eagle* (Fig. 24, opposite).

Those who have travelled over to Northern Ireland by sea may well have come in a Harland and Wolff-built cross-Channel vessel, for the Queen's Island have built a large number of this type of ship. Beginning in the 1870's with paddle steamers like the *Princess Beatrice* up to the present time, when members of the British Association were able to see, during their visit, the new Diesel-engined Irish Coast at one of the Queen's Island fitting-out wharves, one may point to a long list of steam-reciprocating, steam-turbine and two-cycle and four-cycle Diesel-engine cross-Channel ships constructed at Belfast. The *Hibernia* and *Cambria* (Fig. 25, opposite) for the Kingstown-Holyhead service, and the *Leinster* and *Munster* for the Dublin-Liverpool service are all post-war cross-Channel motor ships

built at the Queen's Island, and with pre-war Harland and Wolff motor ships such as those operating on the Belfast-Liverpool and Belfast-Glasgow service, sufficient proof is given of the correctness of the decision, taken at the Queen's Island 25 years ago, to propel cross-Channel vessels with Diesel machinery.

Harland and Wolff, Limited, have also built a large number of stationary Diesel-engines for driving generators in countries all over the world; for driving pumping sets on some of the great oil pipelines in the near East; for use in sewage schemes, like the 17 working at Mogden in West Middlesex; and for stand-by emergency sets in such secluded but important spots as the Bank of England. Gas-engine driven compressors, manufactured under licence from the parent firm of Cooper-Bessemer, Mount Vernon, Ohio, are also built at Belfast in large numbers.

It is not proposed to describe in detail the layout of the shipyard and works at the Queen's Island in this paper, but it is important to refer to the devastating effect of the air-raids which were made during the months of April and May, 1941, by the German Luftwaffe. There is no doubt that the Belfast works of Messrs. Harland and Wolff, Limited, were a very legitimate target for the enemy's bombers. The works are the largest single industrial unit of its kind in the world; and the firm have headed the tonnage output of shipbuilding firms throughout the world on 24 occasions. During the war period over 30,000 employees produced approximately ten per cent. of the total merchant ship output of the country and built all types of weapons of war from 3.7 in. anti-aircraft gun barrels and mountings to army tanks, in addition to tank-landing ships, corvettes, minesweepers, frigates, fleet oilers, transport ferries, landing craft, cargo ships, tankers, cruisers and aircraft-carriers. This great concentration of industrial strength, together with the nearby aircraft factory of Messrs. Short Brothers

MARINE OIL ENGINES BUILT AT BELFAST.

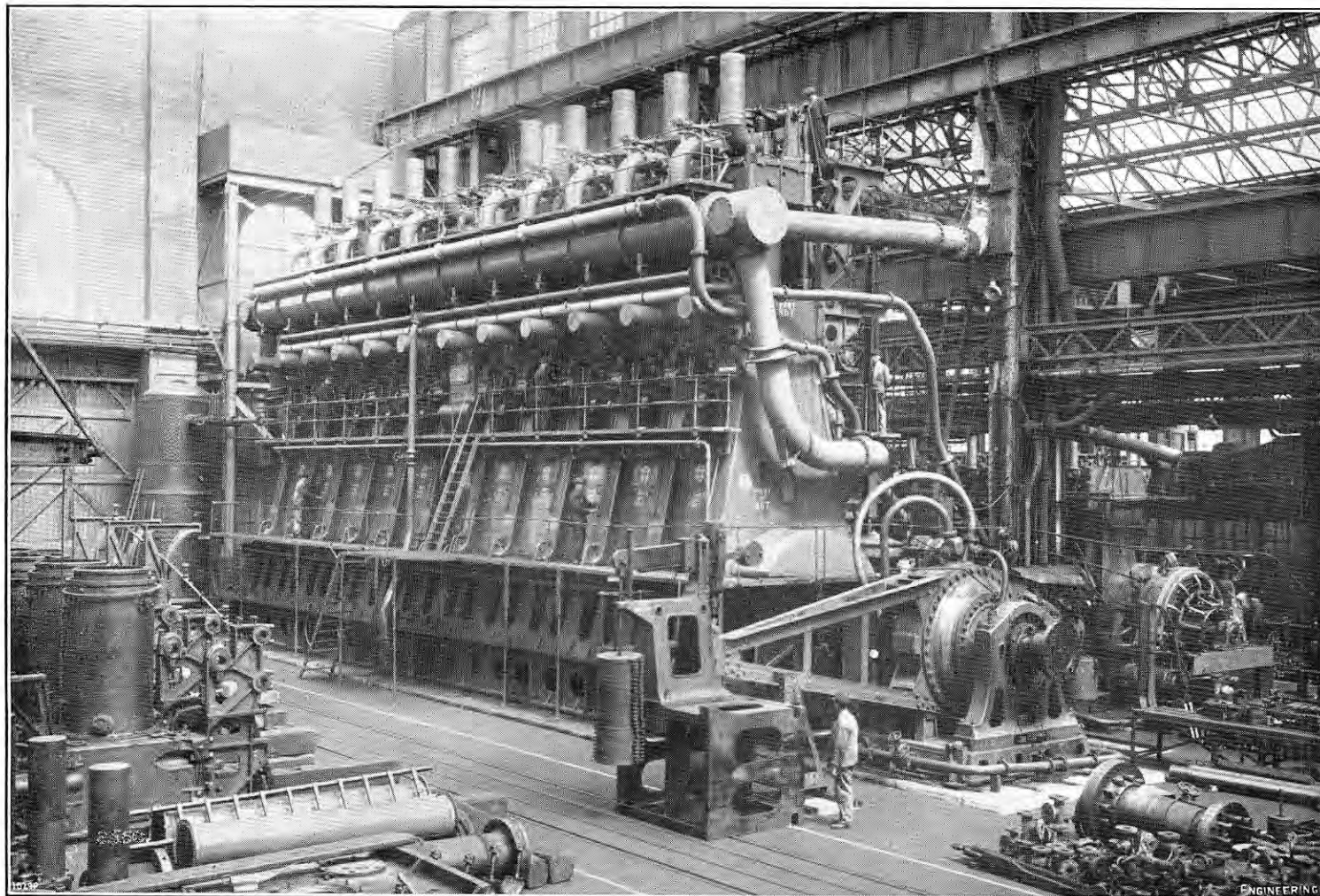
(For Description, see Page 417.)

FIG. 17. ONE OF TWO 9,250-B.H.P. MAIN ENGINES OF THE THIRD "BRITANNIC," 1930.

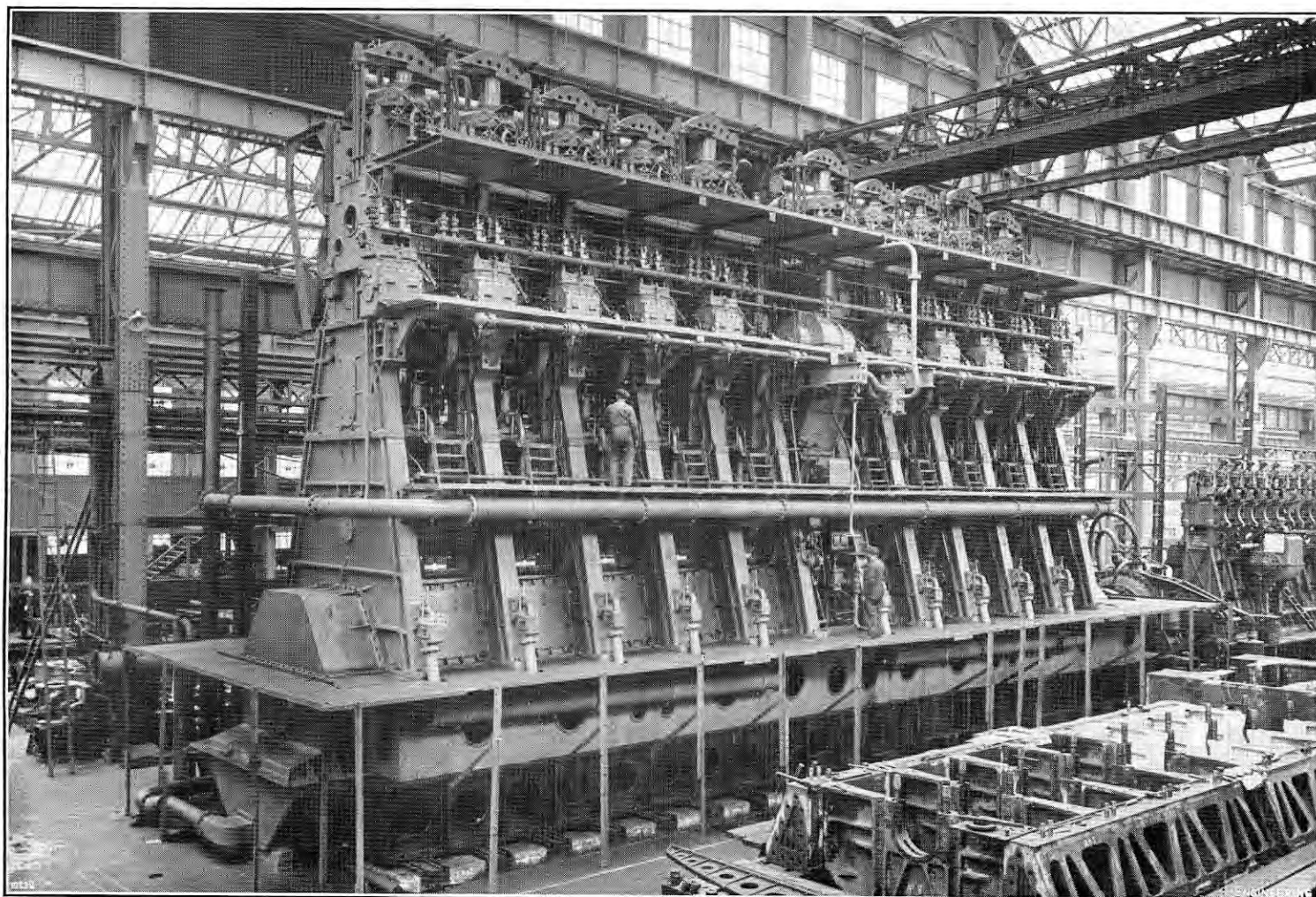


FIG. 18. ONE OF TWO MAIN ENGINES OF THE "CAPETOWN CASTLE," 1938.

