FORGE FOR CONTINUOUS PRODUCTION OF SOLID RAILWAY WHEELS AND DISC CENTRES.

A NEW forge for producing rolled-steel solid wheels and disc centres for railway carriages and wagons has been brought into use at the Trafford Park Steel Works, Manchester, of Messrs. Taylor Brothers and Company, Limited. The plant includes a notable rotary-hearth furnace (believed to be the largest in Europe), an 8,500-ton forging press, two other large presses, and a rolling mill for forming the rims. The block from which a wheel or wheel centre is made is heated in the furnace to forging temperature—the heating and soaking taking about 6¼ hours, equivalent to nearly one revolution of the rotary hearth—and is then passed through the presses and mill in about five minutes, without reheating, emerging as a completed forging ready for machining.

The whole plant is mechanised to an unusually high degree, mechanical handling equipment conveying the steel blocks between the furnace, presses and mill with a minimum of human control. The man-power is only 50 per cent. of that in the old plant, which is to be used for tyre manufacture and produced an average of 40 wheels an hour. In the new plant 11 operators, including furnacemen, produce 60 wheels an hour. This output may be increased when the operation and maintenance of the forge have been perfected. With a plant which is so automatic in operation, a few months must elapse before its optimum performance is reached, but then it will undoubtedly justify the investment of over 1,000,000*l*. which it represents. It has been financed by the English Steel Corporation—Messrs. Taylor Brothers being one of the E.S.C. group of companies—the money coming wholly from profits. Taylor Brothers, Limited, have been the largest producers of railway wheels in the British Empire for many years, and as the English Steel Corporation have recently also installed new plants in Sheffield for the more efficient production of railway springs and cast-steel bogies and automatic couplers, the new wheel forge is further evidence of the importance attached in the E.S.C. group of companies to the manufacture of railway materials, more than 50 per cent. of the output being exported.

The new plant produces wheels ranging from 24 in. to 50 in. diameter on the tread, at a continuous rate of 60 pieces per hour. In conjunction with Mr. E. Homer Kendall, the American consulting engineer, the layout of the plant and the design of the equipment were completed by Taylor Brothers' engineering department, under the control of Mr. J. H. Ellis, assistant chief engineer in charge of development. The major items of plant comprise the 69-ft. diameter rotary-hearth furnace, illustrated

Fig. 3. HOT BLOOM BEFORE SLABBING.

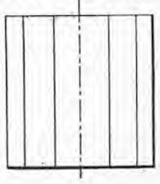


Fig. 4. SLABBING AND DUMPING.

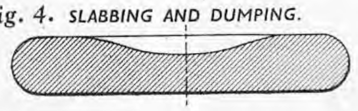


Fig. 5. FORGING.

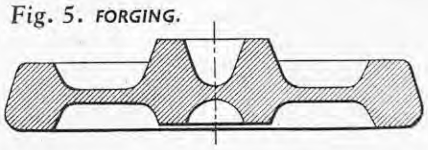
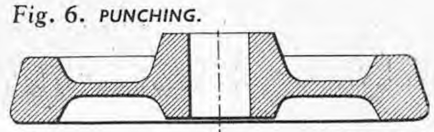


Fig. 6. PUNCHING.



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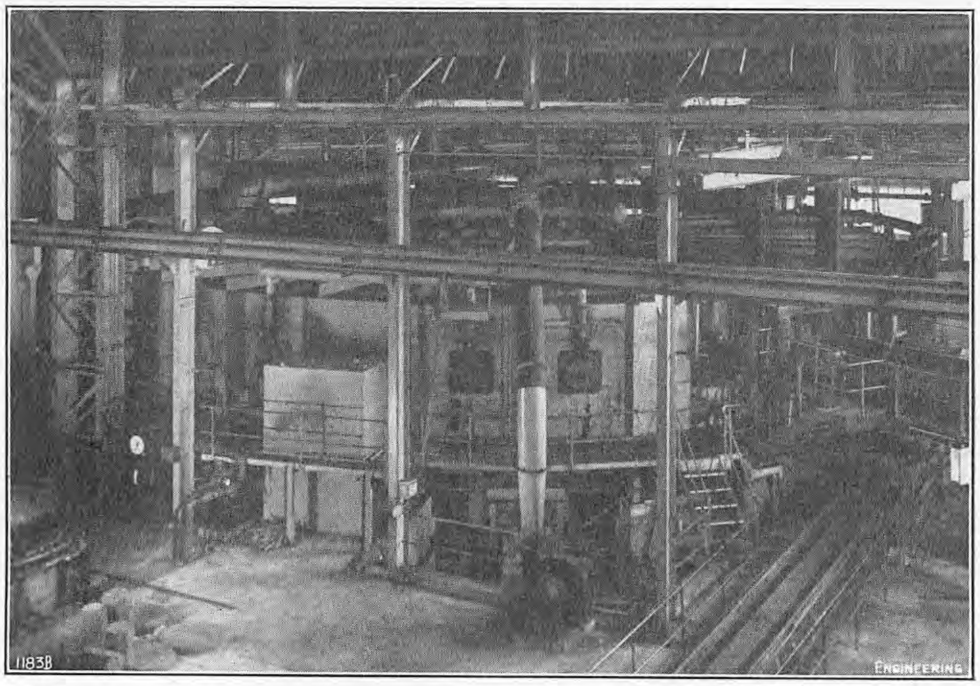
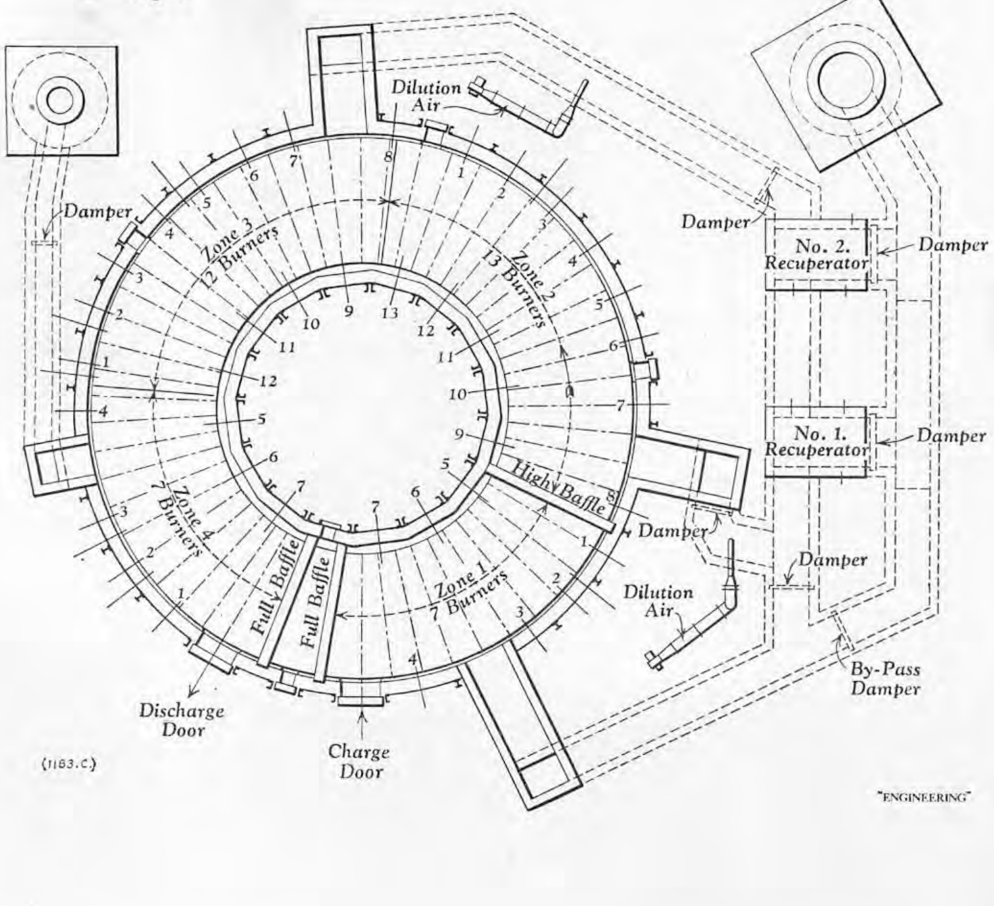


FIG. 1. ROTARY-HEARTH FURNACE.

Fig. 2.



in Figs. 1, 2, 7 and 8, the 8,500-ton forging press, a 1,000-ton punching press, an electrically-driven rolling mill, a 2,000-ton dishing press, and fully-automatic handling plant designed to ensure fast production and an appreciable saving in labour. Separate 6,600-volt incoming supply cables and switchgear have been installed and the plant has self-contained hydraulic, cooling-water and compressed-air services. These, together with the mill motors, generators, oil hydraulic and lubricating equipment, are housed in a separate building. To reduce production delays and maintenance costs to a minimum, attention has been paid to the installation of single-purpose equipment wherever possible. A distinctive feature of the new plant is the extensive use of special manipulating machinery fitted with individual oil hydraulic units. Economies in power have been effected by the use of air-loaded accumulators in conjunction with the main hydraulic plant to regulate the operating pressure in accordance with the section being made. Power-operated controls and automatic equipment are incorporated to eliminate physical fatigue and facilitate the continuous maintenance of high rates of production.

SEQUENCE OF OPERATIONS.

The sequence of operations should be read in conjunction with Fig. 9, on page 715. The two control rooms A and B, shown in this plan, are well placed for observing the operations which they control. The furnace control room A enables the operator to view the charging and discharging gear, and the main control room B, which is placed high up, allows the operators to watch their presses and mill. The blocks of steel from which the wheels are made are cut or broken from an octagonal or duodecagonal cross-section ingot of which the width across the flats varies from $12\frac{5}{16}$ in. to 18 in. The block weight is calculated from the finished wheel weight with allowances for furnace, punching and machining losses. The blocks in the ingot-breaking shop, *a*, are taken by a gravity roller conveyor to the furnace charger *b*. The charger picks them up individually and places them in radial rows on the hearth of the rotary furnace. The blocks pass successively through the preheating, heating and soaking zones in the furnace and are then taken individually by a furnace discharging machine to a transfer car. This car transfers the block through a hydraulic descaling machine to the 8,500-ton hydraulic press.

After slabbing down between flattening tools, from the shape shown in Fig. 3 to that shown in Fig. 4, the bloom is transferred to forging tools mounted on sliding tables on the bed and crosshead of the press. Under increased pressure the slab is forged to finish the hubs, partially form the bore and prepare a rim section suitable for rolling, as as shown in Fig. 5. The forging is transferred from the dies to a live-roller table by an unloading mechanism and is then conveyed to the 1,000-ton punching press, which is of the upstroking type with hub-clamping dies. The punched slug falls through a hole in the lower die to a quenching bin. The punched wheel Fig. 6 then passes, on a roller table, through a tunnel beneath the main control room to a position from which it is loaded into the rolling mill. In the mill the rim section is reduced in volume and rolled to the required contour, with an accompanying increase of wheel diameter. An unloading mechanism takes the rolled wheel from the mill and, by means of a transfer car, the almost completed wheel is carried to the 2,000-ton dishing press. The wheel rim is clamped by dies in the press and pressure applied to the hub and "plate" to produce the correct hub off-set and plate contour. Finally, after dishing, the wheel is stamped with identification numbers and transferred either to a five-station rim-chilling machine or direct to a cooling bed.

FURNACE-CHARGING MACHINE.

The furnace-charging machine (*b* in Fig. 9) consists of a cable-driven carriage mounted on a fixed but adjustable bridge. The peel hoisting mechanism and the oil hydraulic equipment for the gripping motion are mounted on the carriage. The peel structure is pivoted at the rear and is fitted with forging manipulator sheaves at the furnace end. Mounted on the peel structure is the peel proper, equipped with tongs which ensure accurate spacing of the blocks on the hearth and permit a straight withdrawal from the furnace. Rotation of the peel through an arc of 90 deg. is effected by means of cams and rollers operated by the action of hoisting or lowering the peel structure.

The machine is arranged to complete automatically a cycle of operations initiated by the operator after he has indexed the rotary hearth. With the tong head resting on a centring cam and the block lying on the roller conveyor against the conveyor and the stop, the cycle commences with the lifting of the furnace charging door. The tongs grip the block at a fixed distance from its base. The peel structure is lifted and the tongs rotate 90 deg. to bring the axis of the block into the vertical position and the base of the block to a fixed distance above the furnace-hearth level. The carriage moves to the extreme forward position in order to bring the first block to the innermost position on the hearth. Completion of forward travel actuates first the lowering of the block to the hearth, this motion, in turn, releasing the grips. At the end of the release stroke the carriage returns to its original position and lowers the peel structure until the tong head again rests on the centring cam. The cycle is then repeated and a second bloom is charged. The

FORGE FOR PRODUCTION OF RAILWAY WHEELS.

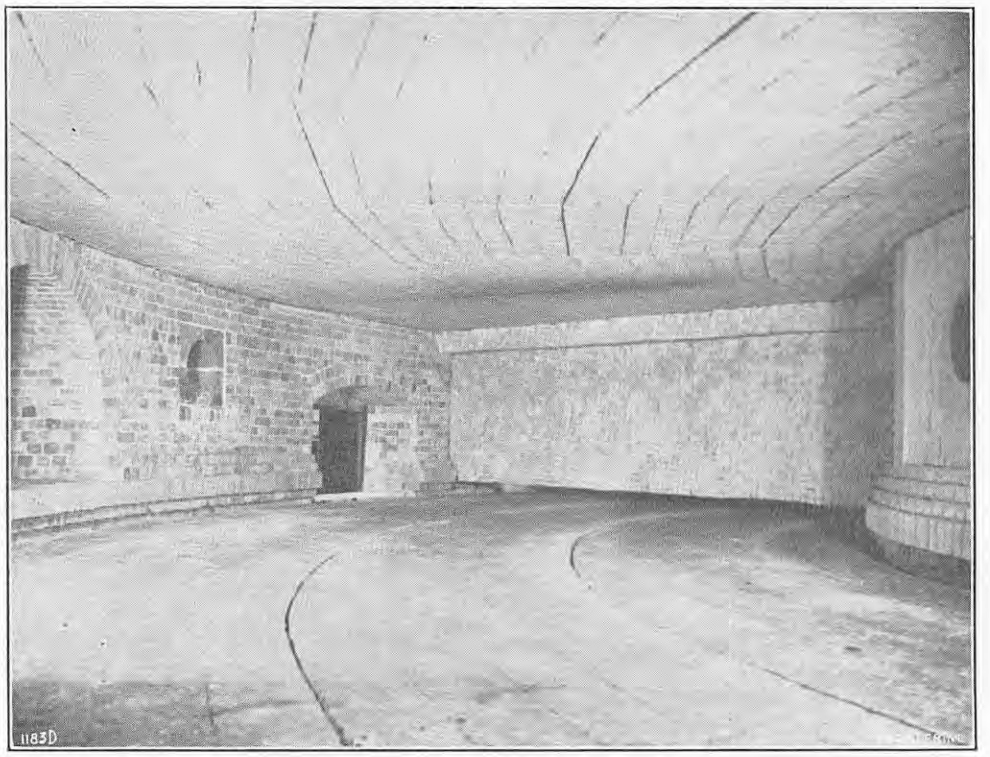
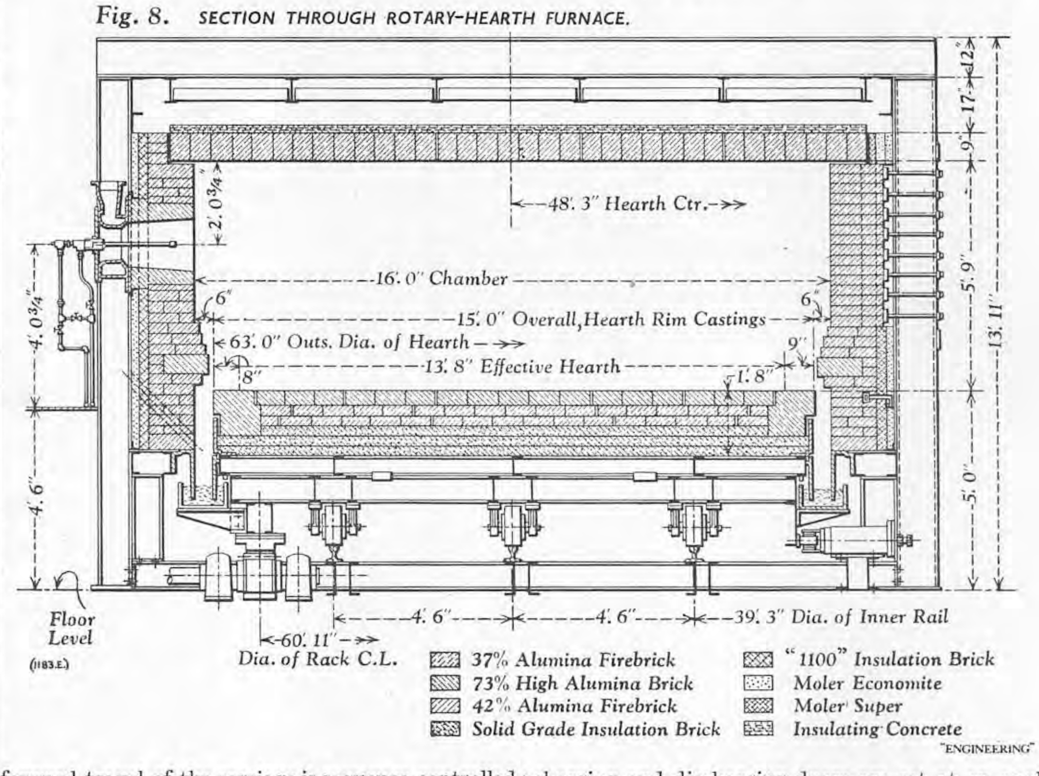


FIG. 7. INTERIOR OF ROTARY-HEARTH FURNACE.

Fig. 8. SECTION THROUGH ROTARY-HEARTH FURNACE.



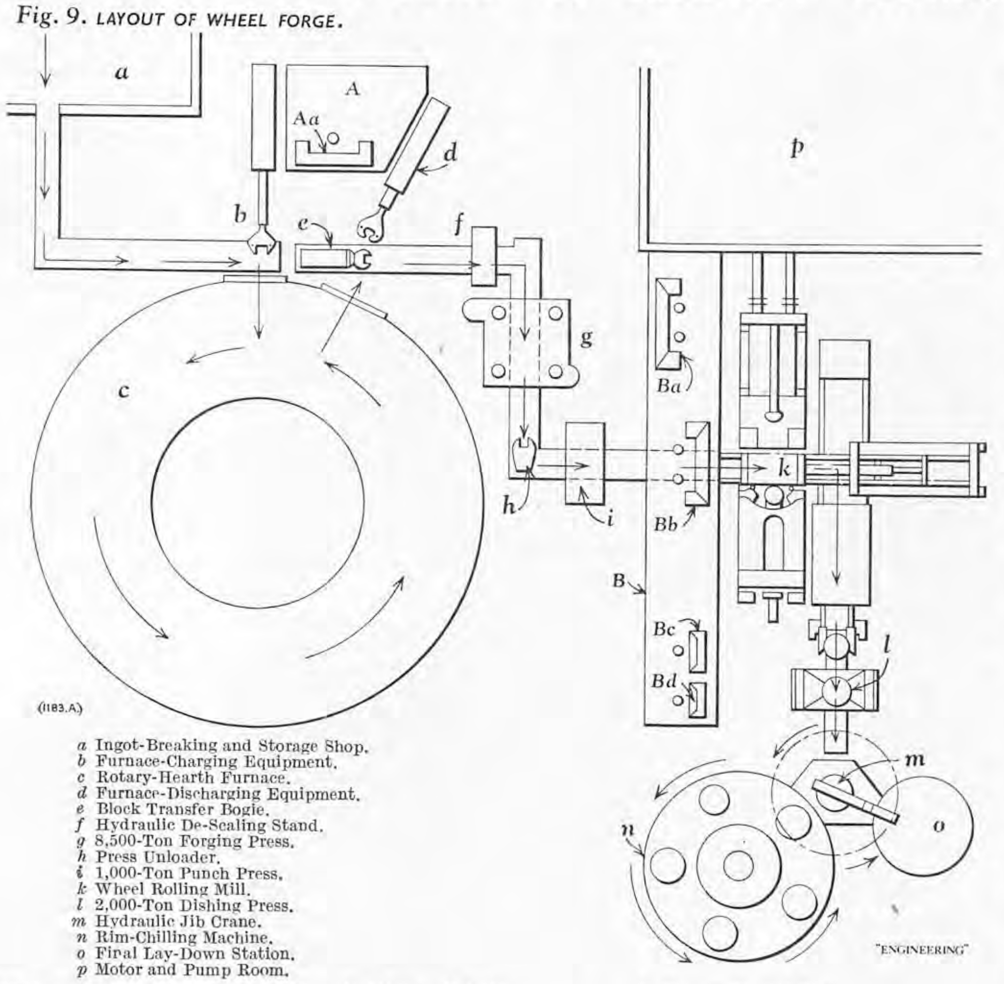
forward travel of the carriage is sequence-controlled from a multiple-cam limit switch of the vernier-setting type. After the seventh or outside bloom has been charged the furnace door is closed and the peel and tong-head cooling sprays are brought into action. The carriage travel control has provision for variable radial spacing of the blocks on the hearth and for charging any number up to a maximum of seven blocks.

ROTARY-HEARTH FURNACE.

The furnace, built by the Salem Engineering Company, Limited, Milford, Derby, is the largest of its kind in the country. It has a rated heating capacity of 40 tons of steel an hour at a maximum temperature of 1,280 deg. C. The diameter over the outer buckstays is 69 ft. and the hearth is 15 ft. wide and has a mean diameter of 48 ft. 3 in. The charging and discharging doors are set at an angle of 30 deg., as shown in the plan, Fig. 2, and there are two suspended baffle walls between the doors, built radially across the furnace; one of these is shown in Fig. 7. Small doors in the inner and outer walls between the baffle walls facilitate cleaning of the furnace hearth while the furnace is in operation. The furnace has four firing zones and is fitted with 39 steam atomising burners designed for burning heavy fuel oil. Preheated air for combustion is obtained by using part of the heat contained in the waste gases, two Newton Chambers needle-type metallic recuperators being used as heat exchangers, as shown in Fig. 2. Preheated air is used in the heating zones and atmospheric cold air in the preheating and soaking zones. The hearth, which is of the Salem floating type, is driven at diametrically-opposite points by a 27-h.p., motor coupled

FORGE FOR PRODUCTION OF RAILWAY WHEELS.

Fig. 9. LAYOUT OF WHEEL FORGE.



a Ingot-Breaking and Storage Shop.
b Furnace-Charging Equipment.
c Rotary-Hearth Furnace.
d Furnace-Discharging Equipment.
e Block Transfer Bogie.
f Hydraulic De-Scaling Stand.
g 8,500-Ton Forging Press.
h Press Unloader.
i 1,000-Ton Punch Press.
k Wheel Rolling Mill.
l 2,000-Ton Dishing Press.
m Hydraulic Jib Crane.
n Rim-Chilling Machine.
o Final Lay-Down Station.
p Motor and Pump Room.

A Furnace Control Room.
Aa Handling Operator's Desk.
B Main Control Room.
Ba Press Control Desk.
Bb Mill Control Desk.
Bc Press Control Desk.
Bd Chiller Control Desk.

through a differential gear and line shafting, all in the furnace foundation. There is a 200-to-1 reduction worm-gear driven by V-ropes at each end of the shafting. A pinion on the worm-gear output extension shaft engages a rack mounted under the rotary-hearth structure, as shown in Fig. 8. The hearth is carried on 108 wheels fitted with taper-roller bearings running on circular rails.

Fifty-three rows of blocks are arranged in the 330 deg. between the charging and discharging doors, giving a maximum of 371 blocks in the furnace. The rows of blocks are carried through the heating and soaking zones of the furnace by progressive indexing of the hearth at a rate corresponding to the output of the plant. At a production rate of 60 pieces per hour the heating time of the blocks is about $6\frac{1}{4}$ hours. The furnace is equipped with Honeywell Brown "Electronik" temperature controllers and Electroflo fuel/air ratio controls in each zone, and with Electroflo automatic furnace pressure control operating on the recuperator dampers.

The roof, shown in Fig. 8, is of the flat suspended-arch type and is formed of tongued-and-grooved interlocking blocks. The tongues and grooves are tapered in two directions. The larger blocks connect with the supporting structure by means of mild-steel hangers and clips, the hangers having toggle joints which, by a hinge action, give maximum movement in all directions to correct for expansion and contraction. The furnace walls are carried on the sand-seal dipper castings. The inner wall forms a polygon of flat vertical panels and is made of tongued-and-grooved interlocking bricks. A four-piece refractory burner is placed in the centre of each panel. The vertical joints at the junctions of the panels are made of dovetailed blocks which are anchored to the inner buckstays by alloy bolts to prevent outward movement due to expansion. The furnace foundation has been designed as an open pit about 7 ft. deep to ensure adequate ventilation under the hearth and to prevent overheating of the steel structure and wheel bearings. Lubrication of the latter is also facilitated. The inner buckstays are carried on piers. Steel beams span the space between these piers and the outer foundation wall forming the bottom ties of the furnace binding as well as supporting the track rails.

FURNACE-DISCHARGING MACHINE.

The heated blocks are removed from the furnace by a high bridge-type discharging machine of 1-ton capacity. The general design of the machine is similar to that of the charging machine, having a cable-driven carriage in which is mounted a rocking peel structure. The hoisting of the peel of the discharging machine, intended merely to clear the hearth, is effected by eccentrics mounted on extension shafts of a worm reduction gear coupled to a 10-h.p. direct-current motor. The grips are operated by a Vickers-Detroit combination pump, the small-volume portion being used to maintain the grip while the large-volume pump is unloaded to the tank. The grip cylinder is controlled by a solenoid pilot-operated four-way valve. The carriage—a welded box-type structure—forms the oil tanks for the gripping gear. Travel of the carriage to the predetermined billet position is controlled by a multiple-cam limit switch with vernier setting adjustment and "slow down" and "stop" rings for each billet position. The grips, at the withdrawn position, are aligned over a vertical air-operated ram which has a stroke of 30 in. Operation of the elevator ram is interlocked with the discharger carriage in order to prevent the release of the block when the elevator is not at the top of its stroke, though permitting the operator to commence the discharging cycle before the elevator is raised.

To commence the discharge of a row of blocks, the carriage travels to the outermost hearth position with the peel lowered. Completion of the travel initiates the gripping, which is followed by hoisting the peel, withdrawal to the elevator and lowering the peel. If the elevator is raised, the release of the grips and subsequent lowering of the elevator take place automatically, together with closing of the furnace door. The operator then initiates transfer of the block to the descaler and press, and the discharging machine may be restarted. After the furnace door has been rehoisted, the machine commences its inward travel again and completes its cycle by withdrawing and holding a second block over the elevator until the latter is automatically raised, following the return of the transfer car to the furnace. The cycles are repeated until the innermost block in a radial row has been discharged. A system of signal lamps on the control desk shows the operator at a glance how many blocks remain to be charged and discharged at any time. The hearth is not indexed until a clear space is indicated at the discharging position. Complete sequence controls on each machine automatically reset for the next cycle of operations. A rotating dial mounted outside the control room is geared to the hearth and is used for maintaining a continuous indication of the progress of the blocks through the furnace and of the operation of the hearth-indexing limit switches. Details of the blocks are chalked on this dial.

TRANSFER CAR.

A tubular fabrication mounted on four flanged wheels forms the body of the transfer car, which is shown in Fig. 10, on Plate LVII. The front bulkhead of the body carries the grips. The operating cylinder and solenoid valve are mounted in the leading compartment, and the centre compartment forms the oil supply tank. A Vickers-Detroit combination pump and valve unit is flange-mounted on the rear bulkhead. The pump motor, pressure switches and electric junction box, enclosed by a ventilated cover, are mounted on a platform at the rear. The car travels on flat-bottom rails on a fabricated track structure 67 ft. 2 in. long, of which one end is built into the hydraulic descaler. Live rails along one side of the track supply current to the pump motor and the sequence-control circuits. The other side of the track is fitted with angle guides for wire ropes which attach the car to a drawbench-type winch unit mounted at the furnace end of the bridge structure. An electrical contact switch at the furnace end of the track is automatically operated by the transfer car to control the supply of cooling water to the peel of the discharging machine. Similar track switches at the press end of the track are used for slowing down the car prior to it entering the descaler, for operating the descaler control valve and for finally stopping the car when the block is over the 8,500-ton press slabbing die. Similar switches are used at the furnace end of the track for slowing down and stopping the car on its return journey to the furnace and for interlocking duties. Release of the blocks from the car grips, which is followed by the automatic return of the car to the furnace, is under the control of the operator of the 8,500-ton press.

HYDRAULIC DESCALING MACHINE.

The hydraulic descaling machine has six Harland-Aldrich No. 2 nozzles, each of 27·2 gallons per minute capacity, mounted in an adjustable header pipe above the block, and six similar nozzles in a fixed header pipe arranged 6 in. below the lower surface of the block. The operating gear is mounted in a box-shaped fabrication, on top of which is fitted the upper-nozzle adjusting gear and a Schneible Multiwash collector with an extractor fan to prevent the steam generated in descaling from obscuring the view of the press operator. The steam is condensed in the collector and the waste water and scale are guided to fall into a scale bin located below floor level, the water draining to the main sump. Canal water is used for descaling, at a pressure of 1,500 lb. per square inch. The water is drawn from the main cooling-water supply pumps by a Berry three-throw pump delivering 34 gallons a minute into a weight-loaded accumulator of 47·7 gallons capacity. Supply to the nozzles is controlled by a Hunt "Quick-as-Wink" air-operated valve and the system is fitted with a priming pipe and non-return valve to maintain water in the nozzle headers and to eliminate hydraulic shock. Descaling is fully automatic, the transfer car turning the water on and off.

8,500-Ton Press.

The block is slabbed down on the forging press (shown in Fig. 11, on Plate LVII) between flat dies until the required thickness is obtained; a "dumping" effect is also produced, as shown in Fig. 4. It is then gripped in centring arms and transferred to the lower forging die. The upper sliding table is moved to bring the top forging die under the centre-line of the press, and the second forging operation is completed under intensified pressure. Meanwhile, the next block to be forged is placed on the slabbing die, and the lower sliding table is moved back to bring the completed forging over the stripping ram and the following block under the press crosshead. A forging at this stage is shown in Fig. 12, on Plate LVII. At an intensified pressure of 5,600 lb. per square inch, the maximum load on the press is 8,500 tons. This load can be reduced on smaller forgings by reducing the pressure in the air-loaded accumulators. The press is fitted with four cylinders, having a diameter of 33⅝ in. and a stroke of 36 in. The "daylight" between the sliding tables is 5 ft. 7 in. and the top and bottom tables have travels of 5 ft. and 9 ft. 6 in., respectively. The columns are at 8-ft. centres and have a minimum diameter of 26 in. The press bed is a fabricated structure made from five castings and plates forming triple-web beams arranged diagonally to take a central load. The press crown is also a fabrication, the four corner castings being joined together with vertical plates to form four triple-web beams which transfer the load from the cylinders to the columns.

The crosshead is a one-piece steel casting designed to transmit the load from the four rams, which are located between the columns, to the centre of the crosshead. Built into the crosshead are twin hydraulic cylinders for moving the top sliding table. The lower sliding-table extension on the outgoing side of the press is a fabrication carrying the stripping cylinder. Top-die cooling equipment is built into the moving guards on the lower sliding table. The water sprays are automatically operated by valves actuated by the table movement. Cooling of the lower dies is effected by spray rings attached to the crosshead and fed through flexible hoses. The spray rings are hinged to facilitate die-changing. Control of these water sprays is by air valves, pedal-operated at the press control desk. The crosshead bushes, which are lined with white-metal, and all main glands, are fed with grease from a Trabon automatic system.

The hydraulic intensifier, which has a ratio of 2·87 to 1, gives a pressing stroke of 6 in. The press is equipped with a large pre-fill tank and surge tank. The latter is mounted directly over the pre-fill valves on the press crown to reduce cavitation in the cylinders when lowering the crosshead under pre-filling conditions. All the main hydraulic valves are arranged in the press foundation between the press and the control room. A pressure switch is installed to prevent operation of the intensifier before full accumulator pressure has been developed in the main cylinders. The control gear is electro-hydraulic, using V.S.G. auto-controlled pump and solenoid-operated pilot valves to direct oil to servo cylinders mounted under the main valve spindles. With this system it has been possible to group conveniently all the press controls on a desk. Thus, this stage of forging is placed under the control of one operator who is protected from heat, steam and noise and seated in clean and healthy conditions in the main control room.

On being lifted from the bottom die by the stripping ram, the forging is gripped, lifted further and slewed through 90 deg. by a special machine to bring it directly over the live roller table which runs through the punching press and on to the rolling mill. The press unloader is operated by the punching-press driver, who is seated alongside the 8,500-ton press driver at a common control desk. A double Vickers-Detroit pump driven by a 5-h.p. motor and a single pump driven by a 10-h.p. motor, both of which are mounted, together with the control valves, on a tank in the oil hydraulic room, supply oil to the grip cylinders and to the hoist and slewing cylinders respectively. The roller table, part of which is shown in Fig. 13, on Plate LVII, is divided into four units each having a separate driving motor. No. 1 section serves as a receiving table from the press unloader. No. 2 section is built into the punching press and mounted on the press column structure. Nos. 3 and 4 tables carry the blank from the punching press under the main control room into position for charging into the mill. Tables 1, 2 and 3 are driven by 10-h.p. alternating-current motors running at 965 r.p.m., giving a surface speed of 192·5 ft. per minute. These tables run continuously. No. 4 table is driven by a 5-h.p. direct-current motor which gives a table speed of 99 ft. per minute. This table is slowed down and stopped by photo-cell equipment at the mill end and is re-started automatically by operation of the mill-loading mechanism.

The punching press is of the upstroking type, equipped with twin 26-in. diameter rams and double-acting pull-back cylinders. The press has a rated capacity of 1,000 tons and a punching stroke of 9½ in. at a speed of 3 in. per second. A 100-ton boss-clamping cylinder is mounted in the press crown around a rigid punch stem. Jack cylinders give an approach speed of 6 in. per second. The forging, on arrival in the punching press, is centred by an adjustable stop mechanism and lifted off the live rollers by the lower boss-clamping die. Continued upward movement of the crosshead first clamps the boss and presses the hub against the rigid punch. When the punch has completely penetrated the boss, the crosshead is stopped by limit-switch control and the forging is then lowered on to the live rollers. In the meantime the centring stop is removed and the forging is allowed to proceed to the mill. The control gear is similar to that used on the 8,500-ton press.

(To be continued.)

Closure of Railway Line Between Canterbury and Whitstable.—The six-and-a-half-mile railway between Canterbury and Whitstable, on the Southern Region of British Railways, was closed on November 29 on the ground that its continued operation was no longer economic. The line was opened to traffic on May 3, 1830, and a number of organisations had agitated for its retention.

Heavy-Duty Overhead Cranes for Iron and Steel Works.—The specification for heavy-duty electric overhead travelling cranes, published by the British Iron and Steel Research Association in May, 1950, has been revised in the light of operating experience, and amendment slips are available, free of charge from the Association's information section, 11, Park-lane, W.1. The amendments relate chiefly to a re-assessment of the forces arising from acceleration and braking which the cranes shall be designed to withstand and a closer definition of some permissible stresses. Other matters dealt with include tolerances for standard crane couplings; the provision of cross-travel conductors on certain cranes for the subsequent fitting of magnets, and the clarification of the main control gear layout diagrams. The amendment slips are gummed and perforated for insertion in the specification.

LITERATURE.

Aerodynamic Drag.

By Dr. Ing. Sighard F. Hoerner. Published by the author at 148, Busteed, Midland Park, New Jersey, U.S.A. [Price approximately 5 dols.]; and Bailey Brothers and Swinfen, Limited, 26-27, Hatton-garden, London, E.C.1. [Price 48s. 6d.]

This is not a theoretical text-book, but an extremely comprehensive collection of information on "drag," that is, the force opposing the motion of a body through a fluid and depending, in particular, on the velocity of the body relative to the fluid. Drag or resistance is of great importance for vehicles of all kinds, as it is one factor of the power required for propulsion; but drag is also of importance for stationary bodies and structures which are exposed to currents of fluid such as natural winds or streams of water. Hence, a collection of data on drag finds applications in many branches of engineering. The book is intended, however, primarily for the use of aeronautical engineers and the reader is assumed to have some familiarity with aerodynamic science.

An introductory chapter deals with some general topics of aerodynamics and includes definitions of various terms and symbols. The titles of the remaining chapters are: "Skin-Friction Drag," "Pressure Drag," "Drag of Surface Irregularities," "Drag of Streamline Bodies and Sections," "Drag Due to Lift," "Interference Drag," "Drag of Aircraft Components," "Drag of Vehicles," "Drag of Internal-Flow Systems," "Subsonic Influence of Compressibility on Drag," "Supersonic Drag," and "Drag in Rarified Gases." This list, comprehensive as it may appear, does less than justice to the diversity and scope of the contents. Some examples of unusual topics are drag of pervious surfaces, drag due to holes and gaps, drag of the human body, drag of parachutes, and drag of structural sections.

The author gained his earlier experience in Germany and moved to the United States after the recent war. In compiling the book he has made very full use of the results of German investigations, but American, British and other sources have also been tapped. In many instances, he has collated the information from many sources and prepared graphs and tables which give a conspectus of a large number of individual results in a convenient form. This helps the user of the book to form his own opinion of the reliability and probable error of the data on any given topic. The amount of research involved in this work of compilation and comparison is clearly prodigious, and could only have been undertaken by an enthusiast and a most industrious one. The author has also derived a number of new empirical formulæ which fit the observations well and which are likely to be of value to practising aerodynamicists.

From its nature, this is a reference book and not one which readers will read from cover to cover. The impression gained from sampling the author's wares is that he has done his work conscientiously and has succeeded in presenting his information in a clear and convenient way. The discussion of the influence upon drag of the position of the point of transition from laminar to turbulent flow in the boundary layers of aerofoils and other streamline bodies seems rather inadequate, and in most cases the data are presented without a specification of the transition point. It would be unfair, however, to put all the blame for this on the author, who can only record the information provided by experimenters. The book is published by the author himself and produced by the photo-offset process. He states in the preface that "the big technical publishing houses in New York were not confident enough to bring a book as specialised as this one on the market." He is to be congratulated on his enterprise, industry and perseverance, and it is to be hoped that these will bring their just reward.

CONTINUOUS PRODUCTION OF SOLID STEEL RAILWAY WHEELS.

(*For Description, see Page* 713.)

