

CENTRALISED MAINTENANCE AT THE WORKS OF MESSRS. STEEL, PEECH AND TOZER, ROTHERHAM.

THE Steel, Peech and Tozer branch of the United Steel Companies, Limited, is situated in Rotherham, Yorkshire, and is devoted mainly to the production and processing of large tonnages of mild, carbon and alloy steels, and the manufacture of forgings, railway wheels, tyres, axles and springs. As an indication of the size of the branch it may be mentioned that the annual ingot capacity is 800,000 tons—one-twentieth of the total production of the United Kingdom. The main works, long and narrow in shape, straddles the River Don and the main Sheffield-Rotherham road for a distance of approximately $1\frac{1}{2}$ miles.

As has been the case at many large steelworks, the post-war period with Messrs. Steel, Peech and Tozer, has been one of continual expansion and modernisation. Much new plant, of increased capability and of correspondingly greater complexity, has been installed. When these projects were in process of being planned during the second World War, it was realised that detailed attention would have to be paid to maintenance in view of

mines, two smelting furnaces and two forges in this district in the latter half of the Twelfth Century. A visitor to the district in 1550 is quoted as having written "... a mile from Rotherham be veri good pittes of cole. In Rotherham be veri good smithes for all cutting tooles;" and it is interesting to note that the *Sheffield Register* of 1650 records "This century steel was made at Rotherham and brought here." It is known that a blast furnace was built on the present site of the works by the Earl of Effingham in 1740, and that this was blown by leather bellows operated by water power, obtained from the River Don.

Between 1840 and 1850, the rolling of steel was carried out on the property, which is described as the "Ickles Rolling Mill (Steel)" in an Ordnance Survey map made about 1850; and on this site the firm of Hampton and Radcliffe built and operated a steelworks in 1871. This works was bought in 1872 by the Phoenix Bessemer Steel Company, Limited, and, with several additions to the plant, was sold in 1875 to Mr. Henry Steel, who founded the company of Steel, Tozer and Hampton, Limited. In 1883, the name of the firm was changed to Steel, Peech and Tozer. About this time, the works had six Bessemer converters and produced 2,750 tons of steel ingots weekly, the cogging mill being capable of an output of 2,600 tons of ingots

mills and the strip and bar mills commenced operations.

Since then, progress has been continuous and, except during the troubled years of 1926 and 1931, there has been a steady increase in the output of steel and rolled products. This is demonstrated by the figures given in Table I, herewith. This sustained and successful effort is due mainly to improvements in methods and to increasing efficiency in the use of plant and machinery, and is the natural consequence of the constant research and development that has been necessary in order to produce and sell at economic price levels.

THE PRESENT PLANT.

The production plant now in use at the works is of a very varied nature, by reason of the wide range of finished and semi-finished products manufactured. All the steel made is produced by the open-hearth process in two melting shops, situated at opposite ends of the works. The normal output of ingots is in the region of 16,000 tons weekly. The Templeborough melting shop houses 14 basic open-hearth furnaces, each of 80 tons capacity, fired either by oil or by pitch and creosote. Plans are in hand to increase the furnace capacities to 100 tons each. Ancillary equipment includes electric overhead ladle cranes, capable of lifting 120 tons.



FIG. 1. GENERAL VIEW OF WORKS.

the special nature and increasing size of the machinery to be installed. The over-riding feature was the wide variety of engineering work to be done. Some of this work had always been let out to specialised firms, who are well equipped both in plant and technical knowledge for particular jobs, and it was felt that a continuance of this policy would be justified; but most of the engineering work (that concerned with day-to-day upkeep) could not easily be placed with outside contractors, so there would need to be an overhaul of the existing maintenance arrangements if these were to keep pace with the increasing demands of production facilities. Before describing in detail how this has been accomplished, however, it is desirable to outline the development of the works and to summarise the main items of plant requiring systematic maintenance.

The works are built on the site of the Roman fort of Templeborough, which dates from approximately A.D. 50, and there is material evidence, in the form of an iron slag bed and beds of charcoal, that the Romans smelted iron there in the early years of the Second Century. Probably the first recorded evidence of iron-making in Rotherham is a document of 1161, in which permission is given by Lord de Busili, Lord of the Manor of Kimberworth, to the monks of Kirkstead, in Lincolnshire, to erect four furnaces at Kimberworth. Historians, too, have referred to the existence of ironstone

per week. In addition, there was a 14-in. mill, rolling 150 tons weekly of spring steel, wire billets, rounds and squares.

Steel, Peech and Tozer, Limited, first began to make open-hearth steel in 1892, when a single Siemens acid furnace of 15 tons capacity was built and tapped. Further furnaces were added subsequently and, by 1911, there were eight of them in addition to the Bessemer plant. The works property then covered 50 acres and some 2,000 men were employed; the annual ingot make was 200,000 tons. Expansion and development took place during the first World War, and in 1918 the Templeborough melting shop was built. This proved to be a turning point in the history of the works, because it enabled the company to concentrate on the large-scale and economic production of steel. In 1922, the Templeborough cogging and billet

The mild, carbon and alloy steels produced here are used for forging, stamping, re-rolling, drawing and pressing, tube-making, bright drawing, free-cutting purposes, and for wire manufacture.

The Rotherham melting shop has seven furnaces, each of 60-65 tons capacity, fired by producer gas and used (with the appropriate lining) for making acid or basic steel. Here, ingots of up to 65 tons are made. This melting shop is mainly engaged on the production of high-carbon, medium-carbon and alloy steels, the greater part of which is used within the works for the manufacture of forgings, railway tyres, wheels, axles and springs, and rolled products.

The soaking pits are located between the Templeborough melting shop and the cogging mill. They consist of 32 gas-fired and oil-fired recuperative chambers, each of which normally accommodates ten 70-cwt. ingots, charged and withdrawn by overhead cranes. The ingots are transferred to the cogging mill by an electrically-driven tipping car. The cogging mill has 43-in. rolls and is driven by an electric quick-reversing motor of 15,500 h.p. The throughput of ingots in normal circumstances is rather more than 17,000 tons per week. A hot de-seamer is provided to de-seam the blooms as they leave the cogging mill.

The billet mills reduce the blooms to billets which range in size from $1\frac{1}{2}$ in. square to $3\frac{1}{2}$ in. square, and consist of a four-stand 21-in. roughing train and a six-stand 18-in. finishing mill. Both

TABLE I. Steel Output of Steel, Peech and Tozer Ltd.

Year.	Ingot Production.	Cogging Mill, Tons.	Strip Mill, Tons.	Bar Mill, Tons.
1923 ..	396,403	202,851	24,851	52,602
1929 ..	411,919	299,608	30,417	82,318
1934 ..	519,737	516,373	58,893	106,934
1937 ..	613,248	506,892*	79,587	114,475
1943 ..	660,520	499,217*	77,072	130,697
1949 ..	763,596	680,512*	96,367	138,035
1950 ..	784,540	707,135*	114,596	138,765

* Excluding re-rolling blooms.

mills are driven from a common shaft to which is coupled a 5,000-h.p. electric motor. The billets are cut to length after they have passed through the finishing rolls by means of steam-operated flying shears.

Large round, square, slab or gothic shapes for forging purposes are rolled in a two-high 30-in. reversing mill, driven by a 7,000-h.p. electric motor. Some of the material passing through this mill is finished in two horizontal 21-in. mills and an interposed 18-in. vertical edging mill.

The continuous strip mill rolls steel strip up to 9 in. in width in a train of six roughing stands, two edging stands and six finishing stands. The roughing train is driven by a 1,500-h.p. electric motor, and the finishing train by a 2,500-h.p. motor. The tonnage produced in the mill averages about 2,400 per week. Facilities are available for descaling the hot-rolled strip in a continuous pickling plant.

The semi-continuous bar mill consists of a pinch roll followed by a continuous roughing train of six stands, with 14-in. rolls; four staggered "cross-country" stands containing 12-in. rolls are used for finishing. All the rolls are driven by the same 3,000-h.p. electric motor. In this mill are rolled rounds, squares, hexagons and flats, which are cooled and straightened on either of two oscillating beds, 300 ft. long. The weekly output averages about 2,800 tons. A fabricating department is included in the works and is equipped with machinery for hooking, bending, welding and screwing bars for concrete reinforcement, etc. There are also 10-in. and 14-in. mills, driven by separate electric motors of 500 and 750 h.p., respectively, which produce a wide range of rounds, squares, hexagons, octagons, ovals, flats and special sections.

The cold-rolling department is equipped with two four-high reversing mills, each capable of an output of 150 tons weekly of steel strapping; and there is a third four-high reversing mill, for the finishing passes on tube strip, with a capacity of 220 to 260 tons per week. The ancillary equipment includes slitting and coil wrapping machines.

The press shop contains a double-cylinder steam-hydraulic intensifier forging press of 2,230 tons pressure, capable of forging ingots up to 60 tons in weight. It produces 400 to 500 tons a week of forgings for rolls, pinions, marine shafting, turbine rotors, cylinders, gearwheel rims and other heavy machinery parts. The axle hammer shop is equipped with a 6-ton double-acting steam hammer and is designed for the continuous production of axles for railway rolling stock. Facilities are provided also for straightening, sawing and heat-treatment. A scheme is at present under consideration for the erection of new shops, with a better lay-out. Under a 5-ton hammer are forged axles in small quantities, armature shafts and other shafting, small rolls, and engineering components weighing between 5 cwt. and 2 tons.

The drop-stamp department is equipped with two 2-cwt. pneumatic hammers and one of 7 cwt., eight steam hammers of up to 15 cwt. capacity, one 25-cwt. hammer, and a drop-stamping hammer. These are used to forge parts for laminated springs, small gear rims, and rings for roller and ball races. In addition, there is an upset-forging machine with an 800-ton electrically-operated ram, for producing upset forgings from bar material.

In the railway tyre, wheel and spring department, blocks cut from ingots are heated and punched, and are then reduced to slabs of suitable shape in a 2,000-ton press. After further heating, the slabs are rolled in a roughing mill, the top roll of which is driven by a 400-h.p. steam engine and the bottom roll by a geared steam engine of 800 h.p. The correct size and shape are imparted to the slabs in a finishing mill, driven by a 1,000-h.p. steam engine. The average output of the mills is 500 tons per week.

The wheel mill, which is capable of producing 3,000 to 3,500 wheels weekly, is equipped with a continuous heating furnace from which the heated blocks are taken for forming into rough wheel blanks under a 6,000-ton press. The blanks are then re-heated and rolled in a mill driven by two 500-h.p. variable-speed motors. The final contour is given to the wheels by a 1,500-ton dishing press. The laminated-spring shops contain machinery for

WORKS OF STEEL, PEECH AND TOZER, LIMITED.

Fig. 2.

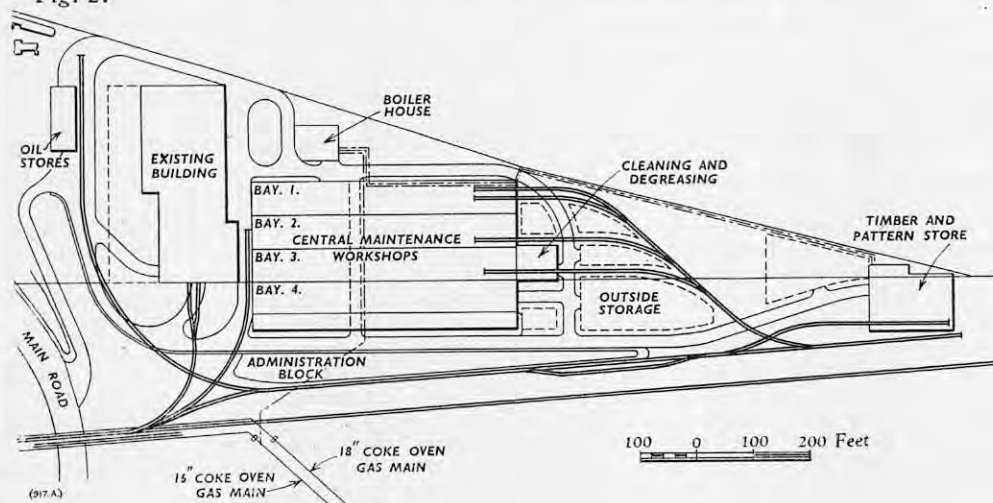
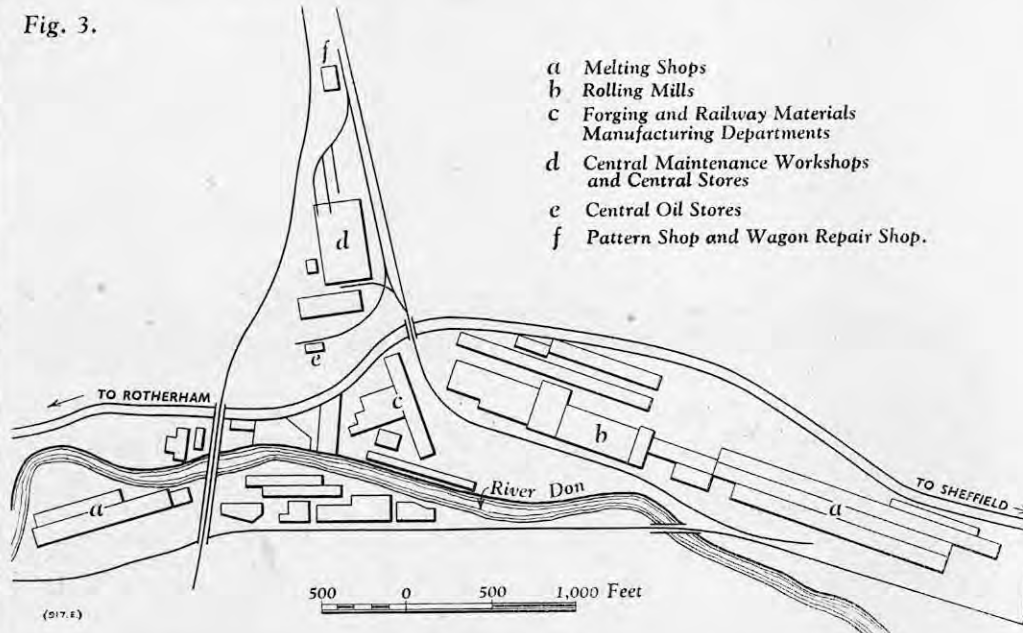


Fig. 3.



- a Melting Shops
- b Rolling Mills
- c Forging and Railway Materials Manufacturing Departments
- d Central Maintenance Workshops and Central Stores
- e Central Oil Stores
- f Pattern Shop and Wagon Repair Shop.

forging, shearing, bending, hardening and tempering material for railway-vehicle laminated springs. Continuous mechanical production and hand fitting methods are used in the manufacture of these springs.

The heat-treatment department operates several types of gas-fired, coal-fired and electrically-heated furnaces, designed for the heat treatment of tyres, wheels, axles, forgings and rolled material. Normalising, annealing, and hardening and tempering treatment are carried out, according to customers' requirements.

The production machine shops are engaged on turning, boring and planing forged and rolled materials and are operated independently of the maintenance workshops. The machinery installed includes, in addition to many smaller machines, three 18-in. screw-cutting lathes, two 18-in. centre double-ended borers, two 30-in. centre lathes, one 20-in. shaper, and a planer, taking work 5 ft. by 5 ft. by 15 in.

INTRODUCTION OF PLANNED MAINTENANCE.

The improved system of planned maintenance, which the company have instituted to deal with the very varied equipment described above, has as its object the prevention or reduction of breakdowns by regular inspection and attention to plant; its basic principle is that of the "stitch in time." The organisation of the scheme has been developed in the well-defined stages listed below.

(i) An inventory is prepared of all plant, machinery and buildings in the works.

(ii) Routine lubrication and attention is given to all plant.

(iii) Plant is examined at regular intervals for defects.

(iv) These defects are reported as soon as they are disclosed.

(v) The type of repair necessary by reason of the defects is then specified.

(vi) The labour force, materials and machines necessary for the repairs are estimated and allocated in advance.

(vii) The repairs are carried out in accordance with the plan made.

(viii) Records are kept of the actual costs of such jobs.

It was realised that the system of planned maintenance as envisaged would require the services of efficient maintenance workshops, the main functions of which would be the manufacture of spares, the re-conditioning of parts, and their re-assembly. The engineering facilities originally available could not meet the expected demands, partly because of lack of machines and partly because of the manner in which they were dispersed round the works. In addition, there was found to be a need for a reorganisation of the stores department if the engineers' materials were to be available quickly for use by the workshops and maintenance men.

Because of the difficulty of expanding the old maintenance shops, it was decided to centralise the engineering repair arrangements and the store-keeping facilities for the entire works in new buildings, to be erected on a vacant site south of the Sheffield road. Mr. Cecil Bentham, C.B.E., M.I.C.E., of Stockport, was appointed consulting engineer for the scheme. By bringing these services together in one place, it was thought that there would be achieved greater control, greater efficiency,

WORKS OF STEEL, PEECH AND TOZER, LIMITED.



FIG. 4. APPROACH ROAD.

and greater working economies, since the scheme offered the opportunity of introducing many new advantages. Work was begun in 1948 on clearing the ground and the transfer to the completed buildings began in March, 1951. The main building, shown in Fig. 1, on page 765, houses the central maintenance workshops and the central stores, and adjacent to it are the central lubricating-oil stores and the wagon repair and pattern shops. The lay-out of the new workshops is shown in Fig. 2, herewith, and their relation to the main plant in the key diagram, Fig. 3.

There is good approach by both road and rail to the site, which has a datum level of +125 and, therefore, is some 35 ft. above the main road. Along one side of the site pass railway tracks connecting the works with the nearby London Midland Region main line of British Railways. A private railway bridge crosses the Sheffield road at the level of the workshops and a smaller bridge for pedestrian traffic has been built beside it. Separate railway lines are provided for the stores and the workshops, the contractors being Messrs. Industrial Sidings, Limited, of Darlington.

The top soil was removed and put on one side for future use, and the site was then levelled by scrapers and bulldozers. This exposed a natural ground of hard shale with a bearing strength of three tons per square foot; therefore, with few exceptions, it was not necessary to provide deep foundation blocks. Drainage of the site, however, presented certain problems. In the first place, it was necessary to tunnel under the adjacent railway embankment and to make a connection to a main culvert in order to dispose of surface water from the high part of the site. Secondly, surface water from the lower part of the site, which is run off from the access road, had to be diverted through a tunnel built under the main Sheffield road. In addition, a pump had to be installed at the wagon repair and pattern shops so that sewage from there could be raised to the level of the existing sewer. For the incidental filling and surfacing of stock-yard areas, crushed slag from the adjoining slag reduction plant has been used. This material provides a surface that drains well and does not easily hold dust; moreover, it is attractive in appearance.

Within the newly developed area, a complete system of roads has been laid out. These were constructed of 15-in. large slag, rolled to camber, covered with 3-in. coarse macadam and finished with a carpet of 1-in. fine macadam and a covering of sealing grit. An exception to this method was the new road built to provide access to the main body of the works, and illustrated in Fig. 4, on this page. This road has a gradient of 1 in 13, and has to carry heavy loads; therefore, in this case, the formation was excavated to camber and "blinded" with fine cinder, then hand pitched with large-size slag, well rolled out, and completed with two layers of tar macadam. It is specially drained

and, as will be clear from Fig. 4, is finished with heavy curbs and gratings.

THE MAIN BUILDING.

The main building covers a ground area of 132,750 sq. ft. and, with the upper floors of the stores and office buildings, provides a total floor area of 180,500 sq. ft. It consists of four workshop bays, each measuring 300 ft. by 60 ft., one bay (No. 3) being further extended to form a degreasing section, 75 ft. by 60 ft. A two-storey office block, 475 ft. by 30 ft., stands on the western side of the workshops. A large area (175 ft. by 240 ft.) of the main building to the north of the workshops has been used for central storage purposes; some details of the facilities provided in this way will be given subsequently.

The main framework of the building, supplied by the United Steel Structural Company, Limited, Frodingham Works, Scunthorpe, who were the steelwork contractors for the new works, consists of lattice-framed columns with fabricated roof trusses, providing a span clear of all obstructions. The monitor-type roof has glazed panels facing east and west, extending for the length of the building, thus giving a uniform lighting effect on the floor of the shop during daylight hours. The outer wall of the building is formed of Askerne Asgold brickwork to a height of 14 ft. and above this is a 6 ft. depth of continuous glazing. Robertson corrugated sheeting, of a maroon colour, is used for the vertical space above the glazing and "V" beam sheeting, by the same makers (Robertson Building Service, of Ellesmere Port, Cheshire), covers the roof. The whole of the area covered by corrugated sheets is backed with Tentest boarding, providing effective heat insulation.

The floor of the shop is formed of 9 in. of concrete and 3 in. of Granolithic concrete, hardened with an "improver" to give a dust-free surface. The main alleys are marked with strips of coloured concrete, 3 in. wide, cast in chases in the Granolithic finish. Inspection pits are provided for access to locomotives or cranes undergoing repair, and are equipped with lighting that is designed to be shadow free.

In Nos. 2 and 3 bays and the degreasing bay there are electric overhead travelling cranes of 10 tons lifting capacity. No. 1 bay is provided with a 30-ton electric overhead travelling crane, having an auxiliary hoist of 5 tons capacity. To afford easy and safe access to the cranes, walkways are built into the main columns at two levels of each crane track. Further reference will be made to these galleries later.

The maintenance units allocated to No. 1 bay are those of the blacksmiths, the chainsmiths, the pipefitters, the rope splicers, and the locomotive repairers. No. 2 bay is devoted entirely to the boiler-smiths and No. 3 bay is used as the machining and fitting shop. At present, No. 4 bay houses the

weightfitters and lubrication engineers, but will probably be used later for electrical maintenance work. The degreasing bay, as its title indicates, is used for degreasing pieces of plant prior to repair in the workshops.

Running across all bays, at the northern end of the workshops, is a road 25 ft. wide, closed by power-operated roller shutter doors at each side of the building. This arrangement permits of convenient inter-bay transfers and also enables lorries from outside to be serviced by the overhead cranes in each bay.

(To be continued.)

LITERATURE.

Industrial Heat Transfer.

By PROFESSOR F. W. HUTCHINSON. The Industrial Press, 148, Lafayette-street, New York 13, U.S.A. [Price 6 dols.]; and Bailey Brothers and Swinfin, Limited, Minerva House, 26-27, Hatton-garden, London, E.C.1. [Price 51s.]

THE main object of this book is to save the time of designers by providing means of obtaining graphic solutions to problems in heat transmission. What may be called the theoretical portion of the volume is confined to brief introductions to the various sections into which the subject naturally falls, and it occupies less than one-fifth of the whole. The remainder contains 127 charts (though the publishers claim only 123 on the wrapper) each faced on its opposite page with a reference to the equation or equations on which it is based, together with notes that may be useful and a numerical example of the solution of a definite problem by means of the chart. The whole arrangement of the book is admirable for a busy man, whose convenience is further served by the provision of a separate index to the subjects charted.

The charts are claimed to give results as accurate as the equations from which they have been constructed, and are all of the same general type. The user invariably starts from a scale along the lower edge and proceeds, by alternate vertical and horizontal steps, to the scale on the upper edge where he reads the desired answer. In simple cases only one horizontal step is needed, and sometimes there appears to be no advantage in having a chart at all when the result could be so easily obtained from the equation by a slide rule or by simple arithmetic. Few designers, we think, would have much use for a graphic method of finding such quantities as the Prandtl or Reynolds numbers, but the process of evaluating the latter number for water flowing through a pipe will serve to indicate the nature of the most elaborate kind of chart. From the known velocity on the bottom scale the path is vertically upwards to a line corresponding to the tube diameter; thence horizontally to a sloping "transfer line"; then vertically to the appropriate density line; from there, horizontally to a second transfer line; vertically once more to the particular viscosity line; then across to a third transfer line, and finally upwards to the top scale where the Reynolds number is read. Complicated as all this may appear, the process is nevertheless quite easy, for all the lines on the chart are straight, and none intersects any other, apart from the dotted transfer lines for each group.

The section dealing with heat conduction contains only five charts, the most useful of which is for finding the logarithmic mean of two numbers. Radiation is covered by 11 charts, most of them being of more interest to architects concerned with space heating than to engineers. The first four give the shape-factor of a "human" of unspecified dimensions standing or sitting, the object being to determine the amount of radiant heat that he (or she) would intercept at different distances from an area of heated surface in the wall, ceiling or floor of a room. The section on free convection has 20 charts, of which the majority are for obtaining the film coefficients, B.Th.U. per hour per square foot per deg. F., for water, air and steam under different conditions of flow. Overall coefficients of heat transfer are next considered, and the final and longest section, containing 77 charts, deals with forced convection. Six of these give general

relationships, while the remainder deal individually with a great variety of liquids, vapours and gases flowing turbulently either through pipes of different diameters, or in a direction normal to the pipes from the outside.

In addition to the substances commonly used in steam engineering and refrigeration, the list includes others such as helium, chloroform, acetone, carbon tetrachloride, etc., besides a goodly collection of hydrocarbons. The systematic way in which the information in the book is presented is wholly admirable, and the multitude of the charts included should enable any of the problems of heat transmission ordinarily encountered to be solved in a few minutes with satisfactory accuracy.

Fluid Mechanics.

By PROFESSOR VICTOR L. STREETER. McGraw-Hill Book Company, Incorporated, 330, West 42nd-street, New York 18, U.S.A. [Price 5 dols.]; and McGraw-Hill Publishing Company, Limited, Aldwych House, Aldwych, London, W.C.2. [Price 42s. 6d.]

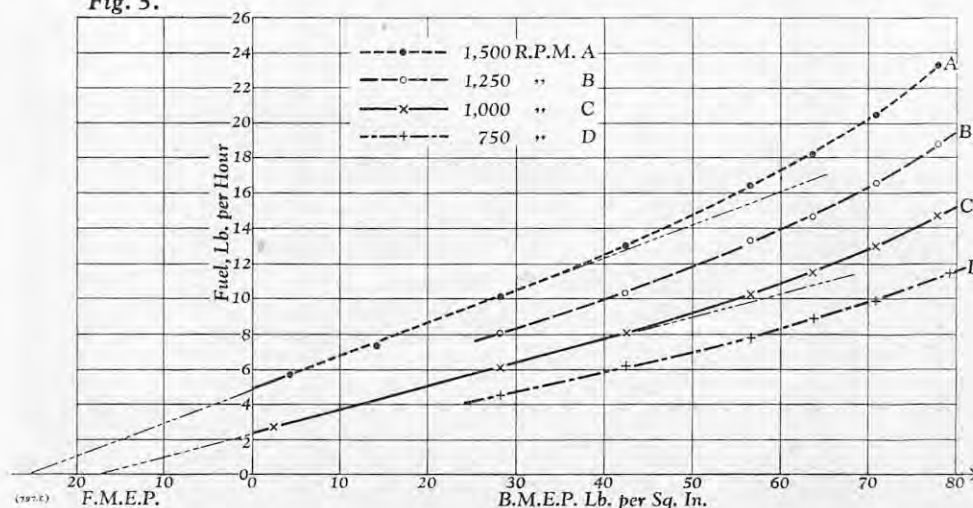
So many excellent text-books on the mechanics of fluids have already been written that much of the interest aroused by a new one must depend on the author's selection and arrangement of the abundant material at his disposal, and on his method of presenting it. In preparing this work, Professor Streeter, of the Illinois Institute of Technology, has had especially in mind the third-year student who has completed two courses in engineering mechanics and has at least a working knowledge of analytical mathematics. The approach, correspondingly, is predominantly mathematical, intended to train the student in analytical expression rather than to present a mass of empirical information or to discuss in extensive detail the practical features of hydraulic instruments and machinery.

Throughout the book, nevertheless, the reader's attention is steadily directed towards the mechanical phenomena of fluids and their applications in physics and engineering, and the theoretical approach, however elegant, is always made to serve the subsidiary purpose of gaining a fundamental knowledge of fluid behaviour. Moreover, the analytical treatment is graduated as regards precision and difficulty, while each fresh subject or concept is introduced in elementary terms. Thus, the student progresses by logical stages from the study of fluid statics and problems of pressure distribution and buoyancy to the physical concepts and theoretical examination of laminar and turbulent fluid motion. The basic knowledge thus gained is then applied to engineering in a succession of chapters dealing with flow measurement, turbo-machinery and flow in closed and open conduits. For the benefit of aeronautical students there follows a theoretical account of flow round immersed bodies, generally along classical lines, though condensed and somewhat simplified. Mechanical engineers have a decidedly easier end to their labours, since their special chapter, which concludes the book, is an almost wholly discursive account of oil hydraulic systems, concerned with the operative characteristics of positive-displacement pumps and motors, together with their associated connecting circuits and valves.

An exceptionally large number of problems, designed to probe searchingly into the theory, are distributed throughout the book. Many of them are of the usual numerical type, ranging in difficulty up to those demanding original analytical work. After every chapter, however, there are also some objective problems where the correct answer may be any one of several suggested solutions. Professor Streeter has found, in the course of his teaching experience, that this type of problem can prove highly effective, and doubtless it serves as a stimulating challenge to a class of students. Instructors will therefore find a great deal of helpful material in this part of the author's work, no less than in the substantial body of the text. The isolated self-instructing reader, on the other hand, must regret that Professor Streeter has not supplied the answers to his problems, since they are evidently complementary to the text and must be accurately solved before progress through the book can be made with confidence that the developing theory of the subject has been mastered step by step.

THE JENBACH VERTICAL OIL ENGINE.

Fig. 5.



ANALYSIS OF THE PERFORMANCE OF THE JENBACH TWO-STROKE VERTICAL OIL ENGINE.

By PROFESSOR S. J. DAVIES.

(Continued from page 740.)