HARLAND & WOLFF'S ENGINE WORKS, BELFAST.

(For Description, see Page 417.)

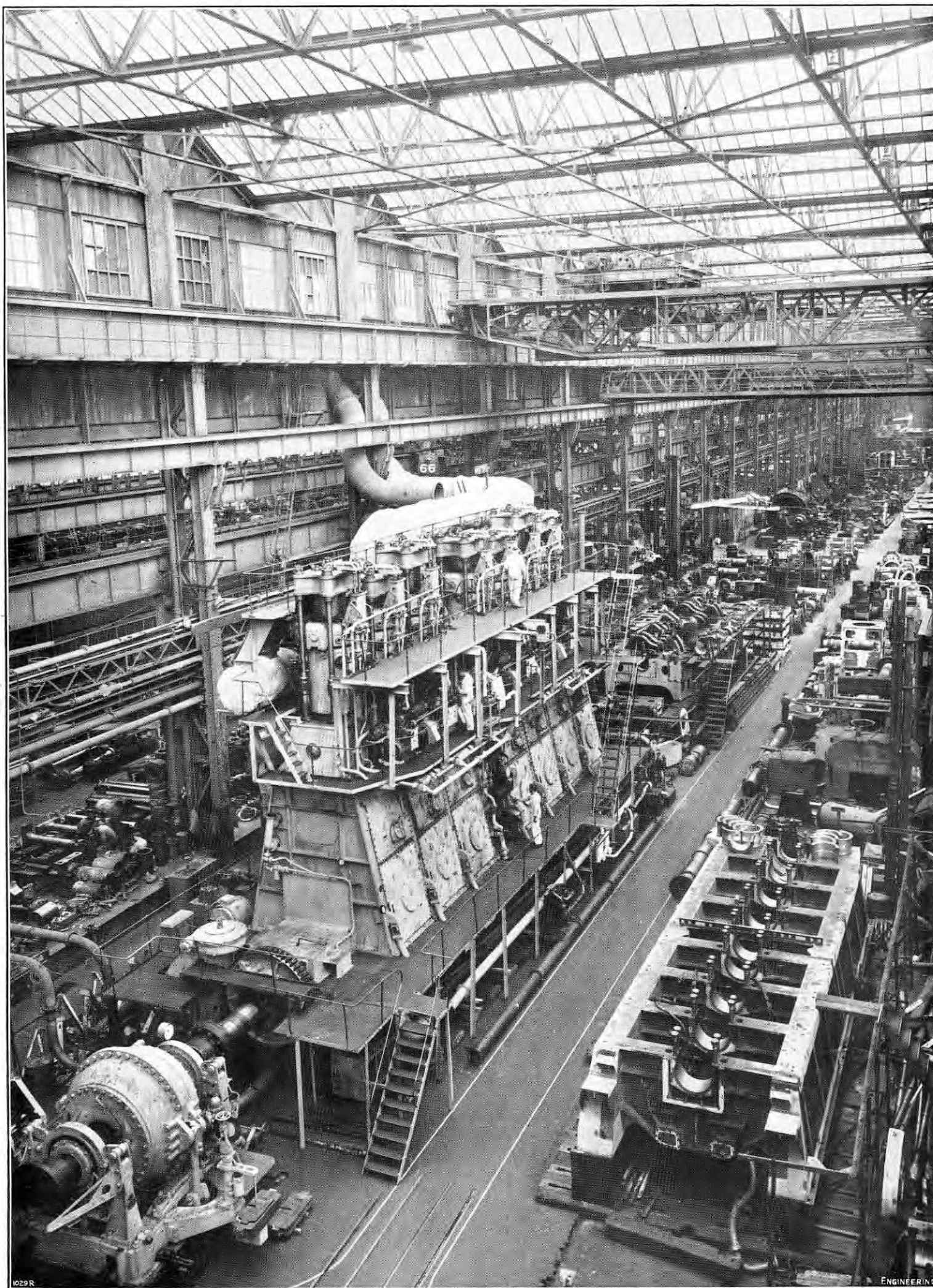


FIG. 19. ERECTING BAY

SHIPBUILDING AT BELFAST.

(For Description, see Page 417.)

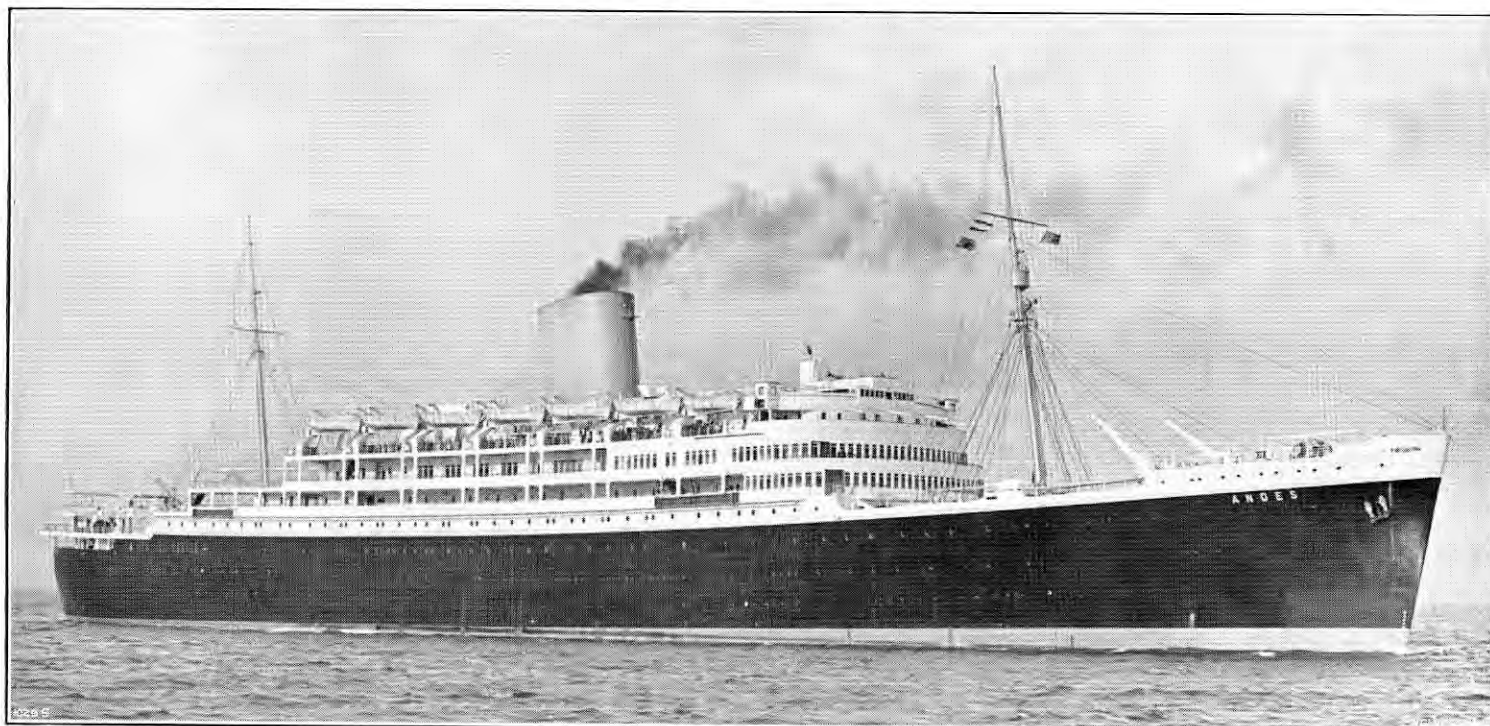


FIG. 20. ROYAL MAIL LINER "ANDES."



FIG. 21. LAUNCH BY RADIO-TELEPHONY OF THE UNION-CASTLE LINER "PRETORIA CASTLE," AUGUST 19, 1947.

HARLAND AND WOLFF'S SHIPYARDS & ENGINE WORKS, BELFAST.

(For Description, see Page 417.)