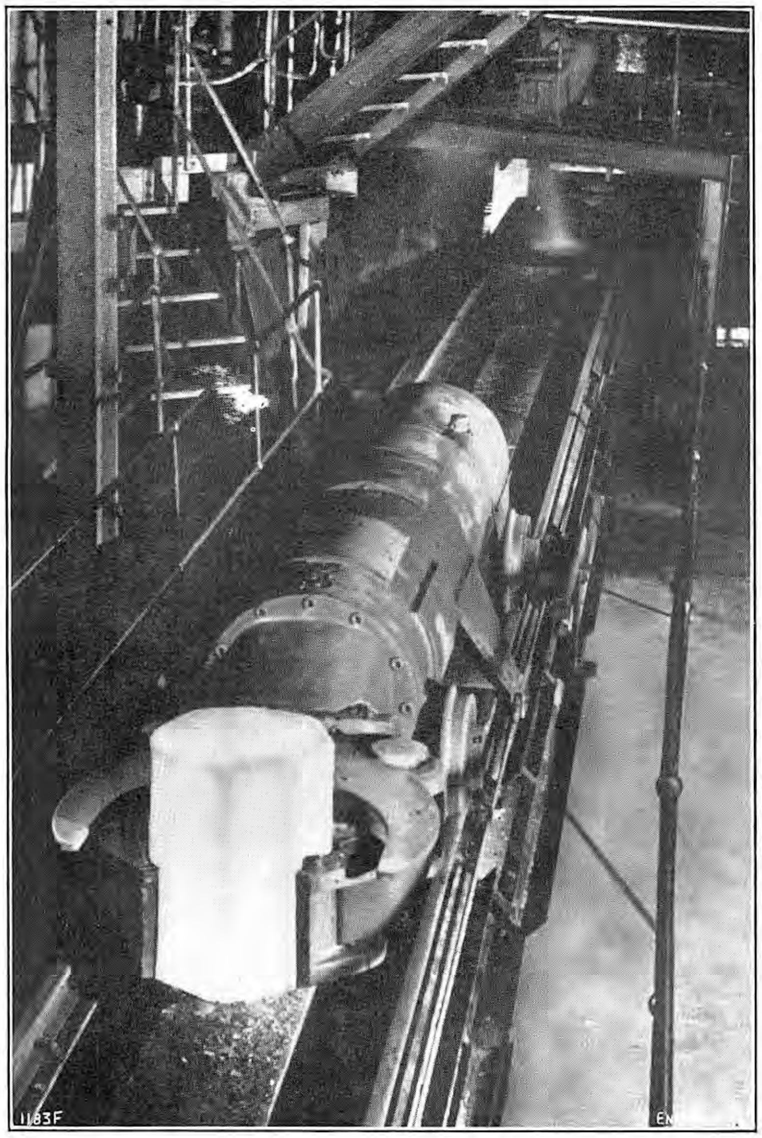


FIG. 10. TRANSFERRING BLOCK FROM FURNACE TO PRESS.

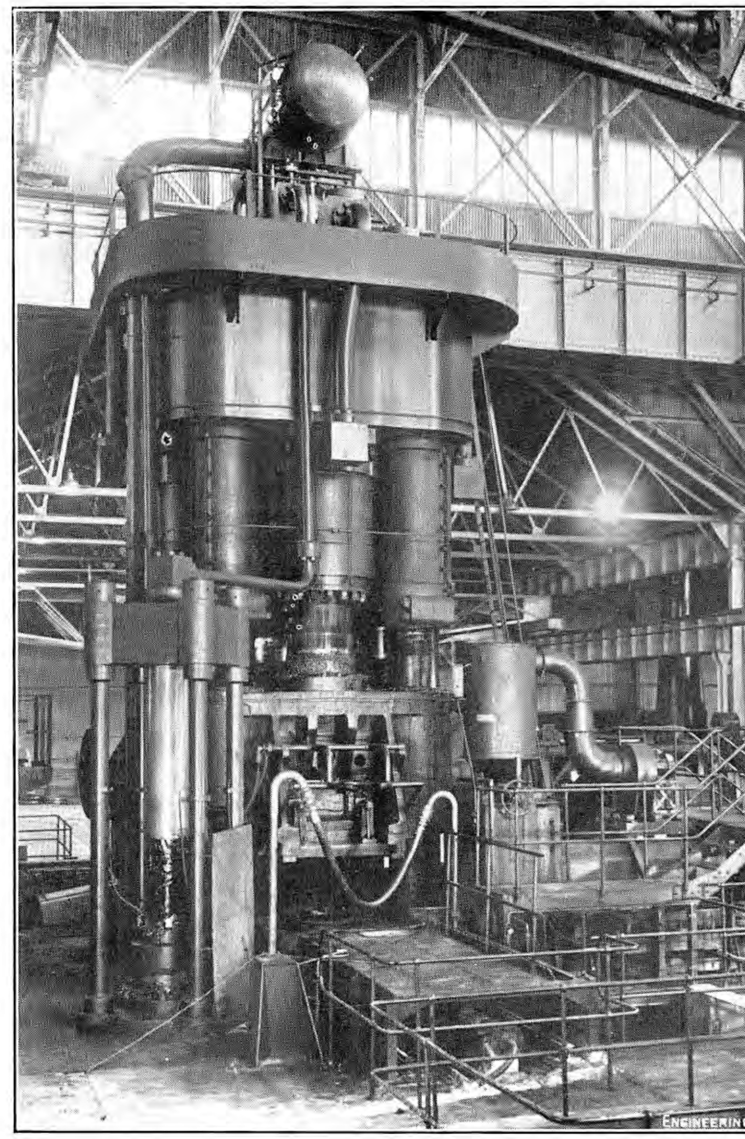


FIG. 11. 8,500-TON FORGING PRESS.

FIG. 12. FORGING PRODUCED IN 8,500-TON PRESS.

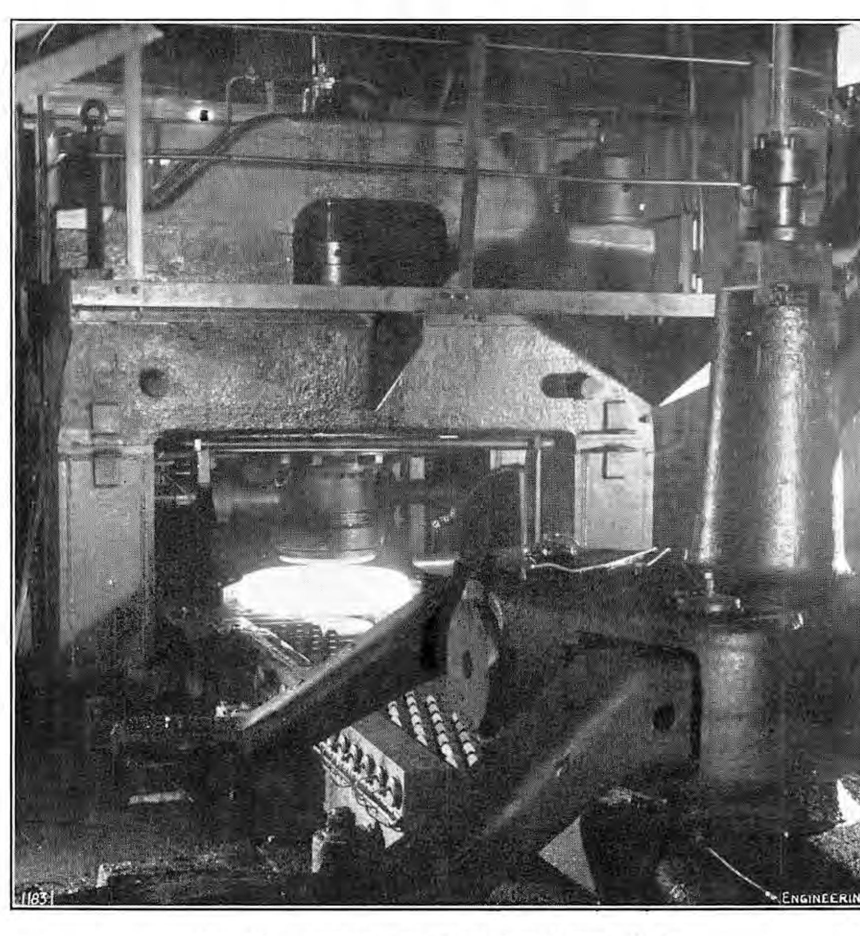


FIG. 13. FORGING IN 1,000-TON PUNCH PRESS.

(*To face page* 716.)

AUTOMATIC COMPUTATION OF RAILWAY TRAIN SCHEDULES.

ALFRED J. AMSLER AND CO., SCHAFFHOUSE, SWITZERLAND.

Fig. 1. TRACTIVE FORCE-SPEED DIAGRAM FOR STEAM LOCOMOTIVE.

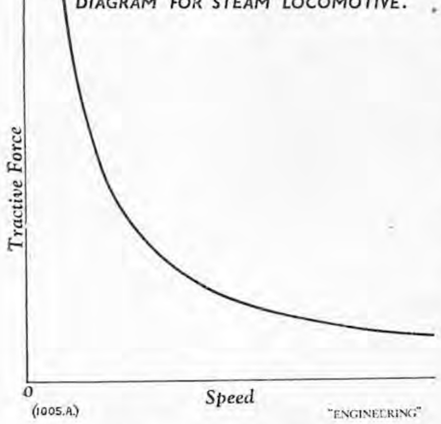


Fig. 2. CHARACTERISTIC DIAGRAM FOR STEAM LOCOMOTIVE.

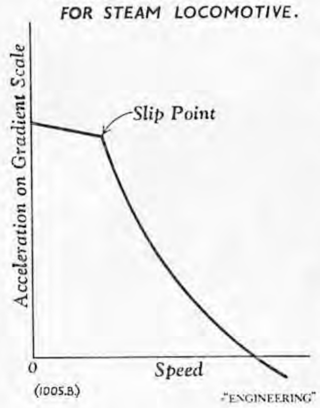


Fig. 4. CHARACTERISTIC DIAGRAM FOR ELECTRIC LOCOMOTIVE.

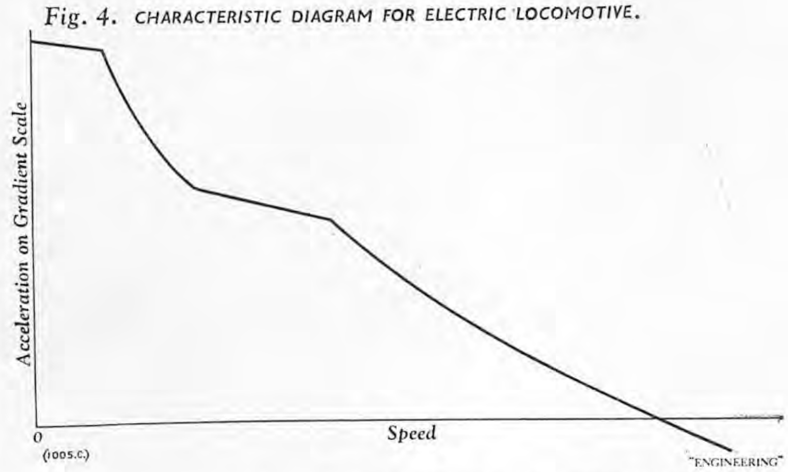
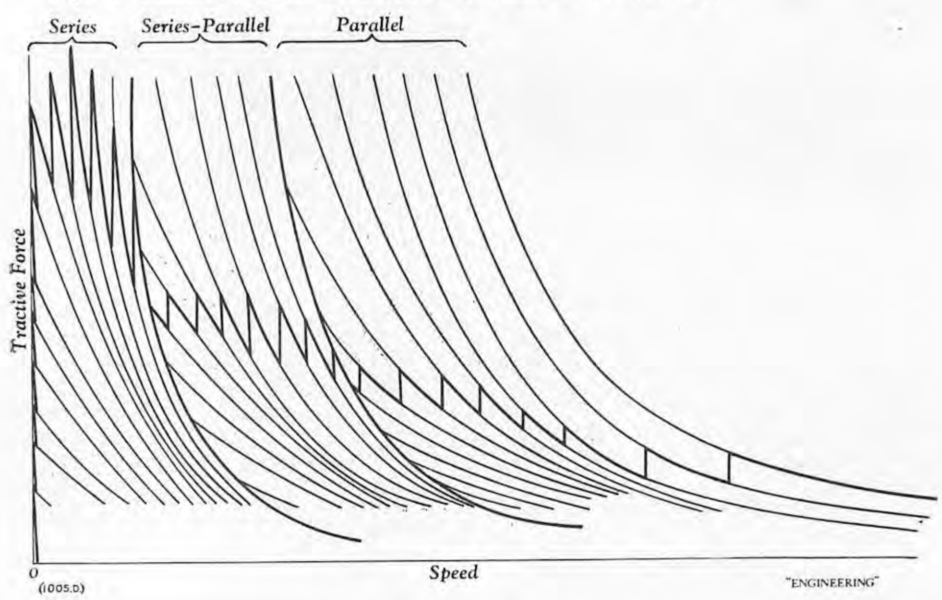


Fig. 3. TRACTIVE FORCE-SPEED DIAGRAM FOR ELECTRIC LOCOMOTIVE.



AUTOMATIC COMPUTATION OF RAILWAY TRAIN SCHEDULES.

By DR. FR. DUBOIS.

ANY moving body, including a railway train, obeys Newton's law of motion which states that, in appropriate units, the acceleration is equal to the force acting upon the body divided by the mass. In the case of a railway train, the force acting is the tractive effort of the locomotive less the rolling resistance of the train, plus or minus a quantity G sin α, where G is the weight of the train and α is the angle of inclination or gradient of the track. The following equation, therefore, holds for the motion of the train:

$$\frac{dv}{dt} = a = \frac{(\mathrm{T} - \mathrm{R})}{m} \pm \frac{\mathrm{G} \sin \alpha}{m} \quad . \quad (1)$$

where a = acceleration, v = velocity, t = time, and m = the mass of the train, including the locomotive. The significance of the second term on the right-hand side of this equation is obvious, $\frac{\mathrm{G}}{m}$ being merely the acceleration g, due to gravity, but the other term $\frac{(\mathrm{T} - \mathrm{R})}{m}$ needs further consideration.

In the case of a steam locomotive, if the rate of firing is constant, it may be taken that the mechanical work done in unit time is also constant, since the efficiency of the boiler and engine are practically constant. The product of the drawbar pull and the velocity are, therefore, constant, and if T is in metric tons and v is in kilometres per hour, the horse-power of the locomotive is $3 \cdot 7 \mathrm{T} \times v$. This is true for all conditions of running, and if plotted the relationship between tractive force and velocity can be represented by a rectangular hyperbola, as in Fig. 1. The total rolling resistance R of the train varies approximately as the square of the speed, and if T – R be plotted against velocity a curve similar to the hyperbola of Fig. 1 is obtained, but with slightly lower ordinates. This curve, however, does not hold for $v = 0$, when the curve would be asymptotic to infinity, but at a finite value of T – R, representing the slipping point of the locomotive, the curve bends abruptly to the left as shown in Fig. 2. If in this diagram the ordinates are referred to the total mass of the train and the locomotive, the "locomotive characteristic" is obtained which is valid for a given train composition and a given boiler capacity. In Fig. 2, the abscissæ are the running speeds v in kilometres per hour and the ordinates are the corresponding accelerations a in metres per $\mathrm{sec.}^2$ In railway practice, however, it is usual to express accelerations not in metres per $\mathrm{sec.}^2$, but in kilogrammes of tractive force per ton of train weight. This has the same dimensions as the gradient of the track per 1,000; in fact, a gradient of ± 1 per 1,000 corresponds to a force of ± 1 kg. per ton of train weight acting in the direction of the drawbar pull.

For electric locomotives conditions are similar, but more complicated. At constant terminal voltage the diagram connecting torque with speed of rotation for a series-wound motor is a quasi hyperbola resembling that of Fig. 1, which applies to a steam locomotive. For each terminal voltage a separate hyperbola can be drawn, those for higher voltages being farther from the origin. In starting, the terminal voltage applied to the motors of an electric locomotive is progressively increased; on single-phase locomotives by means of a tap-changing transformer and on direct-current locomotives by changing the motor connections for series, series-parallel, and parallel running, and by gradually cutting out the starting resistance in circuit. As a result of the voltage variations at starting, the curve connecting tractive force with running speed shifts from one hyperbola to another, and the curve takes the saw-tooth form shown in Fig. 3. The part of the curve on the extreme right in Fig. 3 follows the hyperbola for maximum speed with the full line voltage applied to the motor terminals. From this saw-tooth diagram a characteristic curve can be drawn for an electric locomotive corresponding to that for a steam locomotive. Such a curve for a direct-current locomotive is shown in Fig. 4.

Now that the two terms on the right-hand side of equation (1), i.e. the tractive force from the locomotive characteristic and the gradient from the track profile, are given, the mathematical treatment of the train running can be carried out. From a first integration of the acceleration (equation 1) in respect of time, the speed is obtained thus.

$$\frac{dx}{dt} = v = \int_o^t a \, dt \quad . \quad . \quad (2)$$

and by a second integration in respect of time the distance travelled x is obtained as

$$x = \int_o^t v \, dt \quad . \quad . \quad . \quad (3)$$

It will be obvious that from these equations all the necessary elements of a train schedule, i.e., the train speed v and the point at a distance x on the track reached in a time t, can be obtained. The automatic computation of train schedules thus depends on the continuous integration of two simultaneous first-order differential equations, so that, mathematically speaking, it is a second-order problem. For the practical solution of such problems, graphical methods have been employed for many years and are still used in a somewhat specialised form for the computation of traffic schedules.*

More recently, however, the automatic solution of differential equations by mechanical means has been extensively employed in applied mathematics and has rapidly attained a remarkably high degree of perfection. It was self-evident that mechanical computers could be employed in the routine work of compiling traffic schedules, and in the past two decades a number of interesting computers for this purpose have been devised. Examples that may be mentioned are those of G. W. Knorr, in Germany, of Perkinson in the United States, of Cuypers in Belgium, and others. The Knorr computer is based on the rather bulky sharp-edged wheel integraph o Abdank-Abakanowicz, while those of Perkinson and Cuypers use the simpler disc and wheel integrator of Wetli-Gonella. Five years ago, the French

* Dr. W. Müller, "Ermittlung der Fahrzeiten durch Zeichnung," *Zeitschrift des Vereins deutscher Ingenieure,* vol. 67, No. 15, pages 368-371 (1923). Also M. Armand and M. Garin, "La détermination des horaires des trains de voyageurs sur la région du sud-est," *Revue Générale des Chemins de Fer,* July-August, pages 276-290 (1941).

National Railways, when confronted with the task of producing complete traffic schedules for the whole of their reconditioned system, proposed to employ for the work a mechanical computer, incorporating the more powerful and lighter Hele-Shaw Amsler ball-type integrator, with which they were familiar as it is employed in the four Amsler dynamometer cars which were already in use on the French Railways. The design and construction of the computer were entrusted to Messrs. Alfred J. Amsler and Company, of Schaffhouse, Switzerland, and the instrument is now on the market under the name S.N.C.F.-Amsler train-schedule computer.

Referring to the photograph reproduced in Fig. 5 and the corresponding diagram, Fig. 6, the locomotive characteristic chart for a train of given weight is fitted round the drum 1 so that the abscissæ giving the speed in kilometres per hour are read round the periphery of the drum and the tractive force of the locomotive, expressed as a slope on the 1 : 1,000 scale, is read along the length of the drum from right to left. The drum is rotated in proportion to the speed of the train by gearing driven from the output of the acceleration-time integrator 11 (at the top right-hand corner of Fig. 6). As the drum rotates, the operator causes a point at the intersection of two lines on a celluloid strip 2 to follow the characteristic curve on the chart by turning a crank-handle 4 which operates a lead screw 3. The paper on which the schedule is recorded is marked 20, in Fig. 6, and is easily visible near the bottom left-hand corner of Fig. 5. It is 21 cm. in width and is wound from one to the other of two cylinders, 19 and 18, located just below the table of the instrument so that the surface of the paper is flush with, and is supported by, the upper surface of the table. Before use, the paper is perforated along the front edge with holes corresponding to the points along the track at which a change of gradient occurs. The holes are made by the punch 5 and the spaces between two holes are marked in pencil with the gradient, on the 1 : 1,000 scale, which prevails in that section; the gradient is considered to be constant over the length of a section. The recording paper is moved to the left proportionately to the distance travelled, the movement being effected by gearing operated by the speed-time integrator 16, and by means of a second hand-actuated crank 8, the operator turns a dial 7, so that it indicates the gradient marked in pencil on the lower edge of the recording paper. The rotations of the two crank-handles 4 and 8, which are respectively proportional to the acceleration due to the tractive force and the acceleration or deceleration due to the gradient, are added to give the resultant train acceleration by mechanism not shown in the illustrations, the result being supplied to the time-acceleration integrator 11. The latter is driven on the input side by a constant-speed motor 9, so that the input is proportional to time. The output, $\int_0^t a\,dt$, is the train speed, and this is transmitted by the gears 12 and 15, the shaft 13, and the rack 14, to the locomotive-characteristic drum 1, to a pen 24 which marks the speed on the recording paper (this pen can be seen near the middle point of its travel in Fig. 5), and to the time-speed integrator 16. The output of this integrator, which is also driven on the input side by the constant-speed motor 9, is the distance travelled, $\int_0^t v\,dt$, and actuates the mechanism for advancing the recording paper through the gearing 17, and the cylinder 18. Finally, Archimedean gearing 22, driven by the constant-speed motor, operates a second pen 23, by means of a contact roller and push rod and this pen marks the time record on the chart in the form of a zig-zag line near the upper edge. The time record can be distinguished in Fig. 5.

It should here be explained that at each change of gradient an electrical contact 25 is closed through the perforation in the lower edge of the recording chart and by means of a relay the apparatus is stopped automatically. The operator then adjusts the dial gauge 7 in accordance with the gradient pencilled on the edge of the chart and afterwards re-starts the apparatus by the push-button 26. He then proceeds as before until the apparatus again stops

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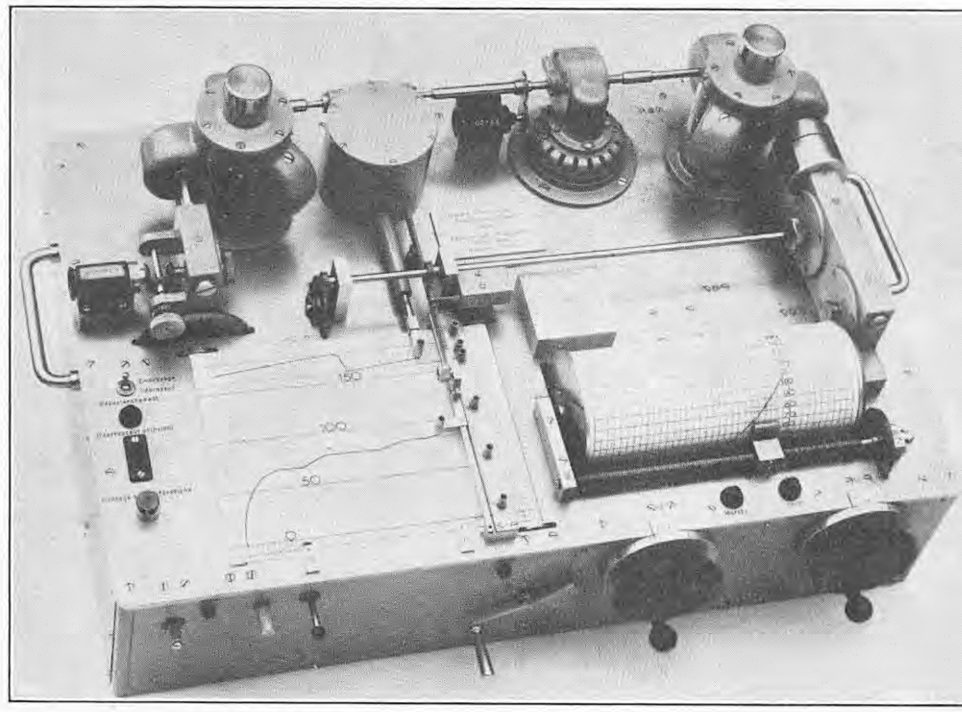


FIG. 5. COMPLETE COMPUTER.

Fig. 6.

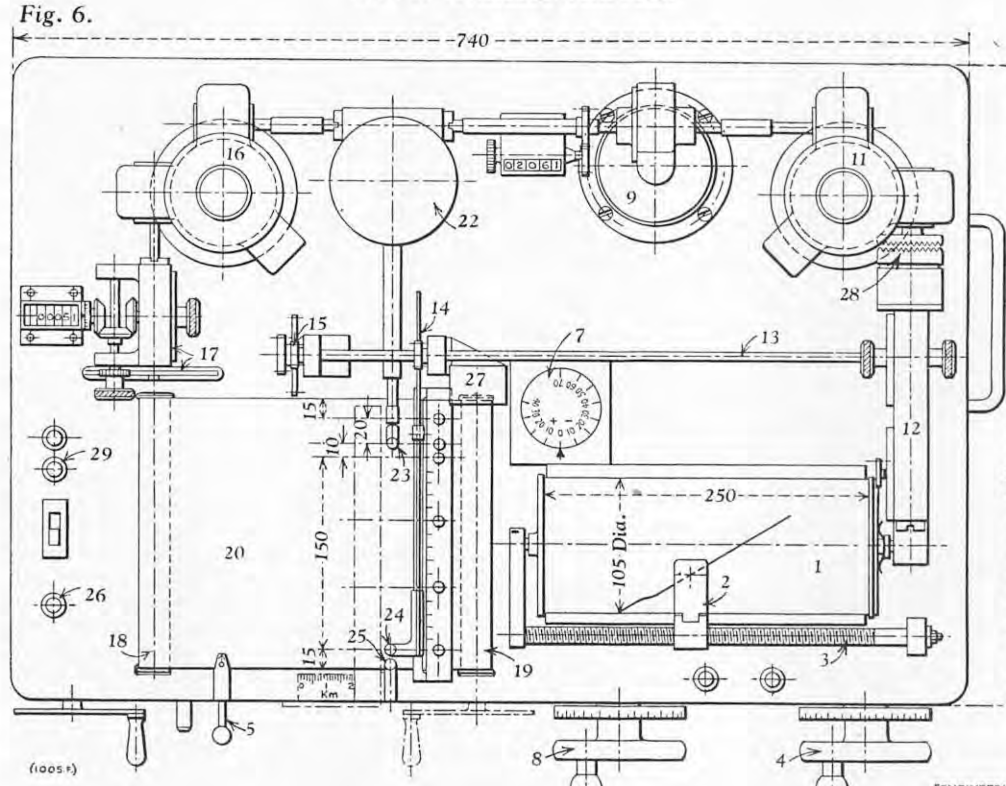
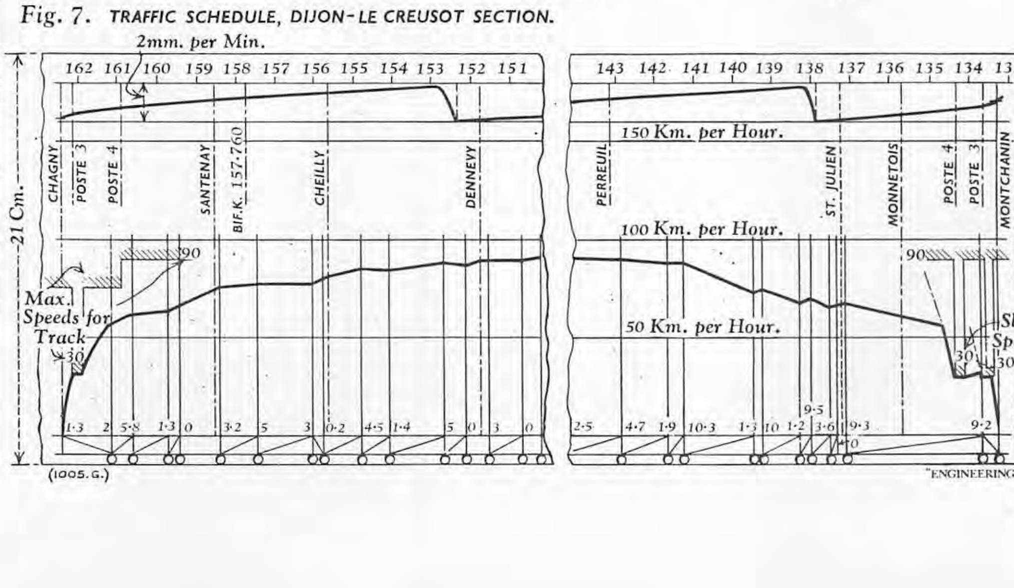


Fig. 7. TRAFFIC SCHEDULE, DIJON-LE CREUSOT SECTION.



automatically at the next change of gradient. The current supply for operating the instrument is taken from the ordinary lighting mains at 220 or 110 volts and 50 cycles. A pedal rheostat is provided to enable the operating speed to be adjusted to suit the frequency with which changes of gradient occur on the track. On sections where speed restrictions are imposed, as on curves, viaducts, or localities where visibility is limited, the traffic schedule must be drawn for constant speed. For this purpose, an electromagnetic clutch 28 is provided in the output shaft from the acceleration-time integrator 11, which enables the shaft 13 and the drum 1 to be stopped. The clutch is disengaged by a contact 27, operated by an adjustable stop on the speed-recording rod 14. The speed-time integration thus proceeds with the constant speed, and after the completion of the speed-restricted section the clutch is re-engaged by pressing the push-button 29.

Brake applications are taken account of by the imposition of an artificial upward gradient on the 1 : 1,000 scale by operation of the crank-handle 8. This braking coefficient, as it is called, is a routine figure which varies in each case according to the make-up of the train. If the braking period is to terminate in a stop in a definite position, as at a station, the point on the speed-distance record at which the brake application must be made cannot be selected at random. Use is therefore made of the following expedient: a braking diagram which, when plotted as velocity against distance, is a parabola, is drawn by hand with the aid of a parabolic curve, back from the point at which the train is required to stop to the point where the parabola intersects the line on the record. A special parabolic curve is used for each individual braking coefficient. Such conditions can be seen in Fig. 7, which is a portion of a traffic schedule for the Dijon-Le Creusot section of the French National Railways, drawn on the Amsler computer.

The makers wish to acknowledge their indebtedness to Mr. G. Bohl, head of the steam locomotive testing department of the French National Railways, for having suggested the construction of the apparatus and for helpful advice during its design.

WORK STUDY COURSES AT CRANFIELD.—At the College of Aeronautics, Cranfield, Bletchley, Buckinghamshire, a new Work Study School has been set up under the general administrative control of Professor J. V. Connolly, B.E., F.R.S.A., M.I.Prod.E. Although the school can make use of all the facilities of the Department of Aircraft Economics and Production, it is an entirely separate teaching establishment and is intended to serve the needs of industry generally. Mr. H. C. Wiltshire, M.Sc., M.I.Mech.E., M.I.E.E., is the Director of Studies. The course, which covers ten weeks, includes method study, work measurement, labour and cost control, incentive schemes, and general background subjects, including industrial relations. During 1953, there will be three such courses, from January 12 to March 12, from April 13 to June 26, and from October 5 to December 18. Further particulars may be obtained from Professor J. V. Connolly at the above address.

NEW FLIGHT-DECK ARRANGEMENT FOR AIRCRAFT CARRIERS.—Preliminary trials of a new flight-deck arrangement developed in the United Kingdom, that will increase the effective receiving capacity of aircraft carriers, have been carried out by the Royal Navy and by the United States Navy. Known in this country as the "angled" deck, it consists of a flight deck laid out at an angle of about 8 deg. to the longitudinal axis of the carrier, so that the landing path of the aircraft is clear of the deck-park area at the forward end of the carrier. The permanent barriers that are necessary in existing carriers, to prevent landing aircraft that have not been arrested successfully from crashing into aircraft and personnel in the deck park, can thus be eliminated, since any aircraft that has not been brought to rest by the arrester wires at the aft end of the deck can fly straight off over the side of the flight deck without altering course. This results in an appreciable saving in barrier space. An emergency barrier is still required to arrest defective aircraft if, for instance, the arrester hook has become unserviceable, but this can be sited in the landing area. The "angled" layout can also overlap the parking area amidships; this, it is stated by the Admiralty, increases the effective length of the carrier by about 40 per cent.

THE FUTURE OF THE HELICOPTER.

THE role of the helicopter in commercial air transport was discussed in a paper entitled "Some Thoughts on the Operational Future of the Helicopter," given by Mr. Peter Masefield, M.A., F.R.Ae.S., before a meeting of the Helicopter Association of Great Britain, held in London, on Friday, November 7. The only commercial advantage offered by the helicopter, said Mr. Masefield, was its ability to take-off and land in small areas. Present machines were expensive to operate and were too slow to provide the necessary regularity and punctuality for commercial services. A cruising speed of at least 150 m.p.h. and a seating capacity for 40 passengers were essential for practical commercial operation. The aircraft industry, he thought, should be capable of producing by 1960, a 48- to 64-seat helicopter, with a cruising speed of 160 m.p.h., provided that the Government offered immediate financial support on a large scale. A vast amount of development work on power plants, transmissions, rotor systems, and proving flights would be required for the project.

Before such a machine was introduced, he hoped that useful experience would have been gained on a developed version of the twin-engined Bristol 173 helicopter. If work on this aircraft were pressed on without delay, the prototype should be flying by 1954, and in commercial service by 1957. The developed Bristol 173 would have a seating capacity for 18 passengers. Stub wings would be fitted to unload the rotors during cruising flight, to increase the cruising speed; and it would have the more powerful 870 h.p. Alvis Leonides engines, which had still to be produced and type-tested.

The 48- to 64-seat helicopter cruising at 160 m.p.h. would provide important improvements in short-haul transport up to stage distances of about 250 miles, but it would almost certainly be more expensive to operate than either the fixed-wing aeroplane or the railway train. The helicopter would be able to reduce the journey time between city centres 250 miles apart by about an hour, and would provide a luxury service at passenger fares consistent with the level of service offered. It would not, he thought, be competitive for tourist traffic.

Taking into account the potential savings in capital expenditure at new airports, he thought that the development of the large helicopter might well prove to be a valuable national investment. If, however, the helicopter were banned from operating into city centres on account of noise, there was no commercial future for it. The reduction of noise was therefore a primary requisite. Safe operation must be ensured by mechanical reliability, by a careful system of air traffic-control procedures and the development of a reliable navigational aid, and by evolving satisfactory air-line operating standards. It was essential to carry adequate fuel reserves to provide for delays in landing in bad weather conditions and for encountering unexpected adverse headwinds.

The rotor station at the city centre should, he thought, be at roof top to avoid air turbulence, to avoid "sterilising" valuable building land, and to reduce the noise at street level. It should have a landing area of 400 ft. square, including parking space, and fuelling points should be built in. The building should house airways offices, and might incorporate an elevated garage. The roof would have to be rendered impervious to petrol and oil, but would not need to be strengthened greatly beyond normal practice.

RUBBER-BONDED WIRE ROTARY BRUSH.—A power-driven wire rotary brush in which the wire bristles are anchored in a vulcanised-rubber cushion has been developed by A. Luson and Sons, Ltd., Gem Works, Minerva-road, Park Royal, London, N.W.10. Known as the Gem Vulcan, the new brush, it is claimed, has a considerably greater wear resistance than normal wire brushes, is well balanced, will not splay, and retains its proper shape throughout its life. In an Air Ministry test, the brush remained serviceable over a period of 364 hours, whereas the average life of an ordinary brush is 90 hours.

SYMPOSIUM ON ALUMINIUM-ALLOY CASTINGS.

IN order to provide users and potential users of aluminium-alloy castings with the latest technical information available on the subject, to enable them to discuss any problems they may have encountered and to hear about anticipated future developments, the Aluminium Development Association, 33, Grosvenor-street, London, S.W.1, arranged for symposia to be held at the Queen's Hotel, Birmingham, on Thursday, November 6, and at Claridge's, London, on Tuesday, November 11. As the proceedings at each were identical, except, of course for the discussions, we propose to refer only to the London symposium.

MORNING SESSION.

The guests were received by the President of the Association, Mr. Geoffrey Herrington, and by the Vice-President, Mr. R. D. Hamer; and Mr. Herrington, who took the chair at the morning session, invited Mr. J. C. Bailey, B.Sc., A.I.M., the chief metallurgist of the Association, to present a combined summary of the five papers prepared for this session. The first of the papers was by Mr. D. C. G. Lees, M.A., A.I.M., and was entitled "An Introduction to Aluminium-Alloy Castings." This paper dealt with the casting techniques available and called attention to the advantages resulting from the high strength-weight ratio, good thermal and electrical conductivity, non-magnetic properties and chemical inertness of aluminium and its alloys. Aluminium, the author pointed out, could be cast in sand moulds, or formed in iron or steel dies fed either by gravity or under pressure. No other metal, he said, was regularly cast by these three methods, and for this reason, none was cast in such a wide range of sizes. Referring to various forms of surface finish, the author mentioned that a method had been developed for producing anodic-oxide films of substantial thickness in order to give a hard surface to resist abrasion. Standard alloys, the author stated, were available with specific tensile strengths ranging from 7·5 tons to 21 tons per square inch and from among them the designer could generally find a material suited mechanically to his needs.

The next paper, by Mr. E. Elliott, A.Met., A.I.M., and Mr. F. H. Smith, A.I.M., dealt with "The Importance of Standards for Aluminium-Alloy Castings." The authors traced the development of casting alloys in this country, described the mechanism by which British Standards are prepared and explained how the use of alloys to official specifications guaranteed an agreed minimum level of properties and performance. A brief account of the inspection methods used by producers of alloys and castings to confirm that their products met the requirements of the specifications was also included in the paper, but the authors stated that the ultimate responsibility for ensuring the maintenance of the highest practicable level of quality must rest with the user.

A paper by Mr. W. A. Baker, B.Sc., F.I.M., formed a valuable survey of research work on aluminium founding, dealing with the technical problems without reference to economic considerations. It discussed in separate sections the fluidity of molten aluminium and of some of its alloys, the volume-temperature relationships, the mechanism of solidification, the mechanism of hot tearing and the formation of porosity, the influence of grain size and of gas absorption. Other sections of the paper dealt with optimum rates of solidification, the thermal properties of various moulding materials, and the disposition of gates and feeders.

The fourth paper for the morning session, by Mr. A. P. Fenn, A.M.I.Mech.E., described recent developments in methods of finishing aluminium castings to give decorative effects, added protection, or to provide a surface having high resistance to wear. Grinding, sand blasting, scratch brushing and other operations of this character were dealt with under the heading of mechanical finishes. For the preparation of castings for painting, particular reference was made to the use of wash primers or etch primers. These primers are composed of a vinyl-resin vehicle pigmented with zinc chromate, to which thinners containing phosphoric acid are added. The mixture should preferably be sprayed on and forms a very good paint key, but the best protection is afforded by applying the zinc-chromate primer as well as the initial wash primer. Electro-plated finishes, anodising, electro-brightening finishes and vitreous-enamel finishes are dealt with in the paper, as well as chromium plating and anodising to form hard wear-resisting surfaces.

Mr. H. W. Keeble, A.I.M., Assoc.I.Mech.E., prepared a paper on the assembly of aluminium components by welding, the object of the paper being to present the features of unit assemblies involving the joining of sand-cast and wrought aluminium alloys by fusion welding; several examples were illustrated. It was mentioned that, for success, the castings must be of high quality in all respects and the welding methods must be adapted to the needs of each case, which presupposed a full knowledge of, and skill in applying, modern welding techniques.

DISCUSSION.

In the discussion which followed Mr. Bailey's summary of the papers mentioned above, one speaker, representing the aircraft industry, said he was disappointed at not seeing any improvement in the mechanical properties of castings during the last ten years or so. He also remarked that the radiographic inspection of castings added from 50 to 100 per cent. to their cost, but said he was not aware of any casting defect having caused a serious failure in service. He thought that foundrymen should bear the responsibility for the quality of castings and not leave it to the users. Another speaker, also representing the aircraft industry, expressed the view that more attention should be paid to fatigue properties and notch failures, and remarked that Mr. Fenn's paper did not refer to the effect of surface finish on fatigue properties. Other speakers stressed the need for the designers of castings to consult the founders and one speaker asked for more information about hard anodising. The advantages of chromium plating the cylinders of internal-combustion engines were referred to by another speaker and the use of fluorescent liquids for the detection of defects in castings was also mentioned.

The authors then replied individually to the points which concerned their papers. Mr. Fenn, for instance, said that hard surface treatments would enable light-alloy castings to be used for purposes for which previously they had not been suitable. He remarked that not very much was known at present about hard anodising. Thick coatings could be obtained, he said, but thicknesses exceeding about 0·005 in. were not recommended. He added that the coatings afforded useful electrical insulation.

ACHIEVEMENTS OF ALUMINIUM INDUSTRY.