Two methods were used to estimate the total mechanical losses. In the first, curves of the measured fuel consumption, in lb. per hour, were plotted on a base of b.m.e.p. and are given in Fig. 5. In series A and C, "no-load" values were observed, the very small values of the b.m.e.p. recorded being those necessary to overcome the windage resistances, etc., of the electrical dynamometer. On extrapolating the straight-line portions of these two curves, the resulting intercepts on the base line give values of the frictional m.e.p., which was 25.3 lb. per square inch for series A and 17.2 lb. per square inch for series C. The only other comments called for concerning these curves are that they are spaced as would be expected and that the points lie well on the curves; they thus provide evidence of the accuracy with which the tests were conducted. In the second method, the electrical dynamometer was arranged to operate as a motor and provided a means for measuring the torque necessary to drive the engine when "motored." A series of tests was made in which all precautions were taken to ensure that the temperatures of the engine were, as nearly as practicable, the same as those prevailing during normal operation. The following results were obtained:

R.p.m.	752	1,000	1,248	1,478
F.m.e.p., lb. per sq. in.	15.2	17.7	21.8	26.9

These results are plotted in Fig. 6 and the two values obtained by extrapolation for series A and C are added, from which the results by the two methods are seen to be in reasonable agreement.

Taking the values of f.m.e.p. from the curve of Fig. 6, and adding, for all four series in Table I, the b.m.e.p. at normal load, 71.1 lb. per square inch, the corresponding values for the equivalent i.m.e.p. are obtained, and the values of the mechanical efficiency and of the equivalent indicated specific consumption may be calculated. The results are given in Table II.

TABLE II.

Series.	A.	B.	C.	D.
R.p.m.	1,500	1,250	1,000	750
F.m.e.p., lb. per sq. in.	27.7	21.8	17.7	15.1
I.m.e.p., lb. per sq. in.	98.8	92.9	88.8	86.2
Mechanical efficiency	0.720	0.767	0.802	0.825
Specific consumption, lb. per i.h.p. per hour	0.299	0.307	0.316	0.332

The values of mechanical efficiency are also plotted in Fig. 6 and are seen to be very good for a single-cylinder two-stroke engine. The values of the specific consumption based on the indicated horse-power are of great interest; they show a

progressive reduction, and thus a progressive improvement of combustion efficiency, with increase of speed of revolution. Such an improvement in combustion is to be expected, assuming the charging of the cylinder to be uniformly well carried out, owing to the reduction of time for heat losses to occur during combustion. It is normally to be observed in four-stroke engines but, in the present case of a two-stroke engine, these results afford convincing evidence that the scavenging process is at least as well carried out at 1,500 r.p.m. as at 750 r.p.m., an interesting result when the speed range of 2:1 is taken into consideration.

In the charging and scavenging processes of a two-stroke engine there are two basic matters to consider. Firstly, these processes must be carried out so as to ensure the evacuation, as completely as possible, of the exhaust gases, and the re-charging of the cylinder with the greatest practicable weight of pure air; secondly, the mechanical work to be expended in the blower should be as low as possible; that is to say, the overall adiabatic efficiency of the blower should be as high as possible and the quantity of air to be compressed and delivered by the blower should be as small as possible, consistent, of course, with the successful carrying out of the first. The question of the adiabatic efficiency of the blower will be dealt with later and consideration will first be given to the question of the quantity of air actually used.

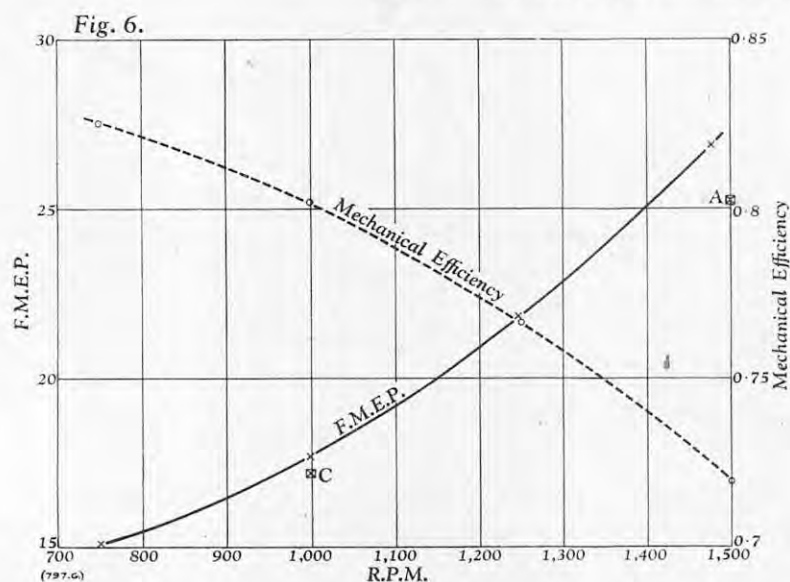
Three series of tests, G, H, J, were made at constant speeds of 1,500, 1,000 and 750 r.p.m., respectively, and with varying load from light to full. The conditions corresponded to those of series A, C, D, but the barometer was slightly higher, at 28.9 in. of mercury. The air to the blower was measured by passing it through a rotating-piston gas meter, made by the Julius Pintsch Company, of Berlin. The results are given in Table III.

TABLE III.

Test No.	R.p.m.	B.m.e.p., lb. per sq. in.	Scavenge Pressure, lb. per sq. in.	Air Cons., Cub. ft. per min.	Gross Volume Efficiency, Per cent., λ_0
G 1	1,500	4.3	4.6	214.2	135
G 2	1,490	42.7	4.9	213.7	135
G 3	1,485	56.9	5.2	213.9	135
G 4	1,500	71.1	5.5	212.0	134
G 5	1,500	78.2	—	210.8	133
H 1	998	2.6	2.2	147.3	140
H 2	992	42.7	2.4	146.7	140
H 3	1,002	56.9	2.6	148.0	140
H 4	997	71.1	2.8	145.6	138
H 5	994	78.2	2.9	145.2	138
J 1	755	1.5	—	108.1	136
J 2	748	42.7	1.8	108.4	137
J 3	745	56.9	1.9	107.0	134
J 4	750	71.1	2.1	106.0	134
J 5	745	78.2	2.3	105.4	134

The volumes given in the fifth column are corrected to the actual air conditions in the laboratory, and give the numerators for the values of the gross volumetric efficiency, which is thus defined as the ratio of the volume of air, under the prevailing

THE JENBACH VERTICAL OIL ENGINE.

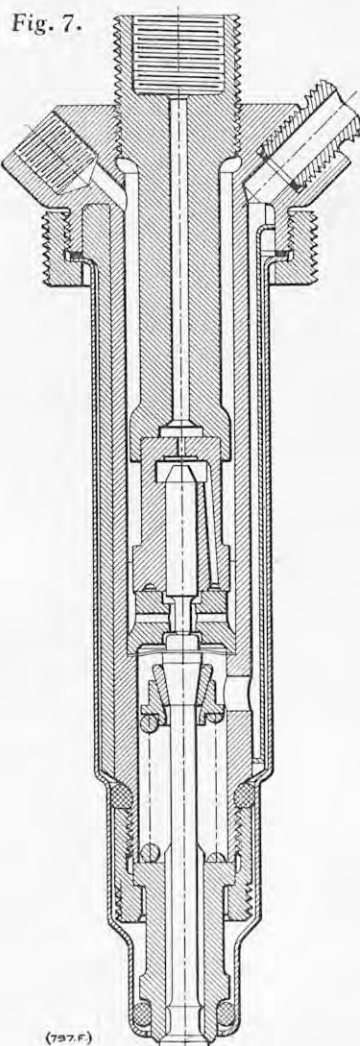


atmospheric conditions, to enter the engine to the total swept volume of the piston. Alternatively, it is the ratio of the weight of air to enter the engine to the swept weight of air; that is, the weight of air, under the prevailing atmospheric conditions, to fill the swept volume. It is here denoted by λ_0 ; this and the other symbols used are given in the following list.

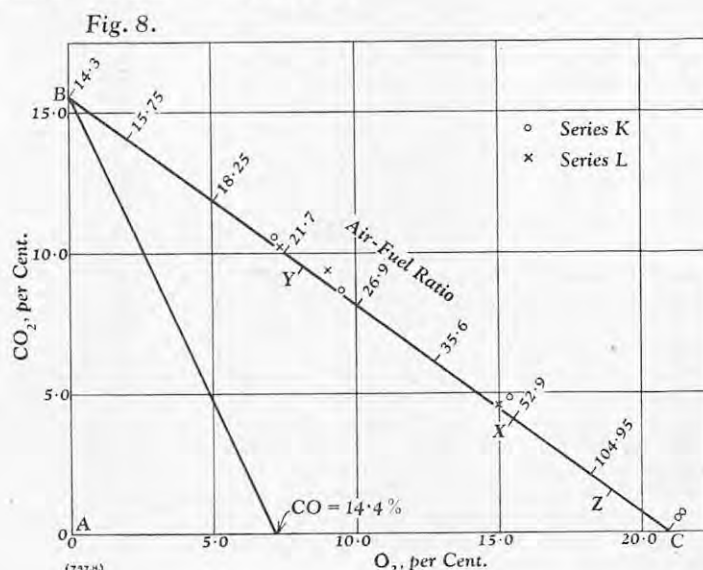
- λ_0 = Gross volumetric efficiency or delivery ratio = volume of air under atmospheric conditions $\div$ swept cylinder volume.
- λ_L = Net volumetric efficiency = volume of air under atmospheric conditions trapped in cylinder $\div$ swept cylinder volume.
- η = Utilisation of combustion air in cylinder = air required for combustion of the fuel to $\text{CO}_2 \div$ air trapped in cylinder.
- p_1, p_2 = Absolute pressures before and after blower, respectively.
- T_1, T_2 = Absolute temperatures before and after blower, respectively.
- η_{ad} = Adiabatic efficiency of blower = adiabatic horse-power to compress the air $\div$ brake horse-power of blower.
- η_v = Volumetric efficiency or volumetric ratio of blower = volume of air under atmospheric conditions $\div$ swept volume of blower.
- G = Weight of air taken by blower, in lb. per minute.
- Q_2 = Volume of air under atmospheric conditions taken by blower, in litres per second.
- p_L = Equivalent m.e.p. on piston to drive blower.
- f_a, f_e = Instantaneous areas of admission and exhaust ports, respectively.
- c_a, c_e = Instantaneous static values of the coefficients of discharge of the admission and exhaust ports, respectively.
- λ_G = Charging efficiency = volume under atmospheric conditions of the total cylinder charge at beginning of compression $\div$ swept cylinder volume.
- λ_S = Scavenge efficiency = the proportion of pure air in the total cylinder charge at beginning of compression.

At 1,000 r.p.m. the swept volume is 105.8 cub. ft. per min. and the corresponding swept weight of air is 471 lb. per hour. The extreme range of values of the gross volumetric efficiency, from 133 to 140 per cent., is remarkably small when the wide variation of load, and the fact that the highest engine speed is twice the lowest, are taken into consideration. At each speed, the variation of λ_0 is only about 2 per cent.

Of the total air delivered to the engine by the blower, a part, which may be called the "scavenge air," displaces the exhaust gases and follows them out of the exhaust port; the remainder is trapped in the cylinder and provides the oxygen necessary for combustion in the next cycle, and is conveniently called the "combustion air." It is often not clear what proportion of the total air takes part in the combustion. In the present tests, however, it was found possible to estimate this. Samples of the



exhaust gases leaving the exhaust port in that interval of time, or crank angle, between the opening



of the exhaust ports and the opening of the admission ports were taken with the aid of the gas-sampling valve shown in Fig. 7. The valve itself is at the bottom, and the component is placed immediately outside the exhaust ports so as to draw off the undiluted exhaust gases during the required short interval of time. The valve is opened by means of the pressure pulse sent by a normal injection pump of the "jerk" type, and closed by the action of its own springs. It could be applied reliably to the engine under test up to an engine speed of 1,000 r.p.m. The gas drawn off through the sampling valve was collected in sampling bottles and then analysed in an Orsat apparatus.

The results of two series of tests, series K at 1,000 r.p.m. and series L at 750 r.p.m., are given in Table IV, from which it is seen that, at each speed, three values of the b.m.e.p., at 40, 80 and 100 per cent. of full load, respectively, were taken. The fuel and total air consumed by the engine were measured by the methods previously described. The percentages of CO_2 and O_2 found in the samples are given in columns 7 and 8 of the table. Calculation of the quantity of air necessary for the complete combustion of the fuel showed this to be 14.3 lb. per lb. of fuel. When all the carbon in the fuel is burnt to CO_2 , the proportion of CO_2 in the dry products of combustion is 15.54 per cent. by volume. When the carbon is burnt to CO, the percentages of CO and O_2 in the products of combustion are 14.4 and 7.11, respectively. With these data, the combustion triangle ABC in Fig. 8 was constructed, and the points for the series K and L were plotted. The points lie slightly above the line BC, corresponding to zero CO in the gases, a result to be attributed to small experimental errors. Along CB, the values of the air: fuel ratios corresponding to percentages of $\text{CO}_2 = 2, 4, \dots, 14$ are given. For each lb. of fuel a minimum quantity of 14.3 lb. of air must be supplied as at B; and the actual quantity supplied, per lb. of fuel, is estimated for the experimental points. If the values so obtained are multiplied by the corresponding values of fuel per hour, the values of the trapped or combustion air, in pounds per hour, given in column 9, are found. The ratio of the air actually utilised in the combustion of the fuel, the minimum

TABLE IV.

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
Test No.	R.p.m.	B.m.e.p.	Fuel, Lb. per hr.	Total Air, Lb. per hr.	Gross Volume Efficiency, λ_G	CO_2 per cent.	O_2 per cent.	Trapped, or "Combustion" Air Lb. per hr.	Utilisation of Combustion Air, η	Ratio of Combustion Air to Total Air.	Net Volume Efficiency, λ_L
K 1	1,005	28.4	6.05	669	1.405	4.8	15.4	293	0.296	0.438	0.621
K 2	1,005	56.9	10.23	663	1.400	8.6	9.5	260	0.563	0.392	0.556
K 3	1,000	71.1	12.95	652	1.385	10.6	7.2	271	0.685	0.415	0.583
L 1	750	28.4	4.47	489	1.385	4.6	15.0	211	0.304	0.432	0.634
L 2	755	56.9	7.88	484	1.365	9.4	9.0	185	0.609	0.382	0.523
L 3	748	71.1	9.90	470	1.330	10.2	7.3	212	0.669	0.451	0.599

air, to that trapped in the cylinder, the combustion air, is denoted by η , and the resulting values are tabulated in column 10. The values of the ratio, combustion air to total air, are given in column 11.

The position of the points on the combustion triangle show the combustion to be complete, as would be expected from the low values of the indicated specific consumption given in Table II. The utilisation of the air at full load, 0.685 at 1,000 r.p.m. and 0.669 at 750 r.p.m., is good for a two-stroke engine, especially when it is remembered that an increase of load of 10 per cent. beyond this was found to be possible before the exhaust became visible. The given quantity of combustion air is ample to produce the indicated power, while the scavenge air has as its principal function the exhausting, as complete as possible, of the cylinder. As a secondary function, it helps in the cooling of the engine in three ways: firstly, the purer the new charge, the lower is its temperature at the beginning of compression, and therefore the lower are the temperatures during the compression period; secondly, the scavenge air comes into contact with the walls of the cylinder liner and head and with the crown of the piston, and takes heat away from all of these; lastly, it takes heat away from the exhaust ports and passages.

Considering the net volumetric efficiency, λ_L , given in column 12 of Table IV, this is defined as the ratio of the weight of the combustion air to the swept weight, that is, to the weight of air, under the prevailing atmospheric conditions, to fill the swept volume. When it is borne in mind that, in the values of the swept weight, the total swept volume of the cylinder is taken, so that a considerable proportion of this volume is already swept through at the closing of the ports, the values of λ_L given are very satisfactory.

From the point of view of the mechanical losses the quantity of scavenge air should, as was stated earlier, be as small as possible. In an actual engine, the determination of the correct quantity is clearly a matter of compromise between the generally beneficial influence of the scavenge air, on the one hand, and, on the other hand, the cost in mechanical work in the blower, as determined by the adiabatic efficiency of compression, by the quantity of air, and by the scavenge pressure to which the air is compressed. The testing facilities available rendered it possible for the author to investigate these various aspects of the performance of the engine.

The first investigation related to the performance of the blower. This is of the two-lobed type, with straight rotors, 150 mm. (5.91 in.) in diameter and 125 mm. (4.92 in.) long. The blower was mounted separately from the engine on a stand, and was driven by a torque-reaction electric motor. The air supply to the blower was passed from the atmosphere through the Pintsch rotating-piston gas meter and then through a reservoir from which it was drawn into the blower. Suitable manometers and thermometers were used to measure the condition of the air before the gas meter, in the reservoir, and after delivery from the blower. Time did not permit the author to make a complete investigation himself, but the observations he made, together with certain calculated data, are given for four tests, A, B, C and D, in Table V. The absolute pressure, p_1 , before the blower, and p_2 , after the blower are given, together with the corresponding absolute temperatures, T_1 and T_2 . During the tests the barometer stood at 29.1 in. (739 mm.) and the room temperature was 64 deg. F. or 524 deg. F. absolute. The values of p_1 are less than the atmospheric pressure on account of the action of the gas meter. The values for the air aspirated, in lb. per minute, are calculated from the readings of the gas meter, and the values of the revolutions per minute of the blower are calculated from the number of revolutions recorded on a counter during the observed times of passing certain given volumes of air through the meter. The adiabatic work per lb. of air, in ft.-lb.,

$$= \frac{\gamma}{\gamma - 1} R T_1 \left[\left(\frac{p_2}{p_1} \right)^{\frac{\gamma - 1}{\gamma}} - 1 \right],$$

in which γ was taken as 1.4 and R as 53.2 ft.-lb. per lb. per deg. F. From this the adiabatic work, expressed in horse-power, was

THE JENBACH VERTICAL OIL ENGINE.

Fig. 9.

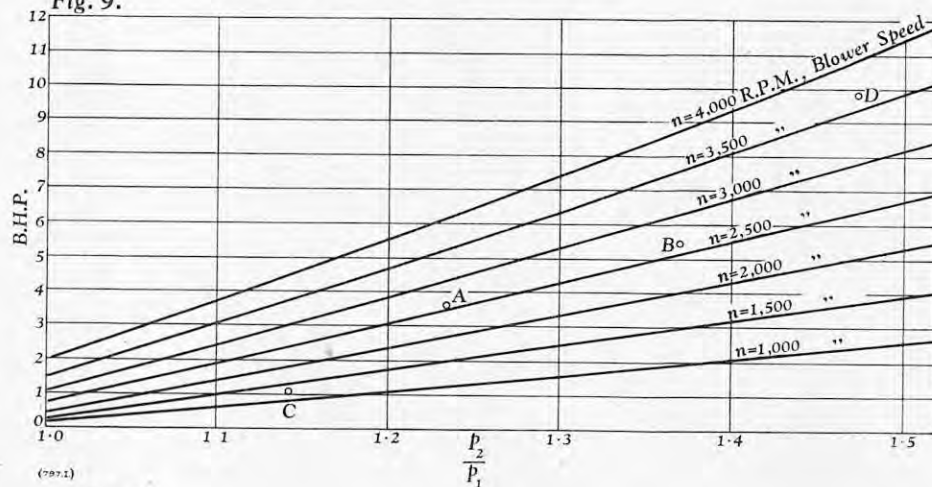


Fig. 10.

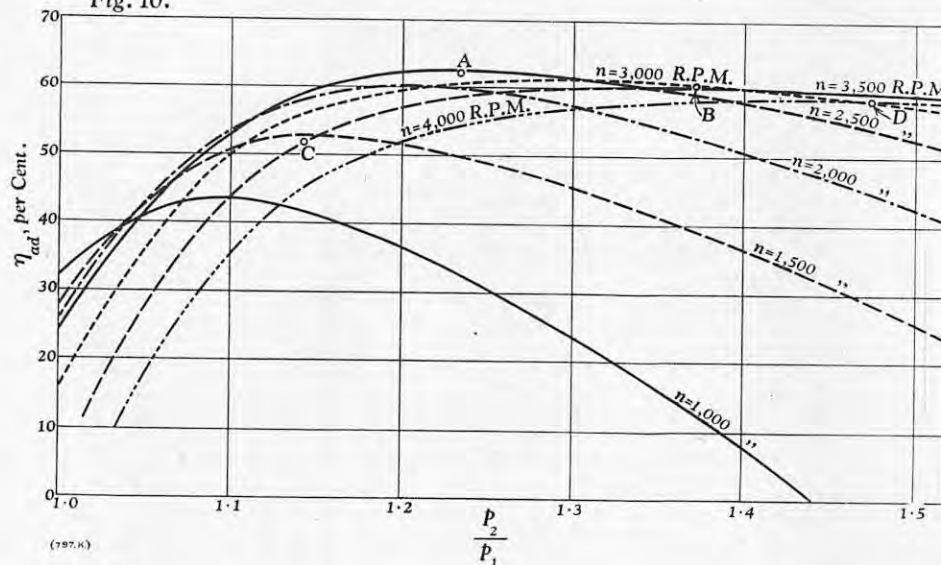


Fig. 11.

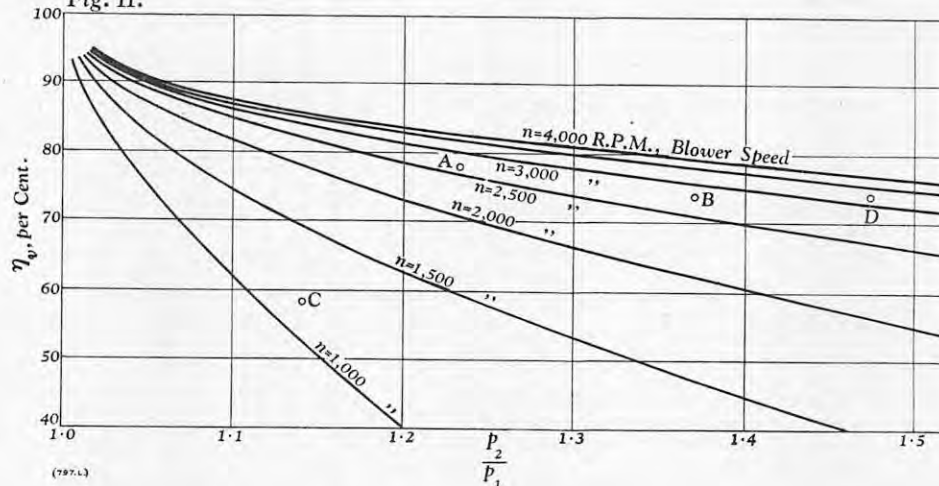


TABLE V.

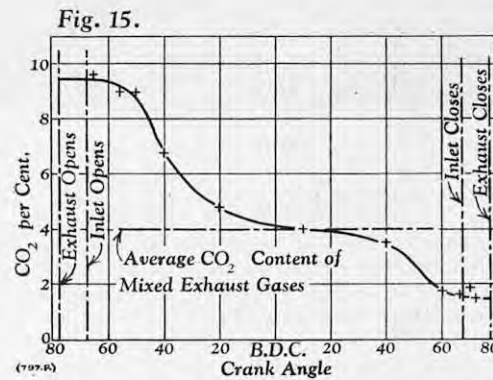
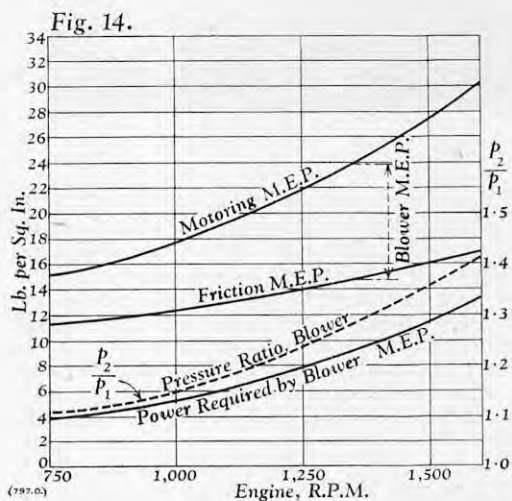
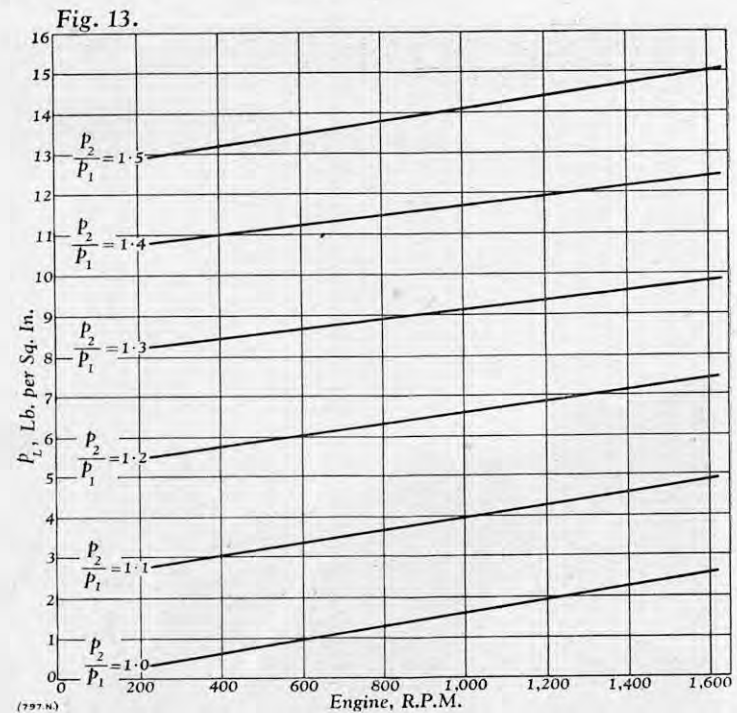
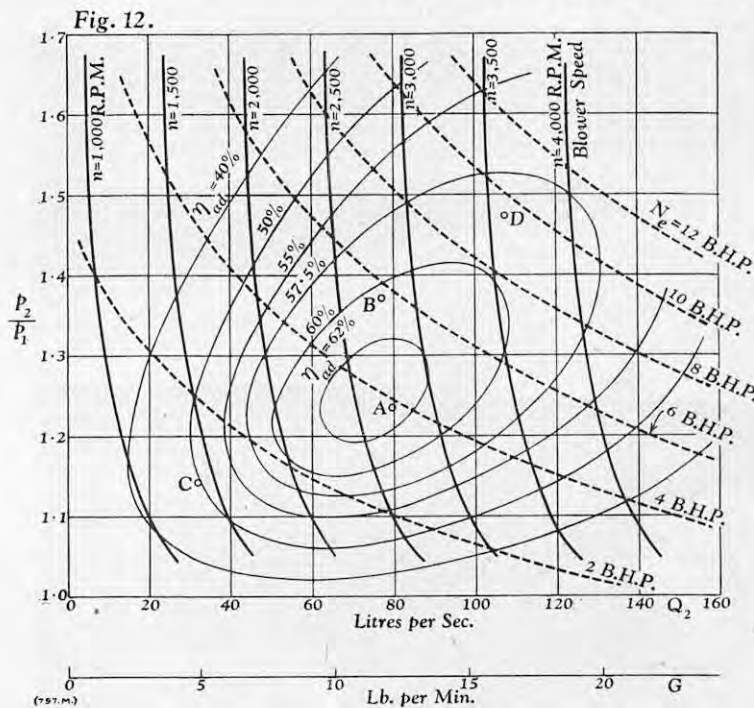
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
Test.	p_1 , mm. of Mercury.	p_2 , mm. of Mercury.	Pressure Ratio, $\frac{p_2}{p_1}$	Air, lb. per min., G.	T_1 , deg. F. abs.	T_2 , deg. F. abs.	R.p.m. of Blower.	Brake h.p.	Adia- batic Work, h.p.	Adia- batic Effi- ciency, η_{ad} per cent.	Volu- metric Effi- ciency, η_v per cent.
A	719.5	887	1.234	12.09	530	573	2,625	3.61	2.24	62.1	78.0
B	720	987	1.371	11.70	528	590	2,670	5.43	3.28	60.4	73.9
C	734	838	1.142	4.95	530	560	1,390	1.10	0.57	51.8	58.4
D	703	1,036	1.474	16.41	529	605	3,820	9.81	5.74	58.5	74.2

calculated for the corresponding values of air in lb. per minute; η_{ad} , the overall adiabatic or isentropic efficiency, is given by: adiabatic work in horse power ÷ brake horse-power. The swept volume of the blower, taken as the total volume of the two cylinders minus the space occupied by the two rotors, was 2.36 litres per revolution which,

at a speed of 1,000 r.p.m., is 83.4 cub. ft. per minute. Using this as basis, the values of the volumetric efficiency, η_v , of the blower in the last column were calculated.

After the author had left, a full investigation of the blower characteristics was made. At each of a series of constant speeds, the delivery pressure

THE JENBACH VERTICAL OIL ENGINE.



of the blower was varied, and the quantities of air delivered and the brake horse-power were observed. From these results, the values of the adiabatic efficiency, η_{ad} , and of the volumetric efficiency, η_v , were calculated; a further calculation gave the values of the equivalent m.e.p. on the engine corresponding to the values of the brake horse-power to drive the blower. Fig. 9 gives, on a base of the pressure ratio, $\frac{p_2}{p_1}$, for speeds of 1,000 to 4,000 r.p.m., curves of the brake horse-power to drive the blower. These are, of course, speeds of the blower which, it will be recalled, are 2.455 times those of the engine. In Fig. 10, the values of the adiabatic efficiency, η_{ad} , are plotted, for the same speeds, on a base of $\frac{p_2}{p_1}$, and in Fig. 11, on the same base, the values of the volumetric efficiency, η_v , of the blower are plotted. In Fig. 12, these quantities are combined into a diagram which gives the characteristics of the blower, in which the two bases are, respectively: G , the air delivered, in lb. per minute, and Q_2 , the delivery in litres per second, under the prevailing atmospheric conditions. On all these figures, the values for the author's four tests, A, B, C, D, of Table V are included, and are seen to be in satisfactory agreement with the results shown by the curves.