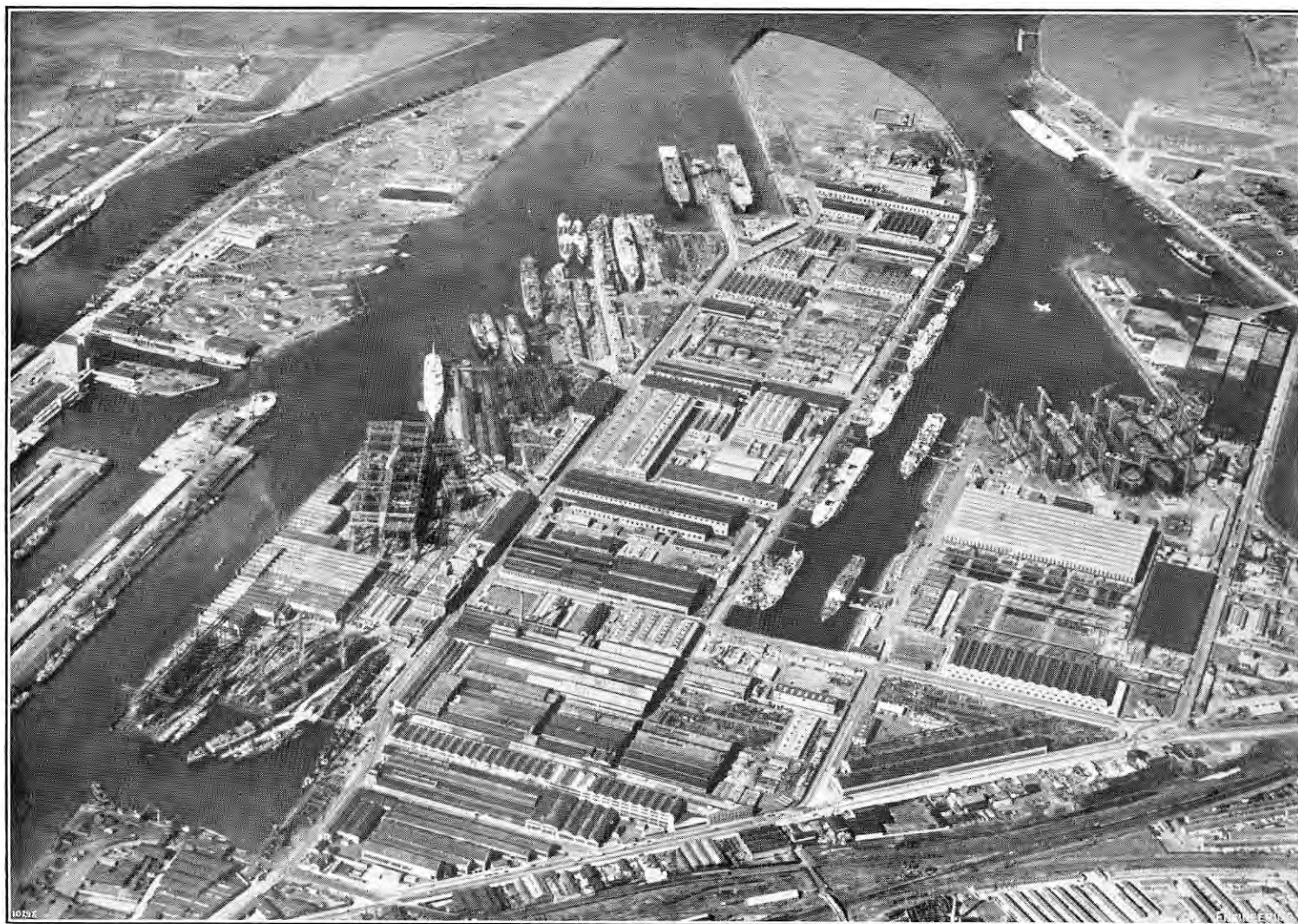


FIG. 22. AERIAL VIEW.



FIG. 23. WELDING SHOP AT QUEEN'S ISLAND.

SHIPS AND SHIPBUILDING IN BELFAST.

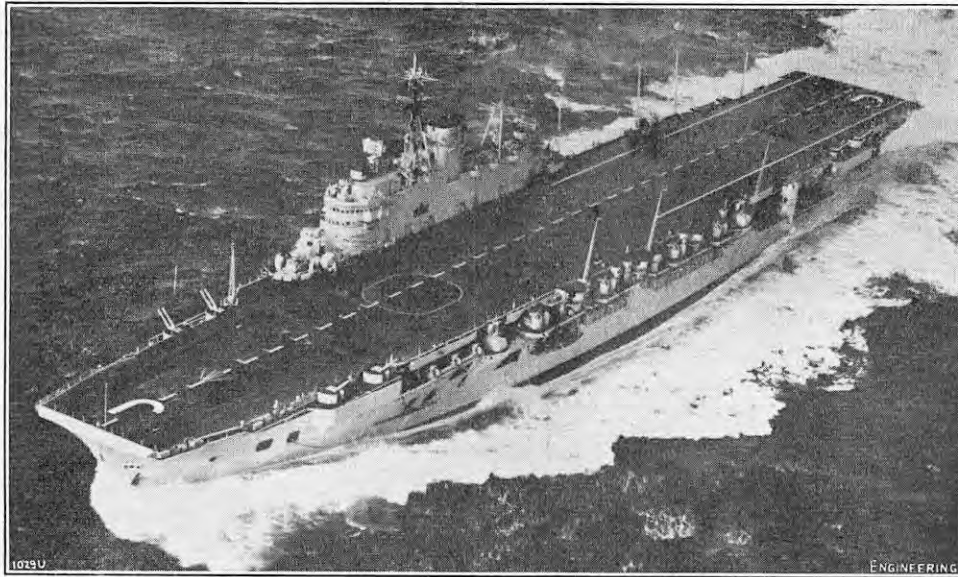


FIG. 24. H.M. AIRCRAFT-CARRIER "EAGLE," 1951.



FIG. 25. BRITISH RAILWAYS M.V. "CAMBRIA," 1949.



FIG. 26. SECTION OF QUEEN'S ISLAND AFTER AIR ATTACKS IN 1941.

and Harland Limited, must have occupied a high place in the enemy's bombing list and yet few persons could have anticipated the extreme ferocity and the Teutonic thoroughness with which the air-raids were pressed home. Fire and explosion wrought tremendous havoc in all parts of the establishment (see Fig. 26, on this page). There can be no doubt that the attacks were made with the deliberate intention of obliterating the shipyards, the engine works and the aircraft factory and thus neutralising the valuable new construction, maintenance and repair work which was being carried out for the Western Approaches and other theatres of war.

Harland and Wolff can claim the questionable privilege of being by far the most heavily damaged shipyard in the British Isles during the second World War. While the damage to the Belfast Works was very severe, there were, fortunately, sufficient fitting-out berths and cranes left available to enable work to proceed to a limited extent, and the construction programme was never completely interrupted. By many improvisations a gradually increasing rate of output was achieved under extremely difficult conditions. In the meantime, the devastated sections of the works, which amounted to some 60 per cent. of the total, were cleared and rebuilt. It is noteworthy that within a period of a little over two years the majority of the wrecked workshops, etc., had been reconstructed, although in most instances crane equipment was not available until later owing to shortage of supply. The repair and replacement of the less urgently required parts of the establishment which had been damaged or destroyed, such as office accommodation, etc., followed as opportunity offered, and, in the meantime, large sections of the technical and commercial staff were transferred to houses in the outskirts of Belfast.

To-day, as the firm approaches its centenary year, it is reassuring to see that on the site of the original tiny Hickson iron shipbuilding yard, stands an establishment of the most modern construction, the size of which is clearly shown by the aerial photograph reproduced in Fig. 22, on Plate XXXI. At the moment, the yards, which are fully booked with work for some years ahead, employ, including staff, 21,500 persons and more could be taken on if the present steel allocation, which represents only some 60 per cent. of requirements, were increased. Nevertheless, the firm continues to expand its activities as already mentioned, and fresh outlets have been found in such fields as structural steelwork. A new section of the works built shortly before the second World War, is capable, in normal times, of turning out, up to 10,000 tons of structural steelwork in a year. This section is self-contained and carries out the design, fabrication and erection of all classes of structural steelwork. A recent example of their work was the steelwork for the very extensive establishment of Messrs. Courtaulds Limited, at Carrickfergus, Co. Antrim, visited by some of the members of the British Association during the Belfast meeting. The establishment covers 275 acres and comprises many different types of specialised buildings, for which the tonnage of structural steel amounted to 12,500 tons.

But it is as shipbuilders that the firm of Harland and Wolff, Limited, will most frequently be thought of, and it is appropriate, therefore, that this paper should conclude with a reference to the latest developments in this sphere at the Queen's Island. The cargo and passenger ships, as well as naval vessels, now building incorporate a great deal more welded construction than they did in pre-war years; for example, some vessels building at Belfast to-day are up to 90 per cent. all-welded. Although the proportion varies considerably, with different types of ships, the average amount of welding has increased and is steadily increasing from year to year. Shortly after the beginning of the second world war, many large shipbuilding and engineering firms were faced with the necessity of rapidly expanding their welding facilities. Queen's Island was no exception, and the target here was an increase in the welding labour force of 150 per cent., from 400 to 1,000 men. It was obvious from previous experience that casual methods of training would be unlikely to produce anything like the desired results. The whole question of training was dis-

cussed from every angle, and with the agreement of the trade union concerned, a large welding school, with a floor area of 3,400 sq. ft., was built and was ready for use in less than 12 weeks, together with 20 welding cubicles and all the necessary equipment. The recruiting of dilutee labour was commenced without delay—the labour force was drawn principally from the building trades—and with 60 trainees at a time, the welding school was soon functioning continuously on three shifts six days a week. The scheme worked well, the average trainee reaching piecework standard in about three months. At the end of two years, the scheme had increased the welding labour force from 400 to 1,150, and this bold policy undoubtedly helped to put the firm in the strong position which it now occupies in producing ship structures which are almost entirely welded.

Such a scheme as that outlined above naturally entailed a considerable extension of existing power and plant installations. The existing average power capacity at the slips was for 30 to 50 welders, while one or two were wired for 100 welders. Additional cables were, therefore, installed so as to increase the capacity up to a minimum power for 100 welders per slip, while several slips were cabled up to supply 200 and 300 welders. As much space as could be spared inside the sheds was allocated to this work, but it was only natural that sufficient room could not be found under cover to accommodate the whole of the prefabrication for ships building on the 18 berths. In addition, the existing sheds suffered from the fact that there was not sufficient headroom for turning large panels and the lack of proper handling facilities was also apparent. Plans were therefore drawn up and approved for a new welding shop, having a floor area of 110,000 sq. ft. and headroom for turning panels of over 40 ft. It is greatly to the credit of the firm's Steel Constructional Department that in less than six months the 1,200 tons of structural steelwork for the new shop was erected and the glazing well in hand. An overhead gantry crane, with a span of 125 ft., was erected outside the shop, covering a storage area of 100,000 sq. ft., and intersected by wide concrete roads leading to the slips.