At the conclusion of the morning session, the meeting was adjourned for luncheon, at which the President, Mr. Geoffrey Herrington, presided. In the course of a short address, Mr. Herrington drew attention to some of the achievements of the aluminium industry. In its short life of less than 70 years, he said, aluminium had reached a point at which its production was equal to that of all the other non-ferrous metals combined, so that it ranked next to steel on a volume basis. The aluminium industry had developed side by side with the aircraft, automobile and internal-combustion engine industries and had been based on the exacting requirements of those industries. In this country, the foundry side of the industry was responsible for about one quarter of the total of semi-finished aluminium products and a great proportion of these were used by the automobile industry. He admitted that there had been some disappointments in the employment of aluminium castings, but pointed out that the industry had gone to great trouble to ascertain the reasons for failures, many of which were explained in the papers presented at the symposium. After a brief reference to the objects and constitution of the Aluminium Development Association, Mr. Herrington mentioned that the aluminium industry of the world was now bringing to fruition plans of the greatest magnitude to ensure adequare supplies of the metal within the next two or three years. It was, in fact, anticipated that within five years more aluminium would be available than could easily be consumed.

AFTERNOON SESSION.

The afternoon session was devoted chiefly to developments in foundry practice and in the use of aluminium castings in various industries, though one of the papers was concerned with future prospects. The four papers presented were jointly summarised by Dr. E. G. West, B.Sc., F.I.M., technical director of the Association. The first paper, by Mr. E. Player, described some of the outstanding developments in foundry practice that had been made during the past few decades. It was divided into three sections, the first of which dealt with moulding methods, including expendable materials such as sand, plastics, etc., and also covered permanent moulds and pressure die castings. Later sections were devoted to foundry equipment and alloys. The author concluded that progress had brought foundry work to the stage of an almost exact science, but, he said, the craftsman was still a most important factor.

The next paper was entitled "Some Interesting Aluminium-Alloy Castings" and comprised four sections by different authors, each illustrating and describing the methods employed in the production of some particular casting or class of casting. The first section, by Mr. A. Eyden, A.M.I.Mech.E., described the production, by gravity die-casting, of a cylinder block for a motor-car engine and the next section dealt with the unusual examples of pattern and die construction involved in the production of a mould required in the manufacture of "Dunlopillo" mattresses. In the same section, of which Mr. G. L. Turner, B.Sc., Mr. J. W. James and Mr. A. Ratcliffe were the authors, the production of a die casting for a lubricator body was described. Another section of this paper dealt with aluminium-alloy castings with "cast-in" inserts. One of these castings was a gland for holding the electrode of an electric furnace; the insert consisted of a double coil of copper tubing through which oil was passed for controlling the temperature of the electrode. The last section, by Mr. H. C. Cross, described the production of a dental stand made in two parts by gravity die-casting from two mirror-image dies; the longitudinal joint between the two castings is welded by metal arc. This method of production, it will be noted, obviates the use of a large central core.

A valuable paper on "The Design of Aluminium-Alloy Castings" was contributed by Mr. L. Fletcher. In this, casting methods and alloys were considered and some of the problems encountered in casting were explained. The need for prior consultation between the designer and founder was stressed. Sectional drawings of several castings were reproduced to illustrate how modifications to the design could improve the quality of the castings and also reduce the cost of the dies or patterns and increase their useful life.

In the final paper of the symposium, Mr. L. R. Carr, M.A., M.P., surveyed the future prospects of the aluminium-castings industry from the standpoint of present achievements. In considering various directions in which the use of aluminium castings might be extended, the author pointed out that although nearly half of the present capacity of the aluminium foundries was used in connection with motor transport, mainly in the form of engine components, there were other components of both engine and chassis carrying heavy stresses and some of these could be made in aluminium with advantage. In this respect, co-operation between the founder and the car manufacturer was essential. Railways, at present, were among the smallest users of aluminium, but there was a tendency to employ the metal in place of brass for numerous fittings. In shipping, aluminium was widely used for fittings and it was anticipated that its use for superstructures would extend. The new American liner United States, the author mentioned, included 2,000 tons of aluminium and many castings. Other fields in which the use of the metal was likely to extend were building, general engineering, agriculture, mining and the electrical industry; in the last-mentioned industry, he added, the weight of aluminium castings absorbed had almost doubled in the last twelve months. In conclusion, the author said that the real task facing the foundry industry was to apply more fully and extensively the technical knowledge and the latest production methods now available.

BICYCLE WITH ONE-PIECE ALUMINIUM-ALLOY FRAME.

As in the morning session, a general discussion followed Dr. West's summary.

EXHIBITION OF CASTINGS.

The symposium was followed by an exhibition, held in the Association's premises at 33, Grosvenor-street, S.W.1. Upwards of 150 castings and other products were displayed and were carefully selected to illustrate some of the principles discussed in the technical sessions. The dimensions ranged from the moulds used in the production of large pneumatic tyres for agricultural tractors and heavy road vehicles to bridges and tail-pieces for violins. Several fine examples of cast-aluminium statues made by the lost-wax process were included and a number of relatively new casting processes were illustrated by examples of work produced by them. Among such examples may be mentioned an aircraft-engine cylinder head produced by feeding the metal into the die under low air pressure. Another interesting development shown was the casting of rings by the centrifugal process. A roller-bearing cage, 10 in. in external diameter, was shown, having been cast in a mould rotating at 500 r.p.m. Examples of castings produced by shell moulding were also exhibited. In this process, developed by

Croning in Germany, a metal pattern is sprayed with sand bonded with synthetic resins and the shell so formed is baked and used as a mould for sand casting. Among the advantages claimed for the method, it is mentioned that the moulds have a high degree of permeability and give a fine surface finish. Another point in favour of the method is that it requires less than one-tenth of the raw material used in a foundry for normal sand casting and thus greatly reduces the amount of handling necessary.

Several of the finishing processes referred to in the papers were illustrated in the exhibition. One example shown was an air-cooled aluminium cylinder barrel, chromium-plated internally to give a high resistance to wear. Cylinders so treated are used on many German small cars as a standard product, and motor-cycle engine cylinders are also regularly chromium-plated. As an example of the exhibits, we illustrate on the opposite page a German bicycle which was brought into this country by the Association for examination and test. The frame is a one-piece gravity die-casting cored for lightness and designed for the direct attachment of fittings and accessories. The aluminium alloy LM 6, containing 10 per cent. silicon and 0·5 per cent. magnesium, is used for the casting as it combines high strength with good ductility. In preparation for stove enamelling, the frame is shot-blasted, which gives a smooth surface with good adhesion for the translucent finish. The machine is suitable for a man or a woman and the riding properties are stated to be equivalent to those of a bicycle of normal design. The frame itself weighs only $5\frac{1}{4}$ lb., and the machine, complete with steel fittings, heavy-section tyres, dynamo-lighting equipment, parcel carrier, prop stand and other accessories, as illustrated, weighs $37\frac{1}{2}$ lb.; using the die-cast frame with aluminium fittings, a standard bicycle could be produced to weigh about 25 lb. In Germany, we understand, the selling price is about the same as that for conventional machines, but increased production would doubtless lower the figure.

The papers and discussion at the symposium will be published in full by the Association as soon as possible.

A PEAT-BURNING GAS TURBINE.

An open-cycle internal-combustion gas turbine to burn peat has successfully completed its initial test runs at the works of the makers, Messrs. Ruston and Hornsby, Limited, Lincoln. The turbine, of 750-kW capacity, has been built under contract to the Ministry of Fuel and Power as part of the research programme into the utilisation of peat resources which is proceeding in collaboration with the Scottish Home Department, and with the general advice of the Scottish Peat Committee. During the tests, powdered peat was used. A system of feeding the peat and controlling its flow into the combustion chamber has been developed; it enables the plant to be run as steadily with this fuel as with oil. Using the experience gained in these initial tests, the plant is now being prepared for prolonged running. An advantage of the new turbine is that the hot exhaust gases are available for drying the peat. The quantity of heat is insufficient to dry the peat from the raw state, when it contains about 90 per cent. of water, but the plan is to run the turbine in association with a special press designed to remove about two-thirds of the water from the raw peat. This system permits peat to be won independently of the weather or the season, which is in contrast to the conventional methods employing air drying. It is intended that the programme should culminate in transferring the turbine to a Scottish peat bog where it will be combined with a press and a dryer.

Film on Belt Conveyors.—Richard Sutcliffe, Ltd., Universal Works, Horbury, Wakefield, Yorkshire, have released a film, entitled "Three Installations," showing their belt conveyors at work in an ironworks, a cement factory, and a civil engineering project. Details of design, manufacture and erection are given in the commentary. The film, which was shown at the 1952 Edinburgh Festival as an example of a technical documentary film, is available on loan, free of charge, in 16-mm. and 35-mm. sizes, and runs for about 28 minutes.

THE IRON AND STEEL INSTITUTE.

As recorded in our columns last week, the autumn general meeting of the Iron and Steel Institute was held in London on November 26 and 27. We dealt with the preliminary formal business transacted at the meeting on page 699, *ante*, and now pass on to the presentation and discussion of papers at the technical session held after the business meeting on the morning of the first day.

Temperature Distribution in Steel Ingots.

The first paper taken was entitled "Cooling of Rimming Steel Ingots in a Casting Pit," and was by Dr. R. T. Fowler and Mr. L. H. W. Savage of the Plant Engineering Division of the British Iron and Steel Research Association. The paper was presented by Mr. Savage. The authors stated that observations had been made on the temperature distribution at mid-height of an 8-ton slabbing ingot mould between teeming and stripping, using an improved technique to eliminate possible errors and obtain fuller data. A good correlation had been established between the change of temperature of a single mould surface reference point and the change in heat content of steel and mould and this would facilitate fuller investigations on all the ingot moulds during a single cast. It had been found that one minute after the end of teeming, all superheat had been lost from the steel and it was estimated that there could then be a mean shell thickness of $1\frac{1}{4}$ in. and that heat transfer between steel and mould could be entirely by radiation. By making a number of simplifying assumptions, estimates had been made of the rate of solidification of the mid-height slice of steel and of the temperatures at its surface and centre.

The paper by Dr. Fowler and Mr. Savage was discussed in conjunction with three other papers, all describing work carried out in the Plant Engineering Division of the Research Association, namely, "Time Studies from Casting to Rolling," by Dr. A. V. Brancker, Mr. J. Stringer and Mr. L. H. W. Savage; "Mould and Ingot Surface Temperature Measurement," by Dr. A. V. Brancker; and "Ingot-Mould Temperature Measurements," by Dr. R. T. Fowler and Mr. J. Stringer.

In the paper on time studies, the authors stated that observation had been made, at three works, of the progress of hot ingots from the casting bay to the cogging mill, in an attempt to find the causes of delays and their effects on soaking-pit operations. It was concluded that worthwhile savings were possible. A comparison between the hypothetical and the actual operations showed that the soaking-pit throughput might be increased by 18 per cent., the additional ingots required being drawn from the cold stock. Alternatively, the soaking-pit capacity might be reduced by 18 per cent. without detriment to the percentage throughput. Either of these results gave an increase in the overall efficiency of the process at least as great as any to be expected from an increase of the thermal efficiency of the soaking pit itself.

In the second of the three papers, on "Mould and Ingot-Surface Temperature Measurements," the author, Dr. Brancker, stated that surface temperatures had been measured at 36 positions on the four sides of a mould. The measurements had extended from teeming to stripping and two complete sets of temperature data had been obtained for two different mould positions in a casting pit during two separate top-teeming operations. In each test, immediately the ingots had been stripped, temperatures were measured with an optical pyrometer. Temperature continuity, therefore, had been maintained until the ingots were charged into the soaking pits. Significant differences had been found between the temperatures on the faces of each mould, according to the position of the mould surface in the casting pit. In the two positions considered, the temperature of a long face adjacent to another mould was considerably greater than that adjacent to the pit wall.

Dr. Fowler and Mr. Stringer, in their paper on "Ingot-Mould Temperature Measurements," stated that further measurement on the surface temperatures of an ingot had been made. The technique employed, that of using fixed thermocouples had been extended to include temperatures through the walls. Two trials had been made with the mould initially at a temperature of 30 deg. C., and one trial with the mould at 125 deg. C., the latter being representative of normal practice. Temperature gradients and isotherms had been plotted to give a picture of the overall temperature distribution throughout the mould at various times from teeming. From the results obtained, the heat content of the mould had been calculated and the amount of heat removed from the steel during solidification estimated.

Discussion.

Mr. N. H. Bacon, who opened the discussion, said that of the four papers to be discussed the second and third had given rise to an interesting and vigorous discussion at the special meeting of the Institute in Glasgow in September, 1950, and the third paper had been discussed at the Institute's last Autumn meeting, so that he proposed to confine his remarks largely to the latest paper, that by Dr. Fowler and Mr. Savage. What seemed to come out of all this work was that non-feeder-head ingots should be charged into the soaking pits before they had reached full solidification, and experience had shown that it was quite safe to do so. This latest work supported what Mr. Robinson, of the Appleby-Frodingham Company, had told the meeting at Glasgow. He had shown, from actual measurements of the centre of 10-ton slab ingots, that in 180 minutes the centre temperature had fallen to 1,200 deg. C. This was in fairly good agreement with the temperatures calculated for an 8-ton ingot referred to in the paper by Dr. Fowler and Mr. Savage. The authors assumed a negligible heat transfer to the top and bottom of the ingot. In point of fact, however, the heat transferred to the bottom must be of considerable magnitude on account of the chilling effect of the base plate. That effect had been found to be of considerable importance, particularly with large forging ingots. Moreover, the heat transfer to the top would also be by no means negligible.

The work under discussion had shown the importance of focusing attention on the desirability of speeding up stripping and charging into the soaking pits. Based partly on his own experience and partly on the knowledge gained from the present papers and from the contribution made by Mr. Robinson at the Glasgow Meeting, he had worked out a little rule which he submitted for consideration. This rule was that if the narrow side of a slab mould were squared and divided by 6·7 the result would give the desirable time (in minutes) to elapse between filling ingots and charging them to the soaking pits, at a point at which they were somewhere near solidification but not fully solidified. Taking an ingot measuring 20 in. square, the formula: $NS^2/6 \cdot 7$ gave $400/6 \cdot 7$, which meant that the ingot should be charged 60 minutes after filling, and from long experience it was known that that was quite safe. In the case of an 8-ton slab ingot, measuring $42\frac{1}{2}$ in. by $25\frac{1}{2}$ in., the formula gave $25 \cdot 5^2/6 \cdot 7$, or $650/6 \cdot 7$, which meant 98 minutes. Reference to the illustrations in the paper showed that that ingot was just about solid in 100 minutes. Taking an Appleby-Frodingham 10-ton slab ingot, which was 47 in. by 28 in., $28^2/6 \cdot 7$ meant a time of 117 minutes and actually the figure given in the paper was two hours; the data which Mr. Robinson produced at the Glasgow Meeting had shown that in 120 minutes the temperature has fallen to 1,390 deg. C.

Mr. H. Brooke Freeman said that the best time for stripping to take place was when there was sufficient heat left in the still-liquid portion in the centre of the ingot to equalise the loss of heat which had taken place in the solidified shell. Dr. Fowler and Mr. Savage had pointed out, however, that contact pyrometers which would give the stripping temperature with sufficient accuracy were not yet available. The authors' own results had shown that a covering of slag on the top of a mould had retarded the cooling of an ingot, as the coating of slag had kept the heat in. Hence, the effect of having no slag on the surface of an ingot was greater than the authors might have expected. It was the same with the base plate, which could not be ignored.

It was also suggested that ingots were still liquid after a period of the order of 116 minutes. At the works of John Summers and Sons, Limited, ingots of comparable size had been tipped on their sides after one hour. It had been supposed that, by laying them on their sides a displaced pipe, and hence increased lamination would be obtained. To their amazement, however, they had not found any displaced pipe or increased lamination. The suggestion was that the ingots were fairly solid in the centre one hour after pouring.

Sir Charles Goodeve, F.R.S., said that he had two questions to put. The first was to the authors, and it was this: if one wasted a tenth of a therm unnecessarily during the cooling of an ingot, what did that correspond to in the soaking pits? His guess was that it was five times as much; namely, if 0·1 therm per ton of ingot were lost unnecessarily, it would take five times as many therms in the soaking pit to recover it. That was a very difficult question to ask, because it must depend on all sorts of conditions; but the order of magnitude should be ascertained. His other question was put to the practical metallurgists present; it was how often, in fact, did an accident occur by approaching too near the critical time or heat content when stripping ingots? Did it happen once a month or once a year and, when it happened, how serious was it? Did it cause a fatality or did it just mean the wasting of an ingot?

Mr. A. J. K. Honeyman stated that he did not propose to answer that last question, but he would like to make one or two comments from the practical point of view. With regard to rimming-steel ingots, for instance, with bogie casting the critical time was the time of moving the ingot, and in an ordinary open-top rimming cast, that was the total time with which the melting-shop manager was concerned. Once he could move the ingot, he could strip it and charge it into the soaking pit as quickly as he desired. On the other hand, a capped ingot could be moved without danger, and in that case the calculations of the authors were important. There were some aspects of the matter with which the authors had not dealt, but which should be mentioned. One was mould temperature; if this were too hot, it was as well not to dress the mould at all, and if the temperature were too cold the same thing applied; hence, a correct mould temperature, which was usually equivalent to "hand warmth," or slightly above that, was of importance.

Mr. H. Brooke Freeman, who again addressed the meeting, stated that Sir Charles Goodeve's question was very difficult to answer, because, although he had seen thousands of ingots stripped, he did not recall ever seeing an ingot stripped in which the shell had burst and molten steel had been thrown out, although he had seen them stripped in less than an hour after the end of teeming. He had never seen an ingot burst. He had noted what were called "cobbles" on the ingots, caused by an exudation from the bottom and splashing, but that took place during the first few minutes of teeming. If ingots were badly wanted by the rolling mill, many casts were stripped long before the time stated by formulæ.

Mr. A. Jackson stated that he had not come forward because he had seen an accident, but to tell the meeting why these did not occur. At the Appleby-Frodingham works 10-ton ingots were stripped after intervals as low as from 37 to 40 minutes. The answer to the question was that if the mould were picked up and lifted, and the mould came off the ingot without the necessity to press on the ingot top, it was obvious that the ingot was sufficiently solid to enable it to be stripped. If it were not ready for stripping and the ram, when lowered on top of the ingot, burst the centre of the top of the ingot, it did not cause an accident which endangered life or limb, but it made a "nasty mess." It must be remembered, however, that if a batch of their ingots were stripped in 40 minutes, it was probably at least 2 hours before they could be charged into the soakers. If, therefore, the ingots were stipped quickly to save mould life, they must be allowed to cool for 2 hours and then placed in the soakers for 1½ hours before they could be rolled. Hence, it was necessary to have somewhere to store these ingots. At Appleby-Frodingham Gjers unfired pits had always been available, and with their help 12,000 tons of ingots could be dealt with a week.

Mr. R. W. Evans said that he wanted to try to answer the question put by Sir Charles Goodeve on the frequency with which trouble occurred with metal pouring out of an ingot after it had been standing for a short time. In the case of a rimming-steel ingot—and he had seen this happen only with a rimming-steel ingot—the mechanism was probably on the following lines. When a mould was filled with steel gas was evolved and passed up the wall of the ingot. Depending on the thickness of rim required in the finished ingot, the evolution was stopped by putting a cap on the top of the metal. When the cap was on, the aim was to get a solid bridge formed at the top, so that the ingot would be completely sealed off and no further gas would come out. Subsequently, there was a struggle between the pressure which was building up in the upper part of the ingot and the strength of the cap on top. If the pressure built up before the cap was strong enough to resist it, there was an ejection of metal which might or might not be dangerous. As for frequency, it might happen about once a month, but in most cases it was not dangerous. Without warning, however, metal has been shot out on occasion, and this had been known to travel 30 or 40 yards. This occurrence might be very dangerous. As evidence of the very great pressures which were built up, the 15-ton bottle-top mould might be cited. This was capped very soon after pouring. Subsequently, the mould sometimes actually rose until there was 6 in. of the ingot protruding underneath. This was due to the pressure on the top of the ingot pushing up the mould, which weighed 15 tons.

Mr. L. H. W. Savage, in a brief reply, stated that one of the main points raised both by Mr. Bacon and by Mr. Brooke Freeman was the heat transfer from the mid-height plane to the top and the bottom of an ingot. Their reason for ignoring this was that although there would be a definite heat loss at both ends, the temperature gradient must flatten out towards the middle of the mould. They were proposing to continue this work, using 15-ton bottle-top moulds, and, in addition to the exploration on the centre plane, mainly for reference purposes, they were proposing to incorporate thermocouples in the top part of the mould and also at the bottom and in the base plate itself, so that they would get some idea of what this heat loss was. Mr. Bacon's working rule was very useful and it would be interesting to see how later work would confirm it. Mr. Brooke Freeman had drawn attention to one very interesting point regarding the ingot which had a thin coating of slag on the top that acted as an insulator.

In reply to Sir Charles Goodeve on the question of how much heat had to be used to make up unnecessary loss, he believed that Sir Charles was not far out in saying that about ten times the amount of heat was needed to replace just a small heat drop. If the centre temperature fell below the rolling temperature, any additional heat must be made to go right back to the core through the whole thickness of the ingot.

(To be continued).

MECHANICS AND PHYSICS OF SOLIDS.—The first issue of the new *Journal of the Mechanics and Physics of Solids* has recently been published by the Pergamon Press, Ltd., 2, 3 and 5, Studio-place, Kinnerton-street, London, S.W.1. The editors are Professor W. M. Baldwin, Jun., of the Case Institute of Technology U.S.A., and Dr. Rodney Hill, of the H. H. Wills Physical Laboratory, Bristol. The editorial advisory board includes representatives of England, the United States, Switzerland, Holland and Germany. The first issue contains articles on plastic instability under plane stress (by Professor H. W. Swift); discontinuous plastic states, with special reference to localised necking in thin sheets (by Dr. Hill); and others on the influence of friction and die geometry in sheet drawing, rheology of metals at elevated temperatures, the time laws of creep, and yield phenomenon in polycrystalline mild steel. Some signed book reviews are also given. The journal is to appear quarterly.

TUBULAR-CONSTRUCTION SKIP BRIDGE FOR BLAST FURNACES.

ANOTHER unusual application of tubes to structural work is illustrated in Figs. 1 to 3, opposite. The reconstruction of plant to increase production frequently presents more difficulties than would occur on a virgin site. Such was the case when it was decided to build a new blast-furnace at the Bilston, Staffordshire, iron and steel works of Messrs. Stewarts and Lloyds, Limited. Here two furnaces, Nos. 2 and 4, were fed by a skip bridge which rose from the site on which it had been decided to erect the new furnace. The problem was to build a new skip bridge so that the existing furnaces could continue to operate while the new furnace was being built. The position chosen was at some 90 deg. to the existing bridge, with the new structure passing between existing stoves and through air and gas mains. Some slight modification to the mains was therefore necessary. The skip bridge had to be carried by an "A" frame for it was unwise to impose additional loads on the existing furnaces or interconnecting bridge; for the same reason the hoisting gear was fitted to a platform built as an extension to the bridge. This platform is shown in Figs. 1 and 3.

Messrs. Ashmore, Benson, Pease and Company, Limited, were in charge of the main contract. Their normal design of skip bridge is in structural sections—rolled-steel joists, etc.—but it was decided that Tubewrights, Limited (a subsidiary of Stewarts and Lloyds, Limited), should produce a design in steel tube, which gave a considerable reduction in weight compared with the normal structural job. The design is a box section 13 ft. wide by 12 ft. high. The overall length is approximately 140 ft. and the weight only about 30 tons. From a review of site conditions it was apparent that normal assembly and construction methods were impracticable and improvisation would be necessary. The bridge was therefore built on a falsework of tubular scaffolding. The London and Midland Steel Scaffolding Company co-operated in the design of a scaffolding structure to act as a support and to provide temporary access platforms. The scaffolding had to be erected accurately to form a template for supporting the main panel members. Moreover, due to the limited space, few facilities were available for pitching the scaffolding to support the upper and lower boom members.

The squad employed consisted of a foreman erector, a fitter, two welders, and three scaffolders who acted as general-utility men. All lifting operations were carried out by Messrs. Ashmore, Benson, Pease and Company. Since No. 4 furnace was in operation during most of the time the bridge was being built, it presented a gas hazard during the course of the work. All tubes were man-handled on to the site. A start was made on the lattice legs of the "A" frame, each leg being built in two halves. Owing to their length—about 90 ft.—it was impossible to make up a leg in one length and thread it into position. Some rather tricky assembly and welding was necessary at the ends of the legs, where they fitted into double-jawed base-plates. After fabricating the half legs, each bottom half was lifted, threaded through and dropped on to the base-plate. Scaffolding was built around to hold it in the correct position. The top half was then threaded through and lined up with the bottom half. A working platform was built round the junction points and welding completed. It was only possible to add about 50 per cent. of the cross-bracings tying the legs together, owing to lack of clearance and the need to remove some of the existing structures which were in the way.

Congestion on the site determined a change of plan in the method of erection. Messrs. Ashmore, Benson, Pease and Company supplied a 100-ft. derrick which made it possible to build the two side girders of the bridge vertically. This was carried out by building a tower of scaffolding round the girders and stubbing on the main boom members in succession. Welding was carried out at heights of up to 80 ft. on working platforms provided by

TUBULAR-CONSTRUCTION SKIP BRIDGE.

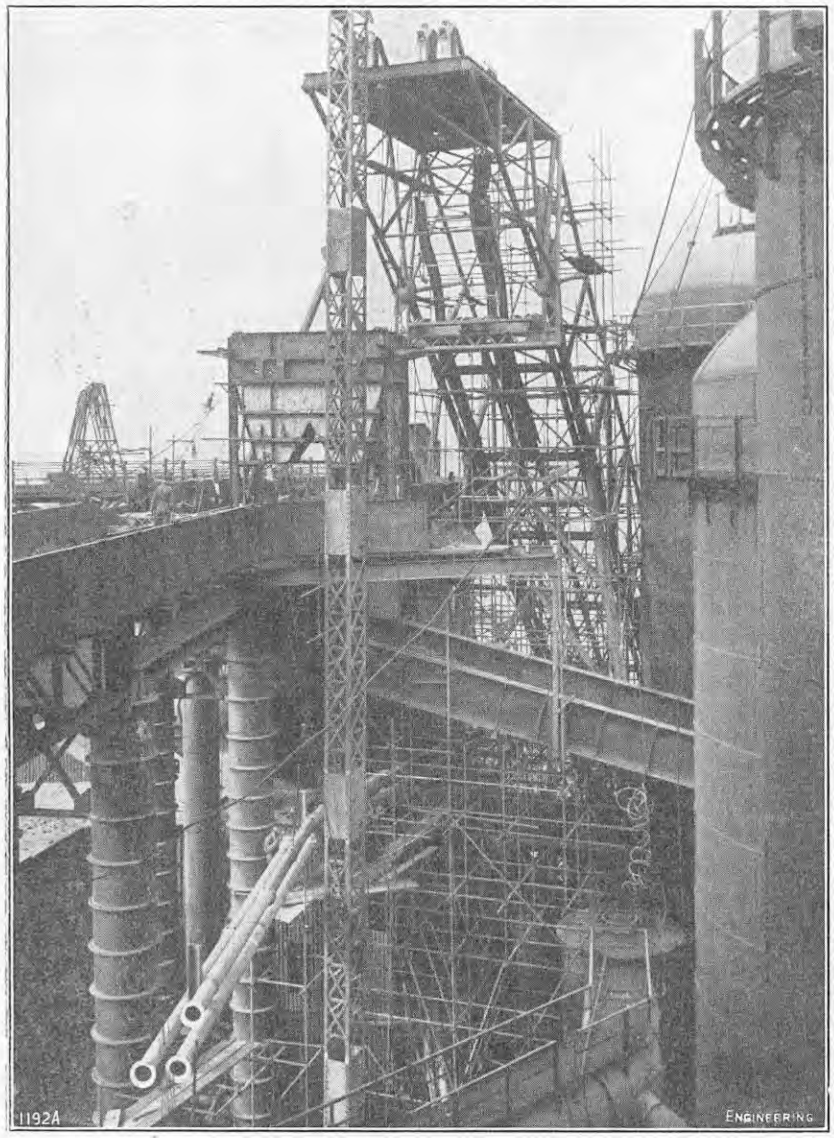


Fig. 1. View of Skip-Hoist Platform from Wheeling Platform.

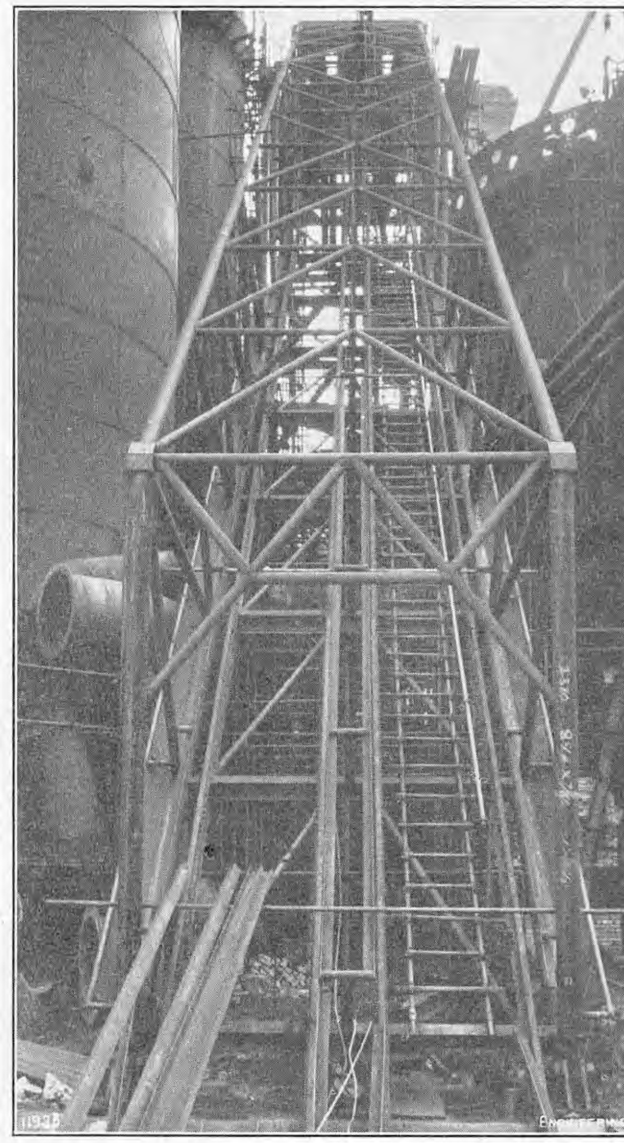


Fig. 2. Erecting Bridge Between Stoves and Furnace.

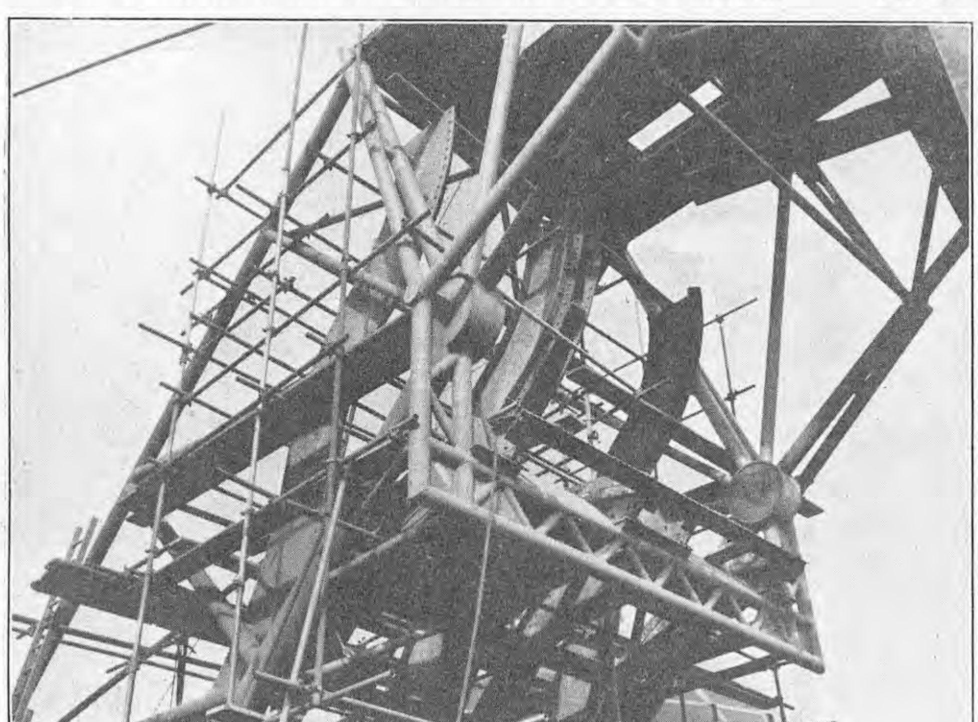


Fig. 3. Dumping Gear Under Hoist-Gear Platform.

the scaffolding. On completion of the main girders it was found that the bleeder on No. 4 furnace would interfere with the girder when it was dropped into position, and therefore the right-hand girder had to be foreshortened until such time as the bleeder could be altered at a suitable shut-down date. When welding was completed the scaffolding in the way of one girder was removed and the girder lowered by means of the derrick until it rested on its seat on the "A" frame. It was then pinned. A similar procedure was followed with the second girder. A scaffolding grillage was then built round the girder, giving support at panel points. The box arrangement of the bridge was completed working from base to top, using rolled-steel joist transomes and longitudinals to carry the rails. Meanwhile No. 4 furnace was still in operation and at one point, under the wheeling platform, the clearance between the furnace and the outside of the bridge was only 6 in.

It was, however, necessary to shut down No. 4 furnace to modify the bleeder and this cleared most of the gas trouble. With the alteration to the bleeder it was possible to complete the platform for the hoist. Girders and dumping rails were fixed, and, as a final precaution, the whole of the bottom deck was plated to prevent material falling through. A 3-ft. wide series of ladders and platforms was built at site and fitted to the skip bridge to give easy access to the wheeling platforms and to facilitate the handling of accident cases.

Apart from the pins at the base of the bridge and at each end of the "A" frame, and the rails which are bolted to the rolled-steel joist longitudinals, the whole job is completely welded. The welds are butt and fillet welds following standard practice, but several were made under conditions of heat, access and height, which caused unusual difficulties but did not impair the final quality. Messrs. Tubewrights, Limited, designed the bridge and "A" frame from information supplied by Messrs. Ashmore, Benson, Pease and Company; the erection was a joint undertaking, with scaffolding provided by the London and Midland Steel Scaffolding Company, Limited.

THE SMITHFIELD SHOW AND AGRICULTURAL MACHINERY EXHIBITION.

THE annual Smithfield Show and Agricultural Machinery Exhibition, which opens at Earl's Court on Monday, December 8, and remains open until the evening of Friday, December 12, promises to be the most successful ever held. Entries in the various livestock sections have already exceeded the previous records and additional space has had to be allocated to the trade exhibits; these two factors alone well illustrate the importance now attached to the Show. That it should continue to gain in popularity is understandable, as it comes at a time when farmers pause to take notice of their future requirements for livestock and agricultural machinery. The appeal of the Smithfield Show, however, is widespread and interest in it abroad has been growing during recent years; last year, for example, more than 1,000 visitors came from other countries and the invitations accepted for the coming occasion indicate that all previous records will be broken in this respect. It is, in fact, becoming obvious that cattle breeders overseas are looking more and more to Great Britain to provide new blood for their herds and the Show undoubtedly provides an excellent opportunity for this purpose.

Broadly speaking, the Show will be divided into three main sections, namely, livestock, supplies and services and agricultural machinery. Practically all types of machinery will be covered by the last-named section, ranging from diminutive horticultural single-wheel tractors to the heaviest crawler tractors, combine harvesters, etc. In all, over 350 manufacturers will be showing representative examples of the many types of agricultural machinery that have helped to make this country's agricultural industry the most highly mechanised in the world. The remarkable growth in the production of such machinery is, perhaps, not fully appreciated; in 1939, for example, our annual output was valued at less than 6,000,000*l*. but by 1949, the year of the first post-war Smithfield Show, it had grown to a value of 64,000,000*l*. Last year it increased to over 100,000,000*l*. for the first time and, as in 1950, more than half the total output was sold overseas. Furthermore, by January last, there were more than 340,000 agricultural tractors in use on farms in the United Kingdom, a figure that by now has probably increased to 360,000 or more. If to this be added the figure of well over 425,000 agricultural tractors that have been exported from this country since the end of the war, the true aspect of the part played by British agricultural engineers towards the national economic well-being becomes apparent. Their efforts, however, should not be judged solely by output figures, good as these are, as since the end of the war equally striking developments have been made in design, and the industry is now able to offer a wide range of equipment suitable for use in all parts of the world. The present need for high production has, naturally, retarded development to some extent but not greatly. This will be evident at Earl's Court where, according to advance information, several new implements will be on view for the first time. Harry Ferguson, Limited, Coventry, for example, will be showing three new mounted implements, namely, a buckrake, a tandem disc harrow and a low-volume sprayer, and in view of this firm's pioneer work in the development of mounted implements, it may be appropriate to commence our report of the exhibits by describing these three items.

TRACTOR-MOUNTED BUCKRAKE.

The buckrake is illustrated in Fig. 1, herewith, where it is shown connected to the tractor. It has been designed to take advantage of the principles built into the Ferguson tractor, in that it can be mounted easily and controlled by the hydraulic system. For its size it is of exceptionally light construction, weighing only 280 lb., but it is capable of effectively handling loads up to 750 lb., a feature obtained by using tubular members. The pressure of the tines on the ground is hydraulically controlled and, when collecting the crop, the rear linkage is used to transmit ground reactions against the tine tips directly to the control system, thus preventing digging in and consequent wheel spin. A simple tripping mechanism is incorporated in the design and the implement is arranged so that, if required, the load can be discharged vertically downwards into a pit, which is a useful feature when making silage. During transport, the weight of the buckrake and its load is supported through a mechanical linkage, thus avoiding unnecessary use of the hydraulic system. Part of this linkage can be seen in Fig. 3, from which it will be seen that it incorporates a simple latch. The tripping mechanism is re-engaged automatically by operating the hydraulic-control lever.

MOUNTED TANDEM-DISC HARROW.

The mounted tandem-disc harrow, which is illustrated in Fig. 2, herewith, will be complementary to the trailed tandem-disc harrow already included in the Ferguson range. It is attached to the tractor through the normal three-point linkage and possesses all the advantages usually associated with hydraulically-controlled directly-mounted implements. Provided the draught of the harrow remains constant, the working depth of the gangs is controlled automatically to predetermined amount; should the draught alter, however, a slight adjustment of the control lever restores the required depth. Connecting the harrow to the three-point linkage gives the added advantage of being able to transfer the weight of the implement to the tractor, thus giving additional adhesive weight and reducing the risk of "bogging-down" in wet and sticky soils. There are two positions for the link pins, namely, upper and lower, use of the former position increasing the sensitivity of the control system, while the latter gives higher ground clearances for transport. The cutting angles of each of the disc gangs are adjusted independently by two levers within easy reach from the tractor driving seat and each gang is provided with an adjustable scraper assembly for cleaning the discs. As the average distance between

EXHIBITS AT THE SMITHFIELD SHOW.