The working range of speed of the engine is from 750 to 1,500 r.p.m., for which the corresponding range of speed of the blower is from 1,840 to 3,680 r.p.m. On Fig. 12, it is seen that, within this range, with suitable adjustment of the pressure ratio, $\frac{p_2}{p_1}$, the values of the overall adiabatic effi-

ciency, η_{ad} , are always either equal to or better than 58 per cent., and actually exceed 62 per cent. This is a very good result for a blower of this type. As a consequence of this high performance, the powers taken by the blower, over this range, are relatively low; they are also plotted in Fig. 12, from which it is seen that they increase with speed from 2 to 10 brake horse-power. While the question of the selection of suitable values of the pressure ratio, $\frac{p_2}{p_1}$, demands separate consideration, it is of interest to consider Fig. 13, in which the values of the brake horse-power taken by the blower have been converted to the equivalent values of m.e.p., and curves of m.e.p., as p_1 , in lb. per square inch, are plotted for a series of values of $\frac{p_2}{p_1}$ on a base of equivalent engine speed, in revolutions per minute.

Fig. 14 gives results of special interest. The broken curve, $\frac{p_2}{p_1}$, shows the values of this ratio, as they were observed during the "motoring" tests of the engine, plotted on a base of r.p.m. of the engine. Taking, from Fig. 13, the values of equivalent m.e.p. for the particular values corresponding to particular engine speeds, the lowest full curve is obtained. The top curve is that for the total f.m.e.p. for the "motoring" tests of the engine, as given in Fig. 6. Subtracting, for all speeds, the values of the m.e.p. to drive the blower, the curve of net friction m.e.p. is obtained. At 750 r.p.m., it is seen that the work to drive the blower represents about 26 per cent. of the total mechanical losses; this percentage naturally increases with speed and, at 1,500 r.p.m., reaches about 44 per cent.

At the author's request, tests similar to those of which the results are given in Table IV were made after his departure, but to cover the analysis

of the gases leaving the exhaust port during the complete exhausting and scavenging periods. The results are plotted in Fig. 15, as percentage CO_2 on a base of crank angle. During the tests, the engine speed was 1,000 r.p.m., and the fuel injected per cycle was kept constant at about 0.091 gramme, corresponding to a b.m.e.p. of about 66 lb. per square inch; the gross volumetric efficiency, as observed by the gas meter, was also practically constant at 1.39 to 1.40. The percentage of CO_2 in the exhaust gases after mixing in the exhaust box was also observed and found to be 4.0, and this value is also shown in Fig. 15. This value is also plotted at X on the combustion triangle Fig. 8 and corresponds to an air: fuel ratio, by weight, of 52.9:1. At this load and speed, the fuel consumption was 12.05 lb. per hour, so that the corresponding air consumption is $12.05 \times 52.9 = 637$ lb. per hour. The swept weight of air at 1,000 r.p.m. is 471 lb. per hour, which gives the value of the gross volumetric efficiency, λ_0 , as 1.35, a value which must be regarded as in satisfactory agreement with the values 1.39 to 1.40 measured by the gas meter.

In considering the curve, it should be remembered that the whole of the exhausting, scavenging and charging process occupies 156 deg. of crank angle, which, at 1,000 r.p.m., represents an interval of time of only 0.026 sec. At the beginning of the interval the content of the CO_2 in the exhaust gases passing the sampling point is 9.5 per cent. and, as would be expected from the value of the b.m.e.p., the percentage lies between those for tests Nos. K2 and K3 in Table IV. The corresponding point is plotted at Y in Fig. 8. As the scavange air mixes with the exhaust gases the content of CO_2 is reduced until, at the end of the interval, the value observed is 1.5 per cent. This may be taken conservatively as the composition of the new charge trapped in the cylinder. This point is plotted at Z on the combustion triangle Fig. 8, and corresponds to an air: fuel ratio, by weight, of 140:1. The ordinate through the point Z intercepts the base at a percentage of oxygen, by volume, of 18.9 which, of course, must be compared with the percentage of 20.9 for pure air. The ratio of the proportion of oxygen by volume in the new charge to that in pure air is thus $\frac{18.9}{20.9} = 0.904$, which indicates a high efficacy of the scavenging process.

(To be continued.)

COAL PRICE STRUCTURE.—The Federation of British Industries, 21, Tothill-street, London, S.W.1, have issued to their members a booklet explaining the basis on which the structure of coal prices, introduced by the National Coal Board on December 31, 1951, has been built up.

ELECTRICITY SUPPLY IN SOUTHERN IRELAND.



FIG. 1. AERIAL VIEW OF POULAPHUCA DAM.

ELECTRICITY SUPPLY IN SOUTHERN IRELAND.

NEXT week members of the Institution of Electrical Engineers will have an opportunity of seeing something of what has been done to develop the water-power resources of Southern Ireland in the neighbourhood of Dublin. They will also be able to inspect two thermal stations, which have been designed to use peat as fuel, as well as one of the main substations on the extensive transmission network which serves all parts of the country. As, however, these plants form only part of the electrical development in Southern Ireland, this article is prefaced with a general description of the present position.

As is common knowledge, Southern Ireland has no natural coalfields of any importance, and has, therefore, to depend largely on water power and peat as sources of electric power. Although the configuration of the country does not make the selection of good water-power sites easy, the distribution of flow over the year is favourable, as 75 per cent. of the run-off occurs during the winter period, from October to March, when, of course, the electrical demand is at its maximum. The result is that, at the present time, it is possible to meet about 50 per cent. of the country's energy requirements from this source. On the other hand, the hydroelectric supply as a whole is likely to be much reduced in a dry year and steam stations, fired either by coal or peat, had, therefore, to be erected.

At the present time, water-power stations are being operated at Ardnacrusha (85.5 MW) on the River Shannon*; at Poulaphuca (30 MW), Golden Falls (4 MW) and Leixlip (4 MW) on the River Liffey; and at Cathaleen's Fall (45 MW) and Cliff (10 MW) on the River Erne. Water-power stations are being erected at Inniscarra (20 MW) and Carrigadroid (8 MW) on the River Lee. There are thermal stations at Pigeon House, Dublin (95 MW); Portarlinton† (25 MW); North Wall, Dublin (12.5 MW); and Cork (5 MW), the first and fourth of these being fired by coal, the third by oil and the second by peat. A peat-fired station at Allenwood in County Kildare (40 MW) is nearing

completion and another of the same capacity is being built at Ferbane in County Offaly. Two coal-fired stations are being built at Ringsend in Dublin (90 MW) and at Marina in Cork (60 MW).

These stations the positions of which are shown on the map reproduced in Fig. 2, opposite, are, or will be, connected by about 780 miles of 110-kV transmission line and 1,790 miles of 38-kV transmission line and cables. There are also 7,300 miles of 10-kV and lower voltage lines. The 110-kV system is connected to ten substations, one of which, that at Finglas, near Dublin, is to be visited during the Institution meeting. In these stations, the voltage is stepped down to either 38 kV or 10 kV, the aggregate capacity of the transformers being 350 MVA. In addition, there are 110 38-kV substations with a total capacity of 380 MVA and 9,526 10-kV substations with a total capacity of 328 MVA. The output during the year ended March 31, 1951, was 973 million kilowatt-hours.

The Electricity Supply Board started to develop the power of the Liffey in 1937. This river rises in the Dublin mountains at a height of nearly 1,800 ft. above sea level and, as shown in Fig. 3, takes a circuitous course across the plain of Kildare, turning north and finally east to enter the sea at Dublin Bay. It is 82 miles long and drains an area of over 500 square miles. There are a number of falls in its course, those most suitable for power development being at Poulaphuca Bridge, near Naas; at Golden Falls, about a mile farther downstream; and at Salmon Falls, near Leixlip.

All three stations were designed to deal with peak loads, the intention being that they should be used mainly during the early winter months when low flows and reduced storage level might affect the output of the other hydro-electric plant. The station at Poulaphuca, which is that highest up the river, was completed in 1947, work on it having been delayed owing to the war. It consists of a gravity type dam 100 ft. high and nearly 300 ft. long, an aerial view of which is given in Fig. 1, while details of its construction are given in Figs. 12 to 14, on page 774. A reservoir with a surface area of 5,000 acres has thus been formed, the maximum water level of which is at + 618 O.D. with a draw-down of 38 ft. As will be seen, the dam incorporates a building which houses the control gear for an electrically-driven gate at the entrance to the intake.

This gate has a vertical travel of 20 ft. and can be closed in 22 seconds by pressing push buttons in the power house. The dam also incorporates three spillway gates, of which the one in the centre is operated by a 2.5-kW motor. This gate is controlled electrically either from the power station, where its position is indicated, or locally; it can also be manually operated. Both the side gates are, however, arranged solely for hand operation. In addition, the dam incorporates a scour outlet and a compensation-water pipe which terminates in a disperser. A separate outlet is provided a little upstream of the dam through which 20 million gallons of water a day can be drawn off to supplement the supply of Dublin. The contractors for this portion of the work were the Cementation Company, Limited, Doncaster.

The dam is connected by a tunnel $\frac{1}{2}$ mile long to a steel surge tank which is 16 ft. in diameter and 100 ft. high and is situated above the power station, as shown in Fig. 4, Plate XLIII. From the base of this tank, which has a capacity of 60,000 cubic metres and a freeboard of 20 ft. at normal water level, two steel penstocks, 270 ft. long by 12 ft. in diameter, carry the water to the turbines, the flow being controlled by two automatic hydraulically-operated balanced disc valves, 12 ft. in diameter, which are situated at the top of the penstocks and can be closed in as short a time as 18 seconds. The penstocks were manufactured by Sir William Arrol and Sons, Limited, Glasgow, and the valves by Messrs. Glenfield and Kennedy, Limited, Kilmarnock. There is an inclined elevator at the side of the penstocks which was designed to handle plant into the power station from road level. This has a slope of 1 in 1.7 and can deal with a maximum load of 70 tons, which is the weight of an alternator rotor without poles.

The generating plant consists of two 15-MW sets, which are illustrated in Fig. 5, Plate XLIII. The turbines of these sets were manufactured by the English Electric Company, Limited, Queens House, Kingsway, London, W.C.2, and are of the Kaplan type. They are designed to operate at a speed of 300 r.p.m. under a head of 154 ft., this being one of the highest heads for which this type of turbine has been designed and for remote starting and stopping from the control room. The alternators are of the vertical-shaft two-bracket type. The

* See ENGINEERING, vol. 131, pages 250, 340 and 526 (1931).

† *Ibid.* vol. 171, page 389 (1951).

ELECTRICITY SUPPLY IN SOUTHERN IRELAND.

(For Description, see Page 772.)



FIG. 4. POULAPHUCA POWER STATION AND SURGE TANK.

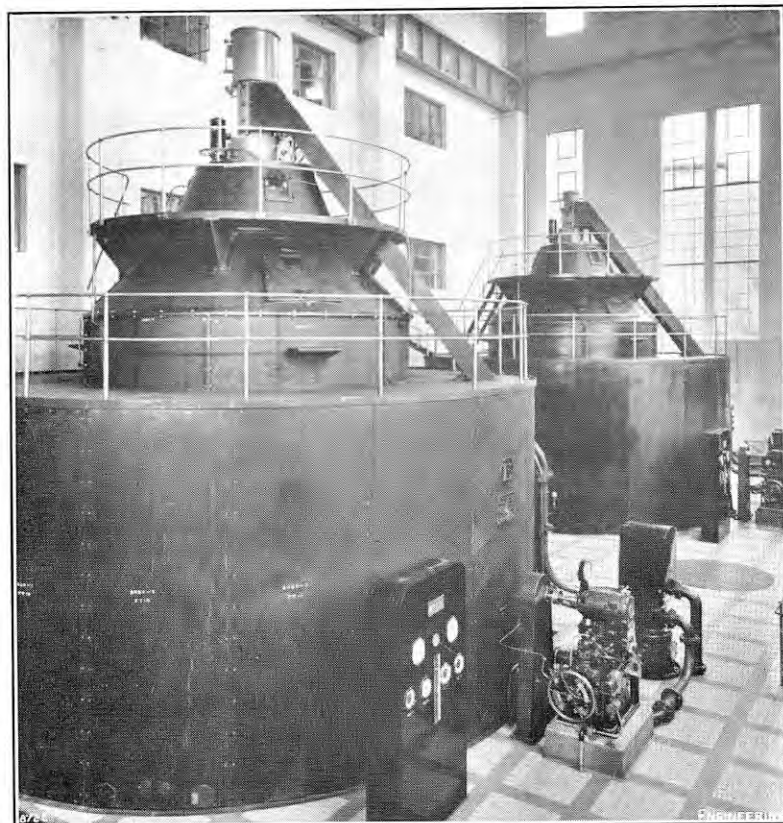


FIG. 5. 15-MW KAPLAN TURBINE SETS AT POULAPHUCA.

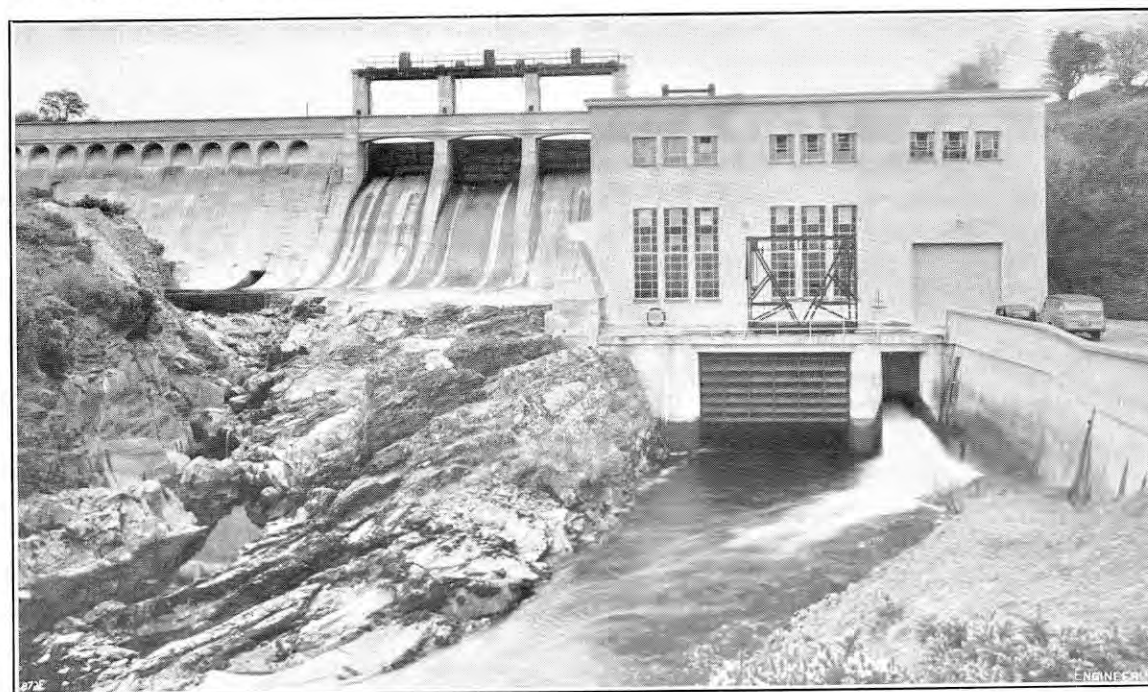


FIG. 6. GOLDEN FALLS DAM AND POWER STATION.

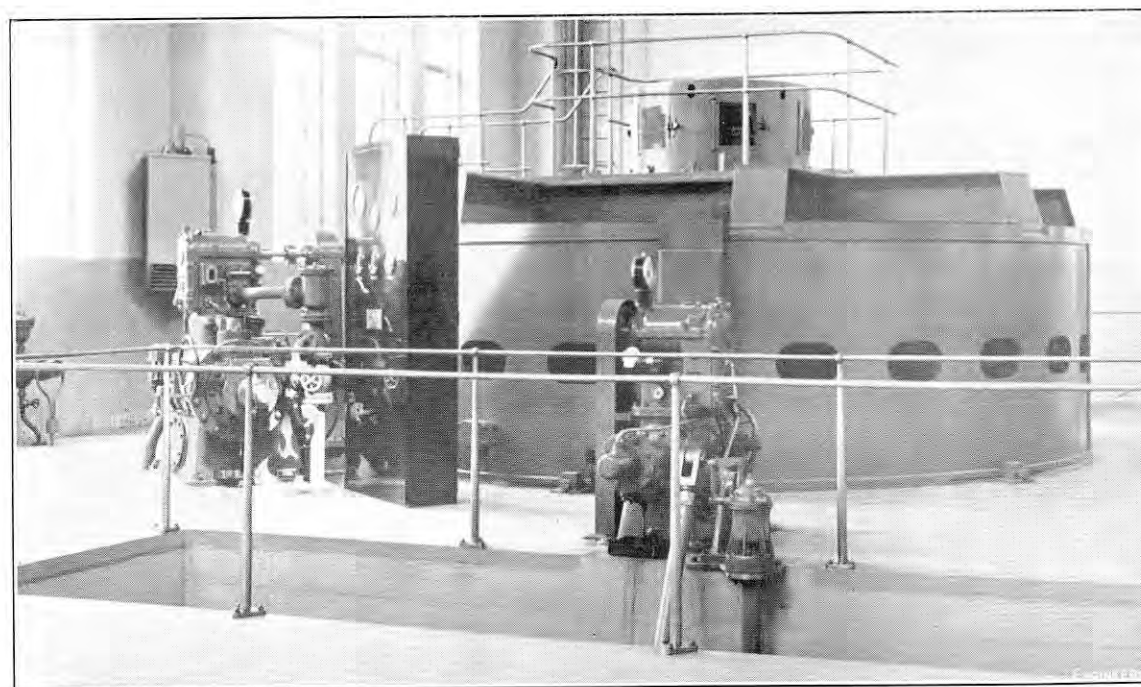


FIG. 7. 4-MW SET AT GOLDEN FALLS.

ELECTRICITY SUPPLY IN SOUTHERN IRELAND.

(For Description, see Page 772.)



FIG. 8. EXTERIOR OF CLIFF POWER STATION.

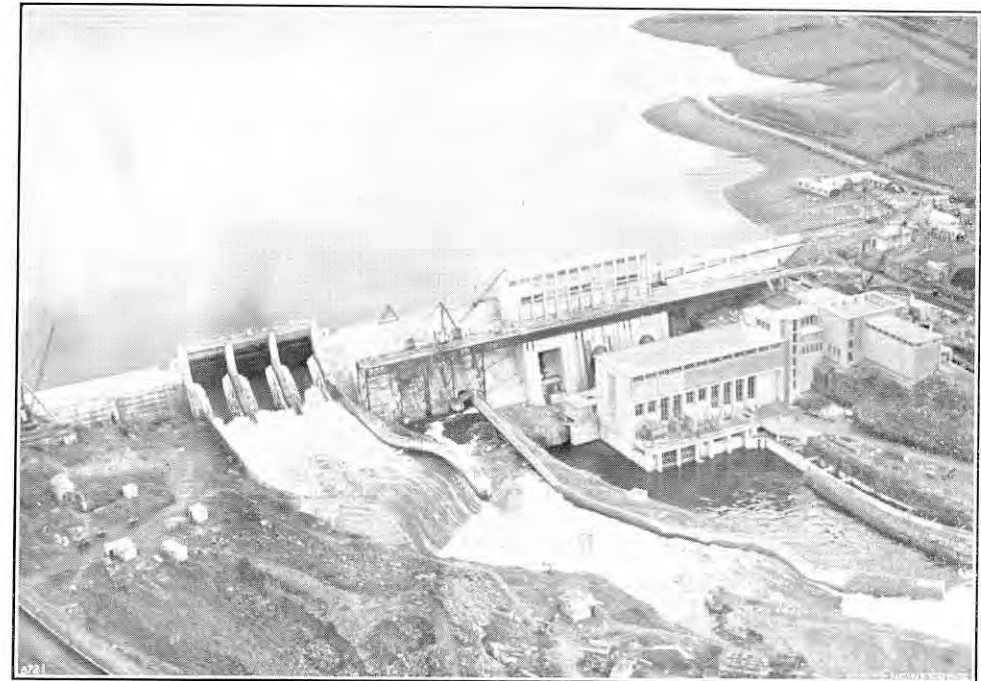


FIG. 9. EXTERIOR OF CATHALEEN'S FALL POWER STATION.

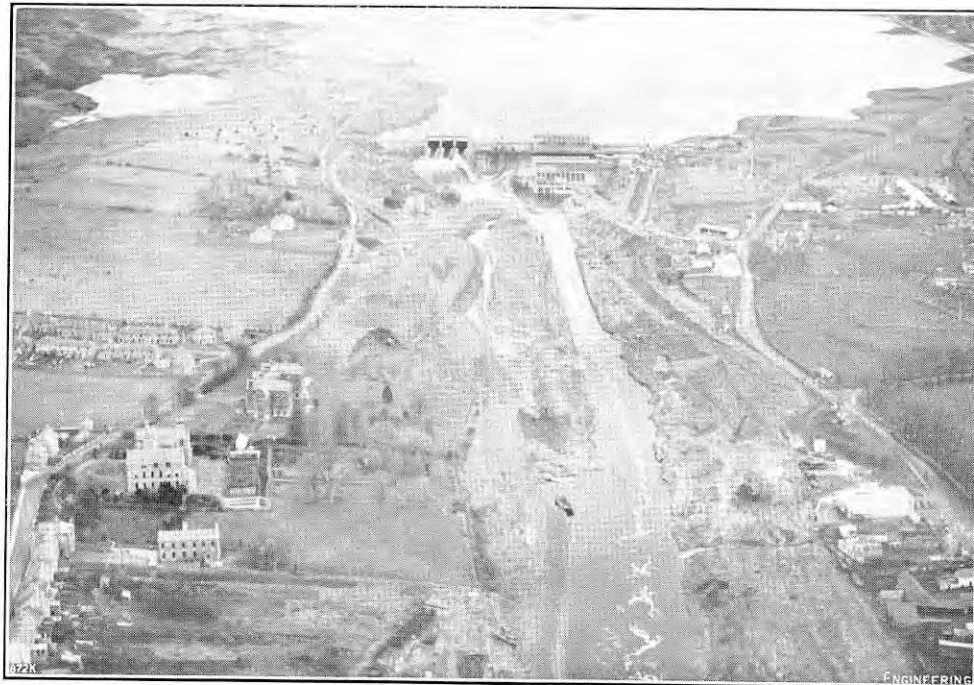


FIG. 10. CATHALEEN'S FALL STATION, LOOKING UPSTREAM.

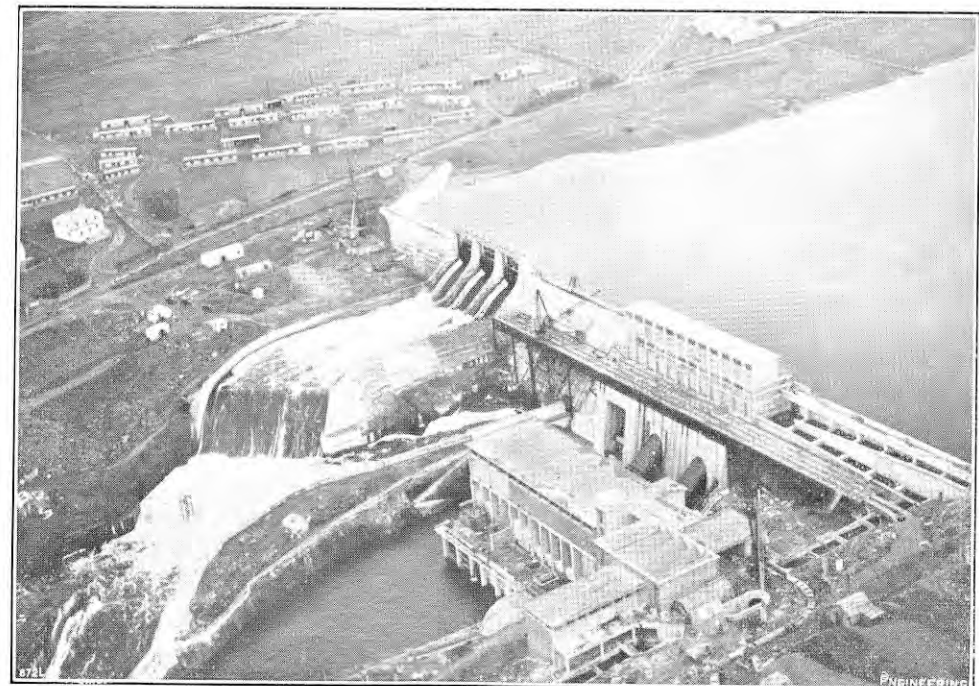


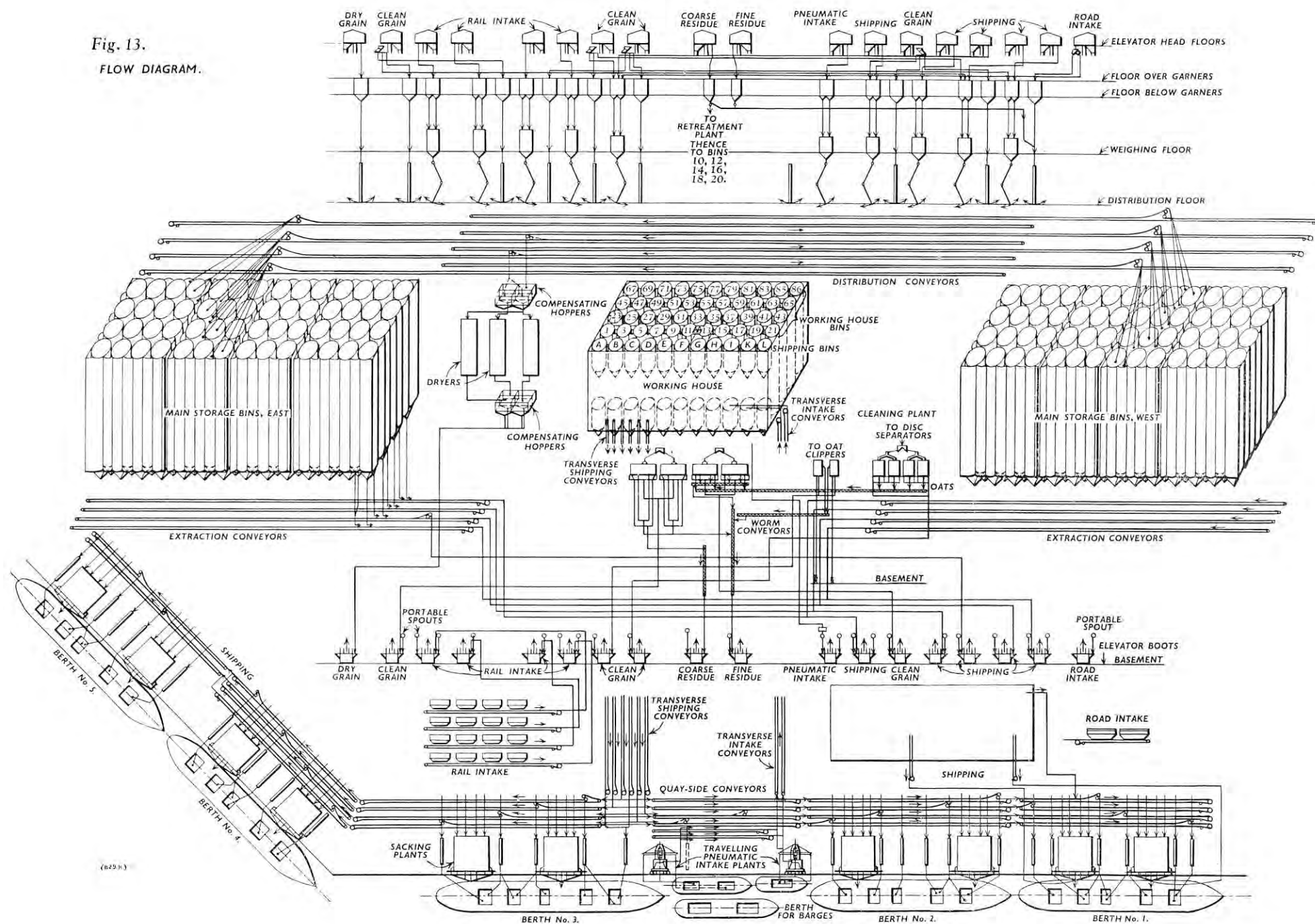
FIG. 11. CATHALEEN'S FALL STATION TAIL RACE AND SPILLWAY.

GRAIN-HANDLING AND STORAGE PLANT AT BUENOS AIRES.

SIMON HANDLING ENGINEERS, LIMITED, CHEADLE HEATH, STOCKPORT.