This huge welding shop is shown at work in Fig. 23, on Plate XXXI. If the steel supply to the yard were not on the present reduced scale the welding shop would be producing over 500 tons of fabricated steel a week—as, indeed, it has done in the past. Prominent among the machines of special application to be found in this shop, is a 40-ft. by 10-ft. flame planer, with a power-driven charging and discharging roller conveyor. But all this splendid equipment avails the company little if an adequate supply of steel is not readily available. The tragedy of the Queen's Island as it nears its centenary year is that, in common with other shipbuilding centres in the British Isles, there is an acute shortage of steel and other materials. At the 67th annual general meeting of Harland and Wolff, Limited, held on June 12 this year, the chairman and managing director, Sir Frederick Rebbeck, said that contracts on hand would keep the company's facilities fully employed for some years ahead, until about 1957. He pointed out, however, that "... the key to what we are able to do is an adequate supply of steel, and until we can obtain nearly double the amount which we are now receiving it will not be possible to meet our delivery commitments in connection with the very considerable programme that lies ahead of us." In spite of present supply difficulties, there is no doubt that the Queen's Island will continue to make its unique and important contribution to the economy of Northern Ireland.

A discerning visitor to the works at the Queen's Island may well wonder how this great industrial undertaking, situated in a predominantly agricultural area remote from the sources of supply of its principal raw materials, has achieved such a remarkable degree of technical and commercial success in spite of the disadvantages inherent in its geographical position. The author believes that Sir Edward Harland supplied a wholly satisfactory explanation when he said "It has been accomplished simply by energy and hard work. We have been well supported by the skilled labour of our artisans; we have been backed by the capital and the enterprise of England."

ON THE FOOT-HILLS OF THE PLASTIC RANGE.*

By PROFESSOR H. W. SWIFT, M.A., D.Sc.,
M.I.Mech.E.

(Continued from page 384.)

THE MATHEMATICIAN'S APPROACH.

IN so far as mathematicians are generally concerned with matter on an effectively macroscopic scale, the engineer feels competent to express an opinion on the physical premises on which their analysis is based. If these are acceptable, he has no doubt that the analysis itself is sound and is therefore prepared to accept the results. All that he asks the mathematician, therefore, is that he should make reasonable assumptions and state them clearly, whether they occur as premises or as imitations or approximations during his analysis; and he should express his results in intelligible terms and in a form in which they are safe and reasonably convenient to handle. For the most part, mathematical theory is at present confined to what is called a perfectly plastic body. Such a body is isotropic and is characterised by the absence of strain-hardening or creep or Bauschinger effect.

For analysis involving compound stress it is also necessary to adopt some stress criterion for yield in the material. In the study of materials, and particularly in the plastic range, it is important to recognise that any system of stress can be, and physically should be, divided into a volumetric system which tends to change the volume of the material, and a distortional or "reduced" system which tends to change its shape.

In a perfectly plastic body the stress system will conform to the same yield condition, however much flow has occurred. In contrast to this, any ordinary metal not only hardens but also becomes anisotropic under plastic strain; so that the yield condition is not only altered in scale, but ceases to be symmetrical and is not uniquely determined by the resultant strain. In its present stage, the mathematical theory of plasticity has only been applied to strain-hardening materials in a few cases, and in these only, as a rule, on the assumption of continued isotropy.

In order to study the plastic flow of a material, it is necessary to know not only the stress conditions for flow to commence, but also the geometry of this flow in relation to the stress system. In isotropic material the principle of symmetry can be invoked to show that the principal directions of stress and strain are identical, and in a material which conforms to the von Mises yield criterion it seems justifiable to assume that at any stage the geometry of distortional strain-rates is the same as the geometry of distortional stress. In fact, the present mathematical theory of plasticity is built on both these assumptions, although it is known that in metals after considerable overstrain the stress and strain systems may not be coaxial, and that in metals in ordinary commercial condition the systems of distortional stress and strain are by no means identical.

The problems to which the theory of plasticity is applied are of two types, namely, those concerned with "contained plastic deformation" in which the total strain is small, so that the elastic strain is not negligible in comparison with the plastic. These include such problems as the autofrettage of thick tubes and the limit design of structures. The other type includes those involving "unrestricted plastic flow," in which the plastic deformation is so great that the elastic strain is negligible. These problems include most of the technological forming processes. In most problems of this type the conditions are complex; one region may be purely elastic; another may be subject to contained plastic deformation; and another to unrestricted plastic flow. To solve such problems completely it would be necessary not only to investigate the stress and strain conditions in each region, but also to determine the boundaries between the regions. The difficulties of mapping the elastic-

plastic boundary are such that very few problems involving contained plastic deformation have as yet yielded to the patience of the mathematical computer, and the boundary between the regions of contained and unrestricted flow may well be found to depend on the history of the stress/strain development. But with the simplifying assumptions discussed above, it has been found possible to map the region of unrestricted flow in a number of cases of practical interest, on the assumption that the material is rigid/plastic, so that no strain occurs except in the regions of actual plastic flow.

It should be pointed out that these solutions apply only to two-dimensional flow, or "plane strain" as the mathematicians call it. Under plane strain the conditions at every point are essentially those of simple shear, which are, of course, by no means representative of most technological processes; but comparisons made with two-dimensional models have given encouraging results, and descriptive agreement has even been obtained with models having radial symmetry.

In spite of these simplifying assumptions, the methods applied to these problems at present have two drawbacks, namely, they are based essentially on a process of trial and error, in that they start with a guessed solution and deduce the conditions which it satisfies, which may or may not be those prescribed; and there is no guarantee that the solution so achieved is unique, it merely stands until a better one is found or until it is disproved an isotropic by experiment. This lack of uniqueness may prove to be an inherent feature of the hypothetical perfectly plastic body, and may disappear when it becomes possible to take strain-hardening into account.

It is clearly impossible to give any reasoned account of the plane-strain technique in this lecture, but solutions to technological problems are becoming increasingly available, and engineers and metallurgists should be in a position at least to interpret a solution in the form in which it is usually represented and to satisfy themselves that it is physically satisfactory.

THE METAL PHYSICIST'S APPROACH.

Broadly, the terms of reference of the metal physicist in the field of plasticity are to explain and ultimately to predict the plastic properties of materials in terms of their atomic arrangement and structure. Within this reference the objectives which appear most significant to the engineering scientist are: to enable the search for new metals for plastic processes to be pursued by less empirical and fortuitous methods than prevail at the present time; to rationalise the prediction of the effect on plastic properties of various mechanical and heat-treatments and of various alloying additions; and to enable test procedure for the plastic properties used in technological processes to be planned on fundamental lines.

These objectives suggest three main fields of scientific inquiry. The first is to explain the properties of a single crystal in terms of its atomic arrangement and structure. The second lies in knowing the plastic properties of a single crystal, to predict the properties of a polycrystalline aggregate. This inquiry must, of course, extend to aggregates in which the crystals are of various shapes, sizes, and orientations, and of different constitutions. The third field consists in studying plastic stress/strain relations in the broadest sense. This would involve separate investigations of: yield conditions for material in any given state; the causes, mechanism, and effects of strain-hardening; and the effects of anisotropy, whether intrinsic to the method of formation or induced by work-hardening processes.

The engineer is conscious that each of these fields of inquiry is extensive, and beset by difficulties both of experiment and theory. He also realises that they have attracted the attention of physicists and mathematicians of the first rank and that real progress is being made. Yet he cannot help feeling that a great deal more time and effort will need to be expended before the metal physicist can hope to produce results of a kind suitable for practical application.

It is accepted that the properties of a polycrystalline body must depend on the properties of

* Twenty-third Autumn Lecture delivered before the Institute of Metals at Oxford on Monday, September 15, 1952. Abridged.

its constituent crystals, but attempts to derive the yield criterion for an aggregate the individual crystals of which conform to the Schmidt law have for the most part been based on simplifying assumptions and unrealistic statistical methods, and the treatments have been one-eyed, in the sense that they have either considered stress distribution and turned a blind eye to the need for conformity of strains, or they have prescribed equality of strain and neglected the need for stress continuity. A recent treatment by J. F. W. Bishop and R. Hill,* based on certain extreme principles and applied to an aggregate of face-centred cubic crystals does, however, seem to be more physically tenable and is likely to survive. It is interesting to find that the yield surface derived by Bishop and Hill lies quite close to that proposed by von Mises, which, in its Hencky form, appeals to the instincts of the engineer as a rational criterion for statistically isotropic material.

But even when the problem of the yield criterion has been solved for the various space lattices and their combinations, and when the nature and influence of marginal conditions have been finally determined, there will still lie ahead the problems associated with the geometry of plastic strain development, with the polycrystalline features of strain-hardening, and with the growth of macroscopic anisotropy, problems to which the present field of inquiry seems to be little more than an elementary introduction.

In the second general field of inquiry, that which is confined within crystal boundaries and is concerned with internal crystal structure, the engineer finds it difficult even to form his own opinion of the present state of knowledge or the direction and rate of progress. He feels confident that the science of crystal plasticity must ultimately be built up on the mechanics of a relatively simple lattice structure, yet he is presented with clear evidence that an intermediate mosaic structure can exist, the unit of which lies somewhere between the unit cell and the metal crystal, and which affects the intracrystalline processes of deformation and strain-hardening. At the present time this rather ill-defined structure can be used as a convenient means for explaining discrepancies between results at the crystal and atomic levels, but in due course it must further extend the field of inquiry of the metal physicist and lead to a critical study of the mosaic law.