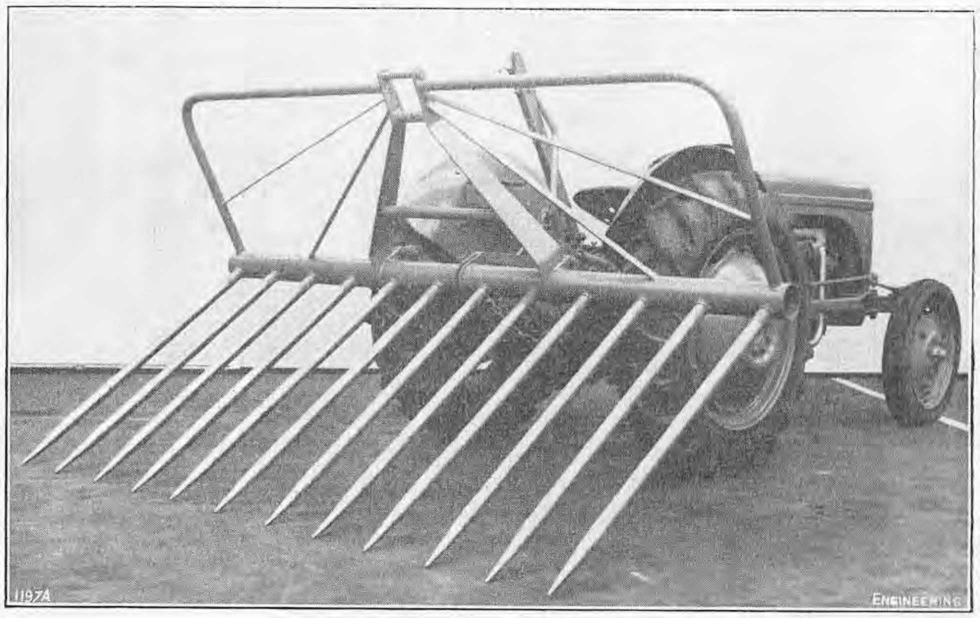


FIG. 1. TRACTOR-MOUNTED BUCKRAKE; HARRY FERGUSON, LTD.

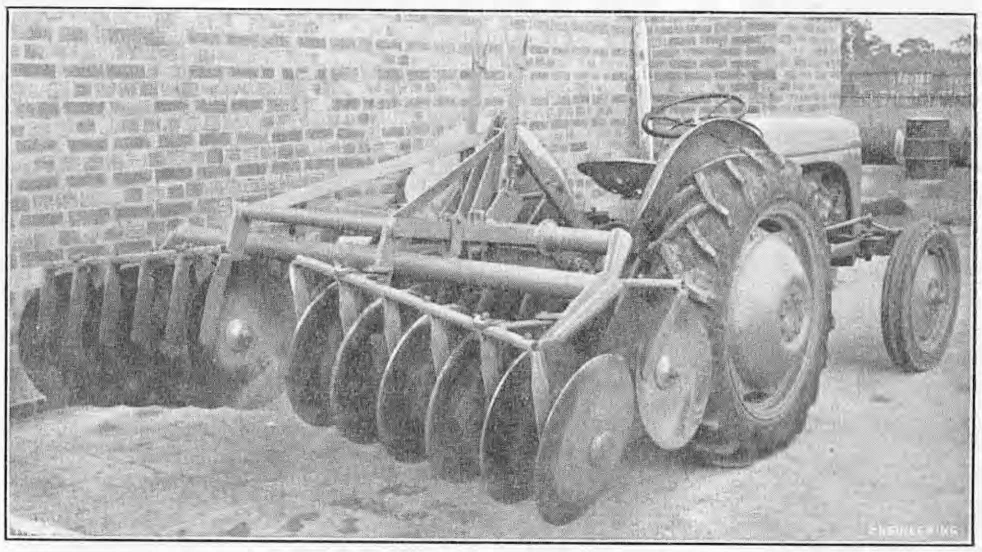


FIG. 2. TRACTOR-MOUNTED TANDEM-DISC HARROW; HARRY FERGUSON, LTD.

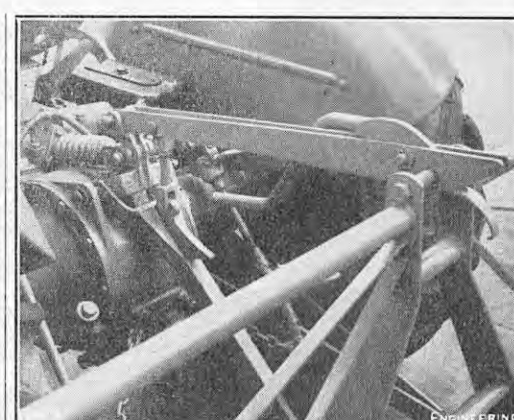


FIG. 3. CONNECTING LINKAGE FOR TRACTOR-MOUNTED BUCKRAKE; HARRY FERGUSON, LTD.

EXHIBITS AT THE SMITHFIELD SHOW.

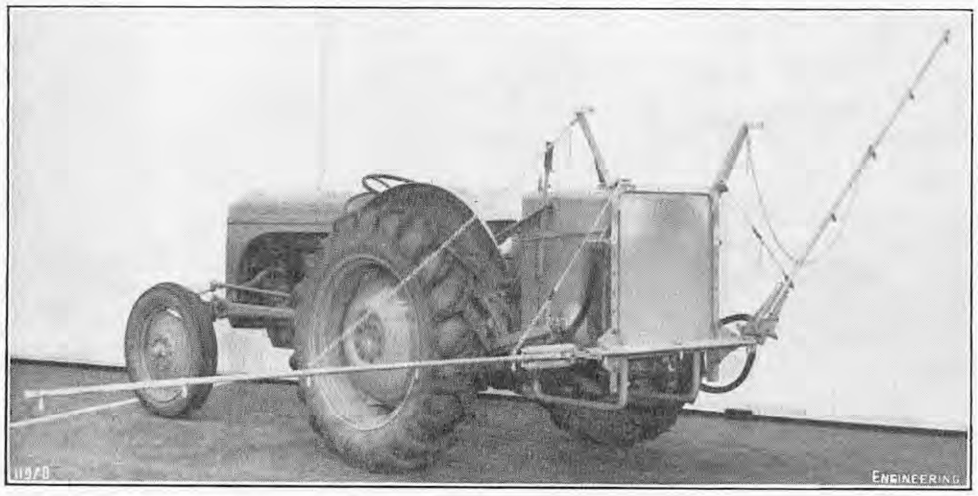


FIG. 4. LOW-VOLUME SPRAYING MACHINE; HARRY FERGUSON, LTD.

FIG. 5. "SAPPER" REAR GRADER; DAVID BROWN TRACTORS, LTD.

the front and rear gangs is only 27 in., the weight of the implement is located as nearly as possible to the tractor, this feature being improved by the provision of a weight box which is placed well forward of the link pins.

TRACTOR-MOUNTED LOW-VOLUME SPRAYER.

The Ferguson low-volume spraying machine has been designed to provide the farmer with an efficient and economical method of overcoming weed problems that can be solved by the application of hormones. It can also be used with a large number of insecticides and fungicides for the control of common pests. It is illustrated in Fig. 4, herewith, from which it will be seen that it is connected to the tractor through the three-point hitch in the normal manner. The volume of spray that can be delivered to the crop ranges from 5 gallons to 20 gallons an acre. The machine consists basically of a 45-gallon steel tank specially lined to resist corrosion, and one centre and two side booms, the latter being hinged so that they can be raised and lowered by levers fitted to the tank sides. A gear-type pump is used and this is driven from the tractor power take-off through a shaft fitted with rubber-jointed universal couplings. The coupling shaft is kept in position on the power take-off shaft by a simple spring-loaded mechanism, no nuts or bolts being required to make the connection.

Special attention has been paid to the filtration system. There is a strainer in the main filling orifice, a main pressure filter between the pump and the nozzles and another filter in each nozzle assembly; all filters are arranged so that they can be dismantled easily for cleaning. Both of the outer spray booms are fitted with spring-loaded hinges to allow them to swing back and return to their working positions if an obstruction is met. The outer booms, as already mentioned, can also be raised independently by means of levers at the sides of the tank. Each side-boom control cock, however, is connected to its associated lifting lever in such a way that when a boom is raised above 45 deg. the sprays are automatically shut down, thus permitting one boom only to be used at a time. All sections of the boom can be adjusted for height while in the spraying position to give a range of nozzle heights from 18 in. to 33 in. in increments of 3 in.

There are three spray control cocks, namely, a main cock operated by a lever within easy reach of the driver and the boom control cocks previously mentioned. The main cock has two positions, spray and spray shut off, the latter incorporating an anti-drip device. When in the shut-off position the tank is isolated from the pump and the suction side of the pump is connected to the booms and associated tubing so that all liquid is drained back into the tank. Although a simple three-point method of attachment is employed to connect the sprayer to the tractor, certain details of the linkage are new, a diagonal link being incorporated. When the unit is in position, its weight is transferred to the tractor in such a manner that there is no strain on the hydraulic system.

DIESEL-ENGINED TRACTOR.

The main exhibit on the stand of David Brown Tractors, Limited, Meltham, Yorkshire, will be their Cropmaster tractor fitted with a new, more powerful Diesel engine. This unit has four cylinders and develops 31 brake horse-power at 1,600 r.p.m., compared with 25 h.p. at 1,400 r.p.m. in the case of the previous model. The new engine is fitted with wet replaceable type cylinder liners, silicon-alloy pistons and a monobloc cylinder head fitted with overhead valves. Direct injection is employed and the injection pump is fitted with a vacuum-type governor which operates over the entire speed range, namely, 600 r.p.m. to 1,800 r.p.m. All the principal features of the previous Diesel-engined tractor are retained in the new tractor. These include internal-expanding brakes operated by a pedal and by independent hand levers, hydraulically-operated implement lift, adjustable front and rear tracks, twin-range gearbox giving six speeds, and a two-speed power take-off.

TRACTOR-MOUNTED GRADER.

David Brown Tractors, Limited, will also be showing a new mounted implement, namely, their Sapper rear grader. This unit, which is illustrated in Fig. 5, herewith, has been designed for attachment to the three-point rear-implement linkage of all David Brown wheeled tractors. The blade is 6 ft. long, 1 ft. 6 in. high, and weighs 330 lb. It is suspended from the tractor in such a way that it can be raised approximately 2 ft. above the ground, tilted 25 deg. to either side and given an angle of cut of from 60 to 75 deg. It is raised and lowered by means of the hydraulic lift and can be set to various degrees of angling in either direction so that difficult corner or confined spaces can be worked. The unit is strongly built and should prove useful on the farm for such duties as snow clearing, road making, terracing and back-filling of trenches.

(To be continued.)

BRITISH STANDARD SPECIFICATIONS.

THE following publications of engineering interest have been issued by the British Standards Institution. Copies are available from the Sales Department of the Institution, 24, Victoria-street, London, S.W.1, at the price quoted at the end of each paragraph.

Methods for Sampling of Ferro-Alloys.—Part 2 of a specification, entitled "Methods for the Sampling of Ferrous Metals and Metallurgical Materials for Analysis," and designated B.S. No. 1837, has recently made its appearance. Part 1 which dealt with methods for the sampling of iron and steel, was published earlier this year. The new specification deals with ferro-alloys and is primarily intended for referee purposes in conjunction with B.S. No. 1121, which covers methods for the analysis of iron and steel. In the first section of B.S. No. 1837: Part 2, are set out the general requirements of sampling procedure. Section 2 deals with the sampling of ferro-tungsten, ferro-niobium, ferro-molybdenum, ferro-vanadium and ferro-titanium. Section 3 is concerned with the sampling of ferro-chromium, ferro-silicon, ferro-manganese and spiegel, while section 4 relates to the sampling of bulk deliveries in wagons. The publication, it is emphasised, should be considered as a guide to sound sampling procedure rather than as a rigid specification and modifications may be agreed upon between the supplier and the consumer. [Price 2*s.* 6*d.*, postage included.]

Flexible Steel Conduit and Adaptors for Electric Cable.—A revision of part of B.S. No. 731, which covers flexible steel conduit for cable protection and flexible steel tubing to enclose flexible drives, has now been issued. The specification was first issued in 1937, and, in the course of revision it has been decided to separate that part of the specification dealing with flexible steel conduit for cable protection from that concerning flexible steel tubing to enclose flexible drives. Part 1 of the revision, now published, relates to flexible steel conduit. Part 2 of the revision, which will cover flexible steel tubing to enclose flexible drives will be published in the near future. Part 1 provides for three types of flexible steel conduit suitable for insulated cables, namely, unpacked, asbestos-packed and rubber-packed. Two types of adaptors are standardised, namely, the clamp-type and the solid-type. In addition to standardising the quality of the materials to be used and the workmanship and dimensions, the specification contains clauses regarding the mechanical tests to be applied to the finished conduit. [Price 2*s.* 6*d.*, postage included.]

NOTES FROM THE INDUSTRIAL CENTRES.

SCOTLAND.

TRANSMISSION LINES IN BEAUTY SPOTS.—Ayr County Council are to advise the British Electricity Authority that overhead transmission lines in villages of high amenity will ultimately have to be placed underground, but that, for economic reasons, overhead cables will be permitted at present. The Council have agreed to allow overhead lines for a power supply to Barrhill if a suitable type of pole, which would to some extent preserve the village amenities, is provided.

PROPOSED DREDGING AT PORT OF INVERNESS.—Until a major dredging scheme is officially approved, the draught of vessels entering the port of Inverness may have to be restricted by 2 ft., Captain J. McLean, the harbourmaster, reported to a meeting of the Harbour Trustees on November 26. It appears that sand and gravel from a former subsidence at one point on the river bank are forming an obstruction in the channel. On the advice of the harbour engineer, the Trust have decided not to carry out dredging, but to wait until the major scheme is begun, probably next year.

HIGH OUTPUT AT ROLLING MILL.—The large section mill at the Lanarkshire Steelworks, Motherwell, had a record output of 4,044 tons last week. The production comprised 24-in. joists, for which there is a strong demand at present. The mill is understood to be the only one in Scotland capable of rolling such sections.

GLASGOW SHIPOWNERS' BENEVOLENT ASSOCIATION.—An appeal for the funds of the Glasgow Shipowners' and Shipbrokers' Benevolent Association was made on November 25 in Glasgow by Mr. William Logan, the President, at the 38th annual dinner of the Association. He was replying to the toast of "The Association and Shipping Interests," proposed by Viscount Runciman, President of the Chamber of Shipping of the United Kingdom, and of the Institution of Naval Architects. Mr. Logan said that the fund now stood at 63,000*l*., and that 2,150*l*. was paid out to 35 beneficiaries last year. That, he thought, was not worthy of the industry.

CLEVELAND AND THE NORTHERN COUNTIES.

SHORTAGE OF SHIPYARD APPRENTICES.—Addressing members of Newcastle-on-Tyne West Rotary Club, Mr. P. Denham Christie, managing director of the Walker shipyard of Swan, Hunter, and Wigham Richardson, Ltd., referred to the shortage of shipbuilding apprentices. This shortage, he said, was endangering the whole industry, as it meant that skilled men could not be replaced. At one time it had been thought that the shortage was due to low wages, but these had been increased considerably. It might be due, perhaps, to the memory of the days of unemployment in shipbuilding. Moreover, parents might not see why their boys should trouble to learn a trade when there was so little difference between the wages of a skilled man and those of an unskilled man. It was also possible that boys were unwilling to take up dirty, heavy work. Mr. Christie added that a committee of both employers and trade unions were trying to find a solution to this "very serious situation."

TRADING ESTATES IN THE NORTH EAST.—North-Eastern Trading Estates, Ltd., Gateshead, have issued a booklet entitled "Industrial Estates," which outlines the history of trading estates in the North. Mr. S. A. Sadler Forster, the chairman, states that the Team Valley Estate, Gateshead, the first of the 34 trading estates now controlled by the organisation, came into being in August, 1936. This marked the dawn of a new era after a period of trade depression. In August, 1951, employment on the trading estates reached the peak figure of 44,500, but, at present, the level is about 1,000 below this figure. Mr. Forster adds that the new industries are bringing into the area a much-needed diversity of industry and are also proving powerful educational forces.

STELLA TO CARLISLE ELECTRIC TRANSMISSION LINE.—Farmers in the South-Tyne area of Northumberland are threatening to continue their opposition to the erection of 110-ft. pylons in the area by refusing to grant wayleaves to the British Electricity Authority. The pylons are part of the 275-kV overhead transmission line to be constructed from Stella, Blaydon-on-Tyne, to Carlisle, a distance of about 50 miles. The proposed route has been approved by the Ministry of Fuel and Power, and it is understood that if farmers withhold wayleaves, the B.E.A. can apply for compulsory powers to cross their lands.

TYNE-BUILT ALTERNATORS FOR ONTARIO.—C. A. Parsons & Co., Ltd., Newcastle-on-Tyne, have been complimented for their speedy completion of a 100,000-kW turbo-alternator for the Ontario Hydro-Electric Commission. The machine was ordered in November, 1950, and has been built, delivered and installed within two years. Messrs. Parsons have received a telegram from Mr. R. Saunders, the chairman, and Mr. R. Hearn, the chief engineer, of the Commission, referring to the fact that the turbo-alternator had been completed ahead of schedule and expressing "sincere appreciation and thanks for another job well done."

DEFENCE AND EXPORT ORDERS IN THE NORTH-EAST.—Factories in the North-East are being visited by Ministry of Supply officials to find out what capacity is still available for defence orders. It is likely that firms whose export work has recently fallen off will receive more work under the defence programme.

RAILWAY AND ROAD CONSTRUCTION AT GATESHEAD.—Gateshead Corporation Town Planning Committee have been informed that British Railways are planning the construction of a new main line on the east side of Gateshead. This, it is stated, may interfere with the Committee's Sunderland road by-pass scheme and the Committee have asked the Corporation officials to submit a report on the matter.

SHIPYARD RIVER FRONTAGE AT WALLSEND.—The Tyne Improvement Commission have approved proposals submitted by Purdie, Lumsden & Co., Ltd., contractors, Newcastle-on-Tyne, on behalf of the Wallsend Slipway and Engineering Co., Ltd., for the construction of a steel sheet-piled frontage, 168 ft. long, at the firm's works at Wallsend.

LANCASHIRE AND SOUTH YORKSHIRE.

FOUNDRY EMPLOYEES GIVEN NOTICES.—Consequent upon a recession in the motor-car industry, Sheepbridge Stokes, Ltd., Sheffield, have found it necessary to give notices to terminate their employment to 100 foundry employees. It is understood that about a quarter of them will be found jobs in other parts of the works. During the past two months, the firm have given notices to nearly 200 men, the first batch from the machine shops. Chesterfield Employment Exchange officials, however, state that they will be in a position to offer jobs to the displaced men.

FIRST AVRO CANBERRA AIRCRAFT.—The first Canberra bomber aircraft from the production line of A. V. Roe & Co., Ltd., Greengate, Middleton, Manchester, made its maiden flight from Woodford aerodrome, Cheshire, on November 25. Production orders for the Canberra aircraft, which is designed by the English Electric Co., Ltd., Warton, Lancashire, have also been placed with Short Brothers and Harland, Ltd., Belfast, and Handley Page, Ltd., London. The first Short-built Canberra aeroplane flew on October 30, ahead of the target date.

THE MIDLANDS.

TRAINING FOR INDUSTRY.—Joseph Sankey & Sons, Ltd., Bilston, Staffordshire, who also have works at Wellington, Shropshire, and in other parts of the Midlands, have produced a booklet describing their Bankfield training school at Bilston. The booklet, which is entitled "Opportunity," describes the facilities available for young men at the school, which is maintained by the firm to provide training in all branches of their business. Mr. G. Ronald Sankey, director and general manager, mentions in a foreword that most of the firm's officials have come from the ranks of the work-people, and that it is hoped that this now established tradition will continue.

TRANSPORT BETWEEN THE MIDLANDS AND SOUTH WALES.—Attention has been drawn again to the inadequate transport facilities between the Midlands and South Wales. Sir Arthur Smout, a director of Imperial Chemical Industries, Ltd., when visiting South Wales on November 25 to open a new factory for Lightning Fasteners, Ltd., said that the question of transport facilities had become more urgent since the steel and tinplate industries of South Wales had been modernised. The Midlands were a natural market for the products of South Wales, and the South Wales ports were admirably suited as an outlet for the export trade of the Midlands. The weak link was the transport facilities.

NEW GAS PLANT AT TIPTON.—The West Midlands Gas Board have decided to erect a new gas plant in the Midlands, to produce 30,000,000 cub. ft. of gas a day. The plant will be of advanced design, and will operate on low-grade coal. The exact site has not yet been disclosed, but the new works will be in Tipton.

ELMDON AIRPORT.—The presence of Ministry of Civil Aviation technicians at Birmingham Airport, Elmdon, in recent weeks has led to a widespread belief in the Midlands that the two 1,400-yard runways are to be extended. There have been numerous suggestions that this should be done, as the airport cannot deal at present with any aircraft larger than a Dakota. The Ministry of Civil Aviation have stated, however, that the inspection recently carried out has no connection with any improvements to the landing facilities at the airport.

SEWAGE WORKS TO BE DISMANTLED.—The sewage works at Brereton, Staffordshire, completed for Rugeley Urban District Council in 1950 at a cost of 20,000*l*., are to be dismantled to make way for a new electric power station. The National Coal Board are sinking a new pit, Lea Hall Colliery, near the sewage works, and the power station is to be erected near the colliery, to take coal direct from underground. The British Electricity Authority tried to devise a layout which would not interfere with the sewage plant, but found that alternative arrangements would cost considerably more than the 20,000*l*. already spent. Rugeley Council will consider constructing new sewage works, to replace not only those at Brereton, but also another works nearby, which will become liable to mining subsidence.

BIRMINGHAM-LONDON HELICOPTER SERVICE.—British European Airways have now given June, 1953, as the date for restarting the Birmingham-London passenger helicopter service. Two Bristol 171 four-seater single-engined helicopters have been ordered for the service, and will be delivered by June. They are slightly larger than those which operated the previous service, and, in addition to accommodating an extra passenger, will carry 100 lb. more baggage.

SCHOOLBOYS AND THE ENGINEERING PROFESSION.—The Vice-Chancellor of Nottingham University, Mr. B. L. Hallward, has expressed the view that too many children of the highest ability are diverted to grammar schools by the examination at the age of 11, and not enough go to technical schools. He urges the desirability of building "grammar-techs" rather than separate technical schools. Engineering departments were not getting their proportion of the highest ability. Pure science and the arts were getting a good supply of talent, but applied science, agriculture and engineering were not having their share. He suggests that Chambers of Commerce, the Federation of British Industries and other organisations should consider the situation.

SOUTH-WEST ENGLAND AND SOUTH WALES.

WELSH COAL TRADE.—In spite of a ban on overtime and on the voluntary Saturday morning shift, unofficially imposed at some South Wales Collieries and resulting in a decrease in production of nearly 110,000 tons during the three weeks in which it has operated, the output in the coalfield, this year, remains well above that of a year ago. Up till November 22, the production of coal amounted to about 21,529,000 tons against 21,108,400 tons in the corresponding period of 1951.

RAISING A SUNKEN STEAMER.—In less than seven hours the coasting steamer Stream Fisher, which sank in Swansea Docks, was raised and brought to an even keel. She had lain almost completely submerged in the dock for the past two months. The vessel had been loading coal when she began to take in water and heeled over on her port side. Before lifting operations were begun, divers removed about 350 tons of coal and sealed the holds. Two floating cranes, five pumps, and the salvage tug Ranger were used in lifting the vessel.

WATCH AND CLOCK MAKING IN WALES.—The directors of Smiths English Clocks, Ltd., have decided to transfer to Ystradgynlais, in the Swansea Valley, the watch-case producing subsidiary, Ming Ware Ltd., Dundee, and the production of domestic chiming clocks from Enfield, Middlesex. The decision was announced on November 26 by Mr. H. O. N. Walford, resident director of the Ystradgynlais clock factory and the adjacent factory of the Associated Anglo-Celtic Watch Company. The Enfield factory, which employs 250 people, has been operating for 22 years. A similar number are employed at the Dundee factory, which has been operating for eight years. Transference to the Swansea Valley is expected to be completed early next year and employment will grow within a year or two, from the present 240, to about 800 persons.

"ZIP-FASTENERS" FACTORY, SWANSEA.—Imperial Chemical Industries, Ltd., have opened a factory at Waunarlwydd, Swansea, for the manufacture of "zip" fasteners. At present about 300 persons are employed, mostly women, the output being 300,000 ft. of fasteners a week.

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.

INSTITUTION OF ELECTRICAL ENGINEERS.—Monday, December 8, 5.30 p.m., Victoria-embankment, W.C.2. Discussion on "Maintenance of Electrical Equipment," opened by Mr. R. H. Cobbold. *North-Eastern Centre:* Monday, December 8, 6.15 p.m., Neville Hall, Newcastle-upon-Tyne. (i) "Inhibited Transformer Oil," by Mr. W. R. Stoker and Mr. C. N. Thompson. (ii) "Stability of Oil in Transformers," by Mr. P. W. L. Gossling and Mr. L. H. Welch. *East Midland Centre:* Monday, December 8, 6.30 p.m., Albert Hall, Nottingham. "Light from the Dark Ages," by Mr. A. R. Cooper. *Merseyside and North Wales Centre:* Monday, December 8, 6.30 p.m., Town Hall, Chester. (i) "Electrolytic Analogue in the Design of High-Voltage Power Transformers," by Mr. D. McDonald. (ii) "The Accurate Mapping of Electric Fields with an Electrolytic Tank," by Dr. K. F. Sander and Mr. J. G. Yates. *Measurements and Supply Sections:* Tuesday, December 9, 5.30 p.m., Victoria-embankment, W.C.2. "Voltage Transformers and Current Transformers Associated with Switchgear," by Mr. W. Gray and Mr. A. Wright. *North Midland Centre:* Tuesday, December 9, 6.30 p.m., 1, Whitehall-road, Leeds. "Post-Graduate Activities in Electrical Engineering," by Mr. W. J. Gibbs and others. *Education Discussion Circle:* Wednesday, December 10, 6 p.m., Victoria-embankment, W.C.2. Discussion on "The B.B.C. School, Eversham," and "The Post Office School, Stone," opened by Dr. K. R. Sturley and Mr. H. R. Harbottle. *Southern Centre:* Wednesday, December 10, 6.30 p.m., Dorset Technical College, Weymouth. "Principles of Colour Television," by Dr. J. H. Mole. *Utilization Section:* Thursday, December 11, 5.30 p.m., Victoria-embankment, W.C.2. "Royal Festival Hall: Electrical Installation," by Mr. J. G. Hunter.

INSTITUTE OF METALS.—*Scottish Section:* Monday, December 8, 6.30 p.m., 39, Elmbank-crescent, Glasgow, C.2. "Bearings and Bearing Alloys," by Mr. R. T. Rolfe.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—*Liverpool Branch:* Monday, December 8, 6.30 p.m., Radiant House, Bold-street, Liverpool. "The Dual Function of Ventilation and the Meaning of Air Conditioning," by Mr. A. L. Longworth.

INSTITUTION OF PRODUCTION ENGINEERS.—*Sheffield Section:* Monday, December 8, 6.30 p.m., Royal Victoria Station Hotel, Sheffield. "Modern Developments in Electric Welding," by Dr. H. G. Taylor. *Yorkshire Section:* Monday, December 8, 7 p.m., Hotel Metropole, Leeds. "Difficulties and Developments in Deep Drawing and Pressing," by Dr. J. D. Jevons. *Derby Section:* Monday, December 8, 7 p.m., Irongates Hotel, Derby. Brains Trust Meeting. *Dundee Section:* Tuesday, December 9, 7.30 p.m., Queen's Hotel, Dundee. "Apprentice Training," by Mr. W. Heigh. *Preston Section:* Wednesday, December 10, 7.15 p.m., Crown Hotel, Market-place, Blackburn. "Current Problems of Management," by Mr. M. Seaman. *Cornwall Section:* Wednesday, December 10, 7.15 p.m., Cornwall Technical College, Pool, Redruth. "Control of Quality in Production Engineering," by Mr. J. H. Williams. *Liverpool Section:* Wednesday, December 10, 7.30 p.m., Radiant House, Bold-street, Liverpool. "Increased Productivity by Machine Shop Practice," by Mr. A. Cameron. *London Section:* Thursday, December 11, 7 p.m., Royal Empire Society, Northumberland-avenue, W.C.2. "Modern Finishing Processes," by Mr. K. W. Abineri.

SOCIETY OF CHEMICAL INDUSTRY.—*Corrosion Group* and *Yorkshire Section:* Monday, December 8, 6.45 p.m., Grand Hotel, Leopold-street, Sheffield. Joint Meeting. "Corrosion Resistance of Stainless Steels," by Dr. U. R. Evans, F.R.S.

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS. —*Central London Branch:* Monday, December 8, 6.45 p.m., St. Ermin's Hotel, Caxton-street, S.W.1. "Fluid Couplings," by Mr. E. C. Farrer. *Bolton Branch:* Tuesday, December 9, 7.30 p.m., Balmoral Hotel, Bradshawgate, Bolton. "Fusegear," by Mr. E. Jacks. *Bradford Branch:* Wednesday, December 10, 7.30 p.m., Midland Hotel, Bradford. "Miniature Circuit Breakers," by Mr. Dorman Smith.

INSTITUTION OF MECHANICAL ENGINEERS.—*East Midlands Branch:* Monday, December 8, 7 p.m., Rolls-Royce Welfare Hall, Nightingale-road, Derby. "Gas-Turbine Development," by Mr. B. E. G. Forsling. *South Wales Branch:* Tuesday, December 9, 6 p.m., Mackworth Hotel, Swansea. "Present and Projected Developments of Gas Supplies in the South Wales Area," by Mr. E. M. Edwards. *Scottish Branch:* Wednesday, December 10, 7.30 p.m., Technical College, Dundee; and Thursday, December 11, 7.30 p.m., Royal Technical College, Glasgow. "Materials Handling," by Mr. A. Roebuck. *Institution:* Friday, December 12, 5.30 p.m., Storey's-gate, St. James's Park, S.W.1. Meeting with *Applied Mechanics Group.* (i) "Experiments on Short-Radius Pipe-Bends," by Dr. Nicol Gross. (ii) "Flexibility of Short-Radius Pipe-Bends," by Dr. Nicol Gross and Professor Hugh Ford. AUTOMOBILE DIVISION.—*Luton Centre:* Monday, December 8, 7.15 p.m., Town Hall, Luton. Film Evening. *London:* Tuesday, December 9, 5.30 p.m., Storey's-gate, St. James's Park, S.W.1. "Research and the Engineering Process," by Dr. H. E. Merritt.

JUNIOR INSTITUTION OF ENGINEERS.—*North-Western Section:* Monday, December 8, 7 p.m., 16, St. Mary's Parsonage, Manchester. "Compression-Ignition Engines," by Mr. C. R. Spencer and Mr. P. Threlfall. *Sheffield Branch:* Monday, December 8, 7.30 p.m., Livesey Clegg House, Sheffield. "Application of Automatic Control," by Mr. A. Muir. *Institution:* Friday, December 12, 7.30 p.m., Royal Society of Arts, John Adam-street, W.C.2. Presidential Address on "The Air and the Future," by Air Commodore F. R. Banks.

INCORPORATED PLANT ENGINEERS.—*Dundee Branch:* Monday, December 8, 7.30 p.m., Mathers Hotel, Dundee. "British and American Maintenance Organisation," by Mr. T. C. Robinson. *East Lancashire Branch:* Tuesday, December 9, 7.15 p.m., Engineers' Club, Manchester. "Alterations to the 'Guardian' Building," by Mr. P. G. Fairhurst. *Edinburgh Branch:* Tuesday, December 9, 7 p.m., 25, Charlotte-square, Edinburgh. Film Evening.

INSTITUTION OF ENGINEERING INSPECTION.—*Wolverhampton Branch:* Monday, December 8, 7.30 p.m., Compton Grange, Compton-road, Wolverhampton. Film Evening. *Leeds Branch:* Wednesday, December 10, 7.30 p.m., Church Institute, Albion-place, Leeds, 1. Film Evening.

CHADWICK TRUST.—Tuesday, December 9, 4.30 p.m., Medical School, Norfolk-place, W.2. "Prevention of Dust Diseases of the Lungs," by Dr. A. I. G. MacLaughlin.

INSTITUTION OF CIVIL ENGINEERS.—*Works Construction Division:* Tuesday, December 9, 5.30 p.m., Great George-street, S.W.1. "Economic Use of Heavy Earth-Moving Equipments and Field Maintenance Thereof," by Mr. B. J. Meighan. *Midlands Association:* Thursday, December 11, 6 p.m., James Watt Memorial Institute, Birmingham. "Practical Soil Mechanics," by Mr. I. K. Nixon.

INSTITUTE OF MARINE ENGINEERS.—Tuesday, December 9, 5.30 p.m., 85, Minories, E.C.3. Symposium on "Unusual Ship and Machinery Defects: Their Investigation and Cure."

INSTITUTION OF CHEMICAL ENGINEERS.—Tuesday, December 9, 5.30 p.m., Geological Society, Burlington House, Piccadilly, W.1. "Use of Sulphuric Acid in a Totally-Enclosed System," by Mr. J. L. Edgar.

ILLUMINATING ENGINEERING SOCIETY.—Tuesday, December 9, 6 p.m., 2, Savoy-hill, W.C.2. "Visual Fatigue," by Mr. H. C. Weston.

SHEFFIELD METALLURGICAL ASSOCIATION.—Tuesday, December 9, 7 p.m., Grand Hotel, Sheffield. "Ceramic-Metal Mixtures: Cermets," by Mr. L. R. Barrett.

BRITISH INSTITUTION OF RADIO ENGINEERS.—*West Midlands Section:* Tuesday, December 9, 7.15 p.m., Technical College, Wulfruna-street, Wolverhampton. Film Evening. *London Section:* Wednesday, December 10, 6.30 p.m., School of Hygiene and Tropical Medicine, Keppel-street, W.C.1. "Production of Television Receivers," by Mr. Frank Allen.

INSTITUTE OF ROAD TRANSPORT ENGINEERS.—*Midlands Centre:* Tuesday, December 9, 7.30 p.m., Crown Inn, Birmingham. "Maintenance of Fuel-Injection Equipment," by Mr. A. J. Rowley. *East Midlands Centre:* Wednesday, December 10, 7.30 p.m., Mechanics' Institute, Nottingham. "Straight Mineral Oils as Opposed to Detergent Oils," by Mr. R. C. Hunt.

INSTITUTE OF FUEL.—Wednesday, December 10, 10 a.m., Engineers' Club, Manchester. Symposium on "Ash and Clinker in Industry."

ROYAL SOCIETY OF ARTS.—Wednesday, December 10, 2.30 p.m., John Adam-street, W.C.2. "Cheaper Building," by Mr. M. Hartland Thomas.

NEWCOMEN SOCIETY.—Wednesday, December 10, 5.30 p.m., Institution of Mechanical Engineers, Storey's-gate, St. James's Park, S.W.1. "The Decapod Locomotive of the Great Eastern Railway," by Mr. W. O. Skeat.

INST[illegible]F WELDING.—Wednesday, December 10, 6.30 [illegible]tution of Civil Engineers, Great George-stre[illegible] "Experiment on Welded Pressure Vess[illegible]Line Components," by Dr. Nicol Gross.

INS[illegible]F STRUCTURAL ENGINEERS.—Thursday, Decem[illegible] p.m., 11, Upper Belgrave-street, S.W.1. "Prestressed Concrete Bridges," by Mr. D. H. Lee.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Friday, December 12, 6.15 p.m., Literary and Philosophical Society's Hall, Newcastle-upon-Tyne. Andrew Laing Lecture: "Application of Research to the Gas Turbine," by Mr. Hayne Constant.

PERSONAL.

SIR MAURICE DENNY, Bt., K.B.E., is relinquishing the chairmanship of William Denny and Brothers, Ltd., Leven Shipyard, Dumbarton, on December 31, but will remain a member of the board. MR. JOHN M. DENNY and MR. WILLIAM DENNY are retiring from the board on the same date. The board intend to invite SIR MAURICE DENNY to become President of the company as from January 1, 1953, with MR. EDWARD L. DENNY as chairman.

LIEUT.-COLONEL H. B. EVERARD, D.S.O., T.D., B.A. (Cantab.), A.M.I.C.E., chief officer engineering (maintenance), Railway Executive, is taking up the appointment of general manager, Rhodesia Railways, with effect from January 16, 1953. The present general manager, SIR ARTHUR GRIFFIN, it is announced by the Rhodesia Railways Higher Authority, is to become chairman of the Rhodesia Railways Board.

The honorary degree of Doctor of Science (Engineering) was conferred upon MR. B. N. WALLIS, B.Sc. (Eng.) (Lond.), M.I.C.E., F.R.Ae.S., by the Earl of Athlone, Chancellor of the University of London, at a Foundation Day ceremony held on November 28.

At the annual general meeting of the Junior Institution of Engineers, held on November 28, MR. S. R. BRODERICK, M.I.C.E., A.M.I.W.E., F.G.S., was elected chairman; MR. S. C. CLARK and MR. F. M. PANZETTA, M.B.E., A.M.I.Mech.E., vice-chairmen; MR. W. N. STATON-BEVAN, honorary editor; MR. S. H. HOLE, M.I.Mech.E., honorary treasurer; and MR. J. A. ROBERTS, honorary librarian.

MR. A. R. MCBAIN, C.B., O.B.E., a part-time member of the Iron and Steel Corporation of Great Britain, has been appointed chairman of the Southern Gas Board. The retiring chairman of the Southern Gas Board, MR. O. R. GUARD, is continuing as a part-time member of the Board.

MR. R. L. BATLEY, A.M.I.Mech.E., chief generation engineer (operations), Merseyside and North Wales Generation Division, British Electricity Authority, has been appointed controller, Midlands Division, in succession to MR. F. W. LAWTON, M.I.E.E., M.I.Mech.E., who is to retire at the end of the year.

MR. F. MOORES, B.Sc. (Eng.), A.M.I.E.E., has been appointed manager of the capacitor department of Johnson and Phillips Ltd., Charlton, London, S.E.7.

MR. I. M. GILLETT, general manager of Silentbloc Ltd., has been appointed managing director, and MR. B. H. DULANTY has been appointed to the board. DR. S. BUCHAN, M.A., B.Sc., F.R.I.C., F.I.R.I., general manager of the Andre Rubber Co. Ltd., a subsidiary company of Silentbloc Ltd., has been appointed to the board of the Andre Rubber Co.

SIR PHILIP HALDIN has relinquished his position on the board of Ilford Limited as from November 27. To fill the vacancy, MR. F. C. HOOPER has been appointed a director of the company.

MR. W. E. FECHER, A.M.I.C.E., A.M.I.Mun.E., at present assistant deputy County Surveyor, Staffordshire County Council, has been appointed Deputy County Surveyor.

MR. L. M. C. ROBINSON, B.Sc., A.M.I.N.A., has been appointed naval architect to the Aluminium Development Association, 33, Grosvenor-street, London, W.1, in place of MR. J. VENUS, A.M.I.N.A., who has resigned to take up an appointment with a firm of consultants.

MR. R. J. GILBERT, engineer-in-charge of the Ottringham transmitting station, British Broadcasting Corporation, retired under the age limit on November 18.

MR. J. B. LIDDLE, B.Sc., of Glasgow, MR. H. J. O'CONNELL, B.E., of Clondalkin, County Dublin, MR. N. A. MACLEOD, B.Sc., of Marple, Cheshire, and MR. F. L. RINGLAND, A.R.I.B.A., of Bangor, Northern Ireland, have been appointed to the Colonial Engineering Service, Mr. Liddle in Tanganyika, Mr. O'Connell in Nigeria, Mr. MacLeod in Malaya and Mr. Ringland in Nigeria (in the Public Works Department).

R. A. LISTER & CO. LTD., Dursley, Gloucestershire, have concluded an arrangement with the WISCONSIN MOTOR CORPORATION, Milwaukee, U.S.A., whereby all spares and servicing operations for the American company's engines in this country will be handled, in future, by POWER UNITS AND EQUIPMENT, Standbrook House, 2-5, Old Bond-street, London, W.1. Hitherto, R. A. Lister & Co. have carried out this work.

The London offices of the TUDOR ACCUMULATOR CO., LTD., Dukinfield, Cheshire, and of PRITCHETT AND GOLD AND E.P.S. CO., LTD., Dagenham Dock, Essex, have been moved to 137, Victoria-street, London, S.W.1. (Telephones, Tudor Accumulator Co.: TATe Gallery 0307, and Pritchett and Gold: TATe Gallery 9212.)

JOHN BROWN & CO., LTD., and the RILEY STOKER CORPORATION, Worcester, Massachusetts, U.S.A., have concluded an agreement which secures to the former company a licence to manufacture and sell, to the Riley Corporation's design, components and complete steam generating plant and equipment for use in land power stations.