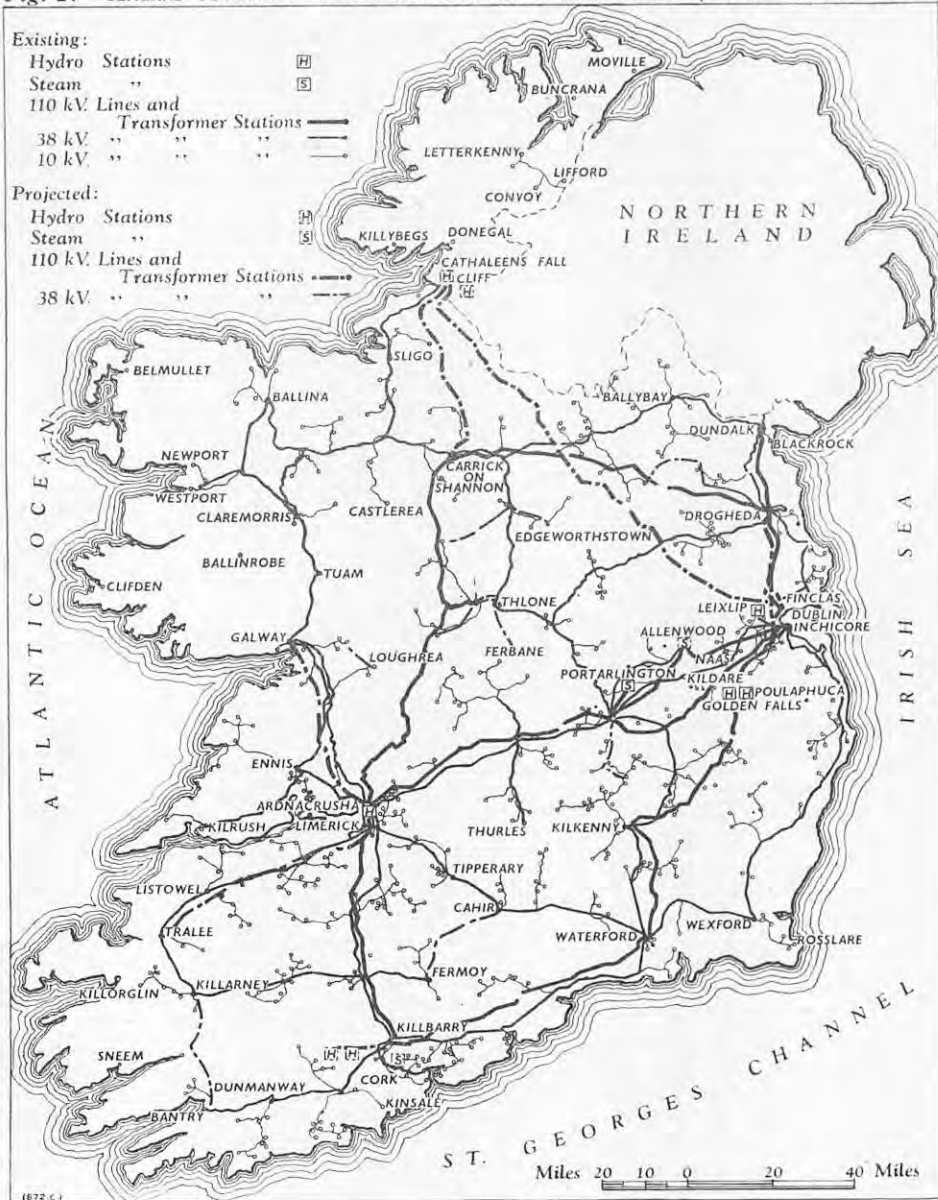
(For Description, see Page 785.)

Fig. 13.
FLOW DIAGRAM.



ELECTRICITY SUPPLY IN SOUTHERN IRELAND.

Fig. 2. GENERAL OUTLINE OF THE ELECTRICITY SUPPLY BOARD SYSTEM, AT 31ST MARCH 1950.



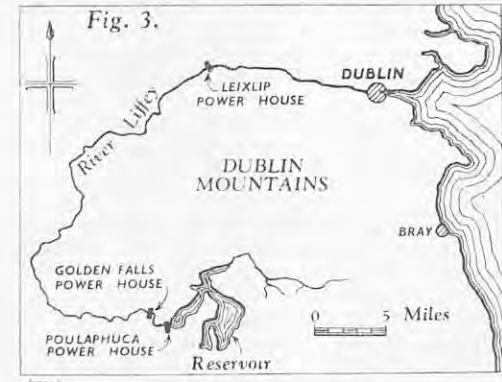
thrust bearing is of the pivoted pattern and is designed to take the load of 360 tons set up by the hydraulic thrust and the weight of the rotating parts. The alternators generate three-phase current at 10.5 kV, which is stepped up to 110 kV in two 20-MVA transformers, the primary sides of which are controlled by low oil-content switchgear with a rupturing capacity of 350 MVA. The secondary, or high tension, sides of these transformers are controlled by switchgear of similar design, with a rupturing capacity of 1,250 MVA. This switchgear is installed out-of-doors, as can be seen in Fig. 4, Plate XLIII, and is pneumatically operated from the power station. Connections are made from this point to the outgoing lines to Waterford and to Inchicore on the outskirts of Dublin. Both the transformers and switchgear were manufactured by Asea Electric, Limited, Walthamstow, London, E.17. The 10-kV bus-bars in the station are also connected through two 400-kVA transformers to a 380-volt bus-bar which is in turn connected to a third 400-kVA transformer in which the voltage is stepped up to 10 kV. Power is transmitted thence through an interconnector to a 400-kVA transformer in the Golden Falls station, where the voltage is stepped down to 380 volts.

The tail water from the Poulaphuca station forms the head water for the station at Golden Falls which, as will be seen from Fig. 2, is about one mile farther down the river. This stretch of water is used as a compensation reservoir to equalise the flow in the lower river when Poulaphuca is in operation, and thus to prevent flooding.

The dam at Golden Falls is illustrated in Fig. 6, Plate XLIII. It is 327 ft. long and has a maximum

height of about 47 ft. It is provided with three roller spillway gates and water is supplied from the reservoir formed by it through a penstock, 10 ft. in diameter and 70 ft. long, to the power house which is incorporated in the structure at the foot. As at Poulaphuca the contractors for this portion of the work were the Cementation Company, Limited, the gates being supplied by Messrs. Glenfield and Kennedy, Limited. The generating plant consists of one 4-MW English Electric propeller turbine with a vertical shaft, which is designed to run at 187.5 r.p.m. under a working head of 60 ft. The generator of this, which is illustrated in Fig. 7, Plate XLIII, is of the umbrella type with a combined thrust and guide bearing below the rotor. In addition, there is a 250-kW horizontal set, the speed of which is 750 r.p.m.; it is fitted with a pump so that air can be pumped in to counteract cavitation. The two sets are supplied through separate penstocks and gates are provided for cutting off the tailrace. The larger of these sets is connected to the 10-kV bus-bars in the Poulaphuca station, while the smaller set is connected to local 380-volt bus-bars from which the low-tension supply from Poulaphuca, which has been mentioned above, is controlled. The station, which is generally unattended, is remotely controlled from Poulaphuca on a 50-volt direct-current system. This incorporates latched-in relays which are changed from one position to another by current impulses. This system is used to operate the turbine governor and for synchronisation.

As already mentioned, these two stations on the upper reaches of the Liffey are run in tandem, Poulaphuca during the peak-load period and Golden



Falls at its maximum capacity for a period varying between three and 16 hours a day, during which period it discharges 30 cub. m. per second. The result is that each day a "block of water" travels down the river and arrives at the third station at Leixlip, about 40 miles away, some 14 hours later. In addition, there is an inflow of about 5 cub. m. per second from the Middle Liffey catchment area which is utilised at the latter station.

The construction of the dam at Leixlip is illustrated in Figs. 15 and 16, on page 775, and a view of it and the exterior of the station is given in Fig. 17. It is situated in a valley which is generally trapezoidal in shape, there being a very steep bank on one side. The dam is of the mass concrete gravity type and is some 374 ft. long, the maximum height above the foundations being 74 ft. There is a small earth embankment at each end of the mass-concrete portions. The spillway sections are located over the full width of the original river bed and incorporate three vertical-lift gates. Each of these gates is 20 ft. wide by 15 ft. deep at sill level, and each is capable of discharging 100 cub. m. of water per second when fully opened. The central gate is fitted with a flap, which is 4 ft. deep, and can be lowered to discharge water from the surface of the reservoir. To the right of the spillway is a scour culvert which is closed by a gate 8 ft. high by 4 ft. wide at sill level; to the right of this again is a fish-pass section to which further reference is made below. Finally, there is an intake with an opening 20 ft. wide and 28 ft. high in the upstream face of the dam. This opening is covered by a coarse screen the top of which is 14 ft. below water level. The intake narrows to 12 ft. 6 in. at the point where there is a gate at the entrance to a 10 ft. 6 in. penstock. The construction of this dam has transformed the river into a narrow lake with a capacity of 750,000 cub. m., which extends some two miles upstream. It is normally capable of storing the water from higher up the river and discharging it at any time of the day.

The annual migration of salmon up the River Liffey raised an important problem at Leixlip by making it necessary to incorporate a fish pass in the dam. After several alternatives had been considered, a hydraulic lift was adopted for this purpose at the suggestion of Messrs. Glenfield and Kennedy, Limited, Kimarnock. This pass, or lift, the construction of which is shown in Fig. 16, is based on the principle of the canal lock. It consists of an open chamber at the top of the upstream face of the dam, which is connected by an enclosed sloping shaft to a second chamber at the base of the downstream face. These chambers are provided with sluice gates, which are opened and closed electrically at times determined by an electric clock. At the commencement of the cycle of operations, the gate at the entrance to the lower chamber is opened so that the water contained in it, as well as that in the shaft and upper chamber, is discharged. The fish are, therefore, encouraged to enter the lower chamber from the tail race, which has been cleared from obstructions so as to eliminate dead water and back eddies. The lower gate is then closed so that the lower chamber and shaft gradually fill with water, the result being that the fish are able to swim into the upper chamber. Finally, the gate controlling the upper chamber is opened, so that the fish can enter the reservoir.

The pass is fitted with two hand-operated needle-type regulating valves with submerged dispersers. The smaller of these provides a small flow through the pass when the gates are closed, so as to encourage the temporarily imprisoned fish to ascend or descend and to provide cover for them. The larger may be used to boost the flow in the tail race when necessary. The timing of the system has been a matter for experiment. At present, a three-hour cycle is in use and this seems to be successful for salmon. Experiments are, however, also being made to encourage smolt to go down the pass by installing lights, the usual practice of allowing them to pass through the turbine being considered undesirable. This may necessitate some change in the arrangements.

The generating plant at the Leixlip station consists of a Kaplan turbine, which was constructed by Messrs. Escher Wyss A.G., Zürich, and is designed for operation at a head of 56 ft. This turbine is coupled directly to a 5,150-kVA vertical-shaft alternator, which was constructed by Messrs. Brown, Boveri A.G., Baden, Switzerland, and generates three-phase current at 10.5 kV when running at 300 r.p.m. The set is equipped with a built-on exciter and a thrust bearing of the segment type, which can carry a total load of 89 tons. The alternator is connected to a Brown Boveri transformer with a capacity of 5 MVA, which steps up the voltage to 38 kV for transmission, through airblast circuit-breakers, to Inchicore switching station 8 miles away. Leixlip station also contains a 400-kVA transformer from which the auxiliaries are supplied. It has been designed for unattended operation from Inchicore and the set is, in fact, started by pressing a button at the latter place. Automatic control gear is also provided for synchronising the set with the network and constant output and constant power factor are maintained by limiting devices and regulators. If a fault occurs, the set is shut down automatically and the fact is indicated at Inchicore.

ERNE POWER SCHEME.

The Erne power scheme makes use of the water of the River Erne, which is about 60 miles long and rises in Lough Gowna, some 13 miles south-west of the town of Cavan. It then flows through the Upper and Lower Lough Erne and after passing through the two stations at Cliff and Cathleen's Fall, in which the full head of 152 ft. between the Lough and the sea is utilised, enters the sea at Ballyshannon in County Donegal. The catchment area is 1,523 sq. miles and lies partly in Southern and partly in Northern Ireland. The average annual rainfall in the area is about 41.4 in., and the average flow 102 cub. m. per second, while the storage capacity of the two loughs at the proposed working levels is some 229 million cub. m.

A view of the exterior of the Cliff station, showing the head lake, dam and tail race, is given in Fig. 8, Plate XLIV. As will be seen, the dam has been constructed across a gorge and consists of a gravity section, intake, spillway and fish pass, together with a central core wall on the right bank. As will also be seen, the power station is immediately downstream of the intake, and, in fact, butts up to it. The top water level upstream of the dam is 152 O.D., the invert of the intake is at 105 O.D., the invert of the draught tube at 75.46 O.D., while the tail-water level is at 112 O.D. The gravity section has a slope on its downstream face of 1 to 0.84 and on its upstream face of 60 to 1. The body of the dam is composed of 8 to 1 concrete with a facing of 4 to 1 concrete about 2½ ft. thick on the upstream face. The intake forms part of the dam and has two openings, each of which leads into a spiral casing. The entrance to this intake is protected by screens, which can be cleared of debris by mechanical rakes. Downstream of the screens are gates, of which there are two to each turbine. The spillway consists of two 20-ft. openings, in which gates are incorporated to control the flow, while downstream of it there is a stilling basin to disperse the energy of the water. A fish pass of normal design has been constructed on the left bank of the river and consists of 36 pools, each of which is 25 ft. long by 12 ft. wide. There is a rise of 18 in. between adjoining pools in this pass, and they are connected by concrete pipes 27 in. in

ELECTRICITY SUPPLY IN SOUTHERN IRELAND.

Fig. 12. UPSTREAM ELEVATION.

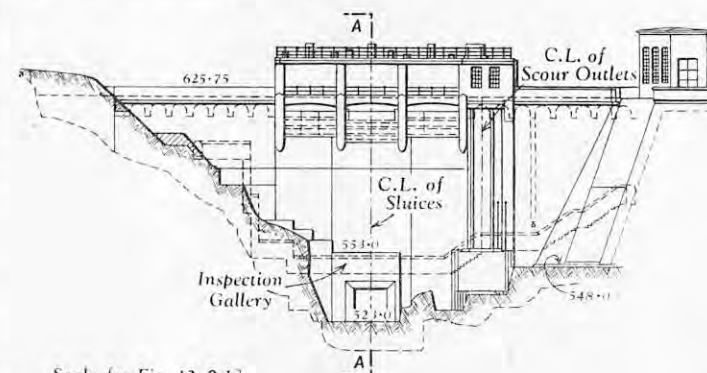


Fig. 13. PLAN.

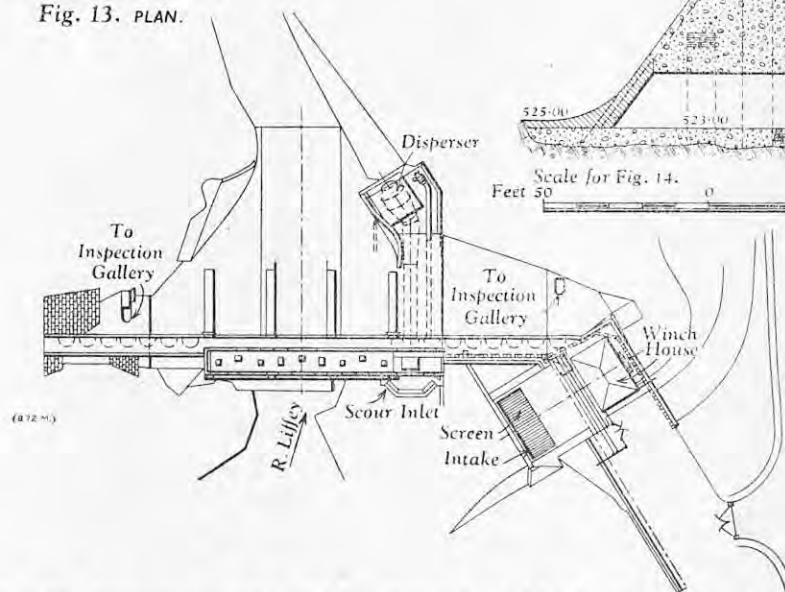
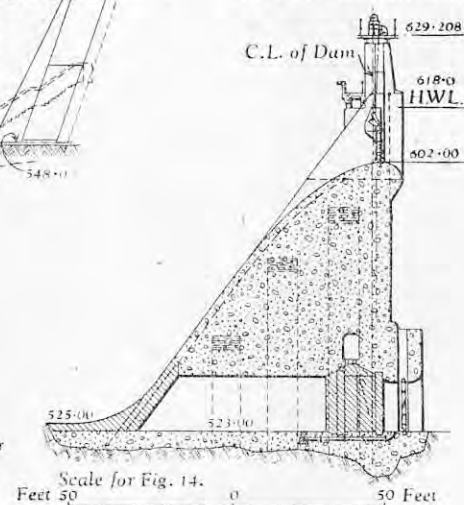


Fig. 14. SECTION AA.



diameter with depressions under their outlets. The contractors for the civil engineering work at Cliff were the Cementation Company, Limited, Doncaster, who found it necessary in certain areas to excavate some way below the designed formation level, owing to the decayed nature of the dolomite rock. The whole of the work was carried out in the original river bed behind cofferdams, the stream being diverted through a channel 50 ft. wide which was excavated in the right bank. This channel was afterwards closed by a pre-cast concrete arched cofferdam and the main dam completed. Excavation was effected by 17 R.B. excavators, which loaded into 1½ cub. yard wagons running on a 2-ft. track. The concrete was brought by lorry from the central mixing plant at Cathleen's Fall, was fed through a 2½-cub. yard re-mixer and handled to the site by derrick cranes. One of the cranes was used to construct the gravity section of the dam on the right bank and was then dismantled and re-erected on the left bank for the construction of the fish pass. The other was employed on the power station, intake and spillway structures, and was mounted on three hollow-concrete towers 50 ft. high, which were erected in 50 hours by means of sliding shutters. The foundations of the dam and power station were pressure-grouted with a mixture of cement and water by the cementation process, so as to cut off all leakage. In some cases this grouting was carried out to a depth of 100 ft. below the foundations.

Cathleen's Fall power-station building, the external appearance of which is shown in Fig. 9, Plate XLIV, has a reinforced-concrete foundation with a steel superstructure, which is filled with mass concrete. The roof is of reinforced concrete. It is interesting to note that no steel lining was used in the construction of either the draught tubes or the spiral casings and that the concrete surface of these parts did not have to be touched after the formwork had been removed.

The generating plant at Cliff consists of one main vertical-shaft Kaplan turbine, which was con-

structed by the Ateliers des Charmilles S.A., Geneva, and has an output of 14,250 h.p. when operating under a 10-m. head at a speed of 115.3 r.p.m. This turbine is directly coupled to a 12.5-MVA Brown-Boveri alternator, which generates three-phase current at 10.5 kV at a power factor of 0.8. This alternator is of the closed air-circuit water-cooled type and is provided with both main and pilot exciters. The former has an output of 97 kW at 220 volts and is directly coupled to the main alternator shaft. It is excited, in turn, by a 6.6-kW 160-volt pilot exciter, which is mounted directly above it. This pilot exciter is also provided with three slip-rings through which three-phase current is drawn off at 110 volts and 26.9 cycles to operate the motor on the turbine governor. There are six brakes on the lower alternator bracket, which are operated by oil pressure. These are usually brought into action by pushing a button, but operate automatically if the speed of the set falls below 50 per cent. of normal. A second similar set is now on order and should be installed in about two years time. There is also an auxiliary house set consisting of a 440-h.p. double-flow Francis turbine with a horizontal shaft. This machine is direct-coupled to a 375-kVA three-phase alternator and 5.5-kW exciter, the former generating three-phase current at 400 volts for use on the auxiliary services.

The main alternator is connected to a 15-MVA transformer through a circuit-breaker of the "oil-minimum" contraction type with a rupturing capacity of 20,000 amperes, which is operated by a motor-wound spring mechanism. This transformer which, like the switchgear, was manufactured by A.S.E.A. Electric Company, Limited, Walthamstow, London, E.17, is equipped with on-load tap-changing gear, so that the secondary voltage can be varied in 14 steps between 132.7 kV and 94.7 kV. The transformer is connected to the 110-kV switching station at Cathleen's Fall, which is described below, through a double-circuit line. The Cliff station also contains two 500-kVA, 11-kV/380-volt on-load, tap-changing house transformers, the low-tension

ELECTRICITY SUPPLY IN SOUTHERN IRELAND.

Fig. 15. SECTION THROUGH INTAKE AND POWER STATION, BLOCK B.

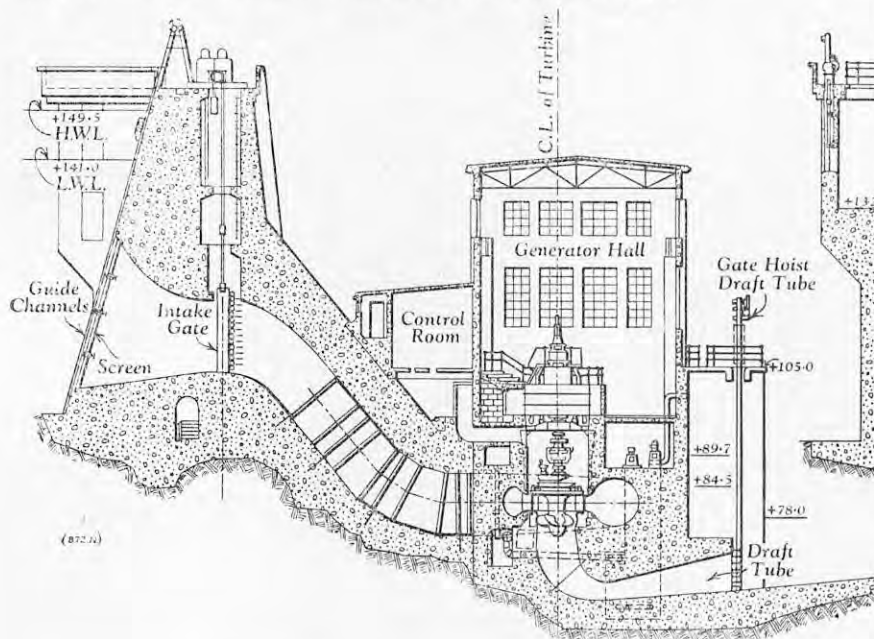


Fig. 16. SECTION ALONG FISH LIFT, BLOCK B.

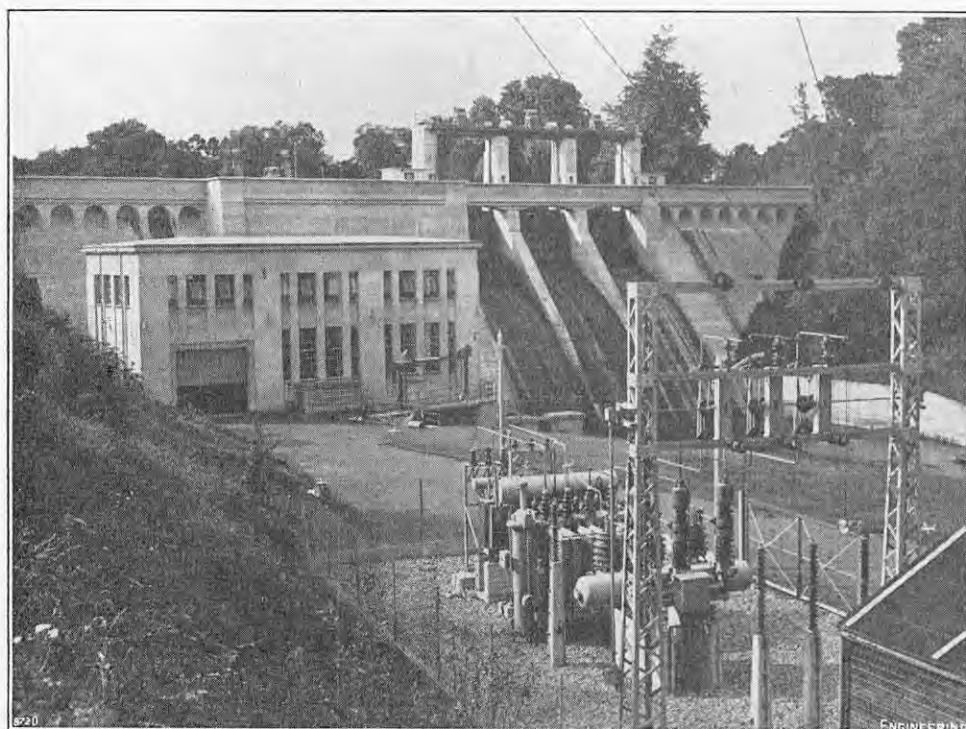
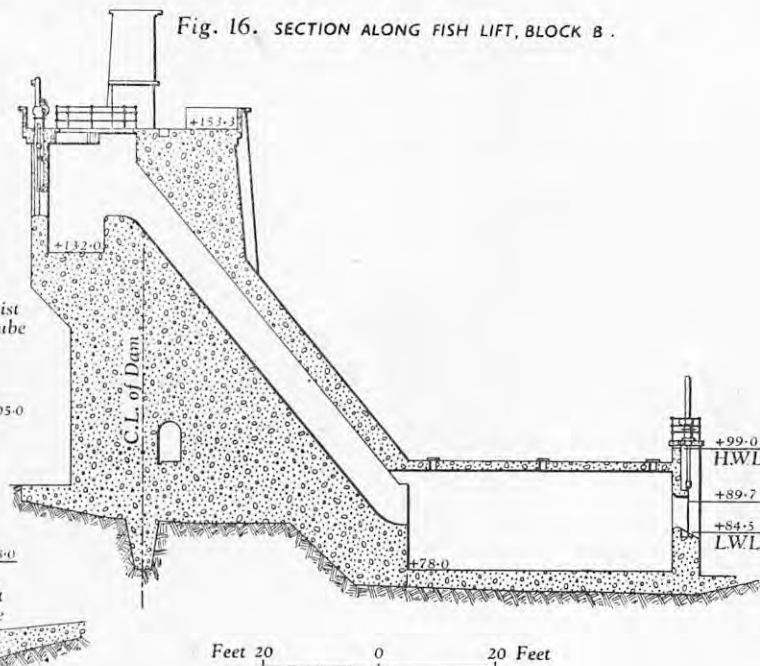


FIG. 17. LEIXLIP POWER STATION.

sides of which are connected to the auxiliary house set. The high-tension sides will eventually be connected to a duplicate overhead line which will lead to two transformers of similar capacity at Cathaleen's Fall. Warning of a fault, an indication of its seriousness and its location on the main or auxiliary alternators, pumps or associated equipment, are given both audibly and visibly on two control boards behind which the necessary relays are mounted.

A core trench was excavated in the left bank of the river between Cliff and Cathaleen's Fall, filled with concrete and subsequently cemented. The bank itself was then built up to a maximum height of 30 ft. by clay obtained from borrow pits and covered with concrete slabs.

The layout of the Cathaleen's Fall scheme is shown in Fig. 18, on page 776, while the general appearance of the works is illustrated by the photographs reproduced in Figs. 9 to 11, on Plate XLIV. The dam is of the mass-concrete gravity type and is 1,000 ft. long with a maximum height of 90 ft. The gravity section is similar to that at Cliff, but

the three spillway openings are 36 ft. wide. The intake section is connected to the power station through two steel penstocks about 20 ft. in diameter, which were supplied by Sir William Arroll and Company, Limited, Glasgow, and transmit the water to steel-lined spiral casings. At present, two main turbines and an auxiliary set are installed in the station. Provision has, however, been made for a third set, the foundations for which have been excavated and are protected by an arched cofferdam. The upstream water level at this point is +112 O.D., the invert of the intake being at +65 O.D., the invert of the draught tube at -31 O.D., while the tail-race water level ranges from +24.5 to +3.0 O.D., according to the tide.