At the atomic level, the engineer realises that he needs to tread very carefully; because he is not accustomed to deal in astronomic reciprocals, and the micro-geometry of the space lattice is based on techniques which have to be seen to be disbelieved. But he feels, none the less, that the traditional model of the space lattice, with which he is entertained at metallurgical lectures, would form an imperfect basis for any realistic mechanical theory. The space lattice ostensibly consists of an array of unit cells which, in nearly all metals, conform to one of three simple types, consisting of a nice round black atom at each corner of the cell, together with attendant white atoms disposed in or around the cell according to its type. To the simple mind of the engineer, such a cell is not a unit at all, for an aggregation of such cells would produce a crystal overpopulated to the extent of some hundreds per cent. If taxed on this point, the metal physicist concedes that the real unit, in the case of a face-centred cubic lattice for example, consists of one (black) corner atom with three (white) face-centres. When he is further pressed to explain the difference between the black atoms and the white ones, he admits that this is merely a matter of convention, and that, in fact, every atom in a pure metal lattice is similar to every other atom and similarly disposed to its neighbours; but he is not so forthcoming if he is asked why his atoms are spherical and why some tolerate close packing while others, even of the same metal, need elbow-room and yet occupy only the same space. Neither is he convincing when he uses his model to demonstrate the difference between elastic and plastic strain or the doctrine of preferential slip on close-packed planes in close-packed directions.

To the simple-minded engineer, who has a weakness for working models, it seems that if every atom

is the same as every other, the logical unit for a crystal lattice is a single atom, and one having such an effective shape and size that an aggregation of identical atoms will pack into the particular array which is revealed by X-ray and similar methods.

The third field of inquiry suggested for the metal physicist, which is in effect the mapping and contouring of the plastic range so that stress/strain relationships can be fully understood in the most general sense, is a field which cannot be fully harvested until intra- and inter-crystalline mechanics is properly understood. But there seems to be a great need and great opportunity for work in this field at a more empirical level, so that the mathematician and the engineer can be provided with at least a serviceable code of practice which they can apply to problems involving strain-hardening in its more general form as affected by anisotropy and strain history. It might be claimed that a great deal is already known about stress-strain relationships in the plastic range, and it is true that a large volume of empirical data on tensile and torsional properties has been accumulated. But, as Prager has recently pointed out, these data are very largely iterative and are concentrated on a very restricted corner of the field. A good deal is known about the initial "yield surface" for annealed materials, but comparatively little about the geometry of strain which follows yield under various stress systems, or about the effect of overstrain on the enlargement, displacement, and distortion of the yield surface. Next to nothing is known of the effects of a stress system which changes during the straining process. There are, of course, certain experimental difficulties which must attend the widening of this field of inquiry; in particular, it is almost essential to have available a combined torsion and tension testing machine in which the two straining systems can be varied independently, and some means for producing thin-walled tubular specimens from intrinsically isotropic and equi-axed material; and difficulties are likely to arise in defining the inception of plastic flow in material the yield point of which has become blurred by the Bauschinger or cognate effects. But this field provides scope for valuable work which, although primarily empirical, might well lead to important generalisations in the mathematical theory and might even assist investigations in the sphere of crystal plasticity.

(To be continued.)

SMITHSON RESEARCH FELLOWSHIP.—A joint committee consisting of representatives of the Royal Society and the University of Cambridge have appointed Dr. R. J. Eden, M.A., Ph.D., of Cambridge University, to be Smithson Research Fellow for four years, in the first instance, from October 1, 1952. Dr. Eden will work on the theory of fundamental particles at the University.

VISITS OF STUDENTS TO ELECTRIC-FURNACE WORKS.—Wild-Barfield Electric Furnaces Ltd., inform us that, during the winter months of each year, arrangements are made for parties of up to 30 senior engineering students from technical colleges and research establishments to visit their works at Watford. The tour includes a visit to the production shops, metallurgical and chemical laboratories, and the furnace-development section. The firm extend an invitation to visitors from now until May 31, 1953, on any weekday (Monday to Friday) afternoon. Prior application, however, should be made to the company, at Elecfurn Works, Watford By-Pass, Watford, Hertfordshire.

INTERNATIONAL MECHANICAL ENGINEERING CONGRESS.—The fourth International Mechanical Engineering Congress was held this year in Stockholm from June 4 to 10, under the auspices of the Federation of Swedish Mechanical Engineering Industries. The chief topic discussed was the question of "Raw Materials." We are informed that no report of the Congress will be issued, but that a complete set of the papers presented, in English, is held by the Department of Scientific and Industrial Research. Copies of individual papers may be borrowed on request. Notes on some of the discussions which took place have been prepared by the Scientific Attaché to the British Embassy in Stockholm; these notes are also available. Requests for loans should be addressed to the Department of Scientific and Industrial Research, Technical Information and Documents Unit, Cunard Building, 3rd Floor, 15, Regent-street, London, S.W.1.

MOTIVE POWER FOR RAILWAYS.*

By C. M. Cock, M.I.Mech.E., M.I.E.E.

THERE seems little prospect of further major development of the reciprocating steam locomotive, which (quoting the Federation of British Industries when giving evidence to the Ridley Committee on the national fuel policy) in a fuel efficiency sense is one of the least efficient machines to survive in a modern age. It would be foolish to say one form of traction is better than another merely because it may be more modern or fashionable. Every form of rail traction is a means to an end, and that is to move trains. A very careful assessment is necessary to determine real values of traction in respect of cost and efficient and reliable movement of traffic. Practical alternatives to the steam locomotive, not necessarily in order of precedence, are self-propelled rail-cars, electrification, Diesel-electric locomotives, and the gas-turbine locomotive.

There is a good deal of misconception regarding rail-cars, probably arising from a belief that they are mere "buses on a railway, possibly hauling a trailer. The fact is that important developments have been made in Diesel units in recent years and they have become firmly established in many countries. They range from single cars to different combinations of power units and trailers which may make up powerful train sets *de luxe*, with restaurant accommodation and air-conditioning, running at high speed on main trunk lines. In the simplest form, a mechanical drive is usual, often with two engines in one coach, and this type seems to be most common in Europe. Many cars have hydraulic drive. Diesel-electric drive is usual with the larger sets, and power coaches up to 600 h.p. are in use. Multiple-unit sets, in a sense, are something between electrification and the ordinary steam hauled passenger train and there would seem to be great scope on British Railways for this kind of development.

ELECTRIFICATION.

Although the electric locomotive is easily the most powerful and efficient of all types of locomotive, and the cheapest to maintain, its cost and characteristics cannot be accepted in any fair comparison with other forms of traction. It does not contain a prime mover; so an expensive fixed installation is required. The fixed line equipment, comprising a contact line, substations and possibly a high-voltage distribution system, is a charge against the running costs of the locomotive when compared with other forms of traction. Nevertheless, electrification under favourable conditions can be the cheapest and most efficient of all forms of traction. There are three basic electrical systems applied to railway traction: direct current; alternating current, single phase; and alternating current, three phase. The three-phase system can be dismissed at once. The constant-speed traction motors make operation somewhat inflexible and the arrangement of the conductors over the track introduces considerable complexities.

The direct-current system is in use successfully in many countries at voltages ranging between approximately 600 and 3,300. Some 22,000 miles of single track have been electrified on the direct-current system with overhead contact line or conductor rail. On the alternating-current single-phase system some 19,000 single track miles have been electrified, mainly in Sweden, Germany, Switzerland and the United States, and the installations in commercial operation use electrical energy at low frequency, 16 $\frac{2}{3}$ or 25 cycles per second. Some experimental equipment at the industrial frequency of 50 cycles is also in use.

Which of these systems is best? No hard and fast principles can be laid down; it has been proved that both the direct-current systems and the alternating-current single-phase low-frequency systems can work with maximum reliability and efficiency. There is also promise in the 50-cycle single-phase system. The justification for the electrification of

* Phil. Mag. (vii), vol. 42, page 1298 (1951).

* Presidential Address to the Institution of Locomotive Engineers, delivered in London on September 24. Abridged.

any railway, and the system to be adopted, is primarily, but not entirely, economic; the value of electrification as a capital investment is determined by comparing the working expenses after electrification with those of steam operation under similar conditions, and a reduction in working expenses must be found more than sufficient to meet the additional fixed charges due to electrification. This applies principally to main-line electrification where no increase in traffic due to electrification may be expected. With suburban electrification, however, the track capacity can always be increased. Although this may result in increased working expenses, experience has shown that the improved but more costly services attract substantial increases in traffic with consequent increased net revenue.

Electrification may be found desirable, or even necessary, for other reasons, not always economic; in some countries there is an abundance of water power, and a shortage of fuel; many well-known advantages with electrification include improvement in working on heavy gradients, increase in line capacity and smoke abatement. Electrification has assisted in the development of cheap power in some countries, for example, in South Africa. The growth of the traction load, which may be considered the base load, resulted in a reduction of from 0.816d. to 0.48d. in the average price per unit of electrical energy for all purposes on this system between the years 1927 and 1949.

For the same horse-power at the train, the current required by the locomotive on a 15,000-volt single-phase system is not much more than one-tenth of the current on a 1,500-volt direct-current system. It follows that the overhead conductor for the higher voltage may be of smaller cross-section and the number of substations may be materially reduced. The supporting structures and foundations for the overhead conductor are lighter. On the other hand, with an increase in operating voltage there is an increase in the cost of the electric locomotives and electrical equipment of coaches; so to determine the economic effect of the variables on any proposed system of electrification the actual case must be worked out. High traffic density demands increased current, thereby tending to increase the size of the line conductors and supporting structures, or to reduce the spacing between substations. Thus with high traffic density the benefits of high voltage cannot fully be realised as regards reduction in cost of the fixed installation. Also with high traffic density the number and cost of the electric locomotives and electrical equipment of coaches increase to a greater proportion of the total cost of the scheme. Therefore, high traffic density tends to favour the adoption of low voltage, and low traffic density favours a high voltage.