SALVAGE OF SINGAPORE FLOATING DOCK.

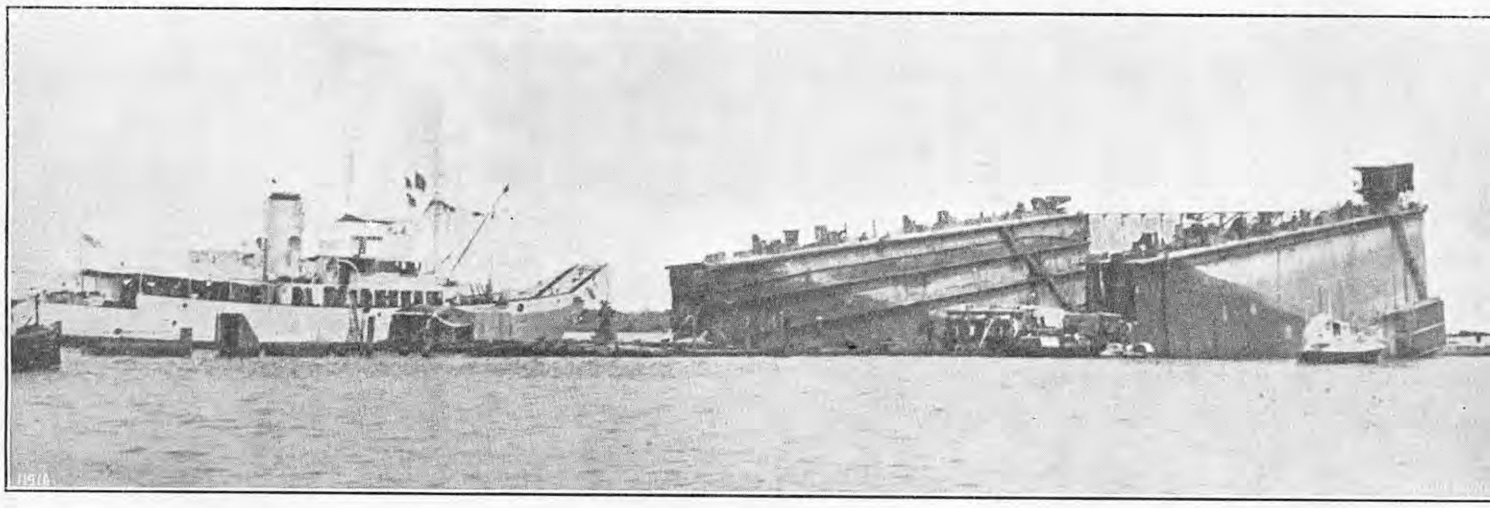


FIG. 1. DOCK SECTION RAISED; BEFORE TRIMMING.

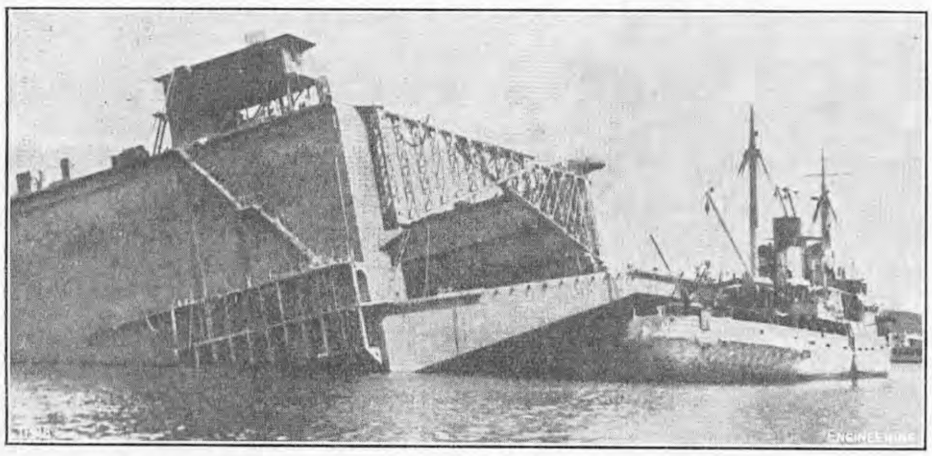


FIG. 2. DOCK SECTION PARTLY RAISED.

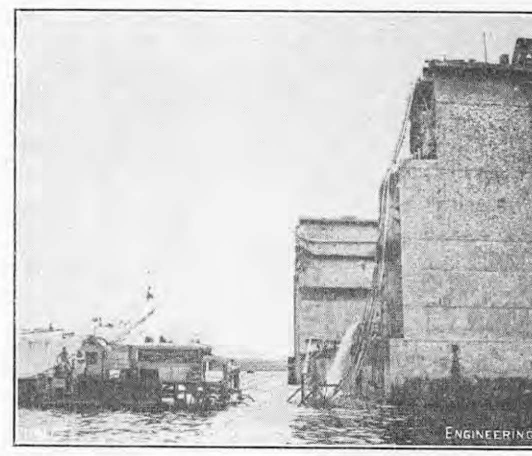


FIG. 3. CUT END OF SALVED SECTION.

SALVAGE OF SINGAPORE FLOATING DOCK.

THE large floating dock which was part of the pre-war equipment of the Royal Dockyard at Singapore was sunk by the British forces before Singapore fell to the Japanese, who subsequently raised and used it. It was again sunk, with a ship in it, in an American air attack. Since last March operations have been in progress for the salvage of the dock. The work was undertaken by the Boom Defence and Salvage Department of the Admiralty, under Captain J. H. Ruck-Keene, O.B.E., D.S.C., R.N., and was planned by the Chief Salvage Officer (Mr. C. L. Black) and supervised by his assistant, Mr. R. Bramall. The ships engaged were the salvage vessel Salvictor and two Bar-class boom-defence craft, with a shore party of 62, including 12 divers. It was announced last week that the first section of the dock, 360 ft. in length and displacing nearly 9,000 tons, had been raised and would shortly be towed to the United Kingdom to be broken up for scrap.

The illustrations, Figs. 1 to 4, herewith, show various stages of the work. The dock being almost completely submerged and badly damaged, it was found necessary to cut it in two, using underwater Oxy-arc cutters. The divers then had to enter the structure to seal the tanks, many of which were leaking, and to blank off the internal piping system before pumping air into the tanks. The buoyancy of each tank was calculated and shown on a model as a guide to the salvors, as it was planned to raise one end first and then to adjust the buoyancy to ensure stability. It is stated that "the section came up exactly in accordance with the calculations." Figs. 1 and 2 show the raised section before trimming; the line of original immersion can be seen by the dark patches on the walls, in Fig. 1. Fig. 3 shows the cut end of the raised section. In the interior view, Fig. 4, the tops of the side walls

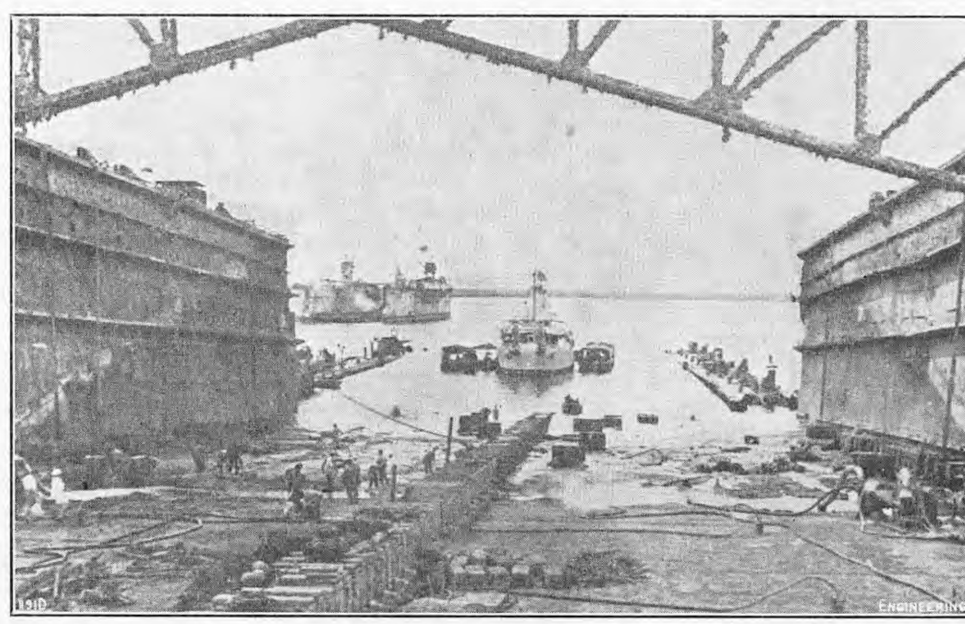


FIG. 4. INTERIOR OF RAISED SECTION.

of the portion still to be raised can be seen on each side of the salvage ship. They project[illegible] just above the water and were used as platfor[illegible]hich to place the air compressors and othe[illegible]

The Singapore floating dock wa[illegible]y the late Sir William Berry, K.C.B., [illegible]rector of Naval Construction at the Adm[illegible]n 1924 to 1930, and was built at Wallse[illegible]-on-Tyne by Messrs. Swan, Hunter and Wigham Richardson, Limited; a brief descriptio[illegible] with illustrations, was published in ENGINEERING of January 20, 1928 (vol. 125, page 84), but few technical details had then been released. Later in that year, however, Mr. (now Sir) Stanley Goodall, R.C.N.C., delivered a paper on "Admiralty Floating Docks" before the Institution of Professional Civil Servants in which he gave some further particulars. This paper was reprinted in our 126th volume, the portion relating to the Singapore dock appearing on pages 213 and 214 of our issue of August 17, 1928. It showed that the dock had an overall length of 855 ft., a clear width between the walls of 135 ft., and a designed lifting capacity of 50,000 tons. It was towed out to Singapore in two parts, by L. Smit and Company, of Rotterdam, and at that date was the largest "vessel" to pass through the Suez Canal.

ENGINEERING

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INDEX TO VOL. 173.

The Index to Vol. 173 of ENGINEERING (January-June, 1952) is now ready and will be sent to any reader, without charge and postage paid, on application being made to the Publisher. In order to reduce the consumption of paper, copies of the Index are being distributed only in response to such applications.

CONTENTS.

ENGINEERING

FRIDAY, DECEMBER 5, 1952.

VOL. 174. No. 4532.

ALUMINIUM FROM THE GOLD COAST.

REMEMBERING Abadan, and not having forgotten entirely certain ill-starred projects for the quantity production of ground-nuts and West African chickens, the ordinary man in the street may well have wondered at the apparently invincible optimism inspiring the Volta River Aluminium Scheme, to which we referred briefly in last week's issue of ENGINEERING, on page 699, *ante*; for this is essentially a long-term plan, requiring some 20 years for its complete fulfilment, and recent history has shown how quickly, on occasion, a Government friendly to Britain and broad in its outlook towards the commercial development of the natural resources in its territory, can be succeeded by another whose motives appear to consist mainly of a bigoted nationalism that finds expression in a dog-in-the-manger policy which makes such development virtually impossible. Indeed, there are not wanting in these islands people who are prepared to damn all overseas development by United Kingdom capital as greedy "exploitation," conveniently ignoring how much permanent good has resulted in many lands from such great engineering works as the Nile barrages, the British-sponsored power and irrigation works of India and elsewhere, and the networks of railways whereby British private investors have provided so many peoples with the means to develop their own countries.

The Volta River scheme, however, has been launched in circumstances, and under auspices, at least as favourable as any great developments of the past, and could not have better sponsors than the Governments of the United Kingdom and of the Gold Coast, and the great industrial corporations on whom will fall the responsibility for the financial and technical realisation of actual production of aluminium from its ore, bauxite. The known reserves of the ore, available for use in the proposed smelting plant, are estimated to exceed 200 million tons—sufficient to maintain the maximum designed output for a couple of centuries. Moreover, the scheme is no sudden "bright idea" of an inspired planner, but has been under careful and expert consideration for nearly 30 years, during which world economic conditions have steadily increased the desirability that it should be undertaken. That there was ample opportunity for hydro-electric power development on the Volta River has been recognised for at least as long, though obviously there was no point in accepting the heavy capital expenditure that this would entail unless there was an assured outlet for the electric power produced. The increasing world demand for aluminium, and the advisability that any expansion of production should take place in the Sterling Area, offered an immediate means of providing a steady electrical load that would justify the cost of the hydro-electric works, so that all the conditions now exist to ensure successful operation.

The White Paper (Cmd. 8702), in which the details of the scheme are published, states that the Gold Coast Government were looking into the possibility of some such development as long ago as 1924. Commercial investigations began in 1938, but were interrupted by the war. In 1945, however, a company was formed, with the title of West African Aluminium, Limited, to resume the project; and two years later Aluminium, Limited, acquired extensive bauxite concessions. In 1949, they secured an interest in West African Aluminium, Limited, and, in the same year, the Gold Coast Government appointed Sir William Halcrow and Partners as consulting engineers to investigate the power-supply potentialities of the Volta River. Concurrently, the United Kingdom Government gave official encouragement to the appointment of a joint commission by Aluminium, Limited, and the British Aluminium Company to examine the practicability of aluminium production in the area. The commission reported favourably in January, 1951, and, in August of that year a favourable report was received from the consulting engineers on the power scheme. The way was then clear for discussions between the two Governments concerned, the eventual outcome being the present scheme.

The Volta is the principal river of the Gold Coast and has a total length of about 1,000 miles. It drains an area of about 150,000 square miles, of which 61,500 square miles are in Gold Coast territory, including Togoland. About 75 miles from its mouth, the river passes through the Akwapim Hills in a gorge which offers a suitable site for a high dam, to raise the water level to about 260 ft. above sea level and form a lake with an area of about 2,000 square miles. Flow records, taken over some 20 years, indicate that the available discharge could be maintained at 35,700 cusecs. The draw-down from the maximum level would be limited to 25 ft., but it is calculated that, by cutting through the rapids below the suggested site of the dam, in order to lower the tail-water level, an output of 564,000 kW could be obtained, sufficient for the production of 210,000 tons of aluminium annually.

The site provisionally selected for the smelter is at Kpong, 12 miles from the dam site, and the bauxite would be taken to it by rail. This would entail the construction of a new railway, in addition to an extensive system of roads for general communications; and, for access to the sites and to provide a sea outlet for the aluminium produced, it would be necessary also to provide a new port. The existing port of Takoradi is about 150 miles from the mouth of the Volta, and the other port, Accra, has already reached the limit of its capacity. It was proposed, therefore, to make a new port at Tema, about 20 miles to the east of Accra and only about 40 miles from Kpong. There being already an evident need for a new port in the near future, apart from the requirements of the aluminium scheme, the Gold Coast Government have decided already that they will proceed with its construction. This work, and the construction of the new roads, railways and townships necessary in connection with the aluminium project, will be financed by the Gold Coast Government and undertaken by the appropriate departments of that Government. The power project, estimated to cost in all some 54*l*. millions, would be financed jointly by the United Kingdom and the Gold Coast Governments, and the cost of the smelting plant, about 64*l*. millions, would be shared between the two Governments, the aluminium companies, and private investors.

The statistics of world aluminium production and consumption which are quoted in the White Paper are of considerable interest; especially those of the growth of consumption in the United Kingdom. Aluminium, as a metal of actual commercial and industrial use, as distinct from merely scientific interest, is not much more than 60 years old; and, even so, it was of quite minor importance until the middle of the 1914-18 war, when the demands of the aircraft industry, in particular, led to a considerable expansion of capacity for its fabrication from the virgin metal. We recall, however, hearing grave doubts expressed by a prominent member of that industry, several years after the war, whether it would be possible, under peace-time conditions, to maintain the public demand at a level which would enable the plants which had been built during the war to be kept in steady production; and, in fact, there was a drop in the United Kingdom consumption, between 1930 and 1932, from 24,000 to 20,000 long tons. The consumption then consisted almost entirely of virgin metal, and it was not until 1940 that separate records were kept of the consumption of "secondary" aluminium, in other words, scrap. By that time, the United Kingdom consumption had risen to 135,000 tons, of which 33,000 tons was "secondary" metal.

The peak war-time consumption in the United Kingdom was 293,000 tons, 85,000 tons being scrap; but by the end of 1945, the total was only 150,000 tons—a fall due almost entirely to the cessation of armament contracts. Thereafter, however, it has climbed steadily until in 1951, the total was 316,000 tons. It is estimated that the United Kingdom's requirement of virgin metal will have risen to 340,000 tons by 1960 and 720,000 tons by 1975. This additional metal, as well as about nine-tenths of the present consumption, must be imported, for aluminium cannot be produced economically except where there is abundant and cheap electricity, which means, in practice, hydro-electricity. There is no shortage of bauxite, the world's known reserves amounting to some 1,500 million tons, equivalent to 350 million tons of the metal; and these figures leave out of account Yugoslavia, and all the Iron Curtain countries. The requisite power is not always conveniently available, however, and if the capacity for aluminium production is to be expanded, and the needs of the United Kingdom market met without widening the dollar gap, West Africa offers great advantages on all counts, having both bauxite and water in plenty, and being in the sterling area. Canada will continue, as it were, to take the "base load" of aluminium supply, under long-term agreements, but the Gold Coast should be able to provide for peaks beyond any at present feasible.

MECHANICAL ENGINEERING RESEARCH.

IN the report of the Mechanical Engineering Research Board for the year 1951,* it is remarked that "mechanical engineering enters into almost every phase of production." This is not an exaggeration; the machine equipment of any industry, and there are practically none without such equipment, is an application of mechanical engineering. A subject which affects, and largely controls, every industrial activity in the country is of such importance that the Department of Scientific and Industrial Research was fully justified in promoting mechanical engineering research from the status of a department of the National Physical Laboratory to that of an "out station" in its own right. The importance which is justifiably attributed to the subject is indicated by the fact that the laboratories under construction at East Kilbride, near Glasgow, are planned for a staff of from 600 to 700 workers.

The long-term project envisages considerable extension of the range of work which used to be carried on at Teddington. The organisation in course of development will, in due course, comprise seven divisions concerned, respectively, with the strength of materials, stress analysis and vibration, hydraulics, lubrication, metrology, machine shaping, and heat transfer and thermodynamics. These are shortened titles of the official designations of the divisions and that dealing with lubrication, for instance, also covers wear and corrosion; but the list adequately indicates the extent of the research programme for which plant and accommodation are to be provided. The brief description given in the report names 11 laboratories, with the administrative building, workshop, boiler house, electrical substation, store and restaurant.

It need not be assumed that each of the eleven laboratories will be accommodated in a separate building and certainly, at the present stage of development, that conditions is far from being achieved. At the end of the year covered by the report, the workshop had been completed and also the first stage of the Properties and Strength of Materials Laboratory. At present, this latter building is being used for general purposes and is accommodating the staff engaged in work on the strength of materials, stress analysis, hydraulics, machine shaping and thermodynamics. Temporary accommodation for the researches on metrology has been provided in the workshop. It is clear that a move from Teddington to East Kilbride must have involved considerable interference with research programmes, but although the first building contract was completed in 1951, it represented only about 25 per cent. of the projected works. The original plans provided for a second contract covering the heat-transfer, hydraulic machinery and creep laboratories, but building restrictions have limited work to the hydraulic-machinery laboratory, which is expected to be finished in January, 1954.

In spite of the unfavourable conditions much research work is now in progress. Assistance in making a start was provided by the establishment of temporary laboratories at Thorntonhall, which is situated some four miles from East Kilbride, and the division dealing with Lubrication, Wear and Mechanical Engineering Aspects of Corrosion has been established at Thorntonhall for more than three years. As a consequence, it is "the only division which has so far become reasonably established." The work in hand mentioned in the report is concerned with hydrodynamic lubrication, boundary lubrication, wear, and ball and roller bearings. Various special problems submitted by outside bodies have been studied. These included an investigation of oscillating bearings and of the frictional properties of launching greases for the British Shipbuilding Research Association. In connection with the work on hydrodynamic lubrication, it is stated that "the theories of bearing design so far used assume laminar flow of the lubricant and inertia effects are ignored." In analogous hydrodynamic phenomena, however, a critical Reynolds number is reached beyond which flow becomes turbulent as speed increases. Gas turbines and refrigerating machinery call for bearings running at a higher speed than has been used and work is being directed towards the provision of a basis which would indicate to designers under what conditions a critical parameter might be reached.

The section of the report dealing with the work of the divisions concerned with the strength of materials and stress analysis gives brief particulars of work on fatigue, with emphasis on size effect; tests being carried out on mild steel, heat-treated nickel-chromium steel and aluminium alloys. Work on the properties of materials at high temperatures is still being carried on at the National Physical Laboratory; a creep laboratory formed part of the second building contract which was held up. Various investigations coming under the headings strength of materials and stress analysis are being conducted in university laboratories. Helical torsion springs are being dealt with in Leeds, the fundamental mechanism of fatigue in Bristol, and the dynamic stresses in gear teeth in Cambridge. The apparatus used for this latter investigation was referred to and illustrated in the description of the new engineering-department building at Cambridge on page 669, *ante*. Work in the hydraulic-machinery division has hardly started; as mentioned above, permission to proceed with the building of the hydraulics laboratory has now been received. Experimental work has been carried out by the staff of the division at the National Physical Laboratory to determine the design of plant and apparatus to be installed at East Kilbride. A detail investigation has been undertaken by the Water Pollution Research Laboratory to study the treatment of water to give it high photographic clarity, since work on hydraulic problems will involve the taking of photographs under water.

The postponement of the building of the heat-transfer laborotory has provided an opportunity for further consideration of the design of the medium-speed wind tunnel which is to be used in experimental work on the heating and cooling of bodies in an air stream. The Heat Transfer and Applied Thermodynamics Division has paid much attention to the compilation of an extensive bibliography on heat transfer and a survey of papers published since 1948 is being prepared. A good deal of extra-mural work is being carried out by and for this division. The University of Glasgow has made a laboratory available for investigating the effect of an abrupt change in the diameter of a pipe on the heat transfer from the pipe to a liquid flowing through it. Apparatus for the study of the corresponding effect produced by bends or elbows is being constructed and the work will be carried on in the temporary accommodation provided at East Kilbride. Work on the dropwise condensation of steam is being done at Queen Mary College and steam-condensation studies are in progress at the College of Technology, Birmingham. It is intended to investigate the effects of steam velocity and non-condensable gases on condensation in tubes. The combustion rates of liquid fuels are being studied at the University of Cambridge, and at the Imperial College work is proceeding on heat transfer between surfaces in contact.

* *Report of the Mechanical Engineering Research Board, with the Report of the Director of Mechanical Engineering Research for the Year* 1951. H.M. Stationery Office. [Price 2*s*. net.]

NOTES.

ROYAL SOCIETY AWARDS.

AT the Anniversary Meeting of the Royal Society, on Monday, December 1, the President, Dr. E. D. Adrian, O.M., announced the awards of medals for 1952. The Copley Medal has been awarded to Paul Adrien Maurice Dirac, Lucasian Professor of Mathematics, Cambridge, for his contributions to the quantum theory of elementary particles and electromagnetic fields. In commenting on Professor Dirac's work, the President said it had the distinctive quality of making evident the relationship of the remote abstractions of the pure mathematician to the practical problems facing the atomic physicist. As an example of this, he mentioned the Fermi-Dirac statistic, independently formulated by both these authors, which had served to explain the nature of the conduction of electricity in metals—one of the most formidable difficulties of the older physics. The Rumford Medal was awarded to Professor Fritz Zernike, whose work, the President said, had led to the production of the phase-contrast microscope, now in daily use in laboratories throughout the world. A Royal Medal was awarded to Professor Christopher Kelk Ingold for his investigations into the mechanism of, and the factors influencing, organic reactions. A Royal Medal was also awarded to Sir Frederic Charles Bartlett for his work on experimental psychology. The President mentioned that, during the late war, Bartlett and his pupils in the Cambridge laboratories did a great deal of research for the Services, especially on the effects of fatigue in diminishing the quality of performance in pilots. The Davy Medal was awarded to Alexander Robertson, Professor of Organic Chemistry in the University of Liverpool. The President referred to Professor Robertson as a brilliant organic chemist who had not only solved a long series of structural problems which had baffled earlier workers, but in doing so had opened up new fields of study. Professor J. B. S. Haldane received the Darwin Medal for his work on the analysis of the causes of variation and of the mechanism of selection. After giving a brief summary of Professor Haldane's work, the President said he had made first-rate contributions, by his detailed researches, his mathematical treatments and his general analysis of evolutionary problems, to the field of Darwin's work. The Buchanan Medal was awarded to Sir Samuel Rickard Christophers for his work on malaria. Nearly all our basic knowledge of the conditions leading to the spread of this disease, the President said, arose from investigations carried out, mostly in India, by Christophers and those immediately associated with him. Abram Samoilovitch Besicovitch, now Rouse Ball Professor of Mathematics at Cambridge, was awarded the Sylvester Medal. He is one of the foremost authorities in the world on the theory of plane sets of points and the area of surfaces. The final award was that of the Hughes Medal to Professor Philip Ivor Dee, who was appointed to the Chair of Natural Philosophy at Glasgow at the end of the war. Professor Dee is distinguished for his application of cloud-chamber technique to the study of nuclear transmutations. During the war he was responsible, at T.R.E., for the development of the technique of micro-wave radar, and at Glasgow he has built up an active school of nuclear physics and equipped a high-voltage laboratory.

THE INSTITUTION OF MECHANICAL ENGINEERS.

A paper on "Instruction and Research in Hydraulic Laboratories," presented at a meeting of the Institution of Mechanical Engineers on Friday, November 28, provoked an informative exchange of views among several heads and members of staffs of university and commercial hydraulics laboratories. The proper aims of teachers of the subject were discussed but, regrettably, no ex-student came forward to say whether the instruction he had received as a student was, in retrospect, a sound basis for his later work as an engineer. The written discussion may possibly elicit such a statement, which would enable the teachers to gauge the effectiveness of their methods. The paper was given by Professor Herbert Addison, O.B.E., M.Sc., M.I.Mech.E., late Professor of Hydraulic Machines in the Fouad I University, Giza, Egypt, to whom a tribute from his former students was read by Professor H. Wright Baker in opening the discussion. The author reviewed his thirty years of experience in Egypt, describing the development of the laboratory from a comparatively small establishment, to which students were first admitted in 1926, to a large and well-equipped building which was brought into use this year. This review, together with an outline of the research which progressed as a continuous thread of inquiry under Professor Addison's guidance, was in the nature of a biography of an academic department of engineering. It is only since the first World War that there has been an appreciable demand for higher engineering education in Egypt, and the department therefore faced special problems in expanding rapidly to serve the needs of students who "had not, as yet, that long tradition of mechanical knowledge and aptitude that supported their fellows in Western Europe and America." In summing up his views on his subject, Professor Addison suggested that the hydraulics laboratory should be independent of the civil and mechanical engineering departments, and that the layout of equipment should be flexible. He also passed some critical remarks on the efficiency, for laboratory purposes, of various electrical, hydraulic, recording and measuring apparatus, to which, no doubt, makers of such apparatus can provide answers.

CONTROL OF INTERFERENCE WITH TELEVISION RECEPTION.

Some two years ago, the Postmaster-General appointed a committee, under the chairmanship of Sir Stanley Angwin, to advise him on the extent to which interference with wireless communication was caused by ignition systems. This body reported in August, 1951, on that part of the problem which related to television and made a number of recommendations. As a result, a document entitled The Wireless Telegraphy (Control of Interference from Ignition Apparatus) Regulations, 1952, was laid before Parliament last week. These regulations prescribe that the ignition systems of internal-combustion engines on all new motor cars, motor cycles and motor boats sold after July 1, 1953, which radiate energy sufficient to interfere seriously with television reception, must be fitted with suppressors; they do not apply to engines on aircraft for export, or on foreign vessels. Subsequently, the owner of the vehicle or boat will be responsible for seeing that the suppressors fitted are maintained in a serviceable condition. Failure to comply with these conditions may lead primarily to the receipt of an enforcement notice, then to appearance before a tribunal and, finally, to a fine not exceeding 10*l*. for the first offence, under the powers provided in the Wireless Telegraphy Act, 1946. It is further laid down that the suppressors installed shall be designed so that the field strength of the electromagnetic energy radiated at any frequency between 40 and 70 megacycles per second in any direction does not exceed 50 microvolts per metre at any distance not less than 33 ft. Full particulars of the apparatus and methods to be used for measuring the field strength are given in a schedule to the regulations. These regulations, it may be added, only apply to new cars, although it is hoped that the motoring public generally will co-operate by fitting suppressors. It is understood that further regulations covering domestic electrical apparatus and small electric motors are in course of preparation.

SPHEROIDAL-GRAPHITE CAST IRON.

In October, 1949, an application by the Mond Nickel Company, Limited, for a patent covering the production of spheroidal-graphite cast iron by the magnesium process was accepted by the British Patent Office and published. As a result of opposition to the grant of the patent, however, long proceedings before the Patent Office and the Patents Appeal Tribunal followed, but the position was finally clarified on November 12 last, when Mr. Justice Lloyd-Jacob directed, at a hearing before the Patents Appeal Tribunal, that the Mond Nickel Company's Patent No. 630,070 should be granted. The engineering properties and applications of spheroidal-graphite cast iron were described in a paper presented by Dr. A. B. Everest before the Fourth International Mechanical Engineering Congress, held in Stockholm from June 4 to 10 this year. Dr. Everest stated that the process for making the "S.G. iron," to give it its abbreviated name, involved the introduction of small proportions of magnesium under specified conditions. The process could be applied under all normal foundry conditions and most types of cast iron which usually exhibited flake graphite could be modified to the spheroidal graphite form by appropriate treatment. The magnesium process presented no special difficulties and a particular feature of the S.G. iron was its high yield point, which was markedly superior to that of malleable cast iron. The ultimate tensile strength of the S.G. iron ranged from 35 tons to 45 tons per square inch in the as-cast state and from 27 tons to 35 tons in the annealed condition, compared with 18 tons to 22 tons for a high-duty flake-graphite iron. Generally speaking, the Brinell hardness of the new iron was some 20 to 40 points higher than that of flake-graphite iron of corresponding matrix structure and the impact strength of the S.G. iron was 12 times that of the flake-graphite iron. Moreover, the fatigue strength and other mechanical properties of the new iron were superior to those of older irons, and the magnetic permeability and electrical conductivity were also better. The new iron had now been in commercial production for over three years and had entered every field of engineering practice. About 200 foundries throughout the free world had been licensed for its production and the range of castings made extended from small electric fittings to large components, such as rolls and hammer blocks, weighing up to 50 tons.

THE OLD N'IONS' JUBILEE DINNER.

Former students of the Northampton Engineering College held their 25th annual dinner at the Connaught Rooms, Great Queen Street, London, W.C.2, on Friday, November 28. Mr. S. C. Laws, O.B.E., former Principal, proposed the toast of "The Guests," coupling with it the name of Lord Eustace Percy, P.C., sometime President of the former Board of Education and chairman of the committee who compiled the Percy Report on technical education. Lord Eustace, in reply, claimed that the United Kingdom had raised the standard of technical education above that of any other country, but regretted that it was not possible to maintain students at college for a fourth or even a fifth year, as was done elsewhere. He also remarked upon the ever-increasing gap between school and college mathematics, which was causing too high a "casualty" rate among students. The toast of "The College" was proposed by Mr. H. G. Jenkins, and seconded by the holder of the Association's Memorial Bursary, Mr. M. T. Shilston, who briefly related his experiences in Spain, where he toured civil-engineering sites. Replying, in the absence of the Principal, Dr. J. E. Richardson, Mr. J. C. Oakden reported that the extension to the college premises had been begun and that liberal grants made by the London County Council and other bodies had made it possible for the staff to undertake research projects. Last year, Mr. Oakden recorded the college had obtained 80 engineering degrees, a greater number than had been obtained by any other institution in the United Kingdom. The toast of "The Old N'Ions" was proposed by Mr. H. J. B. Harding, F.C.G.I., a Governor of the College, but, he said, educated "in another place." In reply, Mr. J. Mortimer Hawkins, President of the Association, thanked the secretary and treasurer, Mr. A. N. D. Kerr, and Mr. T. H. Holmes, secretary of the college and Clerk to the Governing Body, for their work, and in his speech, following immediately on the toast to "Absent Friends," mentioned that copies of the menu and dining list would be sent to all overseas members.

ELECTRICAL MANUFACTURING AND THE EXPORT TRADE.

A luncheon to mark the publication of the second edition of the *Beama Catalogue* was given by the British Electrical and Allied Manufacturers' Association at the Connaught Rooms, London, on Monday, December 1. In proposing "Exports and the Electrical Industry," the President, Sir Harry Railing, who was in the chair, said that the electrical manufacturing industry hoped to receive a number of gifts from the Government. These included more electricity, if their efforts were not to be defeated; the decrease of purchase tax, which was necessary if both the home and export trade were not to be injured; and the reduction of taxation generally. The importance of exports in general and electrical exports in particular hardly needed to be stressed in such a gathering, but the publication of the second edition of their export catalogue, which now had a circulation of 16,000, and the establishment of an Electrical Industry Export Service might be mentioned as examples of what the Association was doing to stimulate trade abroad. At the present time, the value of electrical exports was three times what it had been in 1938; delivery times had improved and the quality was second to none. In reply, Mr. H. R Mackeson, Secretary for Overseas Trade, Board of Trade, said that the extension of the buyers' guide and of the trade directory in the new edition of the catalogue would ensure that the potential of the electrical manufacturing industry was more widely known and should help us to secure in that field the increased exports which were essential if this country was to maintain its position in the commercial world. In the electrical machinery group, exports had, in fact, been steadily increasing during 1949, and in the first ten months of this year had already reached the total for 1951. There had also been a satisfactory increase in the export of electrical machinery to Canada in face of severe competition. The Government intended that the industry should be able to offer terms which would be attractive to overseas buyers.

City and Guilds of London Institute.

During the 1950-51 session there were 487 undergraduates studying at the City and Guilds College, South Kensington, London, S.W.7, compared with 465 in the 1949-50 session and 384 in the 1948-49 session. A feature of the work of the College is the large number of post-graduate students in attendance; these comprised 245 full-time and 217 part-time students in 1950-51. This total of 462 compares with 429 in the 1949-50 session and 436 in the 1948-49 session. It is shown in the fortieth annual report of the Delegacy of the College for the 1950-51 session, contained in the recently issued report of Council of the City and Guilds of London Institute, that 94 students passed the final B.Sc.(Eng.) degree examination of the University of London, as many as 51 gaining First or Second Class Honours. In addition, 20 passed the final B.Sc.(Eng.)(Chemical Engineering) degree examination of the University. The report adds that the first of the proposed extensions to the chemical technology building was completed during the year covered by the Delegacy report and that, in July, 1951, the erection of the new aeronautics building was commenced. Other departmental reports included in the report of Council are those of the City and Guilds of London Art School in Kennington Park-road, S.E.11, and of the Department of Technology, at 31, Brechin-place, South Kensington, S.W.7. In the latter it is stated that an outstanding feature of the year's work has been the large number of requests from industry for the preparation of new courses and the considerable amount of exploratory and development work undertaken in connection therewith. New consultative committees in the electrical, building and printing industries are being formed as a result of suggestions made to the Department by the outside interests concerned. The Joint Committee on National Certificates in Production Engineering have informed the Institute that candidates holding the Institute's full technological certificate in machine-shop engineering, and who pass certain examinations in mathematics and applied mechanics, may enrol in the Higher National Certificate Course in Production Engineering. The Institute, it is added in the report, particularly welcomes this form of co-ordination. Few statistics are contained in the report, but it is stated that the number of candidates who took technological subjects at the Institute's examinations in 1951 was 74,580, compared with 73,472 in 1950.

LETTERS TO THE EDITOR.

TEN YEARS OF R.E.M.E.

To the Editor of Engineering.

Sir,—In a letter in your issue of October 24, Lieut.-Colonel Blacker suggests that R.E.M.E.'s usefulness is coming to an end. The argument, as I understand it, is that the maintenance of heavy armour is R.E.M.E.'s only task; that heavy armour is (or should be) "a thing of the past"; and that therefore R.E.M.E. will soon become redundant. As an ex-member of the Corps, I am sorry to see that a distinguished officer should hold this view; the more so in that he has apparently spared so little time to verify his premises.

I need hardly say that R.E.M.E. takes care of a great many more items of specialised equipment than heavy armour. Your leading article of October 3 gives an excellent idea of the Corps's wide variety of repair and maintenance tasks, which, as you say, range from tanks to radar sets and, in the fullness of time, will no doubt envisage guided missiles as well. Whether heavy armour is "a thing of the past" is scarcely for me to say, but I imagine that our troops in Korea still find the Centurion quite a handy weapon. Colonel Blacker's historical allusions in a later part of his letter, so far as I am able to follow them, seem also to be divorced from actuality. For instance, there were only two wars in which Britain participated in the Nineteenth Century, outside the Indian borders, which were not controlled by "Whitehall." These were the First Carlist War and the Second China War. As for the rest, there are dozens of examples in which the War Office was responsible for successful campaigns, including, of course, the Tel el Kebir campaign of 1882, which is still regarded by military historians as a model of its kind.

I am, Sir,
Your obedient Servant,
H. R. Howard,
Brigadier (Retd.), late R.E.M.E.

12, Bouverie-avenue South,
Salisbury,
Wiltshire.
November 24, 1952.

THE SIEMENS MEMORIAL.

To the Editor of Engineering.

Sir,—On many occasions your columns have contained information about memorials to famous engineers, and two years ago, in November, 1950, you kindly allowed me to call attention to the removal from the nave of Westminster Abbey of the memorial window to Isambard Kingdom Brunel, to make room for the window dedicated to the memory of Sir Charles Parsons. I was not alone in hoping that, just as a new position had been found in 1933 for the re-erection of the window to Robert Stephenson, a place might be found for the re-erection of the Brunel window. Happily, the Abbey authorities have done this, and in a letter to me, dated November 20, the Dean of Westminster, Dr. Alan C. Don, kindly wrote that "The Brunel window was replaced some months ago in the nave of Westminster Abbey, on the opposite side to where it originally was. It looks extremely well, and the President and secretary of the Institution of Civil Engineers have expressed their complete satisfaction with what has been done." I am sure, sir, you will agree that this should be generally known, and that there will be many who will appreciate the action of the Dean and Chapter.

Perhaps, now, I may be allowed to plead for the re-erection also of the window dedicated to Sir William Siemens. You gave a full description of this window when it was unveiled in 1888, and from that description there is no reason to suppose that it would not look as pleasing as the Brunel window. Its removal about 40 years ago was, I believe, not unconnected with the increasing clamour, in the early part of the 1914-18 war, against British subjects of German origin, when many foolish things were done. It was this clamour that robbed the Royal Navy of the services of a distinguished First Sea Lord, led to Sir Arthur Schuster being cold-shouldered in the Athenæum, and drove into retirement the nephew and successor of Siemens, Sir Alexander Siemens (1847-1928), who had held the presidencies of the Institutions of Civil Engineers and Electrical Engineers, and who, in 1914, was secretary to the Royal Institution. After the removal of the window to Sir William Siemens, all reference to it was omitted from the *Official Guide* to the Abbey, but, though mention of it is made in later editions, against the note is the ominous comment, "Removed."

Though Siemens was German by birth and parentage, he became a naturalised British subject at the age of 36 and attained an outstanding position in British science and engineering; and his death, at the age of 60, called forth many notable tributes. In view of his many services to the leading engineering institutions, it was not surprising that these should have erected, at the cost of about 1,000*l.*, the memorial in the Abbey. In the press of circumstances, it is easy enough for our debt to the past to be forgotten, but anyone who desires to know what his contemporaries thought of Siemens has only to turn to the 20-page memoir of him, by Sir William Pole, F.R.S., in vol. LXXVII of the *Proceedings* of the Institution of Civil Engineers. There it is written: "Perhaps on no former occasion has the Institution had to mourn the loss of a member so distinguished for the extent of his scientific and technical knowledge, for the versatility of his talents, for the originality of his views, for the greatness and variety of his inventions, for his amazing skill in the adaptation of science to industrial and useful purposes, for the number and value of his scientific publications, for his energy in business transactions, and for the usefulness to the world of his life's work generally."