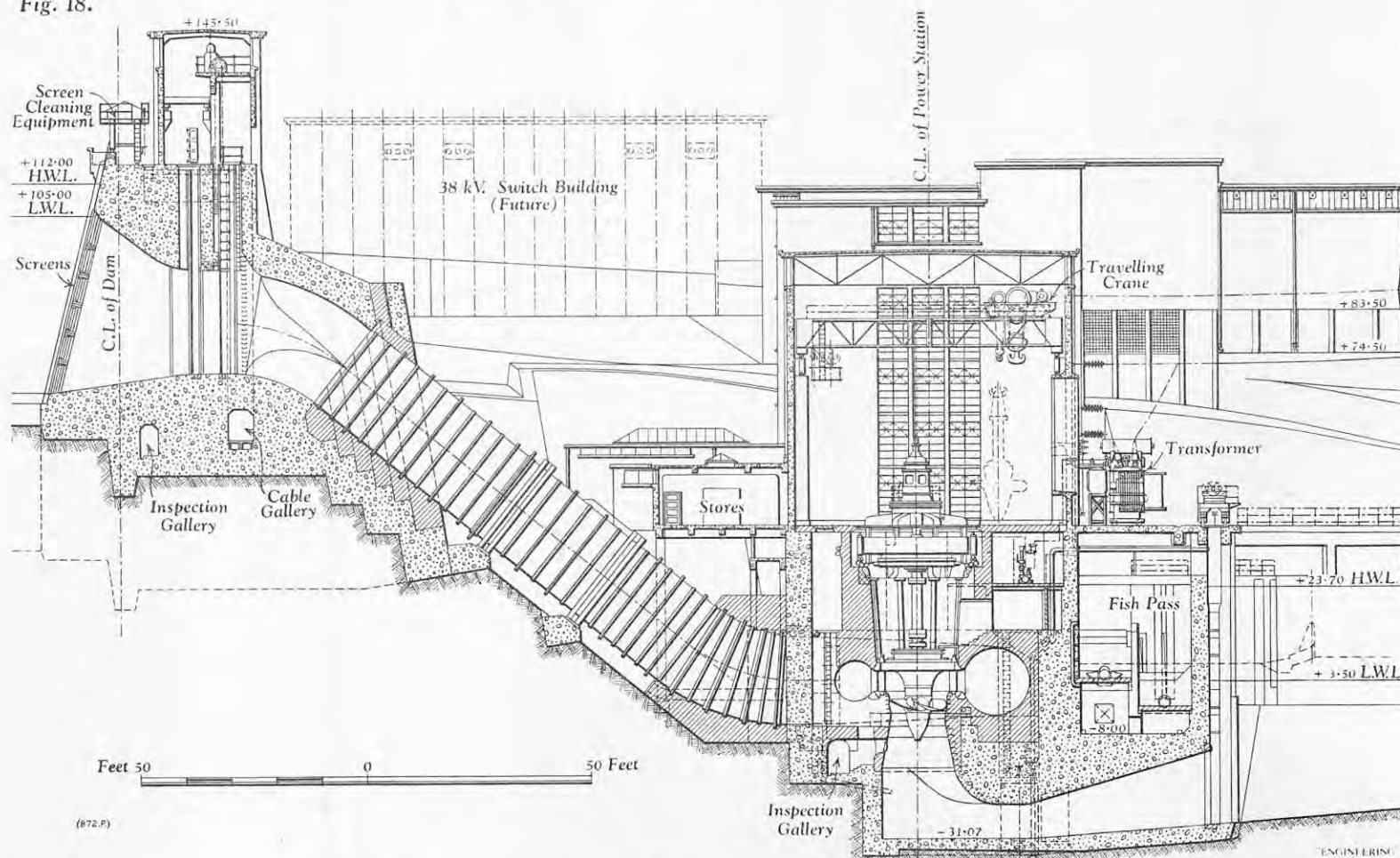
The constructional work necessary for the erection of the dam was carried out by the Cementation Company, Limited, drilling being effected by DA 35 and X 71 Ingersoll Rand drills, which were mounted on wagons. Polar ammon gelignite with Cordtex initiation and millisecond detonators was used for blasting, and the rock was removed either by 17 R.B. mechanical shovels which loaded it into

1½-cubic yard wagons running on a 2-ft. track to a tip, or by three-drum Ingersoll Rand scraper winches with 1 cubic yard buckets, which discharged it into a shaft whence it was hoisted by bucket on to conveyors and fed to the main crushers. The latter plant, which was supplied by Messrs. Frederick Parker, Limited, Leicester, consisted of two 30 in. by 18 in. crushers which were fed by grizzlies; a primary and secondary Kubit; two 18 ft. by 4 ft. Oscillex screens; and conveyors leading to the storage bins, in which aggregate of different sizes was collected. There were also two bins for the natural sand which was obtained from a pit about 20 miles away. The aggregate for the various mixes of concrete was batched in a tunnel below each set of bins—the aggregate by volume and the sand by weight—and then fed into a hopper where the cement was added and the whole fed into two high-speed Blaw Knox mixers, the capacity of each of which was one cubic yard. Normal Portland cement was used which, after being delivered in bulk at Ballyshannon railway siding, was blown by compressed air through steel pipes, 2,000 ft. long and 6 in. in diameter, into the storage bin. The concrete was placed by two travelling derrick cranes, which ran on a gantry spanning the site about 20 ft. downstream of the dam. The power station building was built by two cranes the radii of which were connected both with each other and with the gantry cranes.

The plant in Cathaleen's Fall station consists of two 31,700-h.p. Kaplan turbines, which were constructed by Aktiebolaget Karlstads Mekaniska Werkstad, Sweden, and run at 187.5 r.p.m., when operating under a head of 28.2 m. Each turbine is directly connected to a 30-MVA alternator, which was constructed by the Allmanna Svenska Elektriska Aktiebolaget, Vasteras, Sweden, and is designed to generate three-phase current at 10.5 kV. The rotor has been built up of three sheet-steel rings which are mounted on a cast-iron spider. The poles are laminated and carry damping windings. The alternator is surmounted by a combined guide and thrust bearing. This is designed for a load of 600 tons, 480 tons of which is due to the turbine. A 175-kW main exciter and a 6-kW auxiliary exciter are directly connected to the alternator shaft, while a permanent-magnet pendulum generator, with a three-phase output of 0.8 kVA at 110 volts, is mounted below the thrust bearing and supplies current for operating the turbine governor. In addition, there is an auxiliary set, which consists of a 571-h.p. Francis turbine, running at 750 r.p.m. under a head of 28.2 m., and is coupled to a 500-kVA alternator supplying three-phase current at 400 volts. A 5.3-kW exciter is connected to the main shaft.

ELECTRICITY SUPPLY IN SOUTHERN IRELAND.

Fig. 18.



This alternator is connected to a double 'bus-bar' 380-volt system, which, in turn, is connected by overhead lines to Cliff through two 500-kVA 380-stroke 10,000-volt transformers. At Cliff, this supply is again stepped down to 380 volts and connected to the same 'bus-bar' as the 300-kW house set at that station. Each main alternator is connected through an air-blast circuit-breaker with a rupturing capacity of 500 MVA to an on-load tap-changing transformer with a capacity of 30 MVA. A 110-kV arc-suppression coil, with a capacity of 120 amperes, is placed between the two transformers and is connected to their neutral bushings. The secondary voltage of each of these transformers can be varied from 132 to 94 kV, and they are connected through air-blast circuit-breakers, with a rupturing capacity of 2,750 MVA, to a double 'bus-bar' system. The output from Cliff is also fed to this system from which 110-kV feeders run to Finglas and Carrick-on-Shannon. Connection is further made to the Board's 38-kV transmission network through a 15-MVA transformer. The 110-kV switchgear is installed out-of-doors and, in addition to the air-blast circuit-breakers, includes 21 isolators, the current-carrying capacity of which is 600 amperes. These isolators are operated by compressed air and three of them are fitted with earthing switches, which are worked by the same means. Air for this purpose is supplied from two compressors at a pressure of 30 atmospheres and is reduced by reducing valves to 15 atmospheres, for operating the circuit-breakers and to 5 atmospheres for working the isolators. There are five 500-kVA house transformers, which step down the alternator voltage to 400 volts. Two of these units are connected to the line to Cliff, which has just been mentioned, one to a feeder leading to Ballyshannon, while two enable the station auxiliaries to be supplied from the main alternator.

Returning to the generating plant, the water from the turbines passes through draught tubes, which are lined with steel for a distance of 40 ft. from the turbines, and then runs into a tail race which extends a distance of 1,500 yards to the sea. This tail race consists of a channel 48 ft. wide and about 26 ft. deep, and was excavated from the

solid rock, except for a distance of about 900 ft., where boulder clay was encountered. To carry out this work a cofferdam was constructed down the centre of the river and behind it excavation was effected by blasting, special care having to be taken as the channel ran through the centre of the town of Ballyshannon. The X71 and D35 drills used for this purpose were mounted on pontoons and worked through 2-in. steel pipes, which were withdrawn when the hole had been charged. Excavation was effected by a Ruston Bueyrus 43B excavator, which was mounted on a pontoon, the dipper arm being extended to give a digging depth of 18 ft. 3 in. The capacity of the bucket was $\frac{7}{8}$ cub. yd. and in the early stages the excavated material was loaded into 2-cub. yd. wagons. These wagons were carried on a barge which was hauled by a two-drum electric winch to a site where their contents were unloaded by crane. Later, when the deepened channel had lowered the water level sufficiently, the wagons were handled by a travelling crane to the bank without it being necessary to move the barge.

The channel was excavated to a depth of -6 O.D. except in the gravel section, where the depth was only -4 O.D. The tail race ends in a concrete weir at the estuary, the invert of which is at +0.6 O.D. On the seaward side, however, the excavation was taken down to -16 O.D., thus reducing the velocity of the water in the tail race itself to a maximum of 10 ft. per second and preventing scouring of the banks.

In conclusion, brief reference may be made to the Allenwood peat-fired station in County Kildare, which is also to be visited by those taking part in the summer meeting of the Institution of Electrical Engineers. This station, which draws its supplies of fuel from the Timahoe and Lodge bogs, is of the same general design as that at Portarlinton, reference to which has already been made, and has an installed capacity of 40 MW. The steam-raising plant consists of four boilers, which were manufactured by Messrs. Babcock and Wilcox, Limited, each being designed to supply 150,000 lb. of steam per hour at a pressure of 400 lb. per square inch and a temperature of 800 deg. F.

The generating plant consists of two turbines, which were constructed at the Fraser and Chalmers Works of the General Electric Company, Limited, Kingsway, London, W.C.2. These turbines are of the single-casing type and are arranged so that steam can be bled off at three stages for feed heating, evaporation and de-aeration purposes. They exhaust into single-shell condensers, which are capable of maintaining a vacuum of 28.67 in. when the circulating water from the cooling tower is at a temperature of 70 deg. F. The condensers and feed-heating plant, as well as the evaporator and de-aerator, were supplied by Messrs. Worthington-Simpson, Limited, Newark-on-Trent.

Each turbine is coupled to a 20-MW General Electric alternator, which generates three-phase current at 10.5 kV, but can also give its full output at any voltage between 9.5 and 11.5 kV. The alternators are designed to give 70 per cent. of their kVA rating at zero leading power factor. To meet local conditions, the short-circuit ratio is higher than is usually specified, being 0.75 at the normal working voltage. As a result of the wide-voltage range and high short-circuit ratio, the air gap is larger than that usually adopted. Otherwise, the machines are of normal construction. Ventilation is effected on an external closed-circuit system consisting of two 55-in. in diameter Davidson fans and a four-section cooler. The capacity of this cooler is such that effective cooling is obtained when the alternator is on full load and one section is out of service. The main and pilot exciters are separately cooled.

BUILDING RESEARCH STATION DIGEST.—The June issue of *Building Research Station Digest* (No. 43) contains notes on three subjects: coloured treatments for bituminous surfaces; the discoloration of window glass, which has been found to arise as a result of exposure to moisture before the glass is fixed; and the addition of gypsum plaster to mortars and renderings, which can cause deterioration in work exposed to the weather during or after erection. Copies of the *Digest* may be obtained from H.M. Stationery Office, Kingsway, London, W.C.2, price 3d. net.

PRODUCTION OF CAST-IRON ROLLS.

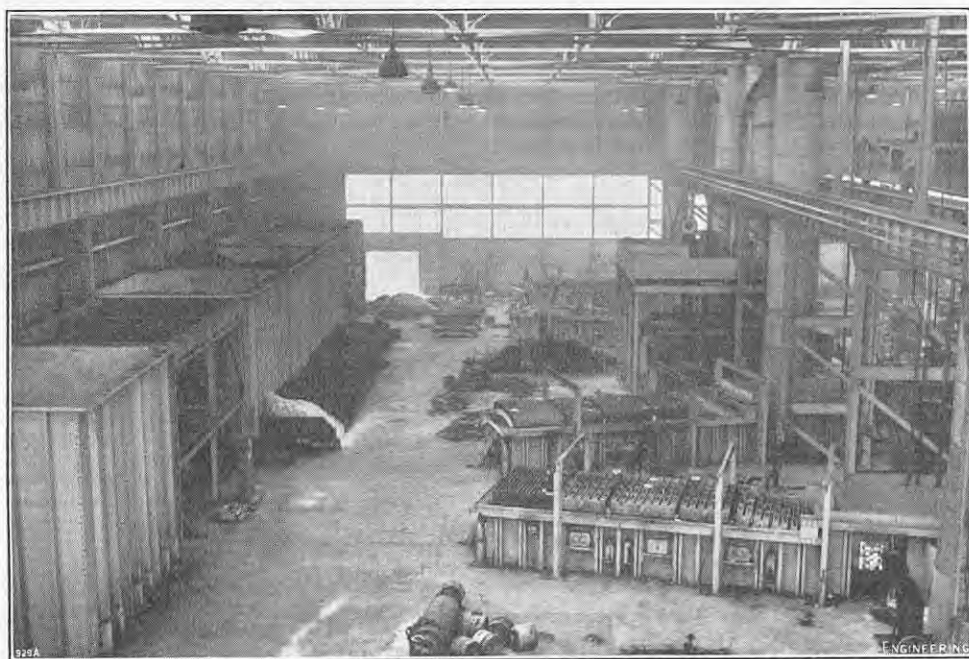


FIG. 1. FOUNDRY FURNACE BAY.

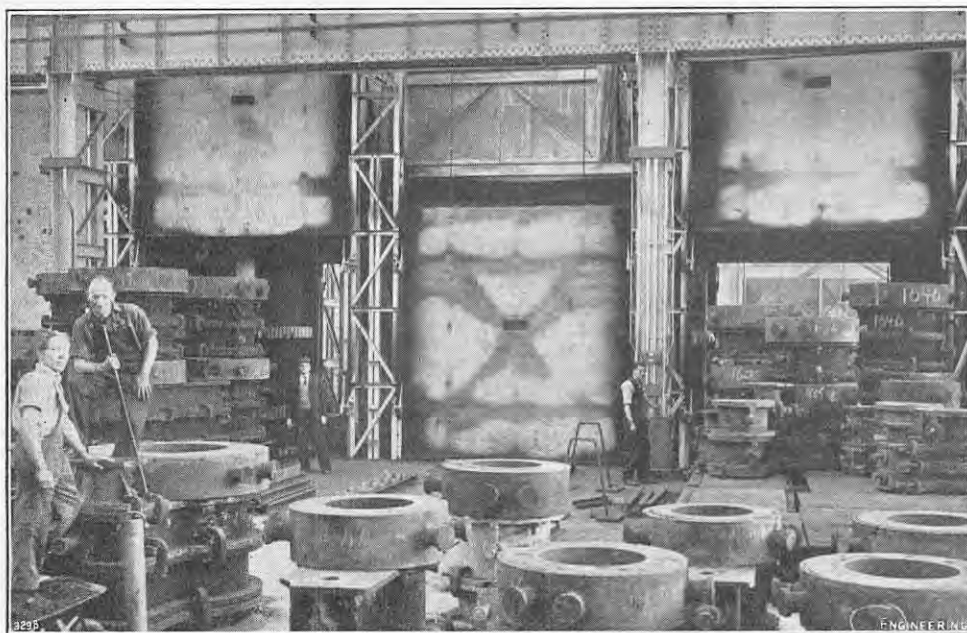


FIG. 2. MOULD DRYING STOVES.

THE CREWE WORKS OF THE BRITISH ROLLMAKERS CORPORATION, LIMITED.

THE British Rollmakers Corporation, Limited, was formed in 1942 by the fusion of three well-established roll foundries, namely, Messrs. R. B. Tennent, Limited, Messrs. C. Akrell, Limited, and Messrs. Thomas Perry, Limited. These three companies had acted in close liaison for a number of years previously and their joint association with an American company had convinced them that only an integrated group of companies could provide the basis for the expenditure necessary to put their respective plants into a proper condition to meet modern demands. In furtherance of this idea, the Corporation acquired, in 1944, the roll businesses of Messrs. Bayliss, Jones and Bayliss, Limited, Victoria Works, Wolverhampton, and Messrs. John Lysaght, Limited, Swan Garden Works, also at Wolverhampton, Messrs. Bayliss Rolls, Limited, being formed to operate these two works. At the same time, a scheme for the expansion and modernisation of the works of Messrs. R. B. Tennent, Limited, was put in hand which, when completed, will, it is claimed, make the works the largest and most modern in the United Kingdom. The works of Messrs. Bayliss, Jones and Bayliss, Limited, and Messrs. John Lysaght, Limited, however, did not lend themselves to expansion, and modernisation, and it was decided, therefore, to build an entirely new works

at Crewe. This project has now been completed and the new works were inaugurated at a luncheon held on the factory site on Wednesday, June 11.

The new works are conveniently situated, being approximately half a mile from Crewe station and bounded on the south-west by the main railway line. Work on site levelling, drainage, sinking of the casting pits and service ducts, provision of roadways, etc., started in March, 1948, and the contracts placed subsequently for the erection of the buildings and provision of the necessary plant called for completion by March, 1951. This date was adhered to closely, production of rolls commencing in May, 1951, which was built up subsequently to the full capacity of the plant then installed by December, 1951. The works entrance and offices are situated on Weston-road, which forms the north-east boundary, and the general layout of the factory area provides for administrative and commercial offices, technical and research buildings, a canteen, and a medical and welfare centre on the right, or north side, of the main entrance; on the other side of the entrance are the works laboratory, foundry and machine shop.

The foundry building consists of four main bays, two with a span of 80 ft. and two with a span of 60 ft.; there are also two intermediate bays of 40-ft. span. The overall length of the bays is 360 ft. and the building houses the raw-materials storage area, the melting units, the ladle and casting pits, the stripping

and fettling area, the sand-preparation plant, drying stoves, moulding area, pattern shop and stores. The melting units include four top-charged air furnaces, each of which is fired by an independent unit-type coal pulveriser, two cupolas and a single oil-fired rotary furnace. The four top-charged melting units and the two cupolas can be seen to the right in Fig. 1, on this page, with the storage bins for the coal to the left. The pulverisers are situated below the bins and these are arranged to discharge directly to the furnaces, there being a separate pulveriser for each furnace. Two of the top-charged melting units have a capacity of 25 tons each, and two a capacity of 15 tons each. The cupolas are each designed for capacities of 7 tons per hour, but at present are lined for capacities of 4½ tons each. They are hand-charged from a platform fed by an overhead traveller, the precision with which they have to be charged to obtain the required alloys precluding the use of automatic charging equipment. The ladles are capable of accepting the full discharge from any melting unit, and to ensure maintenance of the correct casting temperature, are heated by gas.

There are six oil-fired recirculating mould-drying stoves, some of which can be seen in Fig. 2, herewith. The moulds are loaded on to steel bogies in the moulding bay, the bogies being subsequently drawn into the stoves by independent heavy steel chains operated by electric winches. After drying, the bogies are drawn into the casting bay, illustrated in Fig. 4, on page 780, the controls operating the stove doors and the winches for the bogie chains being interlocked to prevent damage being caused by incorrect operation. The sand-preparation plant is located in the moulding bay, the plant being designed to draw screened and cleansed sand from the stripping area and new sand from adjacent storage bunkers. The plant can be seen in Fig. 3, on page 780, which is a general view of the moulding bay. To give a clear working space in the moulding bay, all chills, moulding boxes, etc., are stored in a separate bay set aside for this purpose, the floor of the bay incorporating heating coils so that the chills can be stored at a temperature sufficiently high to prevent condensation and, therefore, rusting. This area is illustrated in Fig. 5, on page 780. The pattern shop and adjacent pattern stores are arranged at one side of the moulding shop. The pattern shop has good natural lighting and is equipped with a comprehensive range of modern woodworking plant.

The machine shop consists of two main bays each of 60 ft. span and an intermediate bay of 40 ft. span. The overall length is 330 ft. and the bays are designed to accommodate overhead electric cranes up to a capacity of 60 tons. It is equipped with a wide range of modern roll and engineering lathes, "wobblers" milling machines and roll-grinding machines capable of machining all sizes and qualities of rolls to a high degree of finish and accuracy. It should, perhaps be mentioned here that the Crewe works are at present employed on the production of plain rolls only. The machine shop also contains the necessary lathes, horizontal and vertical boring machines, radial drilling machines, etc., for the production of the various pieces of equipment used throughout the works, the company making, for example, their own chills. There is also a large tool room equipped for the production of the templates and gauges used throughout the works. A general view of the machine shop is given in Fig. 6, on page 780, from which it will be seen that there is ample room for access to the machines.

The machine shop is served, at present, by two electric travelling cranes and the foundry bays by six similar cranes. These, of course, serve individual bays, and internal transport between the bays is provided by a transfer track on which run electric bogies thus interconnecting all the bays of the foundry and the machine shop. Part of the transfer track and one of the electric bogies, or cars, can be seen towards the right in Fig. 5. Heating of the main buildings is effected by radiant panels some of which can be seen suspended between the main stanchions of the machine shop in Fig. 6. The main offices, canteen buildings and works laboratory, together with the various drying rooms, locker rooms, etc., however, are heated and ventilated on the plenum system so as to ensure a controlled temperature and air free from the smoke and grime contained in the outside atmosphere. Two coal-fired water-tube boilers fitted with chain-grate stokers supply the high-pressure hot water used in the various heating systems and for domestic purposes generally.

Care has been taken in the layout of the foundry areas and the machine shop to ensure an uninterrupted flow of production and to reduce to a minimum cross-tracking and bottlenecks. The designers certainly have succeeded in accomplishing this, and one of the features of the works is the ease with which the raw materials, partly finished products, moulds, etc., are moved from one department to another. The existing buildings are capable of accommodating additional plant which, when installed, will double the present production. This new plant is on order and is expected to be in commission by the end of this year.

NOTES FROM THE INDUSTRIAL CENTRES.

SCOTLAND.

MEMORIAL TO SIR THOMAS BELL.—Lord Aberconway, chairman of John Brown & Co., Ltd., on June 11 unveiled a bronze plaque on the outer wall of the main offices of the firm, to commemorate the service given to Clydebank shipyard by Sir Thomas Bell over a period of more than half a century. During the ceremony, Lord Aberconway said that when Sir Thomas Bell entered the shipyard it was relatively small; when he left, while it was not the largest in size, it was, in reputation, the greatest shipyard in the world. That was due to his ability and personality. The inscription on the plaque reads: "Thomas Bell 1865-1952. Clydebank 1886-1946. Managing director 1909-1935. Si monumentum requiris circumspice."

THE LATE SIR JAMES IRVINE, C.B.E., F.R.S.—Sir James Colquhoun Irvine, Principal and Vice-Chancellor of St. Andrews University, Fifeshire, who died at St. Andrews on June 12 at the age of 75, had been Principal for 32 years. After graduating B.Sc., in 1897 he engaged in research work. In 1901, he began the investigations on carbohydrates with which his name is commonly associated. His researches placed the constitution of sugars and carbohydrates on an exact basis, and produced a revival of interest in the scientific study of carbohydrates generally. In 1909, when only 32 years of age, he succeeded Professor Purdie in the chair of chemistry at St. Andrews, where he had previously been appointed lecturer. He was elected a Fellow of the Royal Society in 1918. Professor Irvine was appointed to the principalship in 1921. He was created a C.B.E. in 1920 and was knighted in 1925.

IRON AND STEEL PRODUCTION.—Production of steel ingots and castings in the Scottish district during May barely reached the level of the preceding month, the respective annual equivalents being 2,150,700 tons and 2,172,600 tons. The corresponding figure in May, 1951, when the number of furnaces was reduced on account of raw-material shortages, was 2,276,400 tons. Pig-iron production was likewise a shade lower at a rate of 904,270 tons per annum against 918,300 tons, but remained in excess of the standard of last year, when, in May, the output represented 807,600 tons a year.

COLLECTION OF STEEL SCRAP.—Mr. A. R. W. Low, Parliamentary Secretary, Ministry of Supply, who has carried out a three-day inspection of West of Scotland plants engaged on defence work, said that steel production in Scotland had fallen because of a reduction in imported scrap. The drive for scrap from outlying parts of the country, however, had yielded a considerable tonnage, and a further substantial quantity was being shipped from the Western Isles.

THE TURBINE S.S. "KING EDWARD" TO BE BROKEN UP.—The Clyde steamer King Edward, the first passenger turbine vessel in the world, has been sold by British Railways to the British Iron and Steel Corporation, and will be broken up for scrap at Troon. Her bells are to be included in the collection of steamer relics at the Glasgow Art Gallery. The war-record and builders' plaques are to be preserved in the Railway Museum, Waterloo Place, Edinburgh. Mr. Peter Thorneycroft, President of the Board of Trade, indicated in the House of Commons on June 10 that the engines, which are 50 years old, will probably be acquired by museums, though we understand that some difficulty is being experienced in finding accommodation for them.

HARBOUR FACILITIES AT GRANGEMOUTH.—With the growth of Grangemouth as an industrial centre, the port also has been increasing in importance. Three new 10-ton grabbing cranes are to be erected at an estimated cost of 100,000l., in an effort to speed up the turn-round of shipping at the docks.

IMPROVEMENTS AT PETERHEAD HARBOUR.—Peterhead graving dock, deepened, refitted, and lengthened, was formally reopened on June 12 by Mrs. Dickie, wife of the Provost of Peterhead, Mr. John A. Dickie, who is also chairman of the harbour trust. Provost Dickie said the new dock could take ships up to 190 ft. long with a beam of 34 ft. The improvement is part of a harbour reconstruction scheme estimated to cost 154,000l.

INDUSTRIAL PHYSICS EXHIBITION.—At the Industrial Physics Exhibition to be held at the Royal Technical College, Glasgow, from June 24 to 28, the Department of Scientific and Industrial Research will be represented by the Mechanical Engineering Research Organisation, East Kilbride, and by the Road Research Laboratory, and the Fuel Research Station. The two last-mentioned have Scottish branches at Thorntonhall.

PRODUCTS FROM SEAWEED.—Moray Firth Seaweed Products, Ltd., who opened a factory at Nairn 18 months ago, have decided to set up a similar factory in a former aircraft hangar near Kirkwall, Orkney. It is hoped to have the factory in operation by the end of the year. The company manufacture stock foods and fertilisers from seaweed.

CLEVELAND AND THE NORTHERN COUNTIES.

CENTENARY OF TEES CONSERVANCY COMMISSION.—The Tees Conservancy Commission are celebrating their centenary this year. The Commission was formed in 1852 to succeed the Tees Navigation Co., Ltd. In 1876, the Commission built a graving dock, and, about 30 years afterwards, Smith's Dock Co., Ltd., North Shields, constructed their dry dock and shipyard at South Bank-on-Tees. In 1917, the Furness Shipbuilding Co., Ltd., Haverton Hill-on-Tees, was established and now has an annual output of 90,000 gross tons. Moreover, Messrs. William Gray & Co. Ltd. have a dock at Graythorp. About nine years ago, the Tees Commissioners drew up plans for important developments, including new open docks at Teesport and new oil berths. The oil berths have been built, but Government sanction to construct the open docks has not yet been received, despite urgent representations on the matter by the Commission. During the annual inspection of the river, it was announced that Shell-Mex and B.P., Ltd., were to undertake the development of 22½ acres of land at Teesport for oil installations. Work on the site is expected to begin next year.

TEES CONSERVANCY COMMISSION.—At the monthly meeting of the Tees Conservancy Commission, held at Middlesbrough last week, it was stated that the tolls, dues and net registered tonnage of the ships dealt with in the Tees, during April, were the highest since November, 1950. The net registered tonnage cleared amounted to 356,509. Imports, at 317,315 tons, showed an increase of 132,814 tons compared with those of April last year. Exports, however, were down by 5,922 tons on April, 1951.

PROBLEMS OF TEES VALLEY WATER BOARD.—At the June meeting of the Tees Valley Water Board, held at Middlesbrough, Alderman C. W. Allison, who presided, stated that the expansion of the Wilton plant of Imperial Chemical Industries Ltd. might be determined by quantity of water that could be supplied to the works. Referring to inquiries from the I.C.I. for the extension of the Low Worsall pumping station to render it capable of providing 9,000,000 gallons of water a day, Alderman Allison said that it had been expected that a daily flow of 6,000,000 gallons would be sufficient for some years. Now, however, with the Wilton undertaking developing so rapidly, that rate would continue to be sufficient for only a few months to come. Mr. T. R. Winter, the Board's engineer and general manager, had been instructed to draw up a scheme for increasing the flow from the Low Worsall station by 50 per cent. It seemed, therefore, that the rate of development at the Wilton plant might depend upon the quantity of water available from Low Worsall.

BLAST FURNACE AT SKINNINGROVE.—The Skinningrove Iron Co., Ltd., have blown in a furnace, stated to be the largest in the North-East, and capable of producing up to 5,000 tons of pig iron weekly. The ceremony of starting the furnace was performed by Mr. A. Callaghan, former secretary of the National Union of Blastfurnacemen, and Mr. J. T. Atkinson, former secretary of the Cleveland Ironmasters' Association and the Cleveland Mineowners' Association. In addition to the new furnace, the Skinningrove Co. have built new railway sidings, wagon tipplers, a crusher and screen for iron ore, bins, a pig-casting machine, and other equipment.

DEVELOPMENTS IN NORTHERN COLLIERIES.—A large development scheme for the No. 3 (Northern Northumberland) Area of the Northern (Northumberland and Cumberland) Coal Board was referred to by Mr. James Bowman, chairman of the Board, at the opening of new 130,000l. pit-head baths at Ashington Colliery on June 7. Mr. Bowman said that the area had been given the task of producing 6,000,000 tons of saleable coal annually and this could only be accomplished by much re-organisation, pushed forward with the greatest vigour. The Shilbottle colliery scheme was the first one of importance to operate, and the output there had been increased by 50 per cent. During 1950 and 1951, the amount spent on re-organisation had averaged a million pounds a year, and, in 1952, this would be increased. Re-organisation was being carried out also at the Lynemouth, Ellington, Linton and Hauxley collieries. Mr. Bowman said that intensive boring between Longhirst and Ulgham village had revealed coal reserves which merited the driving of one or two drifts. There were 14,300 workmen in No. 3 area and these would be increased to 17,000,

largely through the transfer of miners from old areas in South Northumberland where collieries were being gradually worked out. The new Ashington baths are the 131st built by the Miners' Welfare Commission, which is shortly transferring its work to the National Coal Board. The baths have facilities for 3,500 miners.

RAPID DISCHARGE OF IRON-ORE CARGO.—A cargo of 4,980 tons of iron ore, brought from Narvik by the steamer Katjum, has been discharged on the River Wear in an overall time of 16 hours. This is a record for the port.

LANCASHIRE AND SOUTH YORKSHIRE.

EXHIBITION OF FILTERS AND SILENCERS, MANCHESTER.—On June 20, Vokes, Ltd., of Henley Park, Guildford, Surrey, are to open the second special-feature exhibition of their products at the Lesser Free Trade Hall, Manchester. The exhibition will remain open until June 28. The firm are showing a representative selection of their range of filtration and silencing equipment, together with many pieces of equipment indicating the application of their products. Their subsidiary companies will also be represented. The general public will not be admitted on the first day, because of the number of executives, technicians and special guests who will be in attendance.