So far as the annual charges in respect of locomotive coal versus electric power, and steam versus electric locomotive operation and maintenance, are concerned, savings can be obtained after electrification. These savings are offset to a varying extent by the operation and maintenance costs of the fixed electrical equipment. Depreciation charges are heavier, though the effect of these may be reduced by economies in maintenance, in the painting and cleaning of railway property, etc. For suburban electrification the financial case is better still. Indeed, it is likely that the true savings arising from many suburban electrifications have never been computed because the traffics have rapidly exceeded the track capacity possible with steam.

50-CYCLE TRACTION.

Interest is now aroused by the possibility of using single-phase electrical energy at the industrial frequency of 50 cycles per second, since it reduces to a minimum the cost of the fixed installation. Power may be taken directly from the national grid. With a high contact-line voltage the traction substations can be spaced at long distances and reduced to their simplest form, i.e., merely containing step-down transformers. This development may open a field for electrification which could not be justified on the standard systems in use to-day. In Britain, trials with multiple-unit coaches are about to commence on the Lancaster-Morecambe-Heysham line, a section of 9½ miles. The direct-current traction motors are fed from rectifiers.

The Germans have not yet disclosed any intention of proceeding on a large scale with 50-cycle electrification. In fact, electrification is proceeding in the Ruhr on the 16½-cycle system. But in the north of France the S.N.C.F., encouraged by their experiments, are proposing further electrification on the 50-cycle system on the Valenciennes-Thionville line, with the possibility of projecting this into Germany as far as the Rhine at Koblenz. It is reported that the S.N.C.F. have been so satisfied with their experiments between Aix-les-Bains and La Roche-sur-Foron that they are devoting all their financial and experimental resources to 50-cycle traction rather than continuing with the 1,500-volt direct-current system which hitherto has been their accepted standard.

While the 50-cycle system may be attractive in so far as the cost of the fixed installation is concerned, there are disadvantages with the electrical equipment of the vehicles, and the effect of unbalance on the main three-phase power network of the single-phase traction supply. The single-phase commutator motor still compares unfavourably with its direct-current counterpart in characteristics, weight, first costs and maintenance costs, though the designers are narrowing this gap. While the S.N.C.F. do not anticipate any serious disturbance from unbalancing due to single-phase traction loads, it is hardly prudent to accept this as a matter of course. The local conditions in any territory under consideration should be studied to ensure that the magnitude, and possibly irregular incidence, of unbalancing loads can be controlled and absorbed comfortably in the general three-phase supply system. For various reasons, including economic considerations, the British Transport Commission have accepted the 1,500-volt direct-current system as standard for British Railways, but the 50-cycle system has not been ruled out for electrification of secondary lines with light traffic.

THE DIESEL-ELECTRIC LOCOMOTIVE.

The Diesel is the most efficient heat engine available at the present time for practical application in a locomotive but the overall cost of translating efficiency into useful work at the wheel rim must be weighed when determining whether this type of locomotive is indeed a more economical tool for transportation than the steam locomotive. The net thermal efficiency of the Diesel-electric locomotive at the rail is, at about 26 per cent., very much higher than that of the steam locomotive. The direct drive of the steam engine results in the power rising with the speed, whereas the Diesel engine with electrical transmission can operate to develop its full rated power output over a wider and more useful range of road speed. The advantage is obvious with freight services, yard working and heavily-graded lines, but on long sustained high-speed runs it is possible that the Diesel-electric locomotive may lose some advantage.

TABLE I.—Fuel Costs (Delivered to Railway Fuelling Depot).

	Calorific Value, B.Th.U. Per Lb.	Cost Per Ton, £	Cost Per 1,000 B.Th.U., Pence.
Diesel fuel oil:—			
U.S.A. ..	19,000	11.5	0.065
U.K. ..	19,000	16.0	0.0905
Coal:—			
U.S.A. ..	13,000	2.1	0.0173
U.K. ..	10,500–14,500	4.0	0.0355
Ratios:—			
U.S.A. ..	—	Oil/coal, 5.47/1	Oil/coal, 3.74/1
U.K. ..	—	Oil/coal, 4/1	Oil/coal, 2.57/1

Resulting from the relative costs of coal and Diesel fuel and the relative efficiencies of the two prime-movers in the United States, the cost of fuel for equivalent work done by Diesel-electric locomotives is on average little more than 50 per cent. of that for coal-fired steam locomotives in passenger and freight services. For shunting, the corresponding figure is about 30 per cent. on a shunting-hour basis. It is significant that British results are very nearly the same, at about 29 per cent., and

it should be noted that the substantial number of Diesel-electric shunting locomotives now in service in Britain establishes this figure on a reliable basis. A very important, and to some of us in this country a possibly surprising, point emerging from Table I, opposite, is that the differential in cost per B.Th.U., as between oil and coal, is rather more in the United States than it is in Britain. It is not illogical, on this basis, to assume that savings in operating costs could be secured in Britain of no less a proportion than those obtained in the United States. Maintenance and repair costs for main-line Diesel locomotives in the United States are stated to average only one-third to one-half of those for steam locomotives, and there appears to be no reason why the same trend should not be obtained in Britain, and also in other countries.

Considerably more time is required for servicing, repairing and inspecting steam locomotives than is required for Diesels, and as a result the availability and utilisation of the Diesel are considerably higher than for steam locomotives. It has been found in the United States that Diesel locomotive units on freight service average twice the annual mileage and on passenger service from two to three times the mileage of steam locomotives. For shunting service nine steam locomotives are needed to do the same work as five Diesels. In the United States, considerable speeding up of freight and passenger services has been possible with Diesel locomotives. Average train-miles per train-hour on freight and passenger services have increased 20 to 30 per cent. In parallel with these speed increases there have been big increases in the gross freight-ton miles hauled per locomotive mile and in the passenger-coach miles for the Diesels. In spite of the relatively high first cost of the Diesel locomotive, overall operating and repair costs, inclusive of depreciation of interest charges, in terms of gross ton-miles hauled and coaching miles run, are only about 60 per cent. to 65 per cent. of that for steam.

Of all the factors contributing to the economy of Diesel traction in the United States, it would seem that chiefly those concerning capital costs and utilisation might perhaps be unfavourable in Britain. British conditions of railway operation are not similar, particularly with regard to routes lending themselves to long runs and a high degree of locomotive utilisation. There are, however, the many other favourable factors which reasonably may be expected to follow the pattern that has produced such spectacular results in the United States. Taking into account the relative costs and calorific values of Diesel fuel and coal in Britain, a theoretical evaluation indicates that, for equivalent work done over the same route with the same trailing load, the cost of fuel for the Diesel-electric locomotive is less than that for the steam locomotive by about only 10 per cent., and this is supported by actual field tests. When the respective capital charges are added, the higher first cost of the Diesel locomotive swings the balance in favour of the steam locomotive to the order of 25 per cent. But such conclusions when drawn from particular and individual comparisons are unrealistic. The real general and total costs must take into account the many contributing auxiliary factors when a large number of Diesel locomotives displaces a considerably larger number of steam locomotives for equivalent work.

There is no question of the technical success of Diesel locomotives for main-line work in this country, and there seems little doubt that, by the American criterion and the relative British differentials in cost, there is opportunity for commercial success. The fundamental factors of relative fuel costs and the savings possible in maintenance costs go a long way to support this contention, and they justify an assessment of Diesel traction on a large scale to obtain a realistic revelation of the savings in costs, as distinct from operation of only a few locomotives.

TURBINE LOCOMOTIVES.

The steam turbine has been applied experimentally to locomotives over a fairly long period, starting, as far as can be ascertained, in Italy in 1907. Some of the experiments have been costly, but in spite of persistent and patient endeavour nothing so far has emerged as a permanently better substitute for the reciprocating steam locomotive. Reciprocating

CHARACTERISTICS OF LOCOMOTIVES.

Fig. 1. DIESEL ENGINE AND GAS TURBINE: COMPARATIVE EFFICIENCIES.

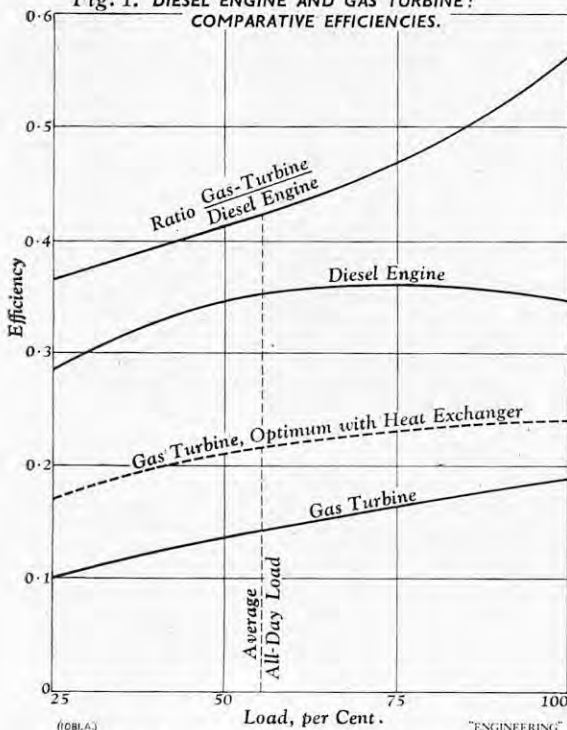


Fig. 2. TRACTIVE EFFORT AND SPEED.