Better never to set up a monument to such a man than to put it up, take it down and stow it away.

Yours faithfully,
Edgar C. Smith,
Engineer Captain, R.N., retd.

Keepers' Corner,
Horley, Surrey.
November 30, 1952.

THE TRANSPORT BILL.

To the Editor of Engineering.

Sir,—Having read your leading article of November 21, on page 665, *ante*, I am perturbed that, even now, it does not seem to be understood by many engineers just why the last Government nationalised transport. Basically, it was nothing to do with socialism. It was done for very practical reasons and, if it had not been done then, it would have had to be done before long, in far more difficult circumstances.

We may draw analogous instances from the past. First, the Post Office. Every country has a nationalised Post Office, but that hardly matters in this issue. Our forefathers showed wisdom right from the beginning. You could send a letter from Oxford-street to Piccadilly for a penny and you could send one to a farmer in Wales, also for a penny. Subsequently, you could send a letter to Australia for the same sum. It was thought wise and, after 100 years' experience, we agree, that rapid cheap communication should be universal. But, to carry out that determination, it was necessary to insist that all letters must be conveyed by the Post Office. It was decided that all should have their letters at the same price; so, to make that possible, we made a law that you are not allowed to carry mail, not even your own; you must employ the Post Office. If we allowed private concerns to deliver letters they would, of course, take all the profitable business and leave what did not pay to the Post Office.

The second experience from which we may learn is "London Transport," formed in 1932 by a Tory Government. In 1932, the position was that the Underground railways were not paying; they could not make enough money to pay the interest on the enormous capital needed to build them. The London 'buses were paying—they ran on roads provided by the public. The Underground railways could go bankrupt and close down, or they could raise fares. In either case, traffic would be diverted to the 'buses, and, more and more traffic being thrown on to the roads, these would become so congested that no one would be able to move. Therefore, the Conservative Government formed London Transport and the profit on the 'buses helps to make up any deficit on the railways. Integrating the two helps both to do better.

A hundred years ago, the railways monopolised traffic, both passenger and goods. Parliament, therefore, made certain rules: at least one train each way must run every day (except Sunday); and third-class fare ("Parliamentary") must not exceed 1*d*. a mile. Goods traffic also had its rules and regulations. The railways paid so well and so regularly that, somewhere about 1900, ordinary shares of some railways were allowed to be treated as trustee securities. Similar conditions obtain on the railways as in the Post Office. The railways must, by law, run these trains whether they pay or not, in the same way that the Post Office delivers letters to the back of beyond, whether it pays or not; it is the big full trains to Birmingham, Manchester, Glasgow, etc., which could charge much cheaper fares than they do, that enable the branch line to function.

The coming of motor transport has changed all that. Unregulated motor transport has free use of the roads. It can operate between, e.g., London and Birmingham with a full load each way and convey goods or passengers at half the cost that railways have to charge, if railways as a whole are to pay. If a journey does not pay, the transport company can give it up. If it pays, it can increase its fleet on that road, taking the traffic away from the railway, which still has to provide the uneconomic services.

Road transport under the conditions that obtained before nationalisation was driving the railways into bankruptcy. You cannot, of course, allow the railways to close down their unremunerative services unless you ensure an adequate substitute. In any case, many non-paying branches have to be kept going for various sound reasons. Can you allow the railways to reduce fares where they meet competition and raise them where they don't? We can allow that no more than we can charge higher postal rates in some parts than others.

We saw that road and rail must work together as an integrated service, not in competition. Railways, by their nature, cannot compete against each other, anyway, and road transport, due to the invention of the limited liability company, was rapidly arriving at the stage of avoiding competition that would interfere with profits. We saw that, if road transport were allowed to flourish wherever it could find profits, many main roads would become congested with lorries and become unbearable to other users of the roads. Therefore, we had to turn transport into a public service. Now we can safely close, wholly or partly, sections of railway which are not economic, since we can easily provide an alternative service. Since British Road Services are universal, we can provide, where necessary, a lorry to go from anywhere to anywhere with an excellent chance of a return load. We can reduce the types of locomotives from 140 to twelve—twelve of the very best. We can do many things on road, rail and water which open up a wonderful prospect to every engineer who is interested in transport.

There is, we all know, a tremendous lot to do before we may have a transport system of which we can be proud. There is 100 years' growth of dead wood to cut out. There are ten years of war and the aftermath of war to recover from. It is only two years since the public service started; we must not expect startling results in that short time. We have not finished yet repairing the ravages of war. There are many new ideas to be tried and proved. I hope that I have given a fairly clear idea of why transport had to be brought under public ownership and what a shame it will be to break it up just because it was introduced by a Labour Government. If we break it up, we shall have to reconstruct it all over again; it may be in five, it may be in ten years time, whatever Government is in power.

Yours faithfully,
H. SANDERSON.

Henley-on-Thames.
November 28, 1952.

[Some of Mr. Sanderson's arguments are of questionable validity. A hundred years ago, the railways did not monopolise traffic, either goods or passengers; local carriers, and canals, did good business in both fields. Nor do we agree with his alleged "100 years' growth of dead wood"; the railway amalgamations cleared away much more of that than nationalisation did. Before the railways were nationalised, we expressed the view that nationalisation was excellent in theory; the objection to it was that it was usually so inefficient in practice. It is in the hope of promoting greater efficiency, as we understand, that the present Government propose to make the changes formulated in the new Transport Bill; not merely because nationalisation had been introduced by a Government of different political colour. In support of that view, we may point out that no proposal has been made to denationalise the coal-mining industry or the gas industry. The case of the Post Office is not truly parallel with that of the nationalised railways; the Post Office puts very strict limitations on the size, weight, shape and nature of the articles that it will undertake to convey as postal packets.—ED., E.]

OBITUARY.

DR. G. V. LOMONOSSOFF.

HIS many friends in this country and elsewhere will regret to learn of the death on November 19, in Montreal, of Dr.-Ing. George V. Lomonossoff, who was for a number of years one of the most eminent railway engineers in Russia.

Dr. Lomonossoff was a native of Gjatsk, where he was born on April 24, 1876, and received his general education in Moscow at the First Cadet School. Subsequently, he attended the Institute of Transport at St. Petersburg for five years, and qualified in railway surveying and locomotive operation, being engaged from 1893 to 1900 in locomotive testing on the Kharkoff-Nicolaieff Railway. He was then appointed lecturer in engineering at the Kieff Polytechnic Institute and, in 1905, professor of railway engineering and economics in the same Institute. He held that position until the end of 1907, when he went to the Ekaterina Railway as assistant mechanical engineer; but a year later he left that railway to become President of the Locomotive Research Bureau, where he remained for nine years, for the first three of which he was also chief mechanical engineer of the Tashkent Railway. In 1911, he returned to the Institute of Transport at St. Petersburg as professor of railway engineering and economics, holding that chair until 1918. Concurrently, he held other important appointments, being chief mechanical engineer of the Nicolai Railway for a short period, then Assistant Director-General of the Russian Railways, a member of the Supreme Engineering Council and, for some years, Under-Secretary of Transport. In 1917-18, he was in the United States as President of the Russian Railway Mission, which ordered there 2,000 locomotives, built to his designs. Later, as High Commissioner for Railway Orders, he was responsible for the design and supply of a further 1,700 locomotives, built in Germany and Sweden. This appointment lasted until 1923, after which he was High Commissioner for Diesel Locomotives until 1926.

Dr. Lomonossoff came to England in 1925 to arrange for the construction of an experimental Schelest Diesel locomotive, which was ordered from Sir W. G. Armstrong, Whitworth and Company. It was never completed—at least, not in this country—being shipped to Russia eventually, unfinished; but he remained in England for a time, proceeding then to the California Institute of Technology, where he held a research appointment in 1929-30. He came back again to England, however, and for about two years was associated in the consulting practice of Messrs. Hitchins Jervis and Partners, Westminster. He was a member of the Institution of Mechanical Engineers, and held Doctor's degrees in the Polytechnic Institute of Kieff and the Technische Hochschule, Berlin.

THE INSTITUTION OF NAVAL ARCHITECTS' AUTUMN MEETING.

(*Continued from page* 691.)

ON Saturday, September 27, the members of the Institution of Naval Architects who were taking part in the autumn meeting in Italy, arranged in conjunction with the Associazione Italiana di Tecnica Navale (ATENA) travelled by train from Genoa to Rome, where the concluding technical session was to be held. It took place on the morning of Monday, September 29, on the premises of the Consiglio Nazionale delle Ricerche (National Research Council) at the Piazzale delle Scienze, the chair being taken by Lord Runciman. The members of the Institution were welcomed by Professor L. Fea, on behalf of Professor Gustavo Colonnetti, President of the Research Council, who was unable to be present.

Professor Fea, who had attended the International Conference of Naval Architects and Marine Engineers in England last year, said that joint meetings were a symbol of that international co-operation which alone made possible great developments in every field of civilisation, an example of which was the work of Guglielmo Marconi, whose name was so greatly venerated in Rome. The pleasure which the congress gave to him and his colleagues was all the greater when they recalled the friendly reception accorded to them at the International Conference, when they had been privileged to visit Hadrian's Wall during their stay on Tyneside. In their turn, the delegates of the Institution of Naval Architects would see the vestiges of the Christian and Roman Eternal City, where they would find symbolic evidence of their civilisation's common ties which came from a common past, a history which was developing in the present time and pointing to future reliance on the fruitful co-operation of all peace-loving peoples.

Lord Runciman expressed the thanks of the Institution of Naval Architects to Professor Fea for his cordial welcome, and assured him that it was a great pleasure again to meet him and his colleagues who had visited Britain. The delegates from the I.N.A., he said, appreciated greatly the hospitable manner in which they were being entertained.

GENERAL GIUSEPPE ROTA, HON.M.INST.N.A.

General Giuseppe Rota having been elected to honorary membership of the I.N.A., Lord Runciman continued, the occasion provided the opportunity to present his diploma. It was wonderful to realise that they were honouring one who was a contemporary of Froude, Taylor and others, and who, with them, did so much to develop an understanding of ship resistance and propulsion through model experiments. General Rota's latest contribution to the science of naval architecture was made more than 50 years after his first notable work. He might well be proud of an achievement which covered the span of the present century, now more than half-way on its course.

General Rota's work at the Spezia Tank and later at the Rome Tank, and the part he played in the provision of those enterprising facilities, had shown him to be a worthy disciple of the Froudes. He was attracted to the novel and to the fundamental, as evidenced by his papers on contrary-turning propellers, which were reported in the *Transactions*. His experiments on that subject were probably the most informative available, and his proposals might well be ripe for future development. His fundamental work on the influence of depth of water on ship resistance was pioneering, and his early investigations on the influence of beam to draught proportion had long been classic. That and his more recent work would continue to be a source of inspiration for later investigators.

General Rota's interest in naval architecture had been wide, and was reflected in the fine collection of ship models which adorned his home. He had long been a good friend to the Institution of Naval Architects, and a member of it for 55 years. He was prominent among those Italian naval architects who had welcomed the Institution to Italy in 1929.

"We are indeed glad," said Lord Runciman, "that he has survived all the vicissitudes of life and of war to afford us the privilege of presenting him with the Diploma of Honorary Membership of our Institution."

Unfortunately, poor health prevented General Rota from attending in person to receive the Diploma, but the delegates extended a warm welcome to his daughter, to whom it was handed by Lord Runciman.

Dr. Della Ragione, President of the Associazione Italiana di Tecnica Navale, then presented to Lord Runciman the Diploma which made him the first honorary member of that body; and also a model of an anchor as used to moor the State barges of the Emperor Caligula, in Lake Nemi, some 2,000 years ago. By that symbol, said Dr. Ragione, the ATENA wished to be tied ever more closely to the I.N.A. A number of gentlemen prominent in the development of naval architecture in Italy were also elected to honorary membership of ATENA, among them being Commendatore J. A. Pattison, of the Castellamare shipyard, who said he was doubly gratified because he was probably one of the oldest members of the I.N.A.

Lord Runciman expressed the grateful thanks of the members of the Institution of Naval Architects for the honour conferred upon him and, through him, upon them. He was most grateful also for the extremely interesting model that was presented to him, the symbolism of which had been explained in such clear terms. "May it indeed hold us tightly together," he said, "and may no storm cause it to drag." He was impressed to see how little the design of anchors appeared to have changed over 2,000 years. It was about 2,000 years ago, he continued, that the forefathers of the present-day Italians discovered the British delegates' forefathers, and it was his confident expectation that the next 2,000 years would serve to weld the two peoples even more closely together.

Lord Runciman then called on Mr. R. W. L. Gawn, O.B.E., to present his paper (the sixth in the programme of the joint meeting) on "Effect of Pitch and Blade Width on Propeller Performance."

PROPELLER PERFORMANCE.

In Mr. Gawn's paper, results were given of tests of 37 propellers, each with three blades, covering a range of pitch ratio from 0·4 to 2·0 and of blade area ratio from 0·2 to 1·1. The models were all of 20-in. diameter and they were tested at high duty from zero to 100 per cent. slip. It was found that the thrust and torque coefficients increased appreciably with pitch, and generally, though to a less extent, with blade area. The most favourable peak efficiency was 0·84, appropriate to the greatest pitch and the narrowest blade. The peak efficiency was least for the smallest pitch and the widest blade tested, and was less than half of the optimum value. No significant improvement in peak efficiency was expected from an increase of pitch ratio above the largest value (2·0) covered by the series. More favourable peak efficiency was expected by a reduction of the blade area ratio below the lowest test value (0·2) but the blades would then be exceptionally narrow. Theoretical deductions indicated that laminar or transitional flow had been avoided, and that the critical Reynolds number in that respect was 250,000. The tests extended to a Reynolds number of 4·3 million. One upshot of that considerable advance was that the results might be expanded to ship propellers with only a small correction for skin-friction resistance. The peak efficiency of ship propellers might be a little more favourable, but that was subject to smoothness of finish. Departures were noted from the results of previous series, which might be due to scale effect and to differences in design. It was thought that the investigation might prove useful as a step in the clarification of the scale effect of propellers, to which importance was attached by the International Conference of Ship Tank Superintendents.

DISCUSSION.

Dr. J. F. Allan, opening the discussion, said that Mr. Gawn's paper represented the completion, to a certain stage, of a programme of work which the Admiralty Experiment Works embarked on some time before and which, he supposed, had been delayed because of pre-occupation with other matters. As a programme of tests on propellers, it was very comprehensive in its scope as regards range of pitch ratio and range of blade area ratio; the scale of the experiments was such as to please the most critical in regard to the scale-effect question. It provided a useful analysis of the extensive experimental work that had been carried out. The first criticism he would make was that the blade section shapes were segmental. There had been developments since the programme was started, and probably further programmes would be undertaken, using more modern sections. He thought that the standard method of testing at 500 r.p.m., varying the speed of advance, was definitely one to be adopted by anyone who went in for that line of work. Mr. Gawn stated that he had varied the revolutions in order to explore the effect of the older method of testing model propellers, using a constant speed of advance at varying revolutions per minute to see if there were any alterations in the effects. He does not say, however, what he had discovered, and it would be valuable to have some indication. Presumably, when running at constant revolutions per minute and varying the speed of advance with the high pitch-ratio propellers, the loading on the blades must have been considerable, and he thought that, with the bigger area ratios, there might have been some distortion. Were any observations made in that direction?

Looking at the general information diagrams, it was noticeable that, at the lower pitch ratios, there was a material curvature both on the k_T and k_Q curves, whereas at the middle pitch ratios they were almost straight lines. At the low blade-area ratios, there was a marked curvature on the k_T and k_Q curves, whereas at the high blade-area ratios they were almost straight lines and showed some peculiar hollows. He wondered what the explanation might be. In connection with the diagram showing the outline of the model propellers, he drew attention to the fact that the low area-ratio screws were exceptionally low. Those were segmental sections, with a very high thickness ratio, approaching 40 per cent. It was well known that thick segmental sections were subject to a serious circulation scale-effect, apart from the question of friction scale-effect, and he thought it possible that, in spite of what the author endeavoured to demonstrate to the contrary, there was an appreciable amount of circulation scale-effect on the inner sections of the low-area screws.

The questions of laminar flow on propellers, and of what was the minimum Reynolds number at which it was safe to predict for the ship, had received attention on an international basis for some time, and the author's diagram showing profile frictional-drag coefficient was interesting in that connection. It appeared to indicate that, if a Reynolds number of the order of a quarter of a million were exceeded, the worst effects of laminar flow would be avoided; that was valuable confirmation to have. The question of laminar flow on model screws was being studied and undoubtedly there had been indications of laminar flow at much lower Reynolds numbers than a quarter of a million. It did not follow, of course, that, because there was laminar flow, there would be any major influence on the forces; there were balancing factors. He hoped, in conclusion, that Mr. Gawn would pursue experiments on a similar scale with more modern blades.

Dr. G. Giliberto, speaking in Italian, congratulated the author on the interesting information he had given as the result of his tests, but pointed out that an important factor in the study of propellers was the number of blades. It seemed, that, for a certain series of values of blade-area ratio, as compared with a smaller ratio, a propeller with more blades—say, four—could have a better efficiency than a propeller with three blades, because it was easier to avoid the effect of cavitation. He asked why the number of blades was not increased to avoid using large blades, and to ensure a better distribution of the thrust when the propeller was loaded; also, why Mr. Gawn did not test propellers with an aerofoil section, and what importance he attached to the theory of circulation.

Dr. Ir. W. P. A. van Lammeren thanked the author for having given so much information of direct use to all who were concerned with the design of propellers, so realising the ambition of many research workers in that field. He hoped that his few comments would not be regarded as criticism; they were intended merely as an endeavour to indicate the activities of the Wageningen ship-model basin with respect to the research on systematic propeller series which was in hand, to stimulate further relevant research, and, if possible, international co-operation. The propellers dealt with in the paper were of segmental blade sections, probably in order to link up with the former Froude and Gawn series. Although that had the advantage that the results could be compared with the former series and the well-known series of Taylor, he was inclined to ask whether the efficiency could not be improved by applying, especially in the vicinity of the boss, sections of more or less aerofoil shape. The comparatively large efficiency values of some of the propellers did not leave much room for improvement, but, on the other hand, comparison of the efficiency curves of the Wageningen B-series propellers, tested at a much smaller Reynolds number, with those of the new Gawn series, at advance coefficients less than those corresponding with peak efficiencies, led to the conclusion that some improvement might be possible by the application of more modern sections over a certain part of the blade, especially with the smaller pitch ratios and blade area ratios.

Although the cavitation characteristics of segmental blade sections for the larger blade-area ratios were not bad, improvement might be possible by applying the modern constant-pressure profiles with shock-free entrance, i.e., von Kármán-Trefftz sections. He understood, however, that the series in question was set up as early as 1938, long before von Kármám-Trefftz sections came into use. The Wageningen ship-model basin has set up a systematic series of three-bladed and four-bladed propellers, having von Kármán-Trefftz sections at the tip and aerofoil sections near the boss. The diameter of the bronze models was 42 cm. (about 16 in.). Tests in the cavitation tunnel, as well as in open water, were planned. Only five models having been cast, and not yet finished, it would be possible to re-make the models with the same dimensions as those of the author's series and to test them under the same conditions, i.e., the same Reynolds number. A direct comparison of the results with those of the basic series used by the author would then be possible. He himself considered that to be of great interest, and he would be pleased to have the author's opinion. If Mr. Gawn had not already planned cavitation tests, he would like to offer him the opportunity to test his propellers in the Wageningen cavitation tunnel, if the Alpax alloy could stand the greater forces imposed. It would not be possible to cover the whole slip field, because of wall interference at the higher slip values, but the Wageningen cavitation tunnel was suitable for that propeller research. The tests could be carried out at the same Reynolds number, and probably also at a still higher Reynolds number, so that the scale effect, if any, could be determined. He made the offer because he realised that the cost involved in research work by the various ship-model basins could be justified only if every opportunity for international co-ordination and co-operation were used. Finally, he asked whether it would be possible to give the results of Mr. Gawn's tests also in the well-known form of B_p-δ diagrams, which was so suitable for the propeller designer.

Professor A. M. Robb said that one of the difficulties in all experiments with propellers was that it was not practicable to alter what might be called a secondary variable, such as blade area or blade thickness, without also altering the primary variable. For instance, in the diagram showing propulsive characteristics, Mr. Gawn purported to show the effective blade area for constant pitch ratio, whereas, in fact, he did not do so. The diagram showed that, when the blade area was altered, at once the effective pitch ratio was altered also. The pitch ratio was not 1·2, but the effective pitch ratio—the most important factor in the performance of a propeller—varied from 1·26 to 1·47; thus the curve was slightly misleading to that extent. He was not concerned to present the case for the use of effective pitch ratio as a basis for plotting propeller results, having dealt with that fully elsewhere. He had to look at the results from the point of view of effective pitch ratio in order to get a comparison with Froude's results of 1908. His concern was to find out whether R. E. Froude's very simple relations of 1908 for the effective blade area and pitch ratio were valid. A fairly simple analysis showed that the Froude relation for the effective pitch ratio was not valid. His interest was mainly in the validity of Froude's blade factor, and, so far as he could see, the results meant that the effective blade area was much better than was suggested by Froude's blade factor. In connection with scale effect, thrust coefficients were used which were based on the premise that there was a steep dimension relation. True, Mr. Gawn, in his introductory remarks, had said that variations in speed had no material effect; but if he was satisfied with that, he was completely at variance with a large body of experimental workers, starting with Taylor, in 1906. It is of no use to talk about scale effect before having clarified the law of comparison.

Professor E. V. Telfer also referred to the author's treatment of the law of comparison. In the paper, Mr. Gawn said that it was very important that the Reynolds law should be respected; but, having said so, he promptly and utterly neglected it. Presumably, it was equally important to observe the Froude law, but again, in Mr. Gawn's experiments that law, strange to say, was completely neglected. The paper provided some experimental evidence which was exceptionally valuable and useful, subject to the neglect of those laws. He asked the author not to emphasise the enormity of the gaps existing between the model and the ship. If he honestly believed that there was a gap between model and ship, he had no right to continue in that, because, as the result of his advice, the Admiralty were quite rightly prepared to design their own propellers. The successful experience enjoyed over the past 80 years, since Froude introduced the subject, showed that the gap did not exist, and any emphasis on it was misleading the experimenter. Turning to the curious behaviour of the thrust line at the higher blade area ratios: there, instead of the uniformly convex form, there was a re-entrant type. He was prepared to doubt whether that actually took place, because it was open to question whether the draughtsmanship of the diagrams was necessarily 100 per cent. correct. He asked if Mr. Gawn would give the complete experimental spots for one particular screw, and show how those re-entrants were justified; if the scatter of the spots was so small that he could justify his statement, he had discovered a most important phenomenon.

Mr. A. J. Williams thought that the paper expressed succinctly a great mass of data; the advance coefficient curves completely defined the performance, under non-cavitating conditions, of a very large family of three-bladed propeller shapes. In the design of a propeller to meet specific requirements the choice of blade area ratio was not, as the author pointed out, as simple as his curves might suggest, as the efficiency of propellers of small blade-area ratio was impaired by cavitation. Mr. L. G. Bell had shown, in his paper to the Institution of Naval Architects in 1947, that, for the propellers of a fixed pitch ratio, there was an optimum blade area ratio which depended upon the cavitation number, and vice versa. He also showed, however, that the effect upon efficiency of varying the blade area ratio was not critical, so that the designer's task in selecting that ratio was not particularly onerous. The more difficult problems involved, and the rather cumbersome cross-plotting which must be carried out before the design features of the propeller could be decided, prompted the question. Could not the data given in the advance coefficient diagrams be re-plotted, using different parameters, so that the factors being sought were presented explicitly rather than implicitly? A further point then arose. The part of each k_T curve that was normally required was that for maximum efficiency, which occurred when k_T was comparatively small; therefore, could not the re-plot be so made as to magnify the parts of the k_T curves that were normally used, thus increasing the accuracy of their interpretation, at the expense of the data for high slip, which were less frequently required?

Professor L. C. Burrill expressed the opinion that the paper would become a classic in the *Transactions* of both the Italian Association and the British Institution. It ranked with the paper by Froude, and, of course, with Mr. Gawn's earlier paper, of 1937. Its content was factual, and, therefore, not much controversial discussion could be raised about it. He thought that the results would be useful mainly for the higher blade-area ratios, above (say) 0·65. That was not an implied criticism of the results at the lower blade-area ratios, but because it was for the higher blade-area ratios that the type of section used, and the three-bladed propeller, might become appropriate. If the Admiralty would agree, it would be well to give, if possible, a four-bladed series to compare with Mr. Gawn's excellent three-bladed series; and perhaps the existing screws, having a high thickness ratio, might be reduced in thickness at the root, so giving the effect of thickness and facilitating interpolation between one thickness ratio and the other. The range of these tests was excellent. The size of the propellers, too, was good, and represented, perhaps, a return to Taylor's work; because Taylor used quite large propellers in his early experiments and, for that reason, his results had been very useful. The Reynolds number was satisfactory, and also, contrary to Mr. Gawn's earlier series, the boss size was in keeping with the normal boss sizes of ships' propellers. He welcomed the change in presentation; definitely, in his view, the $k_T\,k_Q$ method of presenting the results was much better than the Froude system, which was rather difficult and lengthy.

Perhaps the most valuable diagram in the paper was the one giving the effective pitch factors for the various blade-area ratios and pitch ratios. It indicated clearly the important effect of pitch ratio on effective pitch, particularly at the low blade-area ratios of about 0·4 and 0·5, which was the region in which merchant-ship screws were being designed; that diagram would be of great value to those who were engaged regularly in the designing of propellers. It would be interesting, of course, to compare it first with the 1937 diagram, and also with various formulæ which had been put forward. If it proved satisfactory, he was sure that it would solve many problems arising from the thickness of propellers. He, too, would like to see a four-bladed propeller dealt with.

The statement, that the designer interested in maximum propeller efficiency should aim at a large pitch associated with small blade area, appeared to need a great deal of modification. Indeed, it went back to 1907 or 1910, when many people were misled by the general statement that high pitch-ratio was desirable. In place of that, Taylor had taught that the designer ought not to try to obtain a high pitch ratio. For each set of revolutions, speed of advance and power, there was an optimum diameter. In his Fig. 21, Mr. Gawn had compared the results of his tests with the results of his earlier tests on a similar type on screw, and also with Troost's aerofoil section screws. The differences shown might be due in part to the apparatus. It might be scale effect, or a boss change, though he thought that Mr. Gawn had taken the boss off, so that the results were comparable with those of Troost. In Professor Burrill's view, it was principally scale effect, and it was the larger round-back screw which was coming into line with the aerofoil type. What was of interest, however, was the difference between the 1952 and 1937 figures. He agreed generally with Mr. Gawn that the figures could be used as they were, without correction for scale effect in passing from the model to the ship; but he suggested that no propeller was ever designed to suit the peak of the curve. The peak of the curve to a base of J or δ was not the real peak; it should be to a base of B_p.

Mr. Gawn, replying to the discussion, said that, with regard to the presentation of the results, the coefficients chosen, and the methods of presentation, were those agreed internationally. If an alternative presentation was wanted, the data were there; but it was not possible, in a single paper, to produce various sets of curves covering the same data in different forms.

One or two speakers had spoken in favour of the B_p-δ. As a propeller designer, he had never used that form, and he did not think he could persuade the Admiralty to adopt it. What had been done at Haslar to supplement the curves given, which in themselves were suitable for design, was to plot on a base of $k_T\,k_Q$, which was the form in which their propeller results had been used for many years. He was in full sympathy with those who favoured the use of effective pitch ratio as a basis for plotting, but it was not in accordance with the international agreement. It had solved many problems, however; and he had included curves for effective pitch ratio in the paper and had shown how they could be used. He would like to consider Dr. van Lammeren's generous suggestion that, perhaps, all the propellers might be tested in the cavitation tunnel.

Speakers had suggested that he might test small-bladed propellers, and thinner or thicker propellers. That had been done, but it was not possible to put all the results into one paper. Some had asked why he did not test thicker blade sections, and use modern sections. His claim was that those shown were modern sections. At the lower blade-area ratios, it was clear that, as Dr. Allan pointed out and as he had mentioned in the paper, a designer interested in a propeller would like to modify the section at the root, if nowhere else, but he was interested in preserving geometric similarity for the series, which was so important. Dr. Allan raised the point about the change of coefficients with the change of revolutions at sea; but the paper referred to "change of speed" over the range tested. Professor Telfer objected to the use of the word "gap." So far as the work at Haslar was concerned, they claimed to have bridged the gap. He also suggested that the experimental spots should be added for one particular screw. Mr. Gawn was confident that that would show up remarkably well, and he hoped to add the diagram.

(*To be continued.*)

THE DE HAVILLAND COMET.

SOME of the considerations that led to the development of the de Havilland Comet air liner were described by Mr. C. T. Wilkins in a discourse at the Royal Institution on Friday, November 21. Initially, said Mr. Wilkins, British Overseas Airways Corporation had suggested that a design study for a high-speed jet transport aircraft to carry six passengers and 1,000 lb. of mail across the North Atlantic should be undertaken. Many configurations were investigated, including a twin-boom layout with three Goblin engines in the rear fuselage, a tailless swept-back wing, and even a tail-first arrangement. The tailless swept-back configuration appeared to be promising, and to investigate its flying qualities the D.H. 108 tailless aircraft, with 40-deg. swept-back wings, was built. The de Havilland Company felt, however, that to satisfy a broad market, the aircraft would need to carry at least 40 passengers, and although the tailless design showed great possibilities of drag reduction at high Mach numbers, the penalty in payload resulting from the low lift coefficient and higher structure weight of the swept-back wing would amount to 4,000 lb. The landing approach characteristics also left much to be desired. The conventional layout of the Comet as it existed to-day was, therefore, adopted.

De Havilland Ghost engines were selected because the centrifugal jet engine was then far more advanced than the more powerful and efficient axial-flow engine. Moreover, it was desired to tap air from the compressor for supplying cabin air pressure and heat, and wing anti-icing, and at that time there was no experience in doing this with the axial flow compressor, which also presented a more difficult de-icing problem. All these problems had now been solved for the axial-flow engine, but had the latter been chosen at the outset, the commercial operation of the Comet would have been considerably delayed.

Owing to the high fuel consumption of the jet engine at low altitudes, the aircraft had to fly as high as possible. The Comet, taking off at maximum all-up weight, would climb to about 33,000 ft. in 30 minutes, after which the altitude would increase during the cruise to about 40,000 ft. as weight fell off. In order to keep the cabin altitude at 8,000 ft., a pressure differential of $8\frac{1}{4}$ lb. per square inch was necessary across the pressure shell, windows and doors. Using a circular fuselage cross-section, and inward-opening doors and hatches, a surprisingly small increase in structure weight had been found necessary to achieve a safety factor of 2 over the structure generally; the windows and doors had a safety factor of 10.

Discussing the problem of keeping down drag, Mr. Wilkins said that a compromise had to be struck between a thin wing and its high structure weight, a swept wing, also heavy, and the ability to stow the fuel, engines, and undercarriage within the wing, and a reasonably low wing loading to give manœuvrability at altitude and acceptable take-off and landing speeds. The Comet wing had a thickness-chord ratio of 11 per cent., a sweep-back of 25 deg. at 25 per cent. chord, and a wing area of 2,015 sq. ft. Parasite drag was kept low by making the fuselage diameter the minimum required to seat four passengers abreast, by enclosing the engines as far as possible in the wing profile, and by having "flush" radio aerials. The Comet was the first commercial aircraft with suppressed aerials. As regards weight saving, the jet aircraft had the advantage of having no propellers, so that the undercarriage height, and hence weight, could be reduced. The low height also made for easy servicing.

To provide storage space for 7,000 Imperial gallons of fuel in a thin 115-ft. span wing, tanks integral with the wing structure had to be used, presenting considerable difficulty owing to structural deformation and the high permeability of kerosine. The use of metal-to-metal bonding in place of riveting had helped to solve this problem. To avoid fire risk arising from relighting engines in the air, it was necessary to seal off adjacent engines and tailpipes from each other. In the case of a crash landing, there was no propeller to stop the engine, and a detector had therefore been fitted at the lowest point of the aircraft which, when it came into contact with the ground, automatically caused the high-pressure fuel-supply to be turned off, the fire-extinguisher fluid to be released, and, after 4 seconds delay, the electrical services, other than emergency lighting, to be switched off.

Although aerodynamically-balanced flying controls would have been feasible, many hours of test flying would have been required to produce an acceptable standard, whereas power-operated controls could be thoroughly proved on ground rigs. A fully-duplicated power control system had therefore been provided in the Comet.

To investigate noise within the cabin in the early stages, a Ghost engine was mounted beside a test specimen of fuselage and the noise was assessed. This test, carried out under take-off conditions, showed that the passengers should be placed as far forward of the jet orifice as possible, the "offices" being placed in the rear of the fuselage. In cruising flight, a very low noise-level had, in fact, been achieved. From the time that the basic design was first settled until the first flight, $2\frac{3}{4}$ years elapsed. Exactly the same time was taken from the first flight to the commencement of commercial service. The placing of a production order, by British Overseas Airways Corporation and British South American Airways, had saved at least two years in getting the aircraft into service.

"VISCOUNT" AIR LINERS FOR BRITISH WEST INDIAN AIRWAYS.—British Overseas Airways Corporation are negotiating with Vickers-Armstrongs Ltd., Weybridge, Surrey, for the purchase of three Viscount propeller-turbine air liners, on behalf of British West Indian Airways, to operate in the Caribbean and West Indies. Deliveries are expected early in 1955.

THE LATE MAJOR M. J. M. DEWAR.—We have learned with regret of the death, on November 23, of Major M. J. M. Dewar, O.B.E., the public relations and publicity officer of the Western Region of British Railways and previously of the Great Western Railway. Major Dewar was a Regular Army officer and served with the Royal Sussex Regiment in France from 1914 to 1916, when he was invalided out of the Service. He rejoined, however, in February, 1940, and served with the Royal Engineers at the railway training centres at Derby and Longmoor, and at the depots at Halifax and Chatham until ill-health compelled his retirement in December, 1943.

LABOUR NOTES.

STRONG pleas for the development of good informal relations in industry were made by Sir William Lawther, President of the National Union of Mineworkers, when he delivered the Blandford Memorial Lecture at Leicester on Saturday last. Sir William entitled his lecture "Can Industrial Democracy Survive ?" and said that good informal relations were, in fact, just as essential to the well-being of industry as its formal consultative machinery. He affirmed that no nation having an industrial system could survive unless it also possessed an industrial democracy, which involved formal and informal consultations between managements and workpeople, in a friendly atmosphere and to an increasing extent. It was useless to expect educated men and women to tend their machines, under modern industrial conditions, in ignorance of the way in which their industries were being run. It was wasteful to ignore the views of workpeople.

Responsibility also, Sir William emphasised, must operate in both directions. Just as there was an obligation on the part of the owners of private undertakings, and those in charge of nationally-owned corporations, to recognise that they had a duty to their employees, so workpeople, on their part, had to undertake their share of responsibility in the modern industrial structure. So far as the mining industry was concerned, costs could be reduced and production increased by improving efficiency, and it was there that team work could be so helpful. Improvements in organisation and planning, and higher standards of management and labour-saving machinery required adaptability and willingness on the part of the workpeople to accept new and changing working conditions. Without adequate co-operation and a sufficient understanding of the implications and repercussions of new methods, nothing was possible.

Proposals for the amalgamation of the British Employers' Confederation and the Federation of British Industries are reported to be under active consideration at the present time. Both are influential and representative bodies of employers and have wide interests. The former is a federation of trade associations and is mainly concerned with questions relating to man-power and wages. The latter, on the other hand, is a chartered body with a direct membership of firms and other trading organisations, and is concerned with all aspects of manufacture and trade. It may well be considered, therefore, by the advocates of the scheme, that the federation of these bodies into a single entity would do much to enable the views of employers and managements on such matters as trade, wages, taxation, man-power, and the use of savings, to be presented with even greater force and authority. That there is a need for a more widespread realisation of the essential part played by profits in the national economy will be generally admitted. Any such amalgamation, however, would involve a number of administrative and legal problems.

A meeting of representatives of the management of the British European Airways Corporation and of the trade unions catering for the Corporation's employees was held in Jersey during the weekend before last, under the chairmanship of the chief executive of the B.E.A., Mr. Peter Masefield, to consider what steps might be taken to secure greater efficiency and prosperity for the undertaking. A very wide range of subjects came up for discussion, including labour and financial questions, and the policies and prospects of the Corporation generally. Both sides expressed themselves as satisfied with the results of this joint consultation.

Normal working was resumed on Monday last by miners at the Park, Dare and Lewis Merthyr Collieries, South Wales, who, for some weeks past had banned all overtime and piecework, and the operation of the voluntary shift on Saturdays. This action had been taken by the men as a form of protest against the rejection by a national tribunal of the 30*s*.-a-week wage claim put forward by the National Union of Mineworkers. The bans were enforced in spite of an appeal by the union that the adverse decision should be loyally accepted. All collieries which imposed protest bans have now resumed normal operations.

Figures issued by the National Coal Board on December 1 show that a voluntary shift was worked at 567 pits on Saturday, November 29, compared with 563 pits on Saturday, November 15, when 236,000 tons of coal were mined. Scottish collieries, it may be noted, operate a voluntary shift on alternate Saturdays only.

The aggregate membership of trade unions in the United Kingdom at the end of 1951 was about 9,480,000, the highest level yet recorded, according to statistics published in the *Ministry of Labour Gazette* for November. This was about 238,000 more than the total at the end of 1950, and some 207,000 more than the total at the end of 1949. Trade unions registered with the Chief Registrar of Friendly Societies and the Registrar of Friendly Societies for Northern Ireland at the end of 1951 numbered 704, including 25 societies having their headquarters in Northern Ireland. This total represented a reduction of five compared with the total at the end of 1950. The reduction was the net result of seven small unions being absorbed by larger ones, or otherwise ceasing to function, and by the formation of two new unions. Of the 704 unions at the end of last year, 138 had memberships of less than one hundred, and 184 had memberships of between one and five hundred. At the other end of the scale, 15 unions had between 50,000 and 100,000 members, and 17 others had over 100,000 members. Expressed in another way, 32 unions, representing 4·5 per cent. of the total number, had 77·7 per cent. of all unionists in the United Kingdom on their membership rolls. In round figures, the members of these 32 unions totalled 7,370,000.

It may be noted, for comparison with the above figures, that the total membership of the Trades Union Congress, at the end of 1951, numbered some 8,020,000 persons, drawn from 183 affiliated unions. The proportion of women belonging to the T.U.C. was rather less than in the case of those recorded in the books of the Registrars. At the end of 1951, the Registrars' total comprised 7,705,000 men and 1,775,000 women, compared with 7,572,000 men and 1,670,000 women at the end of the previous year. There were 49 federations of trade unions at the end of 1951, three less than at the end of 1950. Although a large proportion of unions are affiliated to federations, and some are affiliated to more than one federation, a number of unions are not affiliated at all, while others are affiliated in respect of only a part of their total membership.

Financial statistics issued by the Chief Registrar give an indication of the very substantial sums passing through the hands of unions in Great Britain. The income of the 413 principal unions, having a total membership of 8,286,881 persons, totalled 18,246,000*l*. during 1951, of which 16,226,000*l*. was obtained from the members and 2,020,000*l*. from other sources, principally investments. Of the outgoings of these bodies, 9,098,000*l*. went in working expenses and 1,931,000*l*. in superannuation benefit. Unemployment benefit absorbed only 133,000*l*. The total accumulated funds of these 413 societies, it may be noted, totalled just short of 65 million pounds at the end of the year, an increase of 2,675,000*l*. in twelve months.

The weekly wages of some 615,000 workpeople in the United Kingdom were increased by a total of approximately 159,000*l*. during October. There was also a decrease of some 17,000*l*. in the wages of 246,000 persons during the same month, mainly owing to the decline in the level of the interim index of retail prices during August and September and the operation of sliding-scale agreements. During the month, 146 stoppages of work occurred and there were 17 disputes in progress when the month began. In these 163 strikes, 25,000 persons were involved and 91,000 days lost.