HOLIDAYS WITH PAY.—Sheffield steel and engineering concerns have planned the operation of their employees' fortnight's holiday-with-pay to link up with the August Bank Holiday break. Order books are well filled, with a growing proportion of re-armament work, much of which is of a lighter type than formerly.

SOUTH YORKSHIRE COAL.—A steady improvement in coal production is taking place in South Yorkshire, and more coal is being exported through the Humber ports. Further expansion is expected as the result of the decision to increase the national export target. Inland consumers are well placed and adequate stocks are being carried by industrial concerns, the railways and gas and electricity undertakings. Some progress is being made in improving the supply of hard coke for industry.

GERMAN COMPETITION.—The secretary of the Sheffield Lighter Trades Employers' Association, Mr. E. A. Tuxford, has visited the Canadian International Trade Fair and, in a speech on his return to Sheffield, expressed surprise at the extent of German participation in the Fair, at which more than a hundred German firms were represented. He stated that he saw a comprehensive range of German cutlery and hand tools, and it was obvious that the German efforts were well co-ordinated. There were several information centres, to cover all the German products on view. British manufacturers must give considerable thought to this severe competition from Germany. He advocated the appointment of "live" agents in Canada who were prepared to carry stocks and so meet the German firms' ability to give rapid delivery.

THE MIDLANDS.

HAMS HALL POWER STATION EXTENSIONS.—Exploratory boreholes have been sunk on the site of the extension to Hams Hall power station, Birmingham. The extension will take the form of a completely new generating station near to, but not adjoining, the two already at Hams Hall, and will be known as "C" station. When the scheme was under consideration, objections were raised locally on the grounds of possible nuisance, and the conditions imposed by the Minister of Fuel and Power make it obligatory to take all possible steps to eliminate smoke, dust, noise and vibration. The site is about two miles from the nearest houses. When the extension is complete, and the three stations are in operation, in 1956, Hams Hall will have the largest concentration of electric generating plant on any one site in this country.

GAILEY LOCK, STAFFORDSHIRE AND WORCESTERSHIRE CANAL.—The gates of Gailey lock, on the northern section of the Staffordshire and Worcestershire canal, are being replaced, after having been in use for 60 years. The bottom gates are close to the A5 trunk road, and the bridge carrying the road over the canal is being widened. When the widening is complete, the bridge structure will be so close to the bottom lock gates that the normal balance beams could not be used. The gates are therefore to be fitted with balance beams which only extend a few feet from the pivots and then turn at right angles, so giving sufficient leverage for manual operation, and clearing the bridge structure.

AN OLD EDGE-RUNNER MILL.—An edge-runner mill from Ledbury, Herefordshire, said to be about 150 years old, has been acquired by the Reading University Museum

of English Rural Life. The mill, which was used for cider making, is of sandstone, 11 ft. in diameter, and was in use as recently as 1943. It was driven by a horse, walking in a circular path.

SOUTH-WEST ENGLAND AND SOUTH WALES.

PROPOSED USK SHIPBUILDING YARD.—Outline proposals for establishing a shipbuilding yard on the River Usk at Newport were considered at a meeting of the East Wales District Committee of the Welsh Board for Industry last week. It was stated that the plans had been sent to the Admiralty with a request from the promoters for Government support for the project. If this were forthcoming, the Board was told, the promoters would apply for the necessary licences to proceed. It is estimated about 4,500 men could be employed at the shipyard.

UNEMPLOYMENT ON TRADING ESTATES.—Redundancy and short-time working on the South Wales trading estates, particularly at Treforest, have recently tended to increase, and it was estimated that, during May, about 500 employees were discharged. Alarm at the position has led the Llantrisant Rural District Council to decide to call a conference of interested organisations on the problem, in which neighbouring authorities are being invited to join.

NEWPORT DEVELOPMENT PLAN.—Newport Harbour Commissioners have decided to object strongly to a clause in the Newport Council's proposed development plan for the town. This provides for a second river crossing, to be made either by bridge or dam. The Commissioners objected that, if such a bridge did not allow ships to pass underneath, it would mean a complete cessation of river traffic. A dam, it is feared, would silt up the river mouth and entrance channel.

FINANCES OF S.W. COAL DIVISION.—The South Wales mines operated at a profit of 196,848l. in the first quarter of this year, according to the National Coal Board returns. On an output of 6,232,865 tons of saleable coal, this represented a profit of just over 7½d. per ton. Losses in the Forest of Dean (76,797l., or 7s. 5d. per ton) and Somerset (152,171l., or 1l. 0s. 7d. per ton), however, resulted in the South-Western Division of the Board working at a loss of 32,120l.

WELSH UNEMPLOYMENT STATISTICS.—Figures issued by the Ministry of Labour and National Service show that unemployment in Wales fell, last month, by 1,838. On May 12, 26,177 persons were registered as unemployed, compared with 28,015 on April 21.

OPEN-CAST MINING NEAR LLANELLY.—The Llanelly Rural Council meeting on June 12 was told of National Coal Board plans for opencast mining in the Trimsaran-Kidwelly area. The plan provides for the construction of a washery near Studdern Bridge and of a large Bailey bridge across the river at that point.

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.

BRITISH COKE RESEARCH ASSOCIATION.—Thursday, June 26, 2.30 p.m., William Beveridge Hall, University of London, Malet-street, London, W.C.1. Conference on "Further Studies of Coking Pressure." (Transferred from May 20.)

INSTITUTE OF PHYSICS.—Wednesday, June 25, to Saturday, June 28. Fourth Conference on Industrial Physics: "Physics in the Transport, Shipbuilding and Engineering Industries," at the Royal Technical College, Glasgow. Wednesday, June 25, 9.30 a.m.: (i) "Physics in the Service of Metallurgy," by Sir Andrew McCance, F.R.S.; and (ii) "Meteorology in Industry," by Sir Robert Watson-Watt, F.R.S. 2.30 p.m., Discussion on "The Education and Training of Industrial Physicists in Scotland." Thursday, June 26, 9.30 a.m.: (i) "Some Applications of Physics in Naval Architecture," by Professor A. M. Robb; and (ii) "Some Applications of Physics in Transport," by Mr. M. G. Bennett and Mr. T. A. Eames. Friday, June 27, 9.30 a.m.: (i) "Automatic Control of Industrial Processes," by Mr. A. J. Young; and (ii) "Noise and Its Suppression," by Mr. N. Fleming. Wednesday, June 25, 7.15 p.m., St. Andrew's Halls (Berkeley Hall), Glasgow. Public Address on "Physics and Sound Reproduction," by Mr. D. T. N. Williamson. The afternoons of June 25, 26 and 27, and the whole of Saturday, June 28, will be devoted to visits and excursions. For further particulars, see page 497, *ante*.

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 Use of Fine-Mesh Sieves.—Sieving tests are used in many industries for the routine control of the quality of materials, for research on their properties and for specifications concerning their marketing. Uniformity of procedure for the sieving tests is highly desirable to facilitate comparisons between tests made in different laboratories and there is also need for guidance in the method of using test sieves. Certain industries specially concerned with the sieving analysis of powdered materials have formulated specifications for the sieving procedure and these are incorporated in the appropriate British Standard specifications. The recommended methods given in a new specification, B.S. No. 1796, entitled "Methods for the Use of British Standard Fine-Mesh Test Sieves," it is emphasised, are not in any way intended to supersede such specifications, but are to serve as a general guide to sieve users. The new specification, which is intended to apply to the sieving of materials within the range covered by B.S. No. 410, concerned with test sieves, contains information on the principles of sieving as well as on the equipment to be employed. Some additional notes on procedure are given in an appendix. [Price 3s. 6d., postage included.]

Filler Alloys for Brazing.—A new specification, B.S. No. 1845, supersedes two previous specifications dealing with filler alloys, namely, B.S. No. 206:1941 covering silver solder (grades A, B and C) and B.S. No. 263:1931 concerned with brazing solder (grades AA, A and B). The preparation of B.S. No. 1723 dealing with brazing, led to the decision to combine both specifications 206 and 263, and to extend their scope to include filler alloys used for all common brazing operations. The same identification letters were employed in B.S. Nos. 206 and 263 for different materials, and, in order to avoid confusion, all the alloys covered by the present specification (B.S. No. 1845) have been given type numbers. A table is included which correlates the old and the new alloy references. The requirements for the alloys covered by the two old specifications remain unaltered, and, in addition, clauses are laid down for four new alloys, namely, a copper-silver-phosphorus alloy, a copper-phosphorus alloy and two brazing brasses. [Price 2s., postage included.]

Burettes and Bulb Burettes.—Parts 1 and 2 of B.S. No. 846 were first published in 1939, and Part 3 in 1948. The specification has now been completely revised and brought up to date. In Part 1, ten sizes of burette, from 1 ml. to 100 ml. capacity, are specified; in Part 2, bulb burettes of 45, 65, 85 and 105 ml. capacity, and, in Part 3, burettes of 5 ml., 10 ml. and 25 ml. capacity, with pressure-filling device and automatic zero, for microchemical work. Part 3 is also being published separately as Part D.1 of B.S. No. 1428, which covers microchemical apparatus. Clauses in the revised specification, B.S. No. 846-1952, include tolerances for capacity and delivery time, and requirements for material, construction and graduation. [Price 4s., postage included.]

Dimensions of Bifurcated, Tubular and Semi-Tubular Rivets.—A new specification, B.S. No. 1855, covers the dimensions of bifurcated, tubular and semi-tubular rivets for general purposes. It stipulates the dimensions of oval-head, flat countersunk-head, and flat countersunk bevel-head bifurcated and solid-drilled tubular rivets, and oval and flat countersunk-head semi-tubular rivets. Drawings of all the rivets specified appear above the relevant tables of dimensions. [Price 4s., postage included.]

Recommended Common Name for Pest-Control Products.—The chemical names of products for pest, weed and rodent control are in many instances too complicated for common use, and shortened forms and trade names have been devised for them. As a result, confusion has sometimes arisen and to remedy this a new publication, B.S. No. 1831, containing a British Standard list of coined common names for established pest-control products has been issued. This, which is designated Part 1, consists of the names of pest-control products already in widespread use and, in view of the urgent need for their simple identification, has been made the first of a series of such lists and published immediately upon completion. Other lists will be issued from time to time. [Price 2s. 6d., postage included.]

ROYAL SANITARY INSTITUTE HEALTH CONGRESS, 1953.—The Royal Sanitary Institute, 90, Buckingham Palace-road, London, S.W.1, will hold their next congress on public health methods at Hastings from Tuesday, April 28, to Friday, May 1, 1953.

PERSONAL.

HER MAJESTY QUEEN ELIZABETH II has been graciously pleased to grant her Patronage to the Electrical Industries Benevolent Association, 32, Old Burlington-street, London, W.1.

The Council of the Institution of Mechanical Engineers, Storey's-gate, St. James's Park, London, S.W.1, have elected LORD DUDLEY GORDON, D.S.O., LL.D., and MR. JAMES ALEXANDER JAMESON, C.B.E., to be honorary members of the Institution.

At a special meeting of the General Committee of Lloyd's Register of Shipping, 71, Fenchurch-street, London, E.C.3, held on June 12, SIR RONALD GARRETT was re-elected chairman for the ensuing year, Mr. A. E. M. GALE, deputy chairman and treasurer, SIR GUY ROPNER, deputy-chairman and chairman of the Sub-Committees of Classification, and Mr. R. M. TURNBULL, vice-chairman of the Sub-Committees of Classification. LORD ROTHERWICK has been re-elected a member of the General Committee and Mr. J. HODGSON appointed chief ship surveyor as from September 1, in succession to Mr. R. B. SHEPHERD, C.B.E., B.Sc., who, as stated on page 651, *ante*, is taking up an appointment with the Shipbuilding Conference.

MR. W. L. DENHOLM was elected chairman of the Scottish Committee of Lloyd's Register of Shipping at a meeting in Glasgow on June 10. He succeeds Mr. I. R. HARRISON. MR. WILLIAM LOGAN was elected deputy-chairman in succession to Mr. G. A. WORKMAN.

MR. KENNETH GORDON, C.B.E., M.C., deputy managing director of Head, Wrightson Processes, Ltd., has been released by them to take up the post of Director General of Ordnance Factories, Ministry of Supply, on July 1.

MR. E. V. WINSTANLEY, B.Sc.Tech., M.I.Mech.E., chief engineer, condenser and gear engineering department, Metropolitan-Vickers Electrical Co. Ltd., Trafford Park, Manchester, 17, has been transferred to the staff of the chief mechanical engineer for special duties. DR. W. H. DARLINGTON, M.B.E., M.Sc., A.M.I.Mech.E., succeeds to Mr. Winstanley's former position.

The chairmen of the local sections of the Institute of Metals for the session 1952-53 are: Birmingham, Mr. H. H. SYMONDS, F.I.M.; London, Dr. C. E. RANSLEY, M.Sc., F.I.M.; Oxford, Dr. H. M. FINNISTON, B.Sc., A.R.T.C.; Scottish, Mr. E. A. FOWLER, B.Sc., A.R.T.C.; Sheffield, Mr. M. M. HALLET, M.Sc., F.I.M.; and South Wales, Mr. K. M. SPRING, A.I.M.

DR. KURT BILLIG, M.I.C.E., M.I.Struct.E., has been appointed by the Indian Government to be director of the Central Building Research Institute of India, at Roorkee. At present, he is Professor of Civil Engineering in the University of Hong Kong.

MR. J. P. BROADBENT has been appointed engineer-in-charge of the television transmitting station of the British Broadcasting Corporation, at Wenvoe, near Cardiff.

MR. R. G. HARPER, M.Sc. (Birm.), hitherto research metallurgist to Fry's Metal Foundries, Ltd., Tandem Works, Merton Abbey, London, S.W.19, has been appointed technical manager to this firm and also to the Eyre Smelting Co. Ltd.

MR. ARTHUR FRANKS is retiring from his office of managing director of W. B. Dick & Co. Ltd., on June 30. He will continue, however, as deputy chairman and director. As stated on page 747, *ante*, Mr. A. J. SEAR has been appointed managing director of the company as from July 1.

MR. J. E. ELLIOTT has relinquished his position in the Development and Research Department of the Mond Nickel Co. Ltd., Birmingham, to take up that of research metallurgist to Bound Brook Bearings (G.B.), Ltd., Litchfield, Staffordshire.

MR. B. ELIOT COMMON has been re-elected chairman, and MR. A. G. EVERETT vice-chairman, of the Tyne Improvement Commission, Newcastle-upon-Tyne.

DR. P. GREENFIELD has left the University of Birmingham to join the staff of the Atomic Energy Research Establishment, Harwell, Berkshire.

MR. KENNETH MOORE has been made export sales manager of Electronic Tubes Ltd., Kingsmead Works, High Wycombe, Buckinghamshire. MR. L. R. THOMPSON has been appointed assistant sales manager, and DR. R. JESSEL, B.Sc., A.R.C.Sc., F.Inst.P., A.M.I.E.E., chief of the engineering division of the firm.

MR. H. E. GOODY, manager of the Mazda lamp and lighting advertising department of the British Thomson-Houston Co. Ltd., Crown House, Aldwych, London, W.C.2, is retiring on July 31.

The Corporation of Darlington have approved an outline plan by WHESSEOE LTD., of Darlington, for the construction of new industrial premises covering 20,000 sq. ft., at Darlington.

INTERNATIONAL BUSINESS MACHINES (UNITED KINGDOM) LTD., a subsidiary of an American firm specialising in the manufacture of electrical office machines, have received approval from H.M. Government for the erection of a factory in the Kip Valley, Greenock.

THE CREWE WORKS OF THE BRITISH ROLLMAKERS CORPORATION, LIMITED.

(For Description, see Page 777.)



FIG. 3. MOULDING BAY.

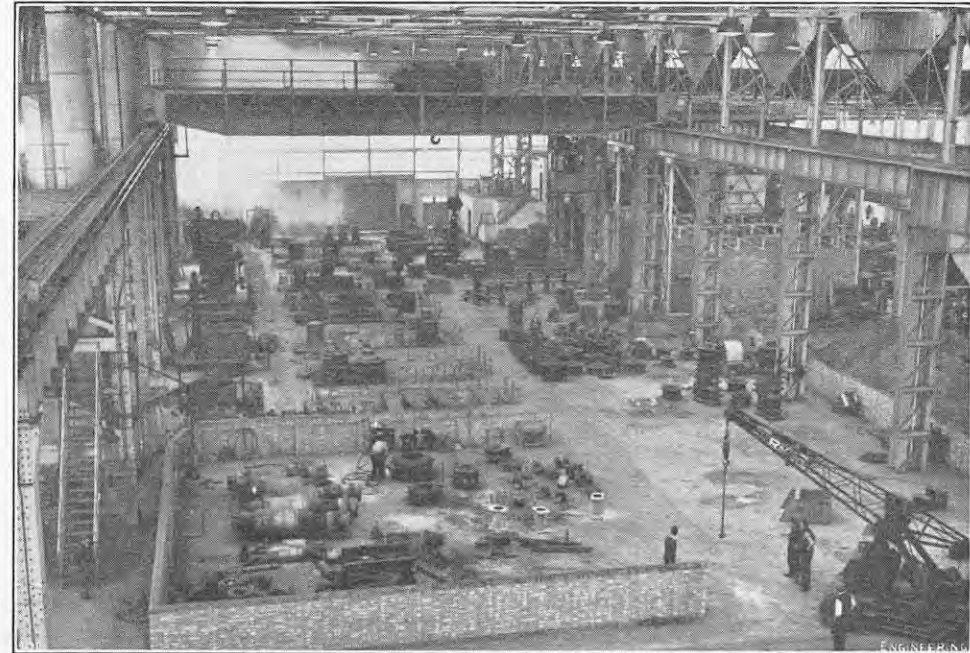


FIG. 4. CASTING AND FETTLING BAY.



FIG. 5. CHILL STORAGE AREA.



FIG. 6. MACHINE SHOP.

ENGINEERING

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

Registered at the General Post Office as a Newspaper.

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

Telegraphic Address:

ENGINEERING, LESQUARE, LONDON.

Telephone Numbers:

TEMPLE BAR 3663 and 3664.

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

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

SUBSCRIPTIONS.

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

For the United Kingdom and all places abroad, with the exception of Canada	£5 10 0
For Canada	£5 5 0

Subscriptions for periods less than twelve months are made on the price of a single copy, namely, 2s. 3d. post free.

ADVERTISEMENT RATES.

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

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

TIME FOR RECEIPT OF ADVERTISEMENTS.

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

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

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

CONTENTS.

	PAGE
Centralised Maintenance at the Works of Messrs. Steel, Peech and Tozer, Rotherham (<i>Illus.</i>).....	765
Literature.—Industrial Heat Transfer. Fluid Mechanics	767
Analysis of the Performance of the Jenbach Two-Stroke Vertical Oil Engine (<i>Illus.</i>).....	768
Electricity Supply in Southern Ireland (<i>Illus.</i>).....	772
The Crewe Works of the British Rollmakers Corporation, Limited (<i>Illus.</i>).....	777
Notes from the Industrial Centres	778
Notices of Meetings	779
British Standard Specifications	779
Personal	779
Further Research on Flame Radiation	781
A Profit on Transport	782
Notes	783
Letter to the Editor.—Leonardo's Mirror Writing.....	784
Obituary.—Sir Samuel Osborn, LL.D.	784
Terminal Grain Handling and Storage Plant at Buenos Aires (<i>Illus.</i>).....	785
Conference on Properties of Metallic Surfaces.....	789
Launches and Trial Trips.....	790
Labour Notes.....	790
Pre-Erected Reinforcement for Concrete Structures (<i>Illus.</i>).....	791
"Proteus" 700 Series Propeller Turbine (<i>Illus.</i>).....	792
150-MVA 3.3-kV Air-Insulated Circuit-Breaker (<i>Illus.</i>).....	793
Prophecy and Achievement in Aeronautics (<i>Illus.</i>).....	793
Wagon-Marshalling Machine (<i>Illus.</i>).....	795
Trade Publications.....	795
The Institute of British Foundrymen.....	796
Electrically-Propelled Mobile Tower Ladder (<i>Illus.</i>).....	796
Books Received.....	796
Three One-Page Plates.—ELECTRICITY SUPPLY IN SOUTHERN IRELAND. GRAIN-HANDLING AND STORAGE PLANT AT BUENOS AIRES.	

ENGINEERING

FRIDAY, JUNE 20, 1952.

VOL. 173.

No. 4508.

FURTHER RESEARCH ON FLAME RADIATION.

IN ENGINEERING of December 7, 1951 (vol. 172, page 705), some account was given of the work that had been in progress in Holland for about two years, under the direction of an international committee of scientists from Holland, France and Great Britain, on the radiating properties of luminous flames, and the methods to be adopted to develop the radiation to its maximum practicable value in furnaces and other industrial combustion chambers. An outline was given of the scope of the investigation and some particulars and illustrations were given of the experimental furnace and the recording apparatus used. This furnace, measuring 7½ m. in length and 2 m. square in cross-section, is situated in the works of the Royal Netherlands Steelworks (Koninklijke Nederlandsche Hoogovens en Staalfabrieken N.V.) at IJmuiden. The work is directed by the joint committee, of which Professor G. M. Ribaud is chairman (and on which Sweden also is now represented) and, up to the stage previously reported, consisted of an investigation into the effect of five variables, namely, the quantity and type of fuel, the quantity and type of atomising agents, and the quantity of the air supplied for combustion. The fuels used were oil and pitch creosote, the latter proving to be the more effective in producing luminous heat radiation, by about 20 per cent.

The experiments with oil fuels, which are now complete, are being followed by a corresponding series with gas; and a third series, with solid fuels, will fulfil the programme as it has been planned—though there seems to be a distinct possibility that the completion of the original schedule will leave many questions still unanswered and will suggest many more avenues for future exploration. The results obtained with oil, some of which were given

in our article on December 7, are discussed more fully below; but it may be remarked that some interesting developments are now in progress, in which a small quantity of oil, injected into a non-luminous flame of coke-oven gas, produces a very pronounced increase in heat radiation, as we had an opportunity to observe on a further visit to the test plant last week. It was noticeable that the gas flame alone is so completely non-luminous that, from the outlet end of the furnace, all the holes in the gas burner could be distinguished clearly through the axis of the 25-ft. long flame. The injection of oil, however, in the proportion of about 10 per cent. by relative calorific value, produced an intensely bright flame which was completely opaque, practically over the full length of the furnace.

The full reports of the 48 trials with oil, which were mentioned in our previous article as having taken place, have been published in the *Journal* of the Institute of Fuel, but may be summarised briefly. Some of the figures were quoted on the former occasion, but are repeated for convenience of reference. It was found that the peak radiation with oil was 17 per cent. less than with 50:50 creosote pitch, and that the flame was 7 per cent. narrower, with the point of maximum radiation farther from the burner; but that oil gave a higher temperature at the gas exit. The creosote pitch flame had a much higher emissivity than the oil flame, but the total radiation was about the same as with oil. An increase of 39 per cent. in the fuel quantity gave a flame 6 per cent. wider, longer and more intense, with a peak radiation 8 per cent. greater; the length of the flame also increased, by about 16 per cent. When steam was used instead of air as the atomising agent, the peak radiation was 11 per cent. lower and occurred at a point 10 per cent. farther from the burner.

An increase of 20 per cent. in the quantity of atomising agent gave a radiation which was lower at the tail of the flame (11 per cent. less at 3 m. from the burner) but with little effect close to the burner; this effect obtained with both air and steam atomisation. An increase of 25 per cent. in the amount of combustion air also produced a lower radiation at the tail of the flame—12 per cent. less at 3 m. from the burner. It appeared that the radiation in the early part of the flame was mainly affected by a change of fuel and a change from air to steam atomisation, whereas the tail of the flame was affected mainly by the quantity of fuel, of atomising agent, and of combustion air, indicating that the radiation in the early part of the flame depended principally on the rapidity of ignition and on the dilution of the fuel. The main effect of increasing the quantity of atomising agent was to increase the momentum of the jet, thus entraining more air, accelerating the combustion, and reducing the emissivity by consuming the soot more rapidly. From the design point of view, the results are of value as enabling the radiation to be predicted in terms of the mean radiation from the flame, the mean temperature and the calculated emissivity at given distances from the burner.

A feature of importance resulting from the trials is the attention that they have directed to the design of burners; it is considered, indeed, that the new facts ascertained may lead to the establishment of a rational basis for oil-burner design. The Joint Committee appointed a panel to investigate the types of burners in existence, which were classified, according to their principles of operation, as "blast burners" (i.e., those in which a stream of air or steam impinges on a column of oil, breaking it into droplets while accelerating it) and pressure-jet burners. So far, only the first group has been studied in detail. Examination of six representative types, following tests of droplet formation carried out at the Shell laboratories at Thornton, Cheshire, led to the general conclusion that small differences between the burners were unimportant, compared

with the effect of varying the quantity of the atomising agent. It is stated that the tests demonstrated the supreme importance of mixing and of jet momentum, which was examined by measuring the recoil of suspended burners. Further trials are planned, in the expectation that designs can be developed which will give equal jet momentum with less steam consumption than at present.

The small conference which we attended last week at Ijmuiden was directed, in part, to explaining the underlying purpose of the experiments as well as the results actually achieved; in the words of Mr. R. Mayorcas, of the British section of the team, "Why do this research? What happens when it is done? Would it matter very much if it were now stopped?" The work began in Sweden in 1928, but the experiments then made by Professor Lindmark were not carried to full fruition. Since that time, much additional work has been done on a laboratory scale in England, France and Holland, but the link was still missing, until the Joint Committee was formed to provide it, between the laboratory-scale research and the full-scale application of it; hence the Ijmuiden furnace was constructed, on what may be termed "pilot plant" scale, to convince the managers of actual steel-works, and other plants in which flame radiation is of importance, that, at least, the results obtained might be worth consideration in the design and operation of full-size plants. That point, it is claimed, has now been reached, even though much of the projected programme has yet to be accomplished; indeed, some of the work done at Ijmuiden is already in process of application on an industrial scale.

In answering the last of his hypothetical questions Mr. Mayorcas naturally concluded that it would matter a great deal if the work were to be stopped; because the gaps in precise knowledge still remaining to be filled are such that, lacking such knowledge, the designers and managers of full-size plants must continue to grope after the solutions by day-to-day *ad hoc* experimentation of their own. This conclusion may not be very debatable in itself, when so much of the intended research still remains to be done; but it is open to question whether the experimental plant should be kept in operation when the present programme is accomplished, to investigate some of the almost innumerable sidelines that have presented themselves and will certainly continue to do so, or whether, on completion of the initial programme, there should not be a firm decision to decentralise the research, using the facilities in the respective interested countries to explore the subsidiary problems. No doubt, some form of co-ordination would be maintained, even if the laboratories of the four countries used it only to exchange reports of results while preserving complete independence in formulating their own separate programmes of further investigation; the intimate liaison that has been established at Ijmuiden is sufficient guarantee of that, extending as it does to an almost complete indifference to the language—English, French or Dutch—in which discussions are carried on among members of the research team. The furnace and the equipment now in use were not constructed with any idea of permanence, and will probably be nearing the end of their useful life by the time that the solid-fuel tests are completed—if, indeed, a fairly considerable reconstruction is not required before then. If the furnace must be rebuilt, the question will certainly arise, whether the rebuilding should be on a temporary or a permanent basis; but, by that time, the fundamental work should have been done, and the further work required to clear up minor points can probably be done with the resources available in the several countries, and on a more modest financial outlay than would be involved in maintaining a pilot plant and an international team in any one of those countries.

A PROFIT ON TRANSPORT.

THE financial and statistical accounts of the British Transport Commission for 1951, which were published this week,* have been separated from the annual report, which is to appear shortly. Whatever may be the reason for this separation, comment is thus restricted, for the present, to the results of the Commission's workings as revealed in figures. The accounts show that, for the first time since the Commission started operations, there was a revenue surplus for the year, amounting to 2,943,512*l.* All the major branches of the undertaking, with the exception of London Transport, contributed to this improvement. After allowing for "extraordinary expenditures," such as provision for capital redemption and special items, a credit balance of 113,558*l.* was left to reduce the outstanding deficit. In 1950, this amounted to 14,083,312*l.* Though the Commission have succeeded in realising their aim, if only for one year, it is already clear that, "taking one year with another" (as the Transport Act requires them to do in planning and assessing the operations of their Executives) any reasonable hope of running the nation's transport consistently at a profit has been delayed by the Government's policy of reducing the increases in passenger fares which independent authorities had recommended. Moreover, in the current year, costs are mounting and traffic is declining, and there was still, at the end of 1951, a deficit on net revenue account of 39,463,811*l.* The outlook, therefore, is not bright.

The Railway Executive managed to increase the figure of net ton-miles hauled per total freight engine-hour in service from 543 in 1948 (the year they took over from the main-line companies) to 595 in 1951. Before the war, in 1938, the figure was 461. In 1951, therefore, this index of efficiency was the highest that has ever been achieved on the congested railways of Britain. It may have been due—in part, at least—to the improvement in "average wagon load throughout," which went up from 6.65 tons for all classes of traffic in 1950 to 6.92 tons in 1951, an increase of 2.5 per cent., following increases in the two previous years, 1948 and 1950. This statistic is itself dependent on the average capacity of wagons employed, which rose from 12.97 tons to 13.16 tons between 1950 and 1951. Loaded wagon-miles per wagon, average passenger-train load, and average freight-train load also increased.