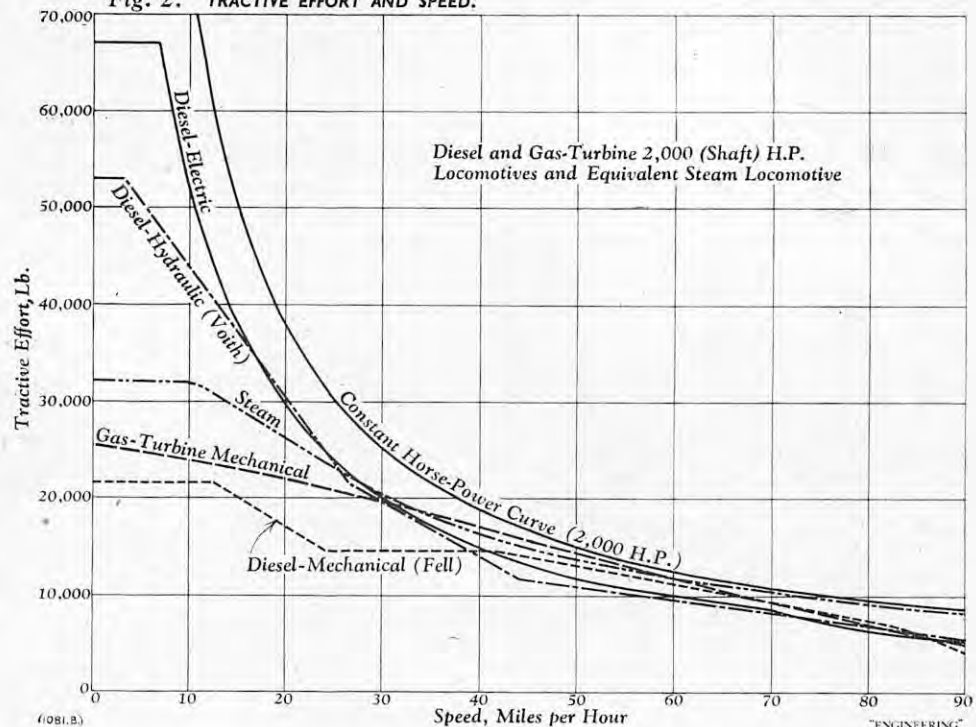
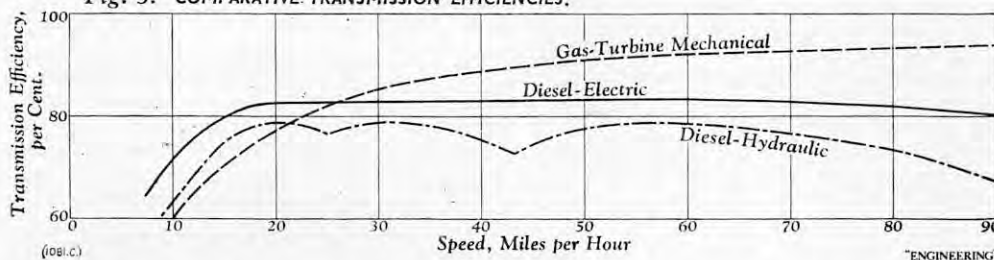


Fig. 3. COMPARATIVE TRANSMISSION EFFICIENCIES.



engines are in the nature of things fully as efficient as turbines; it is only when very large volumes of steam are used, and the cylinder size becomes inconveniently large, that the turbine comes into its own. This, however, occurs at the stage of condensing engines working on high vacuum and for powers beyond the range of locomotives. In non-condensing reciprocating locomotives, so far as efficiency is concerned, the critical limit of cylinder size is not even approached, and the turbine is thus unable to show any advantage in steam consumption. While some condensing steam locomotives have been built attaining a thermal efficiency of 16 per cent. at the drawbar, their weight, size, cost and the complications with condensers and auxiliaries have made them unattractive.

Attention has been turned to the gas turbine, which shows greater promise for locomotive applications, the ultimate hope being that it will enable smaller, cheaper and more powerful locomotives to be built within the limits of existing axle weights and load gauges. The advantages of the gas-turbine locomotive arise from simplicity and consequent low maintenance costs, high ratio of power to total length and weight of locomotive, and high availability factor. As with the Diesel locomotive, however, the overall cost, including maintenance, fuel and capital charges, must be measured under similar conditions of operation against other forms of traction, of which the reciprocating steam locomotive is the convenient yardstick. Gas-turbine locomotives are still in the experimental stage. Two have been built in Switzerland, of which one is in service on the Western Region of British Railways; one has been built in Britain, also in service on British Railways; two have been in service in the United States for some two to three years; and ten more are being supplied (some are already in service) to the Union Pacific Railroad in that country. Two coal-burning units are being built, one in Britain and one in the United States, but neither has yet reached the stage of building into locomotive frames. Sweden, Russia, Japan and

Canada are reported to be building experimental gas turbine locomotives. A French locomotive of 1,000 h.p. now undergoing trials has a free-piston two-stroke compressor supplying pressure gas to the turbine.

The thermal efficiency of gas turbines is limited by various factors, but were it not for practical commercial considerations such as size, weight and cost, there would be no insuperable obstacle to-day to building a gas turbine with a thermal efficiency of 45 per cent. or even higher. In practice, at the present stage, the top figure for electricity generating stations is about 34 per cent., while the best figure yet achieved for the more restricted space in a locomotive is 19 per cent. at the turbine shaft. The full-power efficiency of the locomotive is reduced with electrical transmission to 15.5 per cent. at the rail. It is not impossible, however, to attain 24 per cent. thermal efficiency at the shaft of an open-cycle gas turbine with a heat exchanger, the complete unit being of a size and power suitable for a locomotive. The French 1,000-h.p. locomotive is claimed to have a thermal efficiency of 33 to 35 per cent. at the turbine shaft, using non-distillate fuel, but the free-piston compressor system has not yet been proved in rail service neither are any overall-efficiency figures yet available.

Either Diesel fuel or residual fuel oil can be used in gas-turbine locomotives. Diesel oil is technically preferable as it requires no pre-heating and is virtually ash-free, but it is more expensive. There is no basic reason why a gas turbine should be less efficient when burning residual fuel, but the suitability of residual fuels for open-cycle gas turbines is still subject to further testing as the majority contain ash constituents which are potentially corrosive. American railroads can run their gas-turbine locomotives on selected residuals which are virtually free from vanadium, but in this country the majority of the fuel oils are derived from Middle East and Caribbean crudes which contain this element. The ash contents and compositions of the various fuels available, however,

vary considerably according to their sources and there is not yet sufficient experience to say whether they are all unsuitable. Although considerable work has been done, no economical method has yet been developed for removing from residual fuels the vanadium compound which is harmful to the turbine blading. Coal is another possible fuel which, following extended tests in stationary plant, is to be tried in locomotive service in the United States, though the difficulties with fly-ash in open-cycle machines have not yet been completely overcome. A coal-burning gas-turbine locomotive is being built in this country, and although of relatively normal open-cycle design, it will have combustion taking place in the heat exchanger so that none of the ash will pass through the running parts of the turbine. This involves the use of a somewhat out-size heat exchanger which is difficult to accommodate in the space available in the locomotive.

As gas-turbine locomotives so far have been built and maintained in isolation, and in different countries, it is not possible accurately to assess the true capital costs and the overall costs of maintenance. In contrast with a Diesel locomotive the capital costs may possibly be lower when produced in quantity and the maintenance costs may be lower due to simplicity. Fuel costs, however, are higher than with the Diesel, and this is not only because of lower efficiency at the full-load rating. Since a locomotive under service conditions runs for only part of the time on full power, the all-day thermal efficiency at the rail will be considerably lower than the full-load rating. If the varying duties be assessed as equivalent to running continuously at an average of 50 to 60 per cent. of full power, then the average thermal efficiency of a gas-turbine locomotive at the turbine shaft is not more than 15 per cent., compared under the same conditions with 35 per cent. from the Diesel engine, as shown in Fig. 1, on this page. These curves indicate also that the Diesel engine has much more suitable characteristics over the range of varying load encountered in railway operation. Variations in ambient temperature have an important influence on the performance of gas turbines which may be favourable or unfavourable, depending on the climatic conditions in the territory of operation.

Dynamometer-car trials on British Railways indicate that the thermal efficiency of gas-turbine locomotives so far tested is little better than that of steam locomotives when hauling similar loads over similar routes. This result does not do full justice to the gas turbine because the full power was not utilised, and no final conclusion can be drawn as to overall economy until the total costs are

taken into account, including the many contributing factors when a large number of these locomotives displaces a considerably larger number of steam locomotives for equivalent work.

TORQUE CONVERSION.

From Fig. 2, page 423, it is evident that electrical transmission is the nearest approach to the ideal speed/tractive effort characteristic obtainable from a locomotive, and there is no question that electric cables, motors and single-reduction gears provide the most flexible connections between the prime mover and the road wheels, thus eliminating from the design of the locomotive dominating restrictions caused by mechanical driving shafts and gearboxes, even at the cost of weight and space which in some applications may be important. Electrical transmission permits individual axles to be motored as desired and offers the greatest freedom in the co-ordination of maximum tractive effort with permissible axle loads and total weight of locomotive. Alternative forms of transmission must necessarily be arranged in definite wheel groups to be practicable. For low-power locomotives various mechanical or hydraulic or combinations of these means of transmission have become established on the grounds of higher efficiencies and lower first costs. Fig. 3, page 423, shows the differences in efficiencies of the various transmissions, which in all-day operation cannot have a very great influence on costs. It is mainly on the score of first costs and weight that alternatives to electric transmission are chosen. No equally satisfactory alternative to electric transmission has so far become established, or to any large extent proven, for Diesel or gas-turbine locomotives of high power.

Another means of converting the power of the Diesel engine is by variable rates of speed and of pressure-charging, whereby the cylinder pressure is high at low engine speed and gradually falls to a lower value at top engine speed. Power output then tends to be constant over the full range of engine speed. With this principle, however, the effects on the engine are severe at low speeds due to the very high maximum cylinder pressures. The loading conditions created require generous bearing areas, particularly on the big ends.

There is no fundamental reason why the inherent torque characteristics of the gas-turbine should not be utilised by gearing it to the road wheels of a locomotive. Such a scheme probably could be devised cheaper in first cost than electrical transmission and be more efficient so far as internal losses are concerned; but in cases where maximum proportions of the weight of large locomotives are required for adhesion, difficulties and complications arise in coupling together large numbers of axles which must work equally well in both forward and reverse directions. Comparing locomotives of equal power at the shaft of the prime mover, the mechanical drive with the gas-turbine still falls somewhat short of the ideal speed/tractive effort characteristics inherent in the electrical drive, as shown in Fig. 3.

In this address I can only touch on the main features and make the very broad assessment that electrical transmission is reliable, well proven and ideal. For locomotives of high power, developments of alternatives are proceeding and any supersession of electrical transmission must be on a basis of cheaper first cost, higher efficiency and at least equal reliability, always providing that ideal speed/tractive effort characteristics are not an important consideration.

(To be continued.)

EXPORTS OF ISOTOPES FROM HARWELL.—According to a statement issued by the Ministry of Supply this country is now the largest exporter in the world of radio-active materials for peaceful purposes. During the year ended June 30, 1952, the Atomic Research Establishment at Harwell exported some 3,000 consignments to 37 different countries. The necessary transport was provided by the British Overseas Airways Corporation, who have converted a fleet of Argonauts for carrying the materials in their wing tips. This method reduces the cost of transport by 60 per cent. owing to the elimination of heavy lead containers.

NOTES ON NEW BOOKS.

Modern Electrical Contracting, Business Organisation and Routine.

By H. R. TAUNTON, A.M.I.E.E. Diffe and Sons, Limited, Dorset House, Stamford-street, London, S.E.1. [Price 10s. 6d. net.]

THIS is not another book dealing with wiring systems and the installation of electrical plant; nor is it concerned with the technical side of its subject. The author's purpose is to describe the setting-up and operation of an electrical-contracting business from the financial, operative and administrative points of view. This task he accomplishes with thoroughness and clarity. At the outset, he addresses himself to the individual desirous of becoming an electrical contractor and describes the qualifications he should have and the capital resources desirable. He points out that there are some 10,000 electrical contracting firms in operation and although the small man, as distinct from the large firms, will be concerned with operation in a limited area, success or failure may depend on the existing competition in the district. Advice is given about the choice of premises and—the beginner's greatest difficulty—obtaining orders. Later chapters in the book deal with advertising, estimating, costing, the purchase and handling of stock and the choice and control of labour. The information given covers every business aspect of electrical contracting; the technical aspect of the matter is touched on in the section dealing with standards of work and the Institution of Electrical Engineers' Wiring Rules. Mr. Taunton states that there are wiring contractors who apparently have never heard of these rules. He permits himself one technical criticism when he suggests that too much stress is laid on the mechanical protection of wiring systems, pointing out that very many "armour plated" installations end in flexible cables trailing across the floor. There may be something in this, but safety does not lie in bringing down every link of a chain to the standard of its weakest.

A Geology for Engineers.

By F. G. H. BLYTH, Ph.D., M.Sc., A.C.G.I., D.I.C., F.G.S. Third edition. Edward Arnold and Company, 41, Maddox-street, London, W.1. [Price 25s. net.]

WRITTEN by the lecturer in engineering geology at the Imperial College of Science and Technology in London, this text-book naturally covers the work of the courses in geology for civil engineering students at that College. It will be found useful, however, for students studying at other centres, for candidates reading geology for the examinations of professional institutions, and for all who are looking for an introduction to geology and its applications to engineering practice. The author has aimed to provide a concise account of the fundamental aspects of geological science, and he has supplemented this by citing instances of applications to civil engineering practice. Thus, in the first chapter, headed "Physical Geology," the engineer's interest is aroused by sub-headings such as "river training and flood control," or "coast protection." The following six chapters on minerals and rocks are essentially geological and deal with the nature of the materials forming the earth's crust, and the succeeding four chapters are devoted to structural geology, elementary stratigraphy, and geological maps and plans. Applications of geological science to engineering practice are discussed in the last three chapters, which deal with the geology of water supply, reservoir and dam sites, and the geology of cuttings and tunnels. The elements of soil mechanics and geophysical prospecting are outlined in appendices by Dr. A. W. Skempton and Dr. J. McG. Bruckshaw. In this third edition, some new material has been added to the last three chapters, minor adjustments have been made to other parts and the lists of references at the ends of chapters have been brought up to date. The book is adequately illustrated with 141 line diagrams and 16 half-tone plates, and covers sufficient of the groundwork of the science of geology to enable the civil engineer to undertake his own preliminary investigations and to realise when it is advisable to call on expert opinion.

BOOKS RECEIVED.

- The Nuffield Foundation. Report for the Year Ending 31 March, 1952.* Offices of the Foundation, 12 and 13, Mecklenburgh-square, London, W.C.1.
- Elementary Practical Mathematics.* Book I. By E. W. GOLDING and H. G. GREEN. Second edition. Sir Isaac Pitman and Sons, Limited, Pitman House, Parker-street, Kingsway, London, W.C.2. [Price 6s. net.]
- Electric Fuses. A Critical Review of Published Information.* By DIPL. ING. H. LÄPPLE. Butterworths Scientific Publications, Bell-yard, Temple Bar, London, W.C.2. [Price 25s. net, postage 1s.]
- Locomotive and Train Working in the Latter Part of the Nineteenth Century.* Vol. 3. By E. L. AHRONS. W. Heffer and Sons, Limited, Cambridge. [Price 15s. net.]
- Report of the Committee on National Policy for the Use of Fuel and Power Resources.* H.M. Stationery Office, Kingsway, London, W.C.2. [Price 6s. 6d.]
- Studies in Elastic Structures.* By PROFESSOR A. J. S. PIPPAARD. Edward Arnold and Company, 41, Maddox-street, London, W.1. [Price 60s. net.]
- Concrete Roads.* By F. N. SPARKES and A. F. SMITH. Edward Arnold and Company, 41, Maddox-street, London, W.1. [Price 80s. net.]
- Street Lighting.* By J. M. WALDRAM. With Chapters on Gas Lighting by L. T. MINCHIN. Edward Arnold and Company, 41, Maddox-street, London, W.1. [Price 65s. net.]
- The Farmer's Tools 1500-1900.* By G. E. FUSSELL. Andrew Melrose, Limited, Stratford-place, London, W.1. [Price 42s.]
- Design for a Brain.* By DR. W. ROSS ASHBY. Chapman and Hall, Limited, 37, Essex-street, Strand, London, W.C.2. [Price 36s. net.]
- Training for Ironfounding. Report of a Conference held by the Council of Ironfounding Associations at Ashorne Hill, Leamington, on March 12, 13 and 14, 1952.* The Council of Ironfounding Associations, Crusader House, 14, Pall Mall, London, S.W.1. [Price 3s. 6d., post free.]
- Productivity Team Report. The Provincial Press.* Report of a Productivity Team Representing the British Provincial Press which Visited the United States of America in 1951. Anglo-American Council on Productivity, 21, Tothill-street, London, S.W.1. [Price 3s. 6d., post free.]

TRADE PUBLICATIONS.

Handling Wire Ropes.—British Ropes, Ltd., Doncaster, have issued a 12-page illustrated booklet on how to handle and service wire ropes.

Plastics.—Two publications have been received from Bakelite Ltd., 18, Grosvenor-gardens, London, S.W.1. Of these, the first is the second edition, that for 1952, of the firm's brochure describing the composition, properties and applications of phenolic moulding materials. The second brochure deals with the properties and uses of the company's Bakelite, Wacrite and Vybak plastics.

De-Watering Fluids.—Illustrated descriptions of the action of 110 de-watering fluids are given in a brochure issued by W. B. Dick & Co., Ltd., 43, Grosvenor-street, London, W.1. The action is a mechanical one, namely, the displacement of a film of moisture from the surface of a metal by a film of a fluid containing a surface-active material giving it a powerful affinity for surfaces. The fluids are used as rust or corrosion preventives, the evaporation of the solvent present in the de-watering fluid being behind, on the metal, a film of a rust-preventive medium.

Vitrified Tiles.—J. H. Sankey and Son, Ltd., Ilford, Essex, have sent us a leaflet on their new vitrified light-buff-coloured tile. The tile is stated to be extremely hard and long-wearing, and to withstand permanently acids and alkalis. In addition, its surface is claimed to be non-slippery and its buff colour is light-reflecting.

Fullers' Earth.—A folder of leaflets containing data on the properties and uses of fullers' earth for bleaching and regenerating oils, fats and greases, and other applications, and notes on Fulbonds as bonding materials in foundry sands, and on Fulbent as a suspending, thickening, emulsifying and bonding agent, have been sent to us by the Fullers' Earth Union, Ltd., Patteson Court, Nutfield-road, Redhill, Surrey.

Walking-Beam Furnaces.—The Incandescent Heat Co., Ltd., Cornwall-road, Smethwick, Birmingham, have sent us their bulletin V.13, entitled "Continuous-Flow Balanced-Hearth Walking-Beam Furnaces." Recently-installed furnace plants are illustrated and briefly described.

Industrial Ceramics.—Doulton & Co. Ltd., Doulton House, Albert-embankment, London, S.E.1, have and issued a well-illustrated booklet on their stoneware and porcelain industrial vessels, pans, pipes, porous materials, dishes, insulators, cable conduits, sanitary equipment and fittings, and tiles and plaques.