PUSH-BUTTON CONTROL OF RAILWAY SIGNALLING.

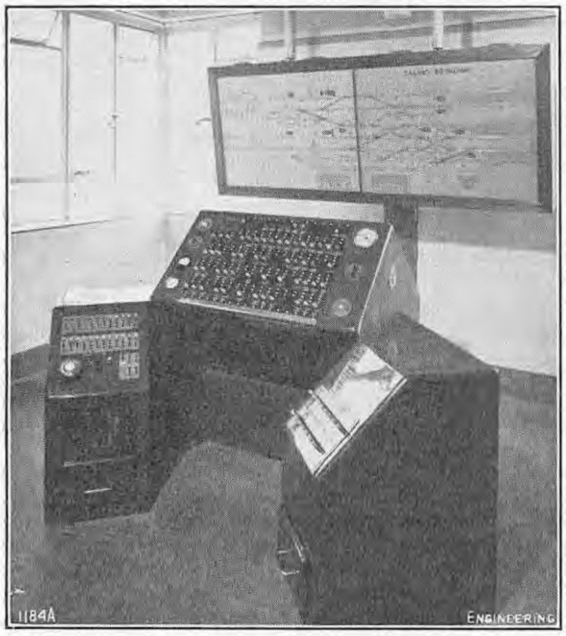


FIG. 1. CONTROL DESK.

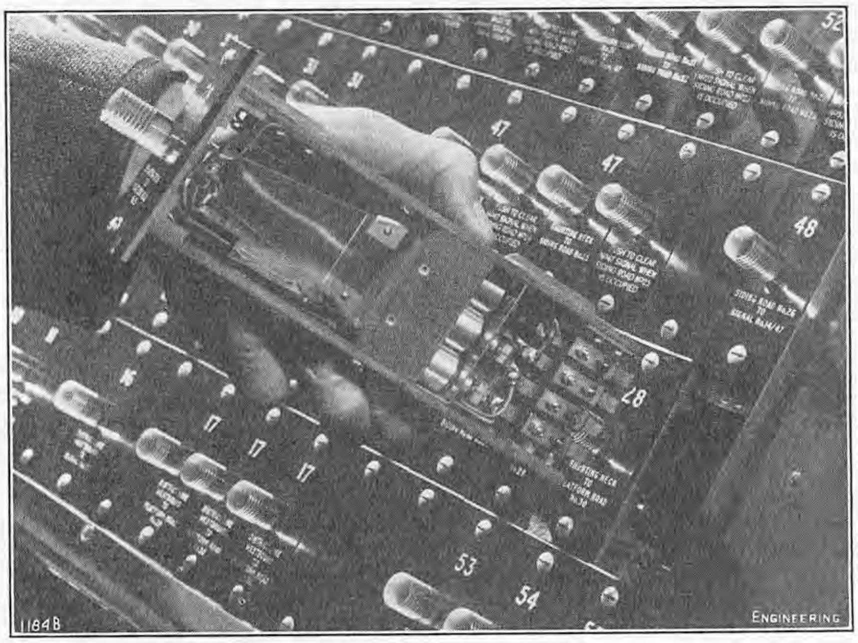


FIG. 2. PUSH-BUTTON UNIT WITHDRAWN.

TEST TO DESTRUCTION OF PRESTRESSED CONCRETE BRIDGE.

SINCE the publication of the report* on the test to destruction of a prestressed concrete footbridge on the South Bank, London, earlier this year, further information has become available during the breaking up of parts of the collapsed span by the demolition contractors. This work is nearing completion, and the Cement and Concrete Association, who have released the information given below, hope it will be of value to all concerned with the design and construction of works in prestressed concrete and may help to improve the already high standard of construction in this country.

The quality of the concrete throughout the structure was very good and failure had generally occurred by fracture rather than dislodgment of the aggregate. The concrete was dense and uniform, having been well consolidated, and excellent adhesion had been obtained between the main bulk of the concrete and the topping which was laid within a few hours of the main concrete. Construction joints had opened up with clean faces when in tension, showing that little or no tensile strength could be relied on at such joints, but no special arrangements were made during construction to obtain additional bond between new and set concrete. Attention had been drawn in the previous report to the loss of the continuity effect after loading to twice the design load, as evident from the deflection profile curves. The first evidence of overstressing of the concrete occurred at the re-entrant angle at the junction of the beam and the penultimate column. The tilting of the beam caused slight spalling of the concrete and the combination of the vertical and horizontal stresses at this point would probably account for the diagonal cracking which was evident.

There was no failure of the steel cables in the deck and no evidence of slip in the anchorages to the deck cables. The end column cable did not fail until the catenary pull, due to the deflection of the collapsing span, had reached a very high value. At the large column in the angle of the bridge span one wire of the cable broke at the moment of collapse, but the remainder were firmly held. The grouting of the cables was an unsatisfactory feature and in no case could it be said that the core hole was completely filled. With some cores no grout had been injected. It appears that more consideration must be given to this aspect of prestressed concrete during construction if the advantages of a fully-bonded cable are to be obtained; the danger of incomplete filling must be fully appreciated at all stages of design and construction, and grouting must be supervised by contractors and engineers to ensure that all cores are properly injected and thoroughly filled.

A check has been made on the final positions of the cables in the structure as compared with the positions shown on the drawings. It shows that at mid-span and over the support where maximum eccentricities were required, some movement of the rubber cores towards the centre of the section had taken place. In addition, it is understood that the friction developed during stressing was appreciable. The combination of these two factors may explain the presence of a crack near the mid-span at working load, since the internal moment available to resist the external bending moment, i.e., the product of cable force and eccentricity, was less than had been assumed in the design. It must be realised that this was one of the first continuous structures to be erected in this country, using inflated rubber cores and curved cables, and, in addition, the site conditions were exceptional. Clearly, the methods adopted to hold the cores in position were not sufficient in this case, but it would seem that manufacturers and users of the rubber cores are now aware of the importance of securing the tubing rigidly in its designed position. It does, however, seem desirable to emphasise that very rigid fixing at close spacing is essential, so as to resist effectively the forces tending to straighten the core and avoid undulation due to the buoyancy of the tubing. This will tend to reduce friction losses, for which allowance must, however, be made in design. Research into this problem must continue, co-ordinated with full-scale tests on site works.

Both the test and the subsequent examination of the structure during demolition confirm that the design and construction of the bridge were such as to provide adequately and economically for all contingencies, such as possible overload, construction difficulties and human fallibility, as covered by the general term of factor of safety.

* See ENGINEERING, vol. 173, pages 595 and 690 (1952).

TITANIUM PILOT PLANTS.—Imperial Chemical Industries, Ltd., have been carrying out a three-year research and development programme covering the manufacture of titanium. The directors have decided that this work has reached a state at which the company can immediately commence to erect pilot plants for the production of wrought titanium and its alloys. When these plants are in production they will provide a British source of supply for the development of prototype applications in the engineering and aero engineering fields.

PUSH-BUTTON CONTROL OF RAILWAY SIGNALLING.

THE traffic control arrangements at the Ealing Broadway terminus of the District and Central Lines of the London Transport Executive have recently been modernised by the installation of pneumatically-operated points and colour-light signals, which replace the original mechanically-operated equipment. Normally the new equipment will be actuated by a system of push-button control, which has been devised by Mr. R. Dell, the signal engineer of London Transport, and is intended to simplify train movement and to reduce labour costs.

The system consists of 43 push-buttons, which are mounted on the desk illustrated in Fig. 1. One of these buttons is allocated to each particular route and, when pressed, energises pneumatically-operated levers through telephone-type relays, so that the appropriate points and signals are actuated. The push-buttons, of which a closer view is given in Fig. 2, are of transparent Perspex and are illuminated from below through a Perspex connecting plate by coloured lamps, a red indicating that the route is at danger, yellow that it is being selected, and green that it has been set and the signals are at clear. When the signals have been replaced to danger by the passage of the train, the red light is restored. A signal which has been cleared, and a route which has been selected, may also be restored to danger by pulling the appropriate button. A further facility is that the signalman can set two routes in succession. When this is done, the second route is set up as soon as the signals for the first movement have been cleared.

The desk has been designed so that the signalman can sit in front of it with all controls within easy reach. On the left is a telephone control panel with a microphone and loudspeaker, and on the right push-buttons and indicators for a train describer system. The conditions of all the track circuits, points and signals controlled from the box are shown on an illuminated diagram. A set of miniature levers is installed on the ground floor of the box and can be used, when required, for operating the various points and levers. The push-button control desk and the signalling equipment, which is generally of standard pattern, were made by the Westinghouse Brake and Signal Company, Limited, York Way, London, N.1.

CYCLE AND MOTOR CYCLE SHOW, 1953.—The next Cycle and Motor Cycle Show will be held at Earl's Court, London, S.W.5, from Saturday, November 14, to Saturday, November 21, 1953.

STATISTICAL METHODS AND OPERATIONAL RESEARCH IN TRANSPORT.

THE application of scientific sampling techniques and operational research methods to some transport problems was discussed in a paper entitled "Statistical Methods and Operational Research in Transport," given by Mr. F. A. A. Menzler, C.B.E., M.Inst.T., at a meeting of the Institute of Transport held in London on Monday, November 17. Scientific sampling, said Mr. Menzler, could help in analysing the differences and fluctuations revealed by routine statistics, which could not be interpreted solely by commonsense and arithmetic.

In applying sampling techniques to the examination of defect rates, the size of the sample had to be related to the proportion of defective units that could be tolerated among the whole of the equipment, and to the risk that could be accepted of getting a misleading result from the tests. A commonly accepted rule was to take the risk as 1 chance in 20. As an example, Mr. Menzler showed the weekly figures for failures of timing chains on 'buses between 1950 and 1951. In this case, the distribution of the number of weeks in which given numbers of failures occurred lay approximately on a "normal curve," and thus revealed that no unusual factor was affecting the failure rate. In the example under consideration, it could be shown that the number of failures might be expected to exceed six in 1 week in 25 without giving cause for anxiety. In two consecutive weeks, however, eight and seven failures occurred; the chances against six being exceeded in two weeks' running were about 600 to 1, and it could be presumed that some abnormal influence had affected the equipment. Conversely, if there were no failures in two consecutive weeks, a significant improvement would be indicated, leading in due course to a lower average number of failures. Such methods were extensively used by London Transport engineers as a systematic aid to deciding when special inquiry was called for. They were not, of course, a substitute for skilled engineering judgment. Sampling techniques had also been applied to the study of vehicle accident statistics, but in this case "stratified sampling" was adopted to take account of the effect of the day of the week on traffic conditions and the influence of weather on the traffic rate.

Certain questions could not be answered from records only, and operational research had to be adopted. By this means, various "passenger-habits" had been studied, yielding information relevant to the design of vehicles. Operational research—theoretical analysis, observation, and direct experiment—played a large part in the work of a team examining problems affecting the capacity of London Transport's railway services. They had determined that the central doorway pillar on underground railway coaches was, on the whole, an obstruction to the flow of passengers; and they had also shown that, if stations and trains could be designed so that passengers would use the trains throughout their length, the capacity of an overloaded station could be increased by 20 per cent.

Operational research was also in progress on the effect on fuel consumption of the technique of 'bus-driving. It had been found that unsteady or intermittent use of the accelerator wasted 16 per cent. of fuel at 30 m.p.h. and 10 per cent. at 20 m.p.h. The fuel consumption of a fleet of vehicles was affected by passenger loadings, the weather, traffic density, the mean daily mileage, the standard of driving, the composition of the fleet, the standard of maintenance, and the viscosity of the lubricating oil. To disentangle the effects of these factors, specialised statistical techniques were employed, by which tentative quantitative explanations had been derived from the differences in fuel consumption between one year and another. Operational research using the "analysis of variance" technique had also been used to investigate the effect on fuel consumption of modifications, such as a change in engine-oil viscosity, alterations to carburettor or fuel injection-pump settings, or a change in silencer design.

Another statistical technique applicable to transport statistics was the "life table," with which the average length of life could be estimated by relating mortality to age over a short period, such as a year. This method could be applied to the study of service life of equipment and also possibly to performance studies. The operational research projects were sponsored by teams, under the Research and Development Committee, the using department generally providing the chairman. The development and research department were represented by a scientist and a statistician, one of whom served as secretary. In this way, both theoretical and practical considerations were taken into account.

GEOLOGICAL RESEARCH AND ITS PRACTICAL APPLICATION.*

By DR. J. E. RICHEY, M.C., F.R.S.

(*Concluded from page* 703.)

LOCATION OF ORE DEPOSITS.

EXPOSED ore-bodies yield denuded fragments of ore to adjacent streams and rivers and were discovered by old-time prospectors finding these clues along the waterways and following them up to the parent masses. Less obvious geochemical and biochemical methods are now being explored for tracking to their sources the superficially oxidised and water-soluble derivatives of hidden primary ore-bodies. These methods include the field analysis of surface water, and laboratory analysis of parts of plants and trees and their derived humus, since heavy mineral salts in soils can be concentrated in the tissues of certain species. An ore-body, suspected for one reason or another in a certain place, may be located by geophysical or other means. Geology becomes highly important, however, in hunting for fresh ore in fields which are under exploitation. These provide much more valuable geological information about the mode of occurrence of ore than natural exposures alone can do. A plea may be made here for the retention of geological advisors throughout the working of a mine. By this means as the workings progress valuable information can be gathered which may be vital for the understanding of the ore occurrence, but may be destroyed during exploitation.

An instructive case where modern methods of mineralogy and petrology have been used in the search for ore comes from the important mining locality of East Tintic in Utah, and is concerned with the alteration of country rocks. Here rhyolitic lavas, probably of Oligocene age, rest upon highly-folded Palæozoic carbonate rocks and quartzite, and both rock series are cut by monozonitic intrusives. Ore occurs only in the rocks below the lavas, and in consequence may be "blind." About 1927, Billingsley made recommendations based partly upon the strong alteration of the barren lavas, and these led to the discovery of the North Lily ore-body. This early work was not followed up until the last war, when the United States Geological Survey studied in detail the time and space relationships between rock-alteration and ore-deposition in the area. From these studies Lovering and his collaborators established five stages of hydrothermal alteration: early barren stage, mid-barren stage, late barren stage, early productive stage, and ore stage. The first stage is a dolomitisation of limestone and chloritisation of lava. Mapping of dolomitised fractures in limestone gave valuable information about the hydrothermal "plumbing" system, for, although the early barren-stage solutions travelled far beyond the ore solutions, the latter generally followed channels previously used by the earlier. The mid-barren stage is one of argillation and is not clearly related to ore deposition, but the succeeding late barren stage, characterised by jasperoid and pyrite, is intimately associated with ore, and the miners consider "quartz" to be an excellent guide to ore. Although Lovering states that "no alteration thus far recognised is a sure indication of ore," his work has borne important fruits and opens up fresh lines of thought in ore geology.

PROBLEMS IN CIVIL ENGINEERING.

In illustration of the methods of approach in geology to civil engineering problems, I propose to describe two examples from Britain. One concerns the foundation of a dam, and is a further instance of the successful pursuit of a scientific idea. The other, the site of a tunnel, was solved by a pattern of converging lines of evidence.

The investigation of the Vrynwy dam-site in North Wales in the '80's of last century is an example of the use an engineer made of his knowledge of geological processes. One of the engineers concerned in the scheme, Dr. G. F. Deacon, was aware that the valley had been occupied by a glacier, and that erosion by ice produces unevenness in rock-floors. He recognised, too, that the superficial deposits covering the valley-bottom had been deposited in a lake of glacial times, and surmised that the lake had been dammed by a rock-bar. To test his idea, nearly 200 bores in all were put down through the surface soils, and a rock-bar was eventually located at a depth of 40 to 45 ft. Rockhead sloped away on either side of the bar, which was used for the foundation of the great masonry dam, and Deacon estimated that, had a site been chosen at a distance of only 220 yards away, this would have involved an additional cost of no less than 300,000*l*. to 400,000*l*. for the works. In similar circumstances at the present day, a geophysical survey should eliminate the need for so extensive a boring programme, but we may admire Deacon's persistence in his search and his well-deserved success.

The second example is the investigation, by Professor P. G. H. Boswell, of the site of the Mersey road tunnel, known as the Queensway vehicular tunnel, which was opened to traffic in 1934. It is a striking instance of the reliance placed upon geological inference which could not be verified by trial boring owing to the rapid ebb and flow of the tide. From the driving of the Mersey railway tunnel, begun in 1879, and from investigations prior to that undertaking by the engineer-geologist T. Mellard Reade, it was already known that the River Mersey was flowing in a buried river-valley or rock-channel which was lined with a deposit of boulder clay. The new tunnel was sited a short distance downstream (i.e., seawards) of the railway tunnel. This raised the question whether the rock-channel was deepening seawards, as might be expected on general principles, or landwards. The investigation took account of the knowledge that the Irish Sea was filled with ice when the rock-channel was cut, and the exit of the Mersey seawards, in consequence, was blocked. It was also known from bores in the Liverpool and Birkenhead area that tributary buried channels existed and that, in plan, their courses made V-shaped angles with the main channel, pointing inland. As with all normal tributaries, therefore, this had been the direction of river-flow. The depth of the main buried channel of the Mersey was known, from bores farther east, to be considerably greater there than the depth proved during the excavation of the railway tunnel.

From these three main lines of evidence, Boswell concluded that the river responsible for the erosion of the rock-channel had flowed landwards, not seawards, and that its floor at the site of the road tunnel would be, at any rate, not lower than at the railway tunnel. The deduction turned out to be strikingly correct, and so near to rock-head was the road tunnel driven that, at one point in the excavation, only 3 ft. of rock separated the tunnel-roof from the bottom of the rock-channel.

Converging lines of evidence are perhaps the most usual means of solving a major geological problem in civil engineering, although approach by analogy from his experience of the surrounding or similar terrain, may often be most useful to the geologist. As the problems that arise are as diverse as geology itself, and the situation different to a greater or less extent in every case, experience is undoubtedly a main asset for success.

* Presidential address to Section C of the British Association, delivered at Belfast on September 8, 1952. Abridged.

DRYING OVEN FOR LARGE TRANSFORMERS.

Fig. 1. FRONT SECTIONAL ELEVATION.

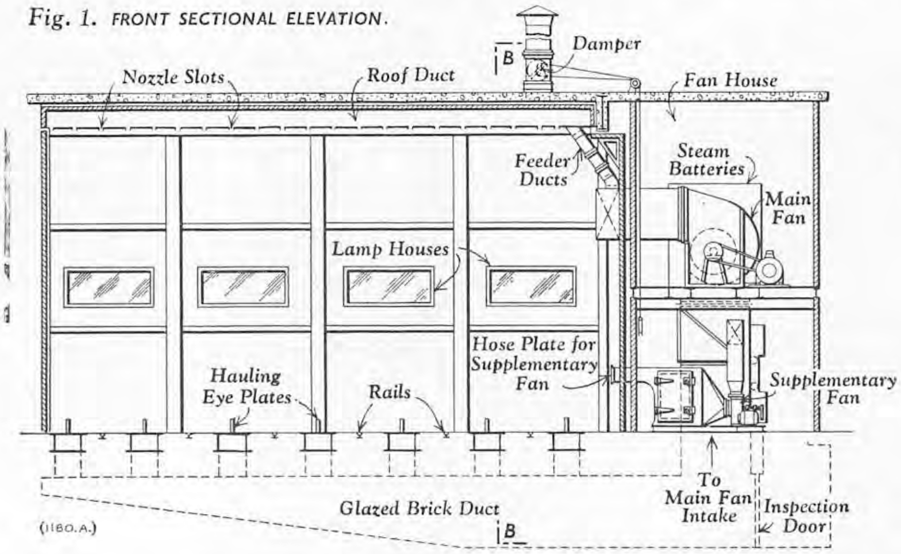
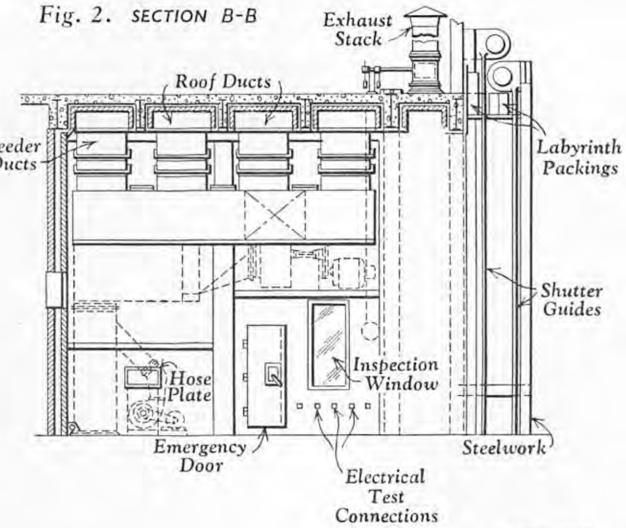


Fig. 2. SECTION B-B



"ENGINEERING."

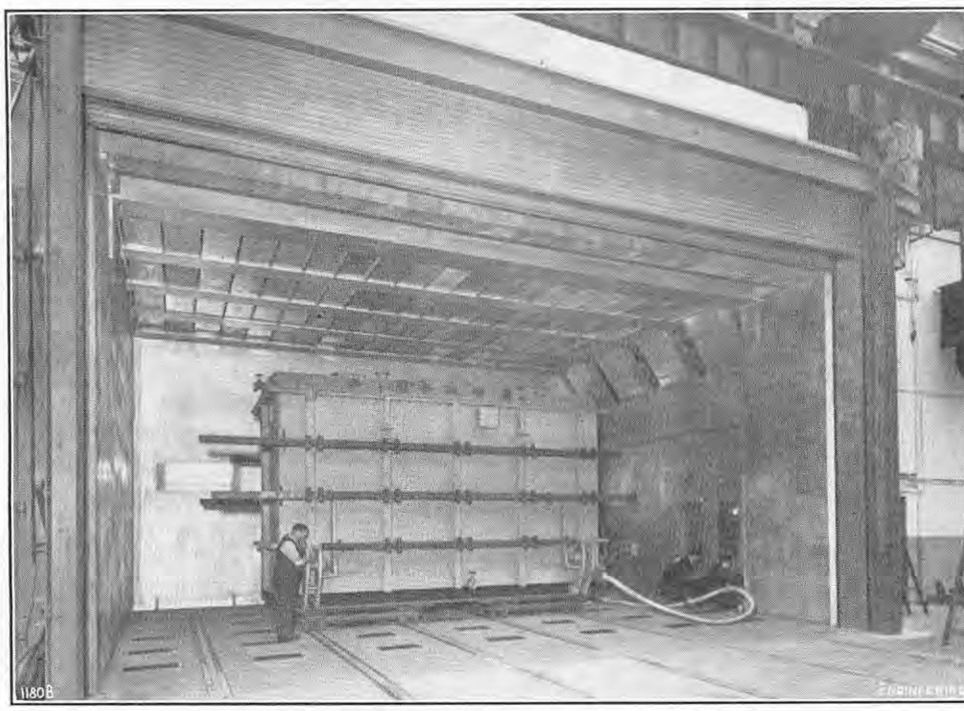


FIG. 3. ENTRANCE TO OVEN AND INNER DOORS.

13,000-CUB. FT. DRYING OVEN FOR TRANSFORMERS.

THE accompanying illustrations show an oven with a volume of 13,000 cub. ft., which has been erected at the Witton works of the General Electric Company, Limited, for drying power transformers with capacities of 100 MVA or more. Its design was based on the estimate that the transformer itself would contain 180 tons of metal and 30 tons of oil, and that it should be possible to control the temperature between 90 and 120 deg. C.

The oven is 17 ft. $8\frac{1}{2}$ in. high, 33 ft. wide and 23 ft. deep, the width of the mouth being 31 ft. $9\frac{1}{4}$ in. It consists of an outer shell of steel framework and brick panels, and a second shell (which has no metallic contact with the first) of steel boxes containing insulating material with included air spaces. Heating is effected by circulating air which, as will be seen from Fig. 2, enters through nozzle slots cut in the bottom faces of four aluminium ducts, which are built into the roof and extend the full width of the oven. The hot air is supplied to these ducts by an electrically-driven fan which is installed in a house alongside the oven. After passing downwards through the oven, the air leaves through grids in the top plates of seven steel boxes, set in the floor, and extending from front to rear of the oven. The air is discharged from the back of the boxes into a glazed brick duct, whence it is conducted to the intake of the fan. The sides and ends of these boxes are covered with plastic asbestos to allow for expansion, and the spaces between them are filled with heat-resisting cement.

Steel rails of heavy section are clamped to the floor between the boxes and support the six-wheeled bogies on which the transformer is carried. To assist in moving the transformer into the oven, hauling plates, or "deadmen," to which wire ropes can be fastened, are also set in the shop floor between the rails at the front of the oven. These "deadmen" are placed below the level of the shop floor and are covered with steel plates when not in use. In addition, hauling eyeplates are set in the angle between the rear wall and the floor, to which blocks can be attached for pulling large transformers into the oven. The oven is closed by a door consisting of two roller shutters, separated by a 20-in. air space. The top of this space is filled by labyrinth packings, similar packings being also placed between the inner shutter and the wall. This double door is electrically driven and is controlled by a switch which is fitted with a deadman's handle. The shutters are electrically interlocked, so that, when the door is being raised, the inner shutter begins to rise before the outer shutter, so preventing inadvertent contact with the hot inner shutter.

The fan house, which, as will be seen from Fig. 2, is situated at the side of the oven, is on two floors. On the upper floor is the main fan, the capacity of which is sufficient to supply the oven with four complete changes of air per hour. This air circulates in a closed system, but an additional amount can be injected if required, the surplus leaving through a ventilator which discharges above the roof. In its passage downwards through the oven the circulating air carries with it any dust which may be present in the air, through the grids in the floor. This dust is removed by a filter in the intake to the fan. Before entering the main fan, the circulating air is heated by two steam batteries. One of these supplies the heat necessary to compensate for the normal losses from the oven shell, while the other is used to control the oven temperature. The steam supply to this battery is regulated by a controller which can maintain the temperature of the transformer at any value between 90 deg. and 120 deg. C. A supplementary fan, which is connected to the transformer tank by metallic hoses, is installed on the lower floor of the fan house and is used to draw air from the tank, thus ensuring intimate contact between the hot air and the transformer windings. A vacuum pump is also provided so that, when the normal heating operations have been completed, the transformer tank may be sealed, exhausted, vacuum-dried and oil-impregnated.

Electrical instruments for testing the transformers during stoving are installed in the fan house, the necessary connections being carried by porcelain bushes through the oven insulation. The transformer may be kept under constant observation through an inspection window, the interior of the oven being illuminated by four fluorescent tubes which are set behind frosted glass in the back wall.

AUTOMATIC SLIDING DOORS FOR FACTORIES.—Doors consisting of two sliding panels, which open from the centre and run on ball-bearing rollers, have been developed by the Express Lift Co. Ltd., Greycoat Street, London, S.W.1, for use in factories and workshops. They are opened and closed electrically through a clutch, which prevents excess torque being transmitted, and are fitted with an edge which ensures reversal should an obstruction be encountered. Operation is by press buttons and an adjustable time delay is provided in the controller so that the doors are held open for a predetermined period.

MACHINE-TOOL SHOWROOM.—H.E.B. Machine Tools, Ltd., have opened new demonstration showrooms and offices at 5-17, Haverstock Hill, London, N.W.3, adjacent to Chalk Farm Underground station. The new accommodation and a display of machine tools were opened on Thursday, November 27, by Monsieur L' Ingénieur Général Bellier, Director of Mechanical and Electrical Industries at the French Ministry of Industry and Commerce, in the presence of Viscount Alexander of Hillsborough, P.C., C.H., chairman of the company. The company will be the sole distributors in the United Kingdom and Commonwealth of machine tools built by H. Ernault-Batignolles, Paris.

WASTE-HEAT GAS-TURBINE PLANT FOR COVENTRY GASWORKS.

Fig. 1. INSTALLATION OF COVENTRY WASTE-HEAT GAS TURBINE.

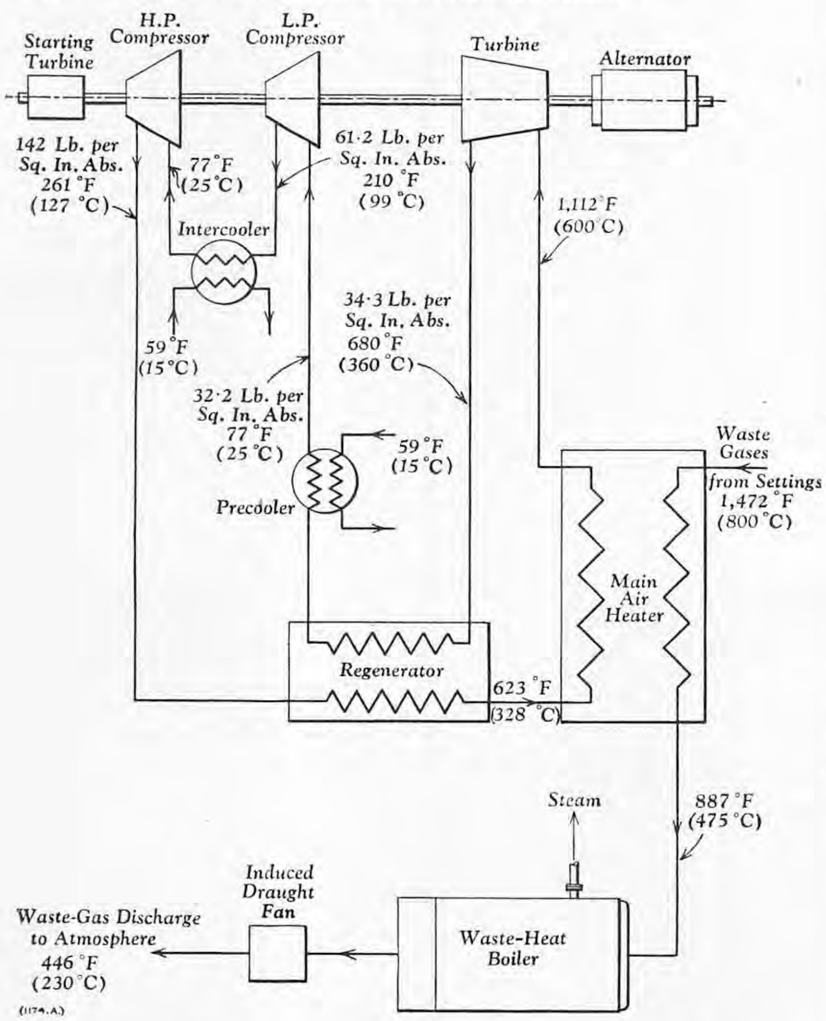


Fig. 2. MAIN AIR PREHEATER.

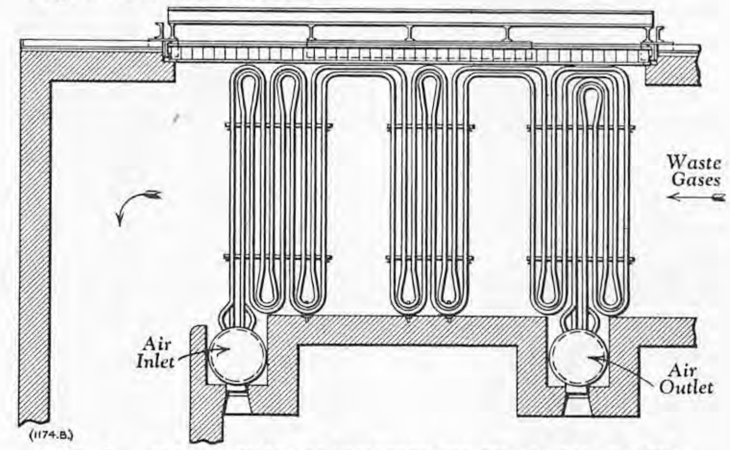
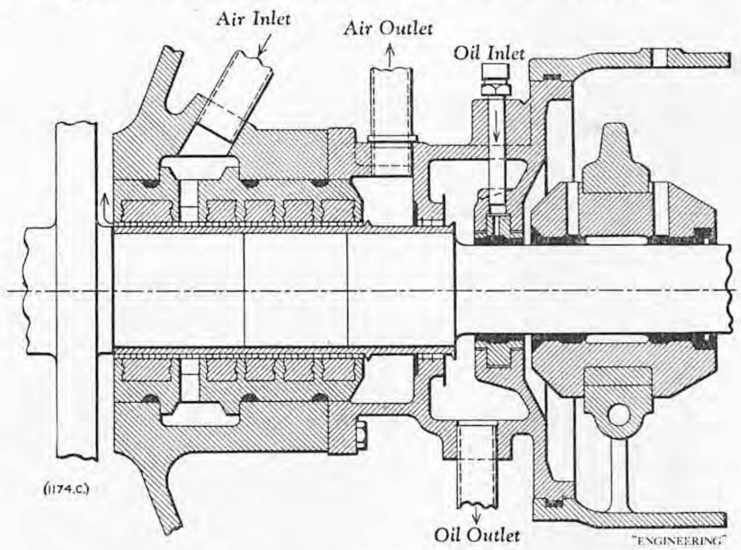


Fig. 3. SEALING GLAND AT HIGH-PRESSURE END OF GAS TURBINE.



WASTE-HEAT GAS-TURBINE PLANT FOR COVENTRY GASWORKS.*

By CAPTAIN (E) W. GREGSON, R.N.R., M.Sc. (Eng.).

THE gas-turbine installation now under construction for the West Midlands Gas Board, at its Foleshill, Coventry, station, is, the author believes, the first of its type to operate on waste heat from a carbonising plant in the world. The settings consist of standard Glover-West vertical retorts incorporating the builders' latest form of balanced heating, and with mechanical hot-gas producers. The unit is designed for heat recovery from 60,000 lb. of waste gases per hour at 800 deg. C., the latter, like all figures on which the design was based, being conservative, since reliability and long availability were dominant factors in the conception of the plant, and all recovery figures were toned down to avoid any suggestion of wishful thinking. The nominal output of the alternator driven by the gas turbine is 700 kW. The layout is linked with an orthodox steam recovery circuit, and any stoppage of the gas-turbine unit can be countered by by-passing the entire gas flow to the boiler (one operational and one stand-by) which will always be producing steam at 120 lb. per square inch. The installation is shown diagrammatically in Fig. 1.

The turbine is a closed-cycle machine made by John Brown and Company, Clydebank, and has eight stages. The compressor is partly axial (10 stages) and partly radial (three wheels), the reason for the change-over to the latter design for the high-pressure end being dictated by the desire for high overall compressor efficiency, as at 142 lb. per square inch absolute (the operational air pressure) the air volume is greatly reduced, which militates against an all axial-flow machine for such a small gas weight. An inter-cooler is located between the two compressor units, the loss in sensible heat being more than compensated for by increased compressor efficiency. The net pressure ratio of the turbine circuit is 4, or 4·46 gross, i.e., allowing for internal pressure losses. At no point in the circuit is the pressure below 30 lb. per square inch absolute at normal load.

Turbine, compressor and primary main gear shaft are all coupled in line, the alternator and its exciter being driven through reduction gearing. The main air preheater shown in Fig. 2, is built of $1\frac{3}{4}$-in. tubing arranged in three banks to facilitate cleaning on the hot-gas side, and the first section is fabricated from alloy tubing (Firth-Brown F.C.B.) followed by molybdenum-steel and then plain carbon-steel sections. The air will be heated to a temperature of 600 deg. C. (1,120 deg. F.) with a corresponding maximum tube-metal temperature of 640 deg. C. (1,184 deg. F.), which is well within the operational limits of the material used, i.e., with due regard to creep stresses. The recuperator, slung underneath the power unit, is of particular interest, as the heating surface consists of bundles of $\frac{1}{4}$-in. outside diameter tubing, this small size being possible as clean air flows on both sides of the heating surface. This effects great economy in space; in fact, with the pressurised circuit employed, compactness is a feature of the entire plant.

The motive air leaving the regenerator for the compressor is passed through a pre-cooler; whereas this could be designed in two sections, the primary (i.e., hotter) end being used for waste-heat boiler feed heating, a unique feature at Coventry is that all the well water used in the works will be passed through this cooler *en route* to the central hot-process softening plant; in other words, a credit for heat recovery not often available will add to the overall thermal efficiency of the plant.

The turbine rotor is constructed of steel alloy containing nickel, chromium, molybdenum and columbium; the turbine blades are of similar material. The general design and construction of the turbine closely follow steam-turbine practice, with due regard to the latest aerodynamic research on blade design. The alternator will feed into the works mains at 400 volts, 50 cycles, and electricity surplus to internal requirements will be stepped up by a transformer to 6,000 volts for the grid.

TABLE I.—*Heat Balance for 700-kW Gas Turbine. (All Values given as Percentages of Heat Input in Motive Air.)*

Turbine, gross output	87·5	—
Power absorbed by compressor	57·5	—
Net output at blading	30·0	—
Mechanical losses	1·5	1·5
Power consumed by auxiliaries, and leakage loss	3·5	3·5
	5·0	—
Net output at coupling	30·0–5·0	25·0
Heat absorbed by pre-cooler	—	40·0*
Heat absorbed by intercooler	—	28·5
Radiation loss	—	1·5
		100·0

* Partly recovered, as explained in text.

Table I gives the heat balance of the gas-turbine unit, and criticism may be made that potential losses are rather magnified, but this is because of the basic conservatism underlying the promise of the complete unit. Fig. 4, opposite, shows the relationship between the output of the plant and the tube weight of the air preheaters. Since about 4,500 lb. of steam per hour are required when the gas turbine is running, the gas temperature leaving the air preheater was fixed at 475 deg. C. (887 deg. F.), a point on the curve which was extremely satisfactory for good "cost" efficiency of the preheater, i.e., comparing heat transfer with weight and, therefore, size and cost of heater. Tables II,

* Excerpt from a paper on the "Application of the Gas Turbine for Recovery of Waste Heat," presented at the 18th Autumn Research Meeting of the Institution of Gas Engineers, held in London on November 25 and 26.

WASTE-HEAT GAS-TURBINE PLANT.

Fig. 4. RELATIONSHIP BETWEEN ELECTRICAL OUTPUT AND SIZE OF MAIN AIR HEATER.

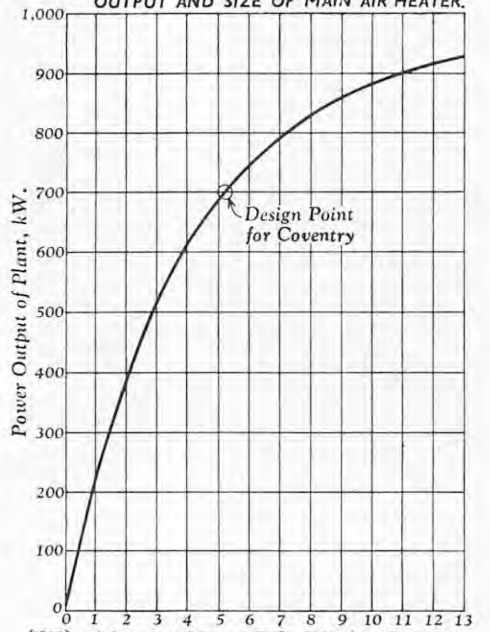
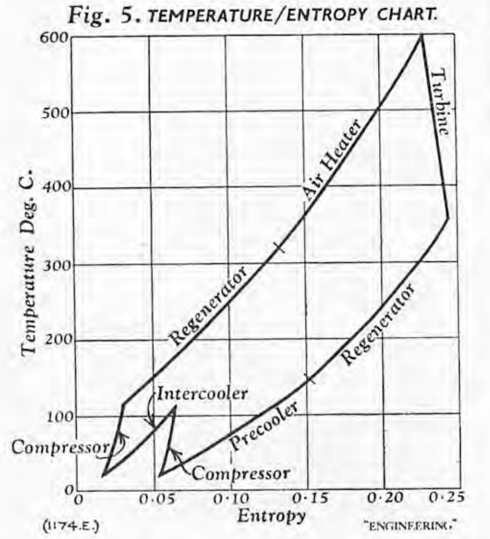


Fig. 5. TEMPERATURE/ENTROPY CHART.