Concurrently with these advances in operating efficiency, there were reductions in the staff employed and in the number of locomotives, passenger carriages and non-passenger-carrying coaching vehicles, though the number of freight vehicles went up slightly. British Railways' staff was reduced from 605,696 to 599,890 during 1951. It appears that this reduction, which has been more or less continuous since the Railway Executive took over with about 660,000 employees in 1948, has now finished. Allowing for the fact that the permitted capital re-equipment is still inadequate, the Railway Executive have thus far succeeded in demonstrating the value of unification in a comparatively short period. It is not likely, for example, that the improvement can be attributed to the introduction of standard locomotives, since only six of the proposed 12 types have appeared, and only a limited number of these have been built. There are still many classes of locomotive on British Railways, and the assumed useful life of locomotives which the Commission have adopted for the calculation of depreciation is from 30 to 50 years. Standardisation of locomotives is a long-term policy, the full benefits of which will only be reflected in financial

and operating statistics when standard engines form a substantial proportion of the total.

During the year, costs increased more than charges. The economies that have been necessary to offset this factor and, at the same time, improve the financial position, have been effected by the rise in efficiency already noted and by several other means. Firstly, there is now a smaller real remuneration of capital compared with pre-war. Secondly, traffic increased during 1951. Thirdly, there has been a better distribution of the unremunerative but essential local services between the several forms of transport. A public service guarantees that all peak-traffic needs, whether seasonal or occasional, will be met, and there is a virtual obligation to operate services regularly even when this may not be financially profitable. There is also an obligation to give all users equal treatment in similar conditions and to apply uniformly an approved and published tariff, which does not necessarily reflect the cost of the services rendered, and which frequently makes no distinction between different types of route or area, or different traffic volumes. The fourth way in which the gap between rise in costs and rise in charges has been closed is that the reserves for replacement are based mainly on historical cost and not on current cost. Economising on the railways was made more difficult by the fact that there has been actually a decline in the average fare paid by passengers as a whole since January 1, 1948. The average fares per passenger mile were 1.38*d.* in 1948, 1.30*d.* in 1949, 1.26*d.* in 1950, and 1.24*d.* in 1951. This trend was due to an increased use of workmen's, season and cheap-day tickets.

British Road Services also operated at a profit in 1951. They earned a working surplus of 3,200,000*l.*, compared with a deficit of 1,200,000*l.* in 1950. A reduction was made in the ratio of staff employed per ton carried and per vehicle operated, and the ratio of "black-coated" workers to other staff was lower than it was in 1948 before the private hauliers and the railway haulage interests were taken over. The proportion of totally-empty running diminished, the average load per vehicle increased, and the number of complaints declined. On London Transport, there was a working deficit of 1,600,000*l.*, due to the long delay in obtaining a decision from the tribunal on the question of increasing fares to meet rising costs. For the first time in the history of London Transport, the railways gave better results than the road services. This change was due partly to the extra fuel duty borne by the road services, but in the main it was because the 'buses, on which, for the first time, early-morning cheap fares were allowed, carried an increased share of London Transport's passenger traffic. The shipping services controlled by the Commission again gave a satisfactory return, amounting, as in 1950, to 2,900,000*l.*

In reviewing these statistics—which, with careful analysis, can reveal much of interest to engineers as well as accountants—it is impossible to avoid speculating whether one table, showing the average earnings of the staff of British Railways, does not, perhaps, give a clue to the controversy over the quality of the service which they provide for the public. This table, which covers all male adults but not officers of the railways, shows that the average earnings for the various grades of employees are extraordinarily close. Thus, for example, the lowest is 127*s.* per week, for engine cleaners, and the highest, for salaried foremen, inspectors and other supervisors in the shops is only 214*s.* 11*d.* Wagon oilers and greasers received an average of 140*s.* 10*d.*, yet men in the locomotive shops were paid only 169*s.* 1*d.* Such differences are too small, especially when allowance is made for the varying incidence of income-tax, to encourage that lively interest, pride and ambition which are essential in a public service.

*British Transport Commission: Financial and Statistical Accounts, 1951. (Cmd. 8752). H. M. Stationery Office, Kingsway, London, W.C.2. [Price 7*s.* 6*d.* net.]

NOTES.

THE INSTITUTION OF MECHANICAL ENGINEERS.

THE summer meeting of the Institution of Mechanical Engineers has been held this week at Bristol, with visits to works in the City, in its environs and as far afield as Bath, Stroud, Gloucester and Swindon. About 310 members, with 167 ladies, have taken part. On Tuesday morning, June 17, after the official opening, Mr. Alex. B. Cooper, B.Sc., M.I.Mech.E., joint managing director of Messrs. Strachan and Henshaw, Limited, presented the customary paper on local mechanical engineering activities. He had an unusually wide field to cover—aircraft and aircraft engines, machinery for the paper and printing industries, cranes, wagon tipplers, brewing plant, paint-making machinery, etc.—but he was aided in preparing his review by engineers of the principal firms concerned, who also amplified their contributions in the course of the discussion. At the opening of the summer meeting on Tuesday morning, at the Embassy Cinema, the Rt. Hon. the Lord Mayor of Bristol, Alderman V. J. Ross, J.P., with members of the reception committee, welcomed the President, Sir David Pye, C.B., M.A., Sc.D., F.R.S., the Council, and members of the Institution, with their ladies. Expressing his thanks on behalf of the visitors, Sir David Pye said that Bristol was, indeed, a romantic city; how could it be otherwise, he added, when ocean-going ships came right into the city? It was the home of the Society of Merchant Venturers, who typified the spirit which was to be found in the town; and it was John Cabot, from Bristol, who planted the British flag in America and then returned to this country rather more than a year before Columbus set sail. A well-known historian had said that, if he were allowed to show a foreigner only one town in England, he would show him Bristol, a town where "almost everything had happened" in industry, commerce and learning. It had the first free library, the first savings bank, and the first workhouse. Brass was first made in Bristol, and the first large Atlantic steamship was planned and built there. The previous Bristol meeting was held in 1930, and it gave him great pleasure, during his presidential year, to visit the city again. On Tuesday evening, a reception was held by the Lord Mayor and the Lady Mayoress in the Museum and Art Gallery, the building of which, though damaged in an air raid during the war, houses a notable collection of pictures, antique pieces and early motor-cars. The following morning, Wednesday, a paper on "The Development of Transport and Commercial Vehicles in Bristol" was presented by Mr. A. W. Hallpike, M.I.Mech.E., general manager of the motor constructional works of the Bristol Tramways and Carriage Company, Limited, and in the evening the Institution dinner was held in the Victoria Rooms, Clifton. A report of this dinner and other events of the meeting will be given in a subsequent issue of ENGINEERING.

THE DON-VOLGA CANAL.

The completion of the canal linking the rivers Don and Volga sees the realisation of a scheme that is more than two and a half centuries old. This notable work, to which *The Times* devoted a leading article on June 11, links the White, Baltic and Caspian Seas with the Sea of Azov and the Black Sea, and is the first to be completed of the series of great works planned for the development of southern Russia. These works, it is stated, include the building of the world's largest hydro-electric plant at Kuibyshev, on the Volga, whence power will be transmitted to Moscow and to other industrial areas; another reservoir at Stalingrad; a reservoir and power station on the Dnieper, which, as well as supplying electrical energy, will water and irrigate more than 8,000,000 acres of land in the Ukraine and the Crimea; and a canal to be built along the bed of the Amu Darya river and across the Karu Kum desert to the Caspian. It was in the days of Peter the Great that the first attempts were made to link the Don and Volga, and the history of the scheme recalls the labours and vicissitudes of Captain John Perry, R.N. (1670-1733),

who, released from the Marshalsea prison, where he was serving a sentence of ten years imposed by a naval court martial, in 1698 accompanied the Czar Peter back to Russia. No pioneer had a harder task, for the country was in a very backward state and the men in power were bigoted, harsh and ignorant. Perry's first job was to survey a route for a canal between the Don and Volga. After reporting to the Czar, he spent three summers on its construction. Even before Perry's day, an attempt had been made to join the rivers by a German military officer, Colonel Breckel, but the failure of one of his sluices led him to decamp discreetly with a pass belonging to his servant. Perry made better progress, but war with Sweden interrupted the work and he was employed elsewhere. After twelve years in Russia, he drew up a memorial, "An Humble Representation of the hard Fortune and Discouragement that the undertaker John Perry hath met with, from the time of his being entertained in England to the present year 1710," in which he wrote that, when employed on the canal, he found himself "and Mr. Luke Kennedy, my chief assistant, treated in a very rough manner, shown the gallows and threatened to be hanged." Through the intervention of the English Ambassador, he was able to leave Russia in 1712 and in 1716 published his entertaining book *The State of Russia under the Present Czar*. On his tombstone in Spalding Church, Lincolnshire, Perry is described as the "Comptroller of the Maritime Works to Czar Peter of Russia." He was certainly the first civil engineer of note in the country.

ROYAL AERONAUTICAL SOCIETY GARDEN PARTY.

"Her Majesty the Queen has graciously consented to become the Patron of the Royal Aeronautical Society," it is announced in the published programme of the Royal Aeronautical Society garden party, which once again was held at White Waltham Aerodrome, near Maidenhead, Berkshire, on Sunday, June 15. After a morning of cloud and drizzle, the sun began to break through shortly before the flying programme was due to commence, and the weather became progressively more seasonable through the afternoon. Guests were received by the President, Mr. George Dowty, and Mrs. Dowty. As in previous years at White Waltham, there was a flying display and static exhibition of light aeroplanes, helicopters and gliders, but this year's display lacked the interest of museum pieces of the pre-war era, such as the Blériot monoplane and the Déperdussin, which have appeared and flown at recent parties; and there was no balloon ascent to provide a climax to the occasion. From the technical viewpoint, the most interesting feature of the display was perhaps the radio-controlled model glider demonstrated by the Low Speed Aerodynamics Research Association, an organisation devoted to the research and development of model aircraft. They have developed lightweight transmitting and receiving radio equipment with four independent channels, three of which control, with great precision, the ailerons, elevator and rudder; the fourth will be used for controlling a miniature automatic pilot, still being developed. So long as the aircraft is within range, the position of the controls is unaffected by the distance from the transmitter and there is no tendency to drift. A control accuracy of $\frac{1}{2}$ deg. on ± 30 deg. movement has been obtained. The glider used in the experiments has a span of 10 ft. 9 in., a wing area of 10 sq. ft., an all-up weight of 116 lb., including the radio equipment, a flying speed range of 20 to 50 m.p.h., and an optimum gliding angle of 1 in 15. The radio equipment, with servo-motors and power supplies for 3 hours' duration, weighs $4\frac{1}{2}$ lb. Examples of the servo-motors and radio components were on view, together with jettisonable rocket units for assisted take-off, designed in collaboration with Messrs. Wilmot-Monsour and Company, to provide a minimum thrust of 2 lb. for 30 seconds.

THE 350-MW STATION OF THE SWEDISH STATE POWER BOARD AT HARSPRÄNGET.

The Harsprång station, which was formally opened by the King of Sweden on Sunday, June 15, is the input end of a 380-kV system which has been designed by the State Power Board to utilise

in the industrial areas of the South the water-power resources of the northern part of the country. It is built on the Stora Lule Älv river, the water of which is impounded by a rock-fill dam 4,700 ft. long and of a maximum height of 148 ft., giving an average gross head of 350 ft. The station itself has been excavated in the rock of the left bank of the river, the amount of spoil recovered being almost sufficient for the construction of the dam. The present generating plant consists of three 105-MVA vertical-shaft single-runner Francis turbines with steel spiral casings; they run at 167 r.p.m. The water from the draught tubes is carried back to the river through a tunnel with a cross-section of 2,045 sq. ft., the length of which is $1\frac{1}{2}$ miles. These turbines are coupled to alternators, which generate three-phase current at 16 kV and are each, in turn, connected to four single-phase transformers. These transformers are also housed in a room excavated in the rock and step up the generator voltage to 380 kV. They are connected by cables, run in a shaft, to ground level, where the high-tension switchgear is situated. The switchgear comprises six air-blast circuit-breakers, which control the output to a single circuit transmission line consisting of double conductors, each made up of two 0.929 sq. in. steel-aluminium cables per phase with an overall diameter of $1\frac{1}{4}$ in. Both cables of a phase are suspended in the same horizontal plane at a spacing of $17\frac{3}{4}$ in. The line runs without an intermediate station to Midskog, where connection is made to the existing system, and thence to Hallsberg, a total distance of 593 miles, where the power is stepped down to 220 kV in two transformer sets, each consisting of three 100-MVA auto-connected single-phase units with three 9-MVA regulating transformers are associated. In addition, there is a 75-MVA hydrogen-cooled synchronous condenser. The system, which has been working successfully since the end of April, incorporates a number of interesting technical features and marks an important advance in the employment of very high voltages.

THE INSTITUTION OF HEATING AND VENTILATING ENGINEERS.

The 1952 summer meeting of the Institution of Heating and Ventilating Engineers was held at Torquay, from June 14 to June 17, under the presidency of Mr. J. R. Kell, M.I.Mech.E. It may be remarked that this was the second visit of the Institution to Torquay, the previous occasion being in 1937; also, that the list of the places where summer meetings have been held in the past 53 years (the Institution was founded in 1897, and held its first summer meeting in 1899) shows an increasing tendency to favour seaside resorts—possibly because such centres afford the best opportunities to accommodate large parties, but also, we suspect, because this particular Institution makes sporting events—tennis, bowls, and golfing competitions, etc.—a prominent feature of the programme, while not neglecting the more serious and technical interests of the members. In the present instance, though the members gathered on Saturday, June 14, the Conference was opened officially on June 16, by the Mayor of Torquay (Alderman T. J. R. Taylor, J.P.), after which a paper on "Heating and Ventilating from the Architect's Point of View," by Mr. Cecil Handyside, A.R.I.B.A., was presented and discussed. In the afternoon, a visit was arranged to the Torquay gasworks; and in the evening, the Mayor and Mayoress held a civic reception, followed by a dance, in the Marine Spa. On the morning of Tuesday, June 17, there was a technical session, with the President in the chair, at which Dr. Idris Jones, Director General of Science, National Coal Board, delivered an address on "Heating and Ventilation in Relation to the Coal Problem," after which a paper on "Heating and Ventilation Problems at Atomic Energy Establishments," by Mr. W. L. Wilson, B.Sc., A.M.I.C.E., was presented in summary and discussed. In the afternoon, in addition to various sporting events continued from the previous day, a coach tour was provided over the southern part of Dartmoor—unfortunately, in somewhat unfavourable weather. In the evening, the official banquet of the Institution, followed by a dance, was held at the Palace Hotel, the chair being taken

by the President and the principal guests being the Mayor and Mayoress of Torquay. The toast of "The Institution" was proposed by the Mayor, who observed that, in the 15 years that had elapsed since its previous visit to Torquay, the Institution had doubled its membership. He wished it a prosperous future, "free from the trammels of Government control"—a sentiment which was greeted with prolonged applause. The President, in responding, said that the status of the Institution was being recognised increasingly in official quarters. This brought added responsibilities, which the Institution was meeting by fostering research into the problems of heating and ventilation, and by striving to increase the quality of the papers presented. The toast of "The Ladies and Other Guests," proposed by Mr. F. R. L. White, senior vice-president, was acknowledged by Mrs. Kell in a speech which, in its humour and neat efficiency, excellently typified the atmosphere of the meeting.

THE FRANKI COMPRESSED PILE COMPANY, LIMITED.

On Thursday, May 12, at the May Fair Hotel, London, the Franki Compressed Pile Company, Limited, 39, Victoria-street, London, S.W.1, held a "21st birthday" party to celebrate the anniversary of their foundation in 1931. At the dinner, which was followed by dancing and a cabaret, the chairman of the company, Mr. W. McCarthy, proposed the toast of the four founders, and presented them with a memento of the occasion. Three of the founders—Mr. E. Frankignoul, Commander D. McG. Newton, R.N.R., and Mr. A. Jourdain, were present and replied to the toast. The other founder member, Mr. A. Putzeys, is overseas. The first patent for the piling processes invented by Mr. E. Frankignoul, of Belgium, was taken out in 1909, but it was not until May 4, 1931, that a company was formed in this country to operate the Franki piling processes, with Commander Newton as chairman and managing director, and with its headquarters at Liverpool. In October of the same year, the company carried out their first piling contract at Codnor Reservoir, Heanor, Derbyshire, and the first test loadings on a Franki pile were carried out successfully at the Gravesend sewage disposal works. In 1937, the head office was transferred to London, a branch office being maintained in Liverpool until it was destroyed by fire in 1941. In 1937 and 1938, a large contract, involving the driving of 20,000 piles, was carried out in 20 consecutive months at the Royal Ordnance Factory, Chorley. As with most business organisations, the second World War was a difficult period for the Franki company. Since 1945, however, there has been a steady expansion in their activities until to-day they are one of the biggest piling organisations in the world. In 1947, they commenced work on what is stated to be the largest piling contract ever undertaken at the Abbey Works of the Steel Company of Wales at Port Talbot; 28,000 Franki piles—about 80 per cent. of the total piling work—were driven, in the years between 1947 and 1950, to carry about 1,750,000 tons of building construction. In 1948, Mr. McCarthy became chairman and managing director, in succession to Commander Newton, who resigned his executive offices in this country, but continued to act as consultant director. In 1950, Commander Newton, now resident in South Africa, became chairman of the Franki Piling Company of South Africa (Pty.), Limited. In 1951, the Franki company commenced work in the British West Indies, and this year they were awarded a contract in Australia.

IMPROVING PAINTSHOP PRODUCTIVITY.

Representatives from a variety of engineering industries and paint manufacturers met at the Café Royal, London, on Wednesday, June 11, at a one-day conference convened by Imperial Chemical Industries (Paints Division), Wexham-road, Slough, Buckinghamshire, to discuss ways of improving paintshop productivity. Four sessions were held, the subject of the first being "Economic Factors," when Lieutenant-General Sir Thomas Hutton, K.C.I.E., C.B., M.C., took the chair. The speaker, Mr. R. G. Hooker, said that, in America, both management and labour were aware of a need to achieve maximum production at minimum cost. To foster this attitude, he suggested, greater

responsibilities should be delegated to men who had the necessary qualities for leadership, and there should be closer co-operation between the various departments. A simple bonus scheme, related to the results obtained, was a useful means for increasing cost consciousness and productivity. At the second session, Mr. W. F. S. Woodford was in the chair and the speaker was Mr. F. C. Ashford. His subject was "Design of the Product." After describing the factors affecting the designer's choice of finish, he spoke on the problems of matching different parts or different batches of production, and how such difficulties could sometimes be avoided. There was, he said, no satisfactory standard of colour reference at present, and he suggested a specification in terms of light frequencies. A set of master colour samples corresponding to the specification should be prepared, possibly based on the British Standard list of colours but with the introduction of a number of shades by adding black or white to the base colours. In the afternoon, Mr. Ernest Owen took the chair at the third session, at which Mr. R. N. C. Logan spoke on "Mechanisation." He advocated a straight production line, with higher conveyor speeds at the end of the line than at the beginning, to avoid the possibility of work accumulating at some stage and holding up production. When going over to mechanised production, the operators should be consulted and prepared for the change well in advance. At the final session, Mr. E. S. Byng was in the chair, and Mr. D. H. Lloyd was the speaker, on the subject of "Process and Quality Control." He discussed the application of process control to the finishing of motor-car bodies, with illustrated examples. The paintshop could be considered as a chemical engineering plant, and ordinary process-control methods could be applied to the various stages of pre-treatment, dipping or spraying, and drying. In the discussions which followed each session, there was a general demand for greater co-operation and exchange of information between paint and plant manufacturers and users. In particular, it appeared that there was a need for a closer specification of drying times and temperatures and a more precise definition of paint viscosity. There was some feeling, by no means unanimous, that paying a bonus to encourage "cost-consciousness" might lead to a deterioration in the quality of work, but it was agreed that more attention should be paid to educating those entering industry and to fostering a respect for craftsmanship.

LETTER TO THE EDITOR.

LEONARDO'S MIRROR WRITING.

TO THE EDITOR OF ENGINEERING.

SIR.—I agree with Mr. I. M. Lyon (page 719, *ante*) that Leonardo da Vinci wrote mirror writing because he was left-handed. His preference for left-handed writing may have been natural, as has usually been supposed or, as has also been suggested, acquired as a result of an injury to his right hand. He did, however, sometimes write from left to right when putting in the place names on maps, which he perhaps wanted to show to other people when discussing canalisation schemes.

Leonardo's habit of running words together, in pairs, his system of abbreviations and the occasional reversed spelling of a word do suggest an attempt to make his notes private, since these devices combined with his mirror writing are enough to make them difficult to read. They can, of course, be read by anyone aware of their interest who is willing to make the effort, but they are difficult enough to deter the casually inquisitive. If Leonardo had intended his notes to be read by others before they had been edited for publication, he would, I think, have written them in the conventional way instead of in their present obscure form.

Yours faithfully,

K. R. GILBERT.

London, S.W.7,
June 13, 1952.

OBITUARY.

SIR SAMUEL OSBORN, LL.D.

IN our issue of May 2, on page 558, *ante*, we reported that, on April 25, a dinner was held in Sheffield to celebrate the centenary of the steel-making firm of Samuel Osborn and Company, Limited, of the Clyde Steel Works in that city; and that the proceedings were relayed by a specially arranged telephone circuit to Sir Samuel Osborn, who, because of his great age—he was in his 88th year—was unable to be present. It is with much regret that we have now to record that Sir Samuel died at his home at Grindleford, Derbyshire, on June 10. He was the second son of the founder of the firm, Samuel Osborn, J.P. (1826-1891), and had been associated with its direction since 1889.

Samuel Osborn was born on July 11, 1864, in a house named "Rutledge," in Clarkehouse-road, Sheffield, which is now—appropriately, in view of his many philanthropic activities—a home for the aged. He was educated at New College, Eastbourne, and entered the family business in 1882, being engaged first in the manufacture of files, which were the firm's original product. Four years later, when a new steel foundry was built in Rutland-road, Sheffield, he was put in charge of it, and in 1889 was taken into the business as a partner. When the firm was reconstituted in 1905 as a private limited liability company, he was made a director, becoming chairman in 1936 on the death of his elder brother, William Fawcett Osborn. He retained that position until 1948, when, on account of advancing years, he took that of President, relinquishing the chairmanship to his younger brother, Fred M. Osborn, who, however, died after holding it for only two years.

Sir Samuel, who received his knighthood in 1941, was not only one of Sheffield's leading steelmakers but also one of the city's most active workers in civic, industrial, religious, educational and social affairs. He was elected to the City Corporation in 1903, and in 1912 became Lord Mayor, an office which his father had held 21 years earlier. He was a past-President of the Sheffield Society of Engineers and Metallurgists and of the Sheffield and District Engineering Employers' Association, and a Pro-Chancellor of the University of Sheffield, which conferred upon him the honorary degree of Doctor of Laws. His interests in social and religious welfare work were wide and numerous, and it was while he was chairman of the Sheffield Juvenile Advisory Committee that he was knighted. As we recorded on May 2, he marked the centenary of his firm by making over a large block of his personal shares to be used for the welfare of the employees; a benefaction that was typical of his character and life.

"APPLIED STATISTICS."—A new journal having this title, the first issue of which appeared on April 25, is being published for the Royal Statistical Society and edited on their behalf by Mr. L. H. C. Poppett. It is intended to appeal to all those whose work and interests lie in applying statistics rather than in following developments in the mathematical foundations of the subject, and for whom, it is stated, no British journal has catered exclusively hitherto. The new journal will be published thrice yearly, in March, June and November, by Messrs. Oliver and Boyd, Ltd., Tweeddale Court, High-street, Edinburgh, 1, from whom it may be obtained. The price of the first number is 10s. and the annual subscription is 25s.

FILM OF STEEL FOUNDRY.—On June 12, at the invitation of Messrs. F. H. Lloyd & Co., Ltd., James Bridge Steel Works, near Wednesbury, Staffordshire, we attended the pre-view of a sound film entitled "Lloyd's Nowadays." The making of steel castings in the firm's modern and highly-mechanised foundry was shown in all its stages, and the functions of the works council and of the departmental production committees, which meet frequently for consultation, were indicated. The film has been produced by the Big Six Film Unit, 35, Endell-street, London, W.C.2. It runs for 35 minutes and copies are available in both 35-mm. and 16-mm. form, with the explanatory commentary spoken in English, French, Spanish, Portuguese, Italian and Yugoslav.

GRAIN-HANDLING PLANT AT BUENOS AIRES.

SIMON HANDLING ENGINEERS, LIMITED, CHEADLE HEATH, STOCKPORT.



FIG. 1. TERMINAL GRAIN ELEVATOR AT BUENOS AIRES DOCKS.

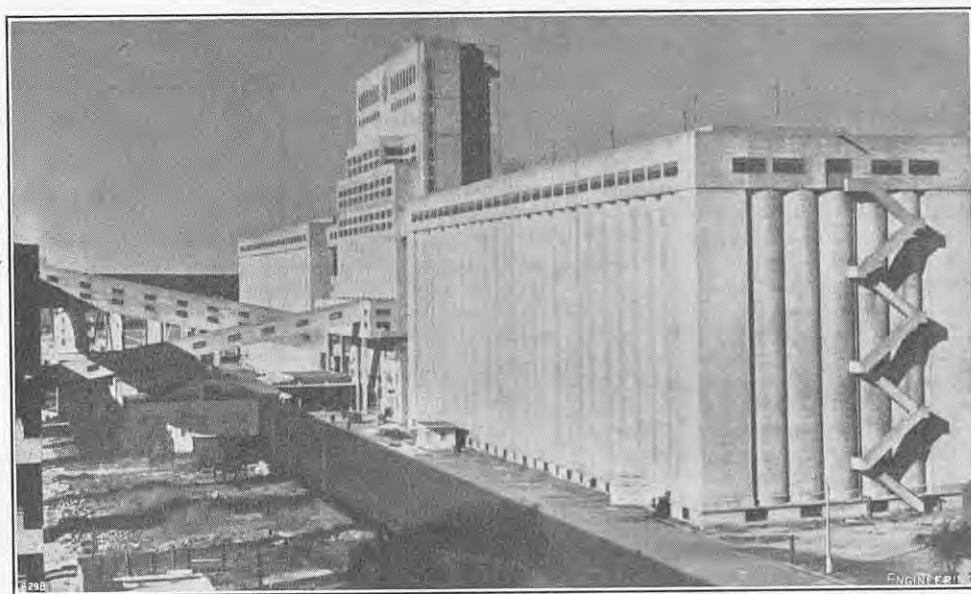


FIG. 2. WORKING HOUSE AND STORAGE BINS.

TERMINAL GRAIN-HANDLING AND STORAGE PLANT AT BUENOS AIRES.

In November, 1951, the fifth and largest of five terminal grain-handling and storage plants (or grain elevators, as they are called in the grain industry), which have been built during the past 14 years under the Argentine Government's national elevator scheme, was opened by the Argentine Minister of Public Works. An aerial photograph of the new grain elevator, which is in the Buenos Aires docks, is reproduced in Fig. 1. It is the largest terminal grain elevator in the southern hemisphere, and is probably the most comprehensively-equipped grain-handling plant in the world. The contract for the mechanical and electrical equipment, which was carried out by Messrs. Simon Handling Engineers, Limited, Cheadle Heath, Stockport, exceeded 27 million in value.

THE ARGENTINE NATIONAL ELEVATOR SCHEME.

To appreciate the technical features of the new grain elevator and its significance in the Argentine economy, it is desirable to have some idea of the background of the Argentine grain trade. Although

Argentina is one of the world's principal grain-growing and exporting nations, Argentine grain has been at a disadvantage in world markets owing to the practice of discharging and storing the grain in sacks, a procedure which is slow, laborious and costly. Moreover, sack handling renders almost impossible the operation of an effective grain-grading system, under which bulk grain can be bought on specification without having to preserve the identity of individual consignments from grain-growing districts. A further disadvantage, under which the Argentine grain trade has suffered until recently, was a lack of adequate grain-storage facilities, leading to congestion of the railways and ports.

In 1928 an Argentine Government commission was set up to investigate and report on the grain trade; the findings of this committee were amplified later by a technical report, prepared at the Government's request, by Messrs. Simon Handling Engineers, Limited. On the basis of these reports, in 1933 the Argentine Congress authorised the development of a national grain elevator scheme, to be operated under Government control. The scheme envisaged the construction of 14 large terminal elevators at river and coastal ports, and of more than 300 smaller country elevators throughout the

grain-growing areas. Its eventual completion will result in great commercial advantages in the distribution of the national harvests, which have often amounted to 18 million tons. The inauguration of the terminal elevator at Buenos Aires marks the completion of the first stage of the scheme, initiated in 1937, i.e., the provision of bulk storage and handling facilities at some of the principal grain-shipping ports.

In 1937 contracts were placed for extending one existing terminal elevator at Ingeniero White, the port of Bahia Blanca, and building five new ones at Rosario Norte, Rosario Sud, Quequen, Villa Constitucion, and Buenos Aires. The building work was placed with Argentine contractors, and contracts for the machinery equipment of the elevators at Ingeniero White, Rosario Sud, Quequen and Villa Constitucion were placed with Messrs. Simon Handling Engineers, Limited. The Rosario Norte project was abandoned, and the Buenos Aires contract lapsed owing to the inability of the machinery contractors (a Continental firm) to carry out their contract after the outbreak of the second World War. After long delays arising from the war, the other four elevators were completed and brought into use by 1945. After the war the Buenos Aires project was revived. The buildings had already been completed, and in 1948 the contract for the mechanical and electrical equipment was awarded, as already mentioned, to Messrs. Simon Handling Engineers, Limited, who have, therefore, equipped all five terminal elevators so far completed.

Terminal grain elevators can be divided broadly into export elevators, built in grain-growing and exporting countries such as the Argentine, North America and South Africa, and import elevators, built in countries such as the United Kingdom, for receiving imported grain and dispatching it for inland distribution. Export and import grain elevators differ mainly in size and in the complexity of the internal handling equipment. The arrival of grain at an export elevator is concentrated mainly in the period during and immediately after the harvest, whereas shipments from it are spread fairly evenly over the whole year. Storage capacity for large quantities of grain must therefore be provided, and the export elevator must be able to receive and handle incoming grain with great flexibility and at a high rate. The loading-out equipment also must be flexible and of high capacity, so that ships are not kept waiting. At import elevators, on the other hand, there are no wide seasonal fluctuations in the arrival and dispatch of grain; storage capacities therefore are relatively smaller, and less elaborate grain-cleaning plant is usually provided, since the incoming grain has often had some treatment at the port of dispatch. The necessity for a rapid turn-round of the ships remains, however; import elevators are therefore usually equipped with high-capacity pneumatic discharging plants.

Certain unique features of the Argentine elevators arise from the fact that the national elevator scheme is not yet complete. The second stage, the building of the inland elevators, has scarcely yet begun, and grain from the growing areas is still dispatched in sacks. The Argentine elevators must therefore be able to handle both bulk and sack traffic—unlike those of the North American continent, which deal with bulk grain only. With bulk handling, an efficient grain-grading system is essential, since the identity of an individual wagon-load of grain is inevitably lost once it has been discharged into a bulk-storage bin, and buyers naturally refuse to accept bulk grain in consignments of mixed and unknown quality. The Argentine authorities have now established a comprehensive system of grades, and the Argentine elevators are distinguished by the great flexibility of the equipment for handling the grain until it first enters a bulk-storage bin, and by elaborate control and signalling systems which help to preserve the identity of individual lots until they have been directed into bins containing grain of a similar grade.

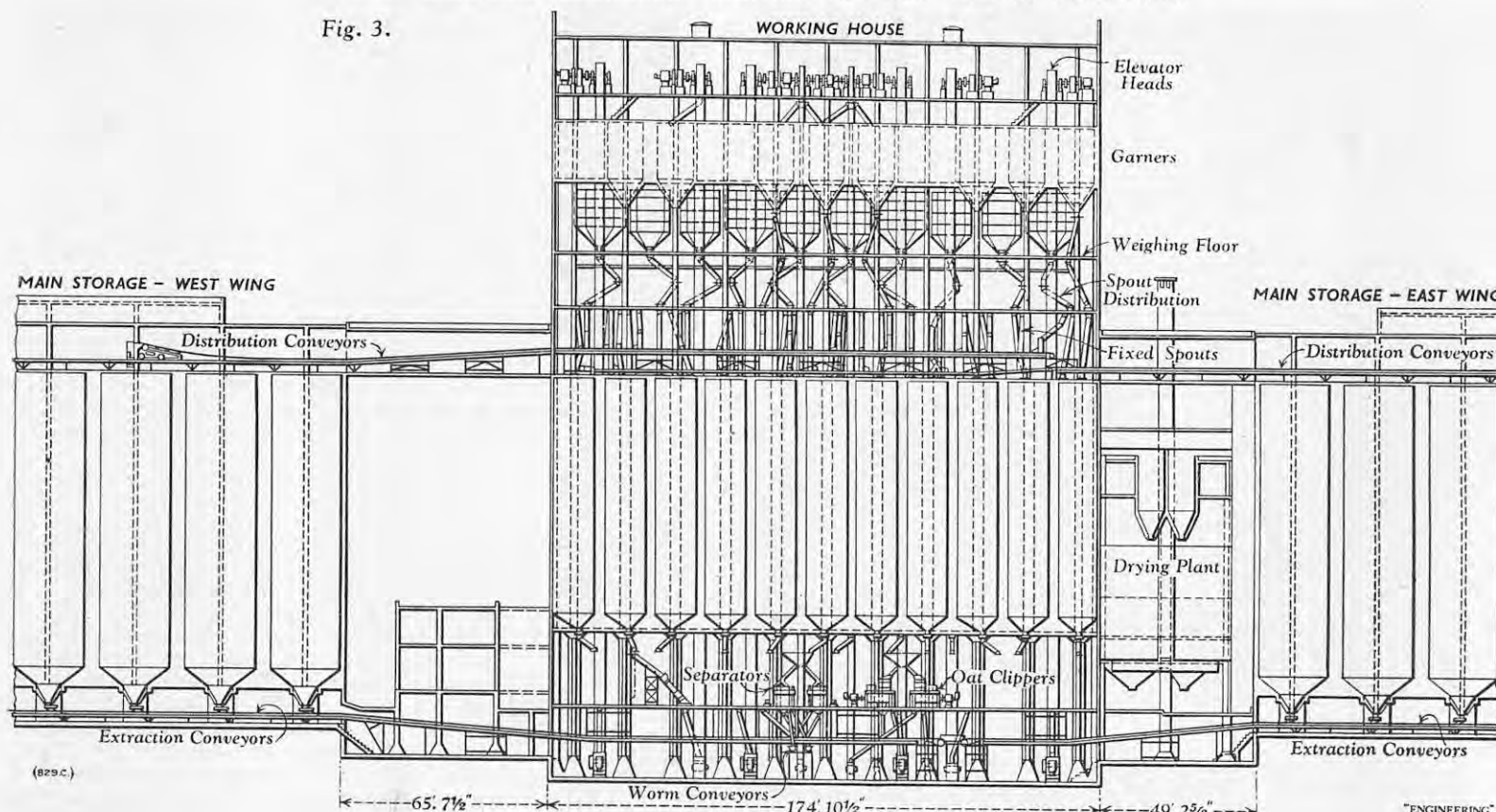
THE BUENOS AIRES ELEVATOR.

The port of Buenos Aires, on the western side of the River Plate estuary, is largely artificial. The grain elevator stands on a quay in the Puerto Nuevo on ground reclaimed from the river. All the main

GRAIN-HANDLING AND STORAGE PLANT AT BUENOS AIRES.

SIMON HANDLING ENGINEERS, LIMITED, CHEADLE HEATH, STOCKPORT.

Fig. 3.



and subsidiary buildings and conveyor galleries were therefore built on pile foundations, comprising some 4,000 pre-cast concrete piles. All the buildings and galleries are of reinforced-concrete construction. The storage-bin slabs are supported from the pile foundations by hollow rectangular concrete "boxes," some of which are 16 ft. long, and others 11 ft. long, all being 9 ft. wide. These boxes divide the space between the floor level and the underside of the bins into a series of passages in which the various conveyors are accommodated.

The buildings include a central working house, and two blocks of main storage bins, illustrated in Fig. 2; a longitudinal section through part of the working house and storage blocks is given in Fig. 3. There are also a dryer house, sheds for receiving grain by rail and road, a storage shed for sacked grain, an electric sub-station, ample office accommodation, and galleries housing the external shipping and transfer conveyors. The elevator itself extends over a length of 1,131 ft. The working house, 231 ft. high, accommodates the grain-weighing and cleaning plant in the upper portion; below are bins providing temporary storage for 14,000 tons of grain. Each of the main storage blocks has 117 bins, with a total capacity of 68,000 tons; comprising 52 main cylindrical bins, approximately 24 ft. in diameter and 100 ft. deep, 39 inter-space bins, and 26 "outer-space" bins formed by enclosing the space between the outer sides of adjacent cylindrical bins, thus making the maximum use of the space available for storage.

HANDLING OPERATIONS.

The Buenos Aires elevator has a total storage capacity of 150,000 tons. As a result of the high-capacity equipment installed, it can receive, store and dispatch $1\frac{1}{2}$ million tons of grain a year. The flow diagram reproduced in Fig. 13, Plate XLV, gives some indication of the variety of operations which can be carried out. Grain can be received in bulk or in sacks by rail, road or water. It can be cleaned and dried if necessary, and sent to any storage bin; it can be loaded out, in bulk or in sacks, to ocean-going ships, coastal craft, or to rail wagons or road vehicles, either after passing through the cleaning plant and storage bins, or directly from the reception point. It can be "turned over"

from one bin to another, to keep it in condition during prolonged storage, and it can be stored in sacks as well as in bulk.

Grain received by rail, road and coastal craft can be discharged into the elevator at a total rate of 2,400 tons per hour. Some grain is received in bulk, but the greater part arrives in sacks in 45-ton side-door rail wagons which are received in a track shed with shunting capstans and four lines of track. Under each track is a row of four underground hoppers, into which the grain is discharged through grids. Below each transverse row of hoppers is a transverse conveyor. There are thus four transverse basement conveyors, each of which can receive grain from a hopper under any of the four tracks and deliver it to one of the main intake elevators in the working house. The capacity of each intake line is 500 tons per hour. Grain arriving in sacks is emptied by hand through the grids into the underground hoppers. For unloading grain in bulk, 32 power shovels are installed. Grain arriving by road is discharged similarly into an intake line of 250 tons per hour capacity.

Most of the grain arriving in bulk comes by waterborne craft from river ports at which bulk handling facilities already exist. To handle grain arriving in this way, two travelling pneumatic intake plants are installed on the quay-side. Fig. 4, opposite, shows these two travelling towers, each of which has a capacity of 70 tons per hour. Each plant has two suction nozzles, attached to flexible telescopic intake pipes carried on booms which can be swung from side to side, and luffed up and down, by electric winches. Suction is provided by vertical double-acting reciprocating vacuum pumps in the travelling towers. The air drawn up the intake pipes carries the grain with it in suspension until it enters a large cylindrical receiver with a hoppers bottom. In the receiver the air expands, and the resulting loss of velocity allows the grain to fall out of suspension to the bottom of the receiver. The air passes on to the vacuum pump by way of a cyclone dust collector and a filter in order to remove grain dust which would otherwise cause wear in the pump cylinder. The grain is discharged from the receiver, without interrupting the vacuum, by a tipper seal. A description of the Simon tipper seal was given, in an article on a floating pneumatic grain-handling plant,

on page 211 of our 163rd volume (1947); it may be recalled briefly that the seal consists of a box, divided vertically into two compartments and rocked from side to side on a pivot, so that each compartment in turn is presented to the receiver outlet. While one compartment is in communication with the receiver and is being filled with grain under vacuum, the other is releasing its load through a hinged door which is kept closed by atmospheric pressure during filling. The two pneumatic plants discharge the grain on to quay-side conveyors, from which it is transferred to transverse intake conveyors leading to the main intake elevators.

The main intake bucket elevators are of impressive dimensions; each has a capacity of 500 tons per hour, and the height between the centres of the head and boot pulleys is 260 ft. The head pulleys are nearly 8 ft. in diameter, and weigh more than 4 tons; their shafts, 9 in. in diameter, are carried in split roller bearings. Each elevator is driven by a 230-h.p. motor.

The elevators deliver all incoming grain to "dormant-hopper" scales for weighing and recording. Dormant-hopper scales are so-called because the movement of the hopper containing the grain to be weighed is almost imperceptible. In this they differ from normal automatic grain weighers, which deliver a fixed weight at every weighing and in which the inlet and discharge of grain are automatically brought about by a mechanism actuated by the travel of the weigher hopper as it fills and empties. The dormant-hopper scale is, in effect an ordinary weighbridge in which the hopper takes the place of the platform; the weight is determined by an orthodox steelyard and cursor. In order to allow the handling of grain by the conveyors and elevators to be carried on continuously, the dormant-hopper scales are preceded and followed by compensating hoppers, or garners, which can accommodate a full wagon-load of grain with a margin of capacity in reserve.

Grain discharged from the scales can be led either directly to the main storage bins by way of distribution conveyors, or directly to the working-house cleaning and drying plant, or to the working-house bins by swivelling and telescopic distribution spouts, for temporary storage and subsequent cleaning. Grain in the main storage bins can also be returned to the working house for cleaning.

GRAIN - HANDLING AND STORAGE PLANT AT BUENOS AIRES.

SIMON HANDLING ENGINEERS, LIMITED, CHEADLE HEATH, STOCKPORT.

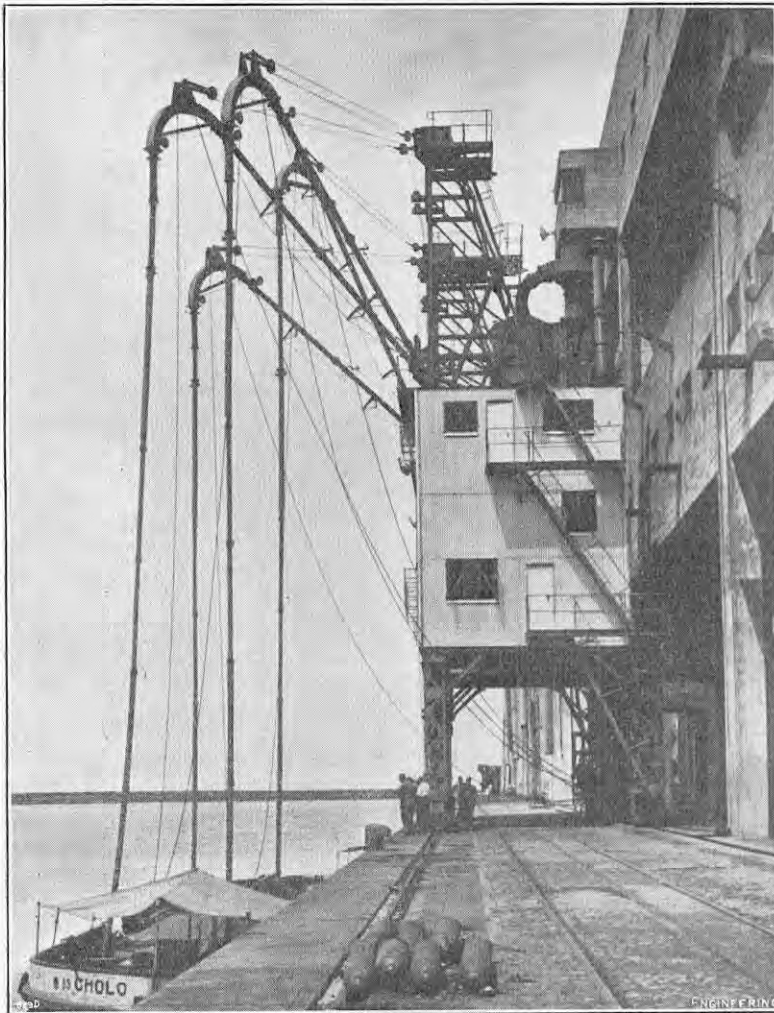


FIG. 4. TRAVELLING PNEUMATIC INTAKE PLANTS.

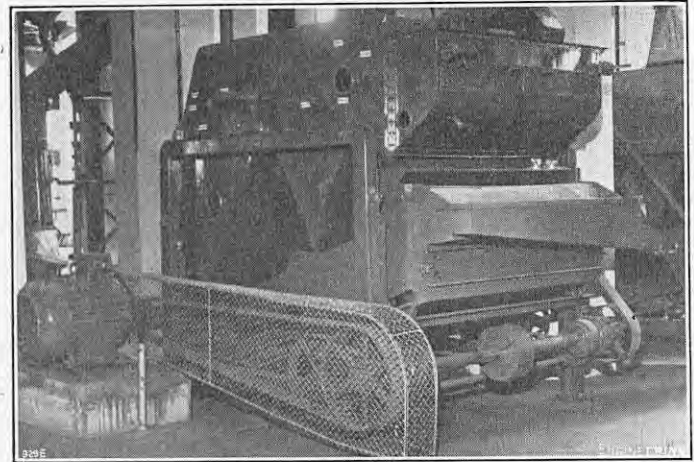


FIG. 5. WAREHOUSE SEPARATOR.

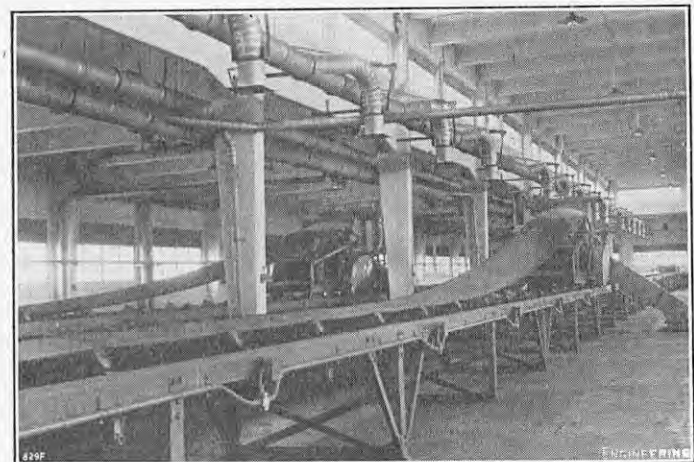


FIG. 6. DISTRIBUTION CONVEYORS WITH TRAVELLING THROW-OFF CARRIAGE.

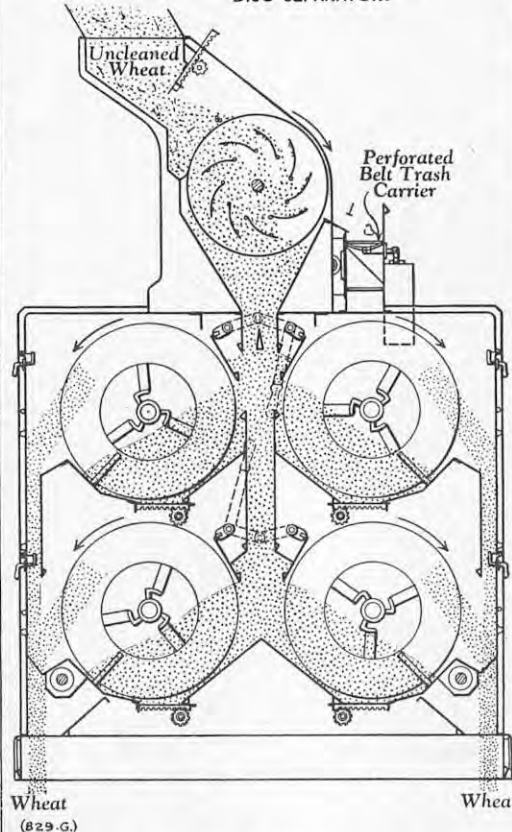
CLEANING AND DRYING.

The working-house cleaning plant can handle 3,700 tons of grain a day. It comprises eight warehouse separators for extracting coarse and fine rubble such as sticks, straws, paper and rag, mud-balls, etc.; two oat clippers for removing "smut" from wheat; and four indented-disc separators for extracting alien types of grain and seeds. The screenings are delivered to a re-treatment plant, situated above the working-house bins, to ensure that no sound grain is lost with the impurities.

The warehouse separators, one of which is illustrated in Fig. 5, are high-capacity primary cleaning machines incorporating oscillating sieves and "aspirating legs." The latter are channels up which chaff, dust and other light impurities are borne by rising air currents to expansion and settling chambers. The grain is fed on to a short "scalping sieve" of large mesh, on which the coarsest rubble is tailed over, the remainder passing through the first aspirating leg on to the upper of the two main sieves, which are mounted in a single oscillating frame. The upper sieve tails over further coarse impurities, and allows the grain and fine impurities to pass through to the lower sieve, which extracts dust, small seeds, etc. The grain tailed over the lower sieve is discharged through the second aspirating leg, where more dust and other light matter are removed.

The oat clippers comprise horizontal cylinders perforated with long narrow slots, against which the oats are scoured by high-speed longitudinal beaters mounted on a horizontal shaft. The tufted ends or beards of the oats are thereby removed, and are extracted from the cylinder through the slots by suction provided by a built-in fan. Although known as oat-clippers, in the Buenos Aires elevator these machines are used mainly for removing smut, a fungus disease, from wheat. Smut occurs in more than one form—as loose, fragile black balls which

Fig. 7. SECTION THROUGH BIG 5 DISC SEPARATOR.



burst readily and cover the wheat with black dust, presenting a serious problem to the flour miller; or as bunt, or stinking smut, which causes the tainted

grains to swell and ultimately to burst, producing a mass of spores which have a strong and unpleasant odour and cause severe flour contamination.

An important phase in the cleaning of grain is the removal of weed seeds and alien types of grain, such as oats and barley, from the wheat. Small amounts of such impurities, which are seldom present in large quantities, can cause trouble which may not become apparent until the wheat reaches the flour mill or the flour reaches the bakery. Some weed seeds are poisonous, and most of them taint or discolour flour. Seeds and alien grains are removed by indented-disc separators; the principle of the indented-disc separator was described fully in an article on "Flour Milling Machinery," on page 58 of our 169th volume (1950).

It may be recalled that an indented-disc separator consists of a horizontal cylinder, inside which a series of hard cast-iron discs, indented with hundreds of specially-shaped pockets in both faces, are mounted close together on a horizontal shaft rotating at a moderate speed. The cylinder is kept rather less than half filled by a mass of grain, which is propelled slowly along it from inlet to outlet, while the discs pass through it, picking out all the particles small enough to lodge in the pockets and discharging them a little beyond the top of the arc of travel into small catch troughs fitting closely between the discs. The pockets are shaped to give the type of separation required; in some types of separation, such as extracting small round seeds from wheat, the impurities are lifted and the sound grain is left, whereas in separating, say, oats and barley from wheat, the sound grain is lifted and the longer oat and barley grains are left.

The disc separators used in the Buenos Aires elevator are of the Big 5 type, specially designed for high-capacity working in granaries as distinct from flour-milling plants. A cross-section through a Big 5 machine is reproduced in Fig. 7; each

GRAIN-HANDLING AND STORAGE PLANT AT BUENOS AIRES.

SIMON HANDLING ENGINEERS, LIMITED, CHEADLE HEATH, STOCKPORT.

Fig. 8. ARRANGEMENT OF CONVEYORS IN THE SHIPPING-BIN TRANSFER GALLERY.

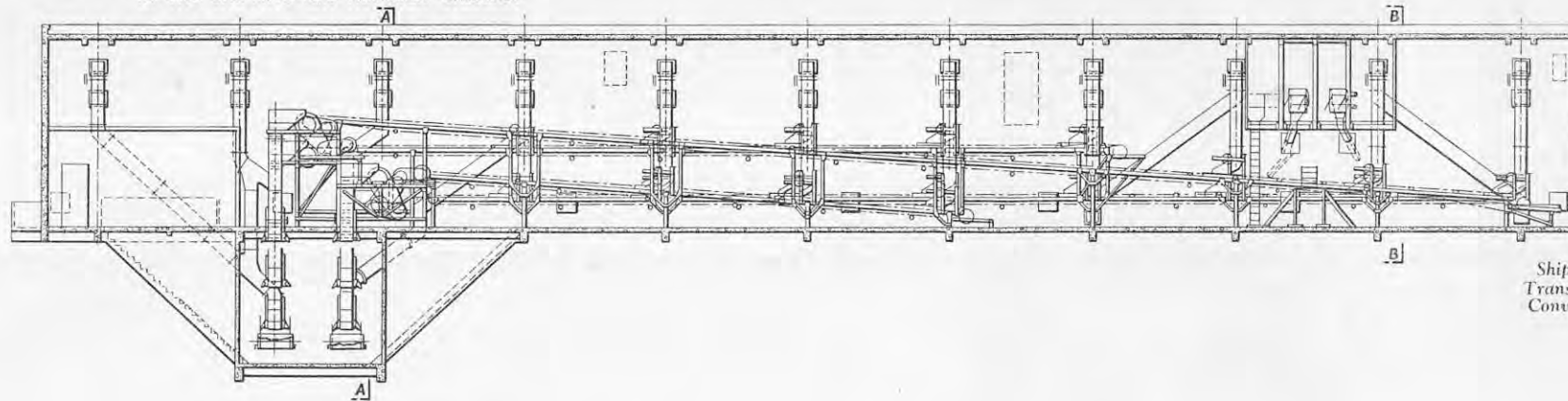


Fig. 10. SECTION A-A

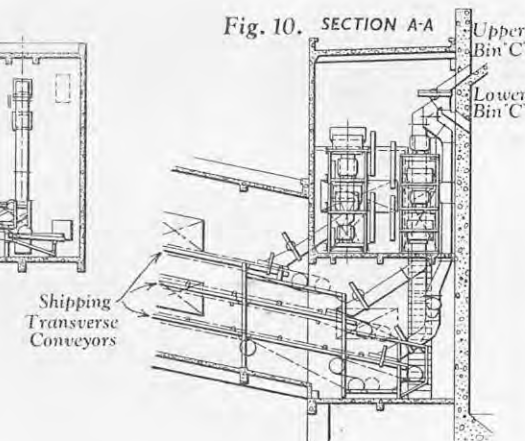


Fig. 9.

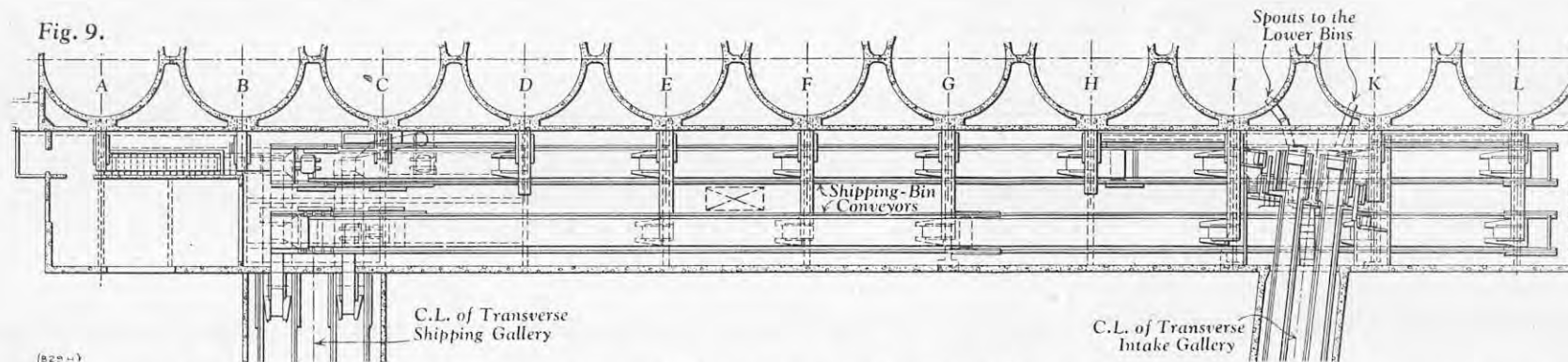
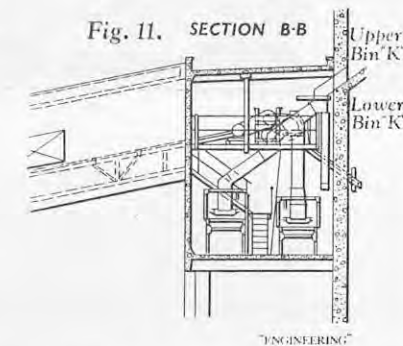


Fig. 11. SECTION B-B



machine consists of a housing containing four separate cylinders and batteries of discs, to which grain is distributed from a preliminary scalping reel mounted on top of the housing. A fifth Big 5 disc separator, and a smaller disc separator, are included in the retreatment cleaning plant, which also has a large double-deck separator similar in principle to the warehouse separators, two scalping separators, and a thresher for treating unthreshed ears of grain.

Since damp grain cannot be safely stored for long, a drying plant of large capacity is installed in an annexe between the working house and the east storage wing. It consists of three separate dryers, each with a capacity of 20 tons per hour, giving a total drying capacity of 1,440 tons of grain a day. The dryers are preceded and followed by compensating hoppers to ensure a constant flow of grain. Each dryer consists of a vertical rectangular column, into which the grain is uniformly distributed through feed hoppers and from which it is discharged through similar hoppers with mechanically-operated outlets to control the rate of flow. The grain mass moves slowly down the column, passing over rows of air ducts closed at the top and open at the bottom. Each row of ducts is staggered relatively to the

rows above and below it, so that the grain is repeatedly shuffled in its downward passage, and every particle is uniformly heated. The dryers are of the direct-heat type, in which a mixture of fresh air and flue-gas from a smokeless combustion furnace is blown through the grain. The gases enter through the inlet ducts, pass through the mass of grain for a distance of about 12 inches, and leave through the neighbouring exhaust ducts. Automatic temperature-control and recording instruments are fitted. Before leaving the dryer, the heated grain is cooled by currents of cold air to a temperature at which it can be stored safely.

The working house is also the focal point of a comprehensive dust-collecting system, comprising 14 separate plants, which extends throughout the elevator. Grain dust is particularly unpleasant and is also highly explosive in atmospheric suspension. At all points where dust is released by agitation of the grain, as, for instance, at conveyor-feeding or discharge points, suction inlets are provided through which the dust is drawn by fans into metal air trunks for disposal. The collected dust is discharged into dust chambers where it is sprayed with water, after which it is pumped into

the sea in the form of sludge. It is interesting to note that whereas dust explosions, sometimes disastrous, still occur occasionally in North American grain elevators, they are extremely rare in grain-handling plant designed by British or Continental engineers.

STORAGE AND DISPATCH.

Grain is distributed from the working house to the main storage bins by eight belt conveyors, four serving each storage block. Each conveyor has a capacity of 600 tons per hour, and is equipped with a travelling throw-off carriage, as shown in Fig. 6, on page 787, for discharging grain to any desired bin on either side of the conveyor. Below the main storage bins in each block are four extraction conveyors for returning the grain to the working house for cleaning or loading out. The belts are fed through fixed feed-on shoes attached to the bin outlets.

Grain to be loaded out to ships is conveyed from the main storage bins to the working house, where it is elevated, weighed in dormant-hopper scales, and delivered to the shipping bins on the north side of the working house, from which it is discharged

from the bin outlets by short conveyors