III and IV give a summary of the main design features of the Coventry unit.

As gas turbines are not self-starting, they must be run up by external power supply, and steam-turbine starting was preferred to an electric motor on the Coventry unit, in order to avoid mains and switchgear cost, steam being available from the waste-heat boiler steam main. (The boiler will always be in operation first.) The gas turbine is actuated by opening the air-heater dampers, as the set is motored by the steam unit. If surplus steam from waste-heat boilers is available, the starting turbine can be kept in operation to augment the gas-turbine power supply and, incidentally, to give useful data on the combined air-turbine and steam-turbine power cycle. The author considers this combined cycle to be a fruitful field for future developments, combining as it does the advantages of the gas turbine at the high-temperature end of the cycle with the outstanding virtue of steam carried down to a high vacuum at the lower end of the curve.

TABLE II.—*Design Features of Coventry Turbine and Compressor.*

—	Turbine.	L.P. Compressor.	H.P. Compressor.
Speed (r.p.m.) ..	9,800	9,800	9,800
Number of stages ..	8	10	3
Blade length (in.) ..	1·14 to 2·89	—	—
Rotor diameter (in.) ..	11·58	21·5	18·25
Tip speed (ft. per sec.)	742	920	780
Air pressure input (lb. per sq. in. abs.) ..	137·8	32·2	60·4
Air pressure output (lb. per sq. in. abs.)	34·3	61·2	142
Temperature input (deg. F.)	1,112	77	77
Temperature output (deg. F.)	680	210	261
Compression expansion ratio	4	1·9	2·35
Mass flow of air (lb. per hr.)	72,000	72,000	72,000

TABLE III.—*Design Features of Main Air Preheater.*

Effective heating surface (sq. ft.)	2,950
Tube outside diameter (in.)	1¾
Effective length per tube (ft.)	114
Number of elements	60
Total effective length of tubes (ft.)	6,840
Air velocity in tubes (ft. per sec.)	75
Gas inter-tube velocity (ft. per sec.)	75
Maximum air pressure (lb. per sq. in.)	142
Air temperature at inlet, deg. F. (deg. C.) ..	623 (327)
Air temperature at outlet ,, ,, ...	1,112 (600)

TABLE IV.—*Design Features of Regenerator.*

Outside diameter of tubes (in.)	¼
Inside diameter of tubes (in.)	3/16
Length of each tube (ft.)	17
Effective length of each tube (ft.)	15⅓
Number of tubes in each bundle	81
Number of bundles	114
Total number of tubes	9,234
Total length of tubing (miles)	26·8
Total effective area based on outside diameter (sq. ft.)	9,250
Total effective area based on bore (sq. ft.)	6,910
Air velocity inside tubes (ft. per sec.)	26·4
Air velocity outside tubes (ft. per sec.)	45·8
Heat-exchanger effectiveness, i.e., "tube efficiency" (per cent.)	87

Normally, the gas turbine will run at full power continuously, but output governing is available (if and when necessary) by varying the pressure in the circuit, and by so doing modifying the heat-transfer coefficient; or by by-passing a proportion of the waste gases around the air preheater. In this latter case, lower electric demand would mean higher steam yield. A third method of power control is by stage by-passing in the turbine itself.

The plant comprises many interesting mechanical engineering features: the author will content himself with mentioning just one, the gland sealing, the John Brown design of which is shown in Fig. 3, opposite. Leakage of hot air along the turbine shaft at the high-pressure end is prevented by leading a bleeder of cold air from the high-pressure compressor to the labyrinth. This air being at higher pressure than the turbine inlet, cold sealing air leaks inwards and helps to cool the rotor face, after which it expands in the turbine itself. Any proportion of this sealing air that leaks outwards is led back to the low-pressure compressor inlet. The oil-sealing glands on the turbine shaft are, therefore, satisfactorily insulated from the effects of high temperature, and potential circuit leakage is reduced to a fractional quantity. Fig. 5 is the entropy diagram for the Coventry unit.

The author much regrets that, owing to material delays in connection with the installation of the retort house for which this plant is destined—delays outside the control of the main contractors—completion has been held up, but operation is confidently expected by the summer of 1953. The original conception of the scheme that became contractual for Coventry emanated from Spencer-Bonecourt, Limited. Co-operation was then effected with West's Gas Improvement Company, Limited, and John Brown and Company, Limited, were brought into the picture at an early stage, as the latter (in conjunction with Escher-Wyss) were already in a position to put forward a proved design of turbine and compressor unit. Subsequently, the very closest collaboration was set up with, firstly, the Coventry Corporation Gas Department (Mr. J. Wakeford, M.B.E., M.Inst.Gas E.), followed by the Coventry District of the West Midlands Gas Board (Mr. A. Allen, M.Inst.Gas.E.) and his local engineering staff.

JOINTING COMPOUND.—A new jointing compound which can be used either to improve the efficiency of metal-faced gaskets or by itself in place of paper, oiled paper and similar materials, has been introduced by Richard Klinger, Ltd., Klingerit Works, Sidcup. It will withstand pressures of up to 100 atmospheres (1,422 lb. per square inch), and temperatures up to 572 deg. F.

TRADE PUBLICATIONS.

Sugar-Cane Mills.—The Mirrlees Watson Co., Ltd., Glasgow, have sent us a small brochure describing some of the sugar-milling plants which they have installed in various parts of the world since the end of the war. Those described include a 15-roller plant in Peru, an 18-roller plant in Natal and a 21-roller mill for Cuba.

Electronic Engine Indicator.—Standard Telephones and Cables, Ltd., Connaught House, Aldwych, London, W.C.2, have issued a booklet on their Standard-Sunbury cathode-ray engine indicator as developed by them in conjunction with the Sunbury Research Laboratory of the Anglo-Iranian Oil Co., Ltd.

Mobile Cranes.—A series of leaflets dealing with their range of Coles mobile cranes has been received from Steels Engineering Products Ltd., Crown Works, Sunderland. The leaflets contain a surprising amount of information and refer to: 6-ton, 10-ton and 15-ton rail cranes; 1-ton, 6-ton, 10-ton and 20-ton mobile cranes; and 6-ton, 10-ton and 20-ton lorry-mounted cranes.

Aluminium in Public-Service Vehicles.—The Aluminium Development Association, 33, Grosvenor-street, London, W.1, have issued a guide to the use of aluminium in public-service vehicles. This publication, which costs 2s. 6d., is designed to place authoritative data on aluminium before builders and operators. Sections of the book deal separately with cast and wrought materials, giving in each case a guide to selection in respect of different requirements such as strength, ductility and machineability. Brief notes on workshop practice are also given and appendices tabulate the properties of aluminium in various forms, stock sizes and weights, specific gravities, etc.

Vertical Oil Engines.—Ruston & Hornsby Ltd., Lincoln, have published a catalogue which deals with vertical oil engines of the medium-speed industrial class having outputs ranging from 102 to 1,560 h.p. Known as the class VB engines, these units have been designed for economy of operation combined with ease of upkeep. They operate at speeds ranging from 375 to 600 r.p.m. and are available in 23 power sizes. The catalogue, in addition to containing full specifications, gives details of the makers' Lincoln works and includes a section on dual-fuel engines.

Earth-Moving Equipment.—Full details of their 4½-cub. yd. Muir-Hill dump truck are contained in an illustrated brochure received from E. Boydell & Co. Ltd., Elsinore-road, Old Trafford, Manchester. This machine is powered by a six-cylinder Diesel engine and is fitted with a rotating seat and steering column which enables the driver always to face the direction of travel. Four speeds are available in both directions.

Saw-Pad Handle.—We have received from James Neill & Co. (Sheffield) Ltd., Napier-street, Sheffield, 11, a leaflet giving details of their new Eclipse pad handle for use with hacksaw blades. This is now moulded from a tough plastic and is designed so that the clamping device can be fixed either above or below the cutting edge.

Cast Milling Cutters.—Some interesting information on their range of cast milling cutters is contained in a leaflet issued by B.S.A. Tools Ltd., Birmingham. It is claimed that these cutters have a performance equal to those made from 18 per cent. tungsten high-speed steel. The leaflet gives recommended cutting conditions, and details of the side-and-face and facing cutters available from stock.

Industrial Lubrication.—A new brochure designed to show how their industrial lubrication service can assist users of lubricants has been issued by C. C. Wakefield & Co., Ltd., 46, Grosvenor-street, London, W.1. The brochure refers briefly to colour coding, consumption charts, mechanical and manual lubrication and the selection of the correct lubricants, and goes on to show by an example how the service operates. A final section describes the firm's research work.

General Engineering.—A small booklet, the object of which is to provide buyers with a concise account of their organisation and range of products, has been issued by J. Brockhouse & Co. Ltd., West Bromwich, Staffordshire. In addition to containing a guide to the products already made and marketed by the different companies in the group, the booklet refers to production capacity in certain engineering processes and to contract work they are prepared to undertake.

High Rupturing Capacity Fuses.—A pamphlet, received from the Brush Electrical Engineering Co., Ltd., Loughborough, describes the range of high rupturing capacity fuses with current ratings for 2 to 300 amperes which are the result of development work undertaken in the firm's Cardiff factory during the first 18 months.

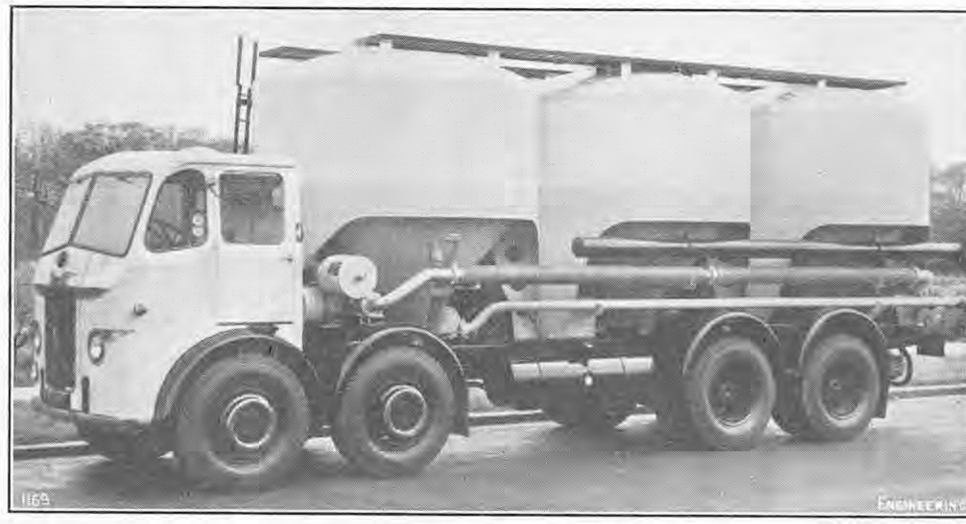
Pumps for Chemical Work.—Details of their A-N pumps, which are being used for a large variety of chemical work and the impellers and volutes of which can be changed to meet different conditions while employing the same bearing and support frame, are given in a publication received from Sigmund Pumps, Ltd., Team Valley, Gateshead, 11.

DISCHARGING FLOUR BY COMPRESSED AIR.

A VEHICLE for the bulk transport and hygienic delivery of flour, eliminating the use of bags and considerably reducing the time and labour involved, is to be introduced in Brazil by the flour-milling company of Matarazzo, Sao Paulo. They have ordered an eight-wheeled Diesel-engined flour-tanker lorry from Leyland Motors, Limited, Leyland, Lancashire. The vehicle, which is shown in the accompanying illustration, is based on the Leyland Octopus chassis, which has two steerable front axles and a double-drive rear bogie. The special equipment for carrying and discharging the flour, supplied by Messrs. H. Tollemache and Company, Limited, 166, Victoria-street, London, S.W.1, comprises three 8-ft. diameter hopper tanks and a system of discharge pipes through which the flour is delivered, in an airborne state, by introducing compressed air into the tanks. The latter have machined joints and are finished to a high degree of smoothness on the inside. They are also lined with Lithcote to protect the flour from direct contact with the metal. Each tank has a manhole at the top through which the flour is loaded from a longitudinal worm conveyor, through slidegate openings registering with the manholes. The tanks can be loaded simultaneously in less than 10 minutes.

When delivering flour to the bakeries, flexible 3-in. hoses, carried on the vehicle, are coupled to a permanent delivery pipe connected to the baker's flour-storage bin. Compressed air is fed to the top and bottom of the tanks by a Reavell rotary air compressor, driven from the five-speed gearbox of the vehicle, and the aerated flour flows through the discharge system into the bin. The pressure in the tanks is maintained at 15 lb. per square inch during discharging. The entire load can be delivered in 30 minutes. An oil separator is fitted in the air circuit to prevent oil from the compressor entering the air. A filter is also provided on the inlet side of the compressor, to prevent dust and dirt from entering the tanks.

DISCHARGING FLOUR BY COMPRESSED AIR.



THE INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND: PRESIDENTIAL ADDRESS.*

By SIR WILLIAM WALLACE, C.B.E., F.R.S.E.

(*Concluded from page 711.*)

WHERE are we to-day in our little island? In the last six months of 1951, we used up almost half our accumulated reserves in the sterling area, the British-dominated area where the pound reigns uneasily. At the rate we were going, to-night we might have met in a country with a deficit of 1,000*l*. millions—an indisputable calamity. Fortunately, we are assured that we are on the way to solvency. Half our food comes from outside Britain, and mostly from outside the sterling area. We must find the equivalent of dollars to buy two-thirds of our wheat, half our sugar and coffee, half our bacon, two-fifths of our butter, half our tobacco, half the iron for our steel industry, a substantial proportion of our lead, copper, tin and aluminium, much of our soft wood and nearly all our cotton. If we lose our ability to purchase these essentials where are we? Industry halted; unemployment general; a nation on half rations. We are not paying our way. In 1951 the overall deficit was equal to 10*l*. per head of our population. Statistics are poured out by Government departments, but politicians rarely state these facts in their speeches. They talk of benefits, a Welfare State, shorter hours, early retirement, more and bigger pensions.

The ex-agitator of the Clyde—David Kirkwood, now Lord Kirkwood—has seen the folly of it all. Hear his words from the red benches of the House of Lords: "We politicians—all of us, in all parties—have failed the workers in one important respect. We keep lecturing them about the need for increasing production and increasing exports. We have ladled out grave and gloomy warnings; we have wheedled them. What we have not done is to explain in clear enough terms just what the consequences of a real economic breakdown means. Ever since the war they have been reading about crises, one after the other, but they have never properly understood just what it is all about. And we, their so-called leaders, have not been able to tell them. They cannot see an economic crisis. It does not frighten them any more. What this country needs above all, at the moment, is a genius in simplification, someone with a heaven-sent gift of words who can make a living enemy out of 'economic crisis,' someone who can make the science of economics as easy to understand as the ABC, someone who can make 'Mr. Crisis' as evil and as dangerous as ever Mr. Hitler was. The workers are intelligent people, but few of them have had courses in economics. They have to be taught the bread and butter facts of this sinister figure called 'Crisis' who keeps creeping up on them and who may one day knock them down. Somehow we have got to find a way to tell them exactly what they are up against. We have got to explain, in a way and with a clarity we have never achieved before, the full background of the threat from 'Mr. Crisis,' and the full meaning of what will happen if we fail to beat him.

"Until we do that we will not get that extra drive, that extra sense of urgency, that industrial fervour which the economists tell us our critical condition demands."

What are the central facts of this crisis? We are 50 odd millions in this island, able to produce only half our bare needs. We have no natural wealth but coal, yet we cannot mine it in sufficient abundance to meet our own needs and provide a margin for what should be our most valuable export—coal. If we could raise another 20 million tons yearly for export, Britain would be placed in a strong negotiating position, able to conclude contracts abroad for essential raw materials on better terms than are possible to-day, and our economic position would be greatly strengthened. The coal is there, the machinery is there, the buyers are there—manpower alas, is lacking and aggravated by high absenteeism, principally among the younger members: the same people, the few dogs in the manger, whose action kept out the Italians brought here and trained with the full approval of the union.

Let us look at our population of 50 millions. Approximately 15 millions are under 15 years of age and we have to feed, clothe and educate them—all consumers. There are five millions over 65, the majority no longer producers—but consumers. There are 30 millions left. Of these, 10 millions are in State, local government and similar vocations. They produce service, they may work hard—but they are consumers. Then we have about 10 millions in the professions—banking, insurance, distribution, entertainment and the like—again, possibly working hard—but they are consumers. And of our 50 million consumers, 10 millions are left. They are all we have left as prime producers—coal, agriculture and fisheries, manufactured goods—and it is from this 20 per cent. of our population that we must obtain all the essentials to maintain our standard of life.

Can we survive as a nation, depending on export of manufactured goods, unless there is a complete change of outlook on the part of management, trades unions and all classes of workers? Advisers to the Government send out their warning. We send teams to other lands to study their methods; reports are made, comparisons drawn, and management made aware of changes that could be made to improve their output. With the exception of the installation of new equipment, how many of these suggestions can management use? Very few. Think of our industry and the disadvantages of demarcation and restrictive practices, particularly remarked upon in the Constructional Steel Productivity Report. We find a British shipyard with a volume of rules, all associated with demarcation of a variety of work which could be carried through by any competent trained individual. Think of the pipe work in a ship. Surely, in five years, a man could be trained to deal with all forms of piping; but, alas, this work must be spread among blacksmiths, plumbers, coppersmiths, fitters—a filling pipe to one trade, a sounding pipe to another trade, high-pressure pipes to another trade, and so on. Yet we hope to survive in a competitive world as shipbuilders, engineers and repairers, competing with nations whose managers have not grown up accepting these limitations as part of the daily routine. Has anyone here experience of a trade union whose attitude has changed following upon the recommendation of a report subscribed to by their representatives, a report that calls upon all to take a wider view of their responsibilities, to accept cheerfully a change of practice which might result in two men doing the work of three, and a capable individual allowed to tackle all work within his capacity? Surely, joiners and carpenters should be interchangeable, and one good man could carry through a repair which at present requires a plater, driller, caulker, and so on.

In engineering, we have a so-called semi-skilled man operating a machine worth thousands of pounds, but an old lathe worth 20*l*. must be operated by a skilled turner if the old tool happens to be capable of screw-cutting. One could give hundreds of examples of how our costs of production are swelled by the survival of these restrictive practices in a land severely handicapped by a shortage of skilled men. A well-known and successful shipbuilder in Sweden prophesied that demarcation might one day destroy Britain's great lead as the efficient shipbuilding nation of the world. Our men individually are grand, our management sound, our inventive capacity the envy of many nations; but this will not save us until we are producing more per man-hour and happily working longer hours. Germany, with a surplus of labour, is competing with our 44-hour normal week by working a normal week of 55 hours, and recently produced equipment

* Delivered in Glasgow on October 14, 1952. Abridged.

for a mill in India at a price 25 per cent. below the lowest British price, delivered the equipment in one-third of the time offered by the British contractor, and made a profit.

We cannot to-day view with complacency our position as shipbuilders. Except during the exceptional war years, when the shipbuilders of the United States produced ships on an unprecedented scale, Britain has maintained her position over the years as the greatest shipbuilding centre in the world. But in the last 20 years, while the total annual world tonnage launched dropped from approximately 5,000,000 tons in 1920 to 3,500,000 tons in 1950, and Britain from 2,000,000 tons to 1,340,000 tons, launchings in Denmark, France, Norway and Sweden all increased—Sweden five-fold. In 1920, Sweden launched one-thirtieth of the British launchings, but in 1950 increased the proportion to one-sixth. Ships owned in Britain have decreased by 600,000 tons between 1914 and 1951. Our Dominions increased their tonnage by 2,000,000 tons and world tonnage increased by 41,000,000 tons. Surely, if we are to survive, we must re-organise ourselves and convert our raw materials into finished saleable goods by the expenditure of the minimum number of man-hours; and thus, if we obtain from our 10 million producers the wherewithal, one day fill the gap between our exports and imports. Then, once again, Britain may face the world with a large exportable margin of coal, a greatly increased production of food, and, by all producers pulling together, ensure ability to export our manufactured goods at prices that will attract purchasers from other nations.

Can we not still rise to these heights? Post-war achievements in Britain have shown the world that we have retained all our inventive capacity. Our scientists, backed by research and development, have shown to all that we have the capacity still to lead. It appears that the curve of scientific achievement rises steadily, but our productive capacity, dependent upon efficient performance by labour, lags sadly behind. Think of what we have accomplished in our own field. Britain built the Dreadnought—a complete departure from past practice in her machinery, guns and armour. She was laid down at Portsmouth Dockyard in October, 1905; launched in February, 1906; went on her steaming trials in October, 1906, and was accepted in December, 1906. A remarkable achievement for a ship of 18,000 tons displacement, incorporating a new design of 12-in. turret and the first turbines installed in a capital ship. Perhaps even more remarkable was the Clyde's effort during the first world war—the construction of the battle cruisers Repulse and Renown, by John Brown and Company and the Fairfield Shipbuilding and Engineering Company. These ships were handed over to the Navy within 19 and 20 months, respectively. They were ships of 30,000 tons displacement, 800 ft. in length, and 120,000 shaft horse-power. Compare these performances with the present day, with all our modern equipment. Obviously, there is latent tremendous scope for increased efficiency in our own industry.

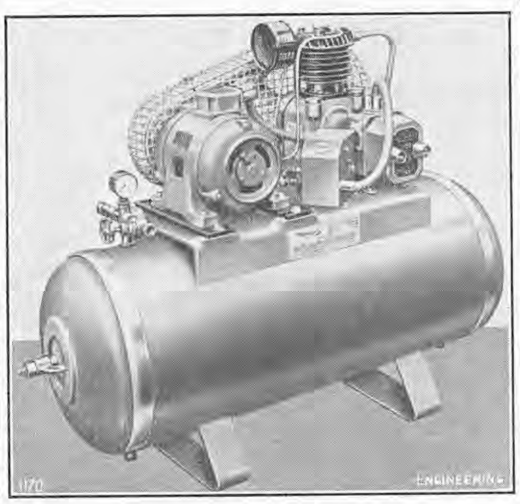
I am confident that we shall yet, under stress which is surely coming our way, once again show the world what we can do. We have the skill to fashion and fabricate. We in the shipbuilding industry can still produce goods at a price which the world is prepared to pay. Other industries, alas, are now finding their markets curtailed by high costs. How long can we hope to avoid this condition? The shipping world is not normal. Already there are signs of shipowners fearful of their ability to operate, profitably, ships purchased under present-day cost conditions. It is up to us all to do everything in our power to fight for efficiency in our manufacturing methods, so that we may be ready once again, as we have been in the past, to prove that British shipbuilding stands pre-eminent.

I appeal to our younger members, many of whom know nothing of our trials and tribulations except by reading past history, to keep ever before their eyes the necessity of building ships, not only to the owners' technical specification, but at a price he can afford to pay. On my own special subject, I wish to remind them that the electrical industry with all its wonders of electronics, etc., will offer apparent solution of nearly all our problems associated with the control of energy, but I do commend to our young engineers the study of hydraulics, so widely applied to-day in ships, aircraft, machine tools, servo problems, etc. Higher and higher pressures are being called for, but whether we are on the right road requires careful examination. Perhaps, as a subject for a paper of particular interest to marine engineers, one providing an unbiased study of installations operating at high pressures would be welcome; for example, one comparing a marine auxiliary, operating at, say, 2,000 lb. per square inch, with one operating at 4,000 lb. per square inch—comparing weight, etc., using same factors of safety, and analysing carefully production and maintenance costs of the different systems.

May I again remind you that we are of the 10 million producers? We are the fighting men in the battle for economic survival: on us, with other producers, depends Britain's rise or fall. I pray we may not fail our country.

COMPRESSOR UNITS FOR GARAGES AND SMALL WORKSHOPS.

Two electrically-driven self-contained compressor sets for use in garages and small engineering workshops have been developed recently by the Hymatic Engineering Company, Limited, Redditch, Worcestershire. One of these units, the G3, has a 1-h.p. motor, driving at 700 r.p.m. a Compressor which has a capacity of 5 cub. ft. per minute at a maximum working pressure of 150 lb. per square inch. It is suitable for tyre inflation, high-pressure greasing and spray-painting with an industrial spray gun, for which purpose it has a small nozzle attachment.



The other compressor set, the G.2, illustrated herewith, is designed for use with spray guns of a larger consumption, and is fitted with a 2-h.p. motor driving, at 1,000 r.p.m., a compressor delivering 7 cub. ft. per minute at 100 lb. per square inch.

The compressor is of the single-stage air-cooled pedestal-mounted type, supported on a 28-gallon cylindrical air receiver. Aluminium alloys are extensively employed in the motor and compressor unit. The compressor has a forged-steel crankshaft, carried in heavy-duty ball bearings. The connecting rod, also of forged steel, has shell-type white-metal big-end bearings. The crankshaft is provided with an oil seal at the driving end. The compressor cylinder, of close-grained cast iron, has a bore of 68 mm. and a stroke of 55 mm. The cylinder head is aluminium, and light-weight large-diameter plate valves are employed. Splash lubrication is provided by an oil dipper on the big end. The oil sump is of generous capacity. The cylinder walls are cooled by a fan pulley, driven by twin V-belts from the electric motor. The air receiver is provided with an automatic pressure control and unloader which switches off the compressor motor when a predetermined pressure is built up in the receiver.

NOTES ON NEW BOOKS.

Sub-Station Practice.

By T. H. Carr, M.I.C.E., M.I.Mech.E., M.I.E.E Second edition. Chapman and Hall, Limited, 37, Essex-street, London, W.C.2. [Price 55s. net.]

The first edition of this book was published in 1946, when we observed that it dealt with the design, construction and operation of substations, rather than with the details of their equipment. In the present edition, nearly one-third of the pages are devoted to such matters as types of substations, constructional works and plant layout, while further sections cover various operating and control problems. This is an advantage, since such questions tend to be neglected in dealing with the subject. There is a wide variety of substations, and they are called upon to perform a variety of functions. The author has dealt adequately with these both as regards layout and construction, although the treatment is generally descriptive rather than critical. Some useful practical information about equipment is also given. Under the heading of converting plant, rotary converters and motor generators are not entirely neglected for rectifiers, although the prominence of the latter equipment in present-day practice is rightly recognised. Protective apparatus receives due consideration, and this part of the book should form a useful introduction to a more detailed study of a complicated subject. Altogether, the book is one to be recommended, but some more energetic attempt might have been made to bring the bibliographies at the end of each chapter up to date, as many advances have been recorded since the first edition was published; and more care might have been taken in the preparation of the line diagrams.

Towards Perfection.

By E. Elmitt Edwards. The Electrical Association for Women, 35, Grosvenor Place, London, S.W.1. [Price 2s. 6d.]

Two years ago the Electrical Association for Women sent out an elaborate *questionnaire* in which housewives were asked to record their views on the design and performance of certain types of domestic electrical apparatus. The present report is based on the data entered on these documents. It contains much that should be of future value. Cookers, fires and heaters, irons, kettles, refrigerators, vacuum cleaners, wash boilers, washing machines, water heaters and miscellaneous apparatus are all considered and from these considerations certain salient points emerge. One is the exceptional longevity of much of the apparatus in use, a quality which, though it reflects credit on the manufacturers, may perhaps constitute an obstacle to progress. The other is that, though the needs of the housewife are diverse, they are in general neither ridiculous nor impossible of achievement. Perhaps the greatest differences of opinion appear in the case of electric fires and heaters, both as regards design and performance, and in this and other cases it is clear that both the first cost and the running cost are factors of importance. A much-desired improvement in the electric kettle is that it should boil water more quickly, while another requirement is that the design should be such that small quantities can be safely heated. Mention is made of the need that refrigerators and vacuum cleaners should be made to work more quietly and that washing machines should be fitted with emptying pumps.

The Caterham Railway: The Story of a Feud—and its Aftermath.

By Jeoffry Spence. The Oakwood Press, Tanglewood, South Godstone, Surrey. [Price 7s. 6d. (10s. 6d. in cloth).]

There is a refreshing candour about Mr. Spence's explanation of his reasons for writing a book of 84 pages, embellished with two good maps and eight half-tone plates, about a branch line only $4\frac{1}{2}$ miles long. They are four in number: "because," he states, "it is my line and I wanted to write about it; secondly, because a large body of men is interested in railway history; thirdly, because local people are often glad to know that 'their line' had a more colourful past than one might, perhaps, think; and lastly, because I have an opinion . . . that history of any sort . . . is of real importance in teaching us about those mistakes which can help to guide us on to the right path for the future." They are all good reasons, and in this instance they are justified by the result, which is not only interesting for its wealth of detail, but throws a vivid light on the mutual relations between the larger railway systems—in this case, the South Eastern Railway and the London, Brighton and South Coast Railway—which so greatly complicated railway travel in this country in the Victorian era, and traces of which still complicate it to-day, in spite of amalgamations and nationalisation.

Proceedings of the Fourth Electrical Power Convention, 1952.

British Electrical Power Convention, 16, Stratford-place, London, W.1. [Price 10*s*. 6*d*.]

THIS book (which has been published with commendable promptitude) contains a full account of the proceedings at the fourth British Electrical Power Convention, which was held at Bournemouth from June 16 to 18, 1952, under the presidency of Mr. P. V. Hunter. As those who attended will remember, the keynote of this gathering was research, which was dealt with in seven specialised papers covering most of the electrical aspects of the subject. In addition, there were papers on the domestic cooking, water heating and comfort heating loads, and on high-performance dielectrics. The book contains full reprints of all the papers read, with the discussions upon them, as well as reports of the speeches at the annual dinner and general meeting. It forms a useful record of an important gathering and a valuable work of reference.

Memorandum on Non-Destructive Methods for the Examination of Welds.

The British Welding Research Association, 29, Park-crescent, London, W.1. [Price 5*s*., post free.]

THIS booklet outlines the non-destructive methods which are available for the examination of welds and welding constructions, and is intended as a guide for engineers and inspectors who may be unfamiliar with the advantages and limitations of the various methods. Beginning with a description of semi-destructive methods, in which a portion of a weld is removed for examination without damaging the construction, it goes on to deal in turn with radiographic, magnetic, penetrant, electrical, chemical and acoustical methods. In each case, general principles are outlined, the apparatus required is described, and the method of use is dealt with. A useful feature is the numerous references to other publications.

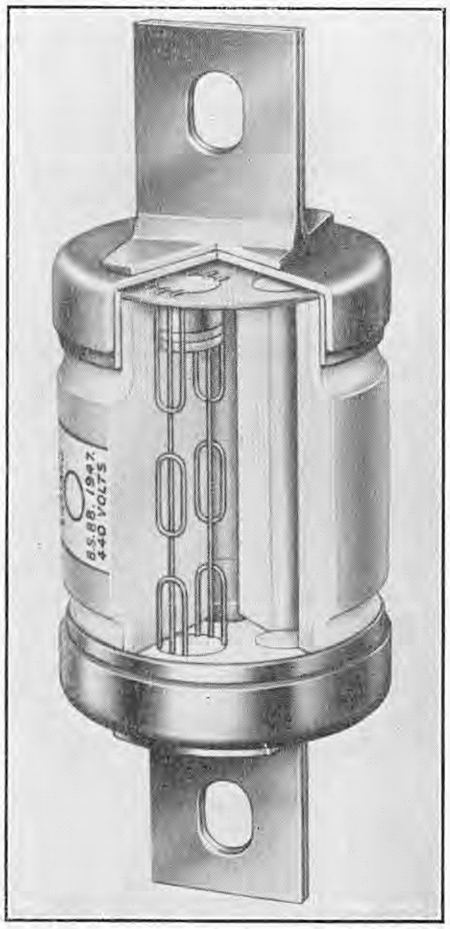
Colliery Rope Haulage and Rope Splicing.

By JOHN KIMBER, JUN. The Colliery Guardian Company, Limited, 30 and 31, Furnival-street, London, E.C.4. [Price 30*s*. 6*d*. post free.]

IT is no exaggeration to say that this is a noteworthy book. The author is a practical rope-smith in a South Wales colliery, whose whole working life has been spent on the installation, maintenance and repair of wire ropes and associated equipment. The publishers state that he has developed a natural gift for exposition by part-time teaching at technical colleges; certainly, it is unusual to find practical men who can pass on the "know-how" (and the "know-why") of their skills as successfully as Mr. Kimber. In addition to writing the text, he has prepared over 200 drawings, which, though they are not masterpieces of modern technical illustration, do reveal the practical man's fundamentally practical outlook. The same attractive quality is found in the text, which is concerned with the construction, handling, care, splicing, repair and maintenance of ropes, as well as sheaves and systems of colliery rope haulage. Not only in collieries, but in all workshops where wire ropes are used will this book be found useful. In a time of universal education it is curious that so few books come from the men on the shop floor. Mr. Kimber raises a hope that other craftsmen will go and do likewise.

300-AMPERE HIGH RUPTURING CAPACITY FUSE.

THE accompanying illustration shows an example of the high rupturing capacity fuses which are now being produced for ratings of between 2 and 300 amperes at the Cardiff works of the Brush Electrical Engineering Company, Limited. It consists of fuse elements of pure silver, which are surrounded by an inert granular material, the combination being enclosed in a ceramic body. The elements are in one or more sections which volatilise under fault conditions, the resulting arc being absorbed by the surrounding filling and forming a non-conducting section with a high



break-down value. Any harmful rise in voltage which might occur when the fuse operates is prevented by shunt wires of high resistance and small diameter. One of these wires is arranged to give an indication of the healthy or blown condition of the fuse link. The end caps are provided with suitable connectors of high-conductivity copper and all the external current-carrying parts are electro-tinned. The fuses comply in all respects with the appropriate British Standard Specification, and have been certified by the Association of Short-Circuit Testing Authorities. As a matter of history, it may be noted that the high-tension fuse invented by Moreley in 1893 was first placed on the market by the Brush Company.

THE CHRISTMAS LECTURES OF THE ROYAL INSTITUTION.—The director of the Science Museum, Dr. F. Sherwood Taylor, M.A., B.Sc., will deliver this year's course of Christmas Lectures, the 123rd of the series, at the Royal Institution, 21, Albemarle-street, London, W.1. The lectures, which are, as always, specially adapted for "a juvenile auditory," will this year be entitled "How Science Has Grown." There will be six lectures in the course, to be delivered at the Institution on December 27 and 30, 1952, and on January 1, 3, 6 and 8, 1953, commencing at 3 p.m. in each instance. The individual lectures will be entitled The First Beginnings of Science; Experimental Science Begins; Science in the Eighteenth Century; The Refounding of the Sciences; The Beginning of the Harvest; and Science Takes the Lead, respectively. The fee for the course is 20*s*. for juveniles aged 10 to 17 and 40*s*. for adults who are not members of the Institution. Tickets and further particulars may be obtained from the secretary of the Institution at the address given above.

BOOKS RECEIVED.

Sell's National Directory and British Exporters' Register, 1952. Business Dictionaries, Limited, St. Dunstan's House, 133-137, Fetter-lane, London, E.C.4. [Price 50*s*.]

Productivity Team Report: Woodworking Machinery. Report of a Productivity Team Representing the British Woodworking Machinery Industry which visited the United States of America in 1951. Anglo-American Council on Productivity, 21, Tothill-street, London, S.W.1. [Price 3*s*. 6*d*.]

F.B.I. Register of British Manufacturers, 1952-53. Kelly's Directories, Limited, 186, Strand, London, W.C.2, and Iliffe and Sons, Limited, Dorset House, Stamford-street, London, S.E.1. [Price 42*s*., post free.]

Gewindewalzen. By HEINZ APEL. Carl Hanser-Verlag, Leonhard-Eck-strasse 7, Munich 27. [Price 24·80 D.M.]

Prüfen und Messen von Gewinden. By DR. FRITZ WOLF. Carl Hanser-Verlag, Leonhard-Eck-strasse 7, Munich 27. [Price 10·50 D.M.]

Road Engineering. By E. L. LEEMING. Constable and Company, Limited, 10-12, Orange-street, London, W.C.2. [Price 30*s*. net.]

Government Information and the Research Worker. Lectures delivered at a Vacation Course of the University of London School of Librarianship and Archives in April, 1951. Edited by RONALD STAVELEY. The Library Association, Chaucer House, Malet-place, London, W.C.1. [Price 18*s*. to members of the Association; 24*s*. to non-members.]

A Selection of Tables for Use in Calculations of Compressible Air Flow. Prepared on behalf of the Aeronautical Research Council by the Compressible Flow Tables Panel. Oxford University Press (Geoffrey Cumberlege), Amen House, Warwick-square, London, E.C.4. [Price 40*s*. net.]

Ministry of Housing and Local Government: Model Byelaws. Series IV. *Buildings.* H.M. Stationery Office, Kingsway, London, W.C.2. [Price 2*s*. net.]

National Building Studies. Research Paper No. 13. *Studies in Composite Construction. Part I. The Composite Action of Brick Panel Walls Supported on Reinforced Concrete Beams.* By DR. R. H. WOOD. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 2*s*. net.]

Report of the Hydraulics Research Board for the Years 1947-1951, *with the Report of the Director of Hydraulics Research for the Years* 1948-1951. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 3*s*. net.]

International Association for Bridge and Structural Engineering. Publications. Twelfth volume. 1952. Verlag Leemann, Stockerstrasse 64, Zürich 39. [Price 38 Swiss francs.]

Automatologie. By WOLFGANG SCHMID. Carl Hanser-Verlag, Leonhard-Eck-strasse 7, Munich 27. [Price 23 D.M.]

Fire Protection Year Book, 1953. Compiled by GEOFFREY D. PRATT. Benn Brothers, Limited, Bouverie House, Fleet-street, London, E.C.4. [Price 12*s*. 6*d*., post free.]

Newnes Engineer's Reference Book. Edited by F. J. CAMM. Fifth edition. George Newnes, Limited, Tower House, Southampton-street, London, W.C.2. [Price 63*s*. net.]

Select List of Standard British Scientific and Technical Books. Edited by E. R. MCCOLVIN. Fourth revised and enlarged edition. Aslib, 4, Palace-gate, London, W.8. [Price 6*s*. to members of Aslib, 7*s*. 6*d*. to non-members.]

Modern Architectural Design. By HOWARD ROBERTSON. Second edition. The Architectural Press, 9-13, Queen Anne's-gate, London, S.W.1. [Price 25*s*.]

The Basis of Mine Surveying. By M. H. HADDOCK. Chapman and Hall, Limited, 37, Essex-street, Strand, London, W.C.2. [Price 30*s*. net.]

Welded Highway Bridge Design. Edited by PROFESSOR JAMES G. CLARK. The James F. Lincoln Arc Welding Foundation, Cleveland 17, Ohio, U.S.A. [Price 2 dols.]

Statistical Theory in Research. By PROFESSOR R. L. ANDERSON and T. A. BANCROFT. McGraw-Hill Book Company, Incorporated, 330, West 42nd-street, New York 36, U.S.A. [Price 7 dols.]; and McGraw-Hill Publishing Company, Limited, 95, Farringdon-street, London, E.C.4. [Price 59*s*. 6*d*.]

Die Hartmetallwerkzeuge in der spanabhebenden Formung. By DR.-ING. J. WITTHOFF. Carl Hanser-Verlag, Leonhard-Eck-strasse 7, Munich 27. [Price 16 D.M.]

Proceedings of the United Nations Scientific Conference on the Conservation and Utilization of Resources. 17 August-6 September, 1949, Lake Success, New York. *Vol. II. Mineral Resources. Vol. III. Fuel and Energy Resources.* Sales and Circulation Section, Department of Publication Information, United Nations, New York, U.S.A. [Price 3 dols. each volume); and H.M. Stationery Office, Kingsway, London, W.C.2. [Price 22*s*. 6*d*. each volume.]

Report of the Building Research Board, with the Report of the Director of Building Research for the Year 1951. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 4*s*. 6*d*. net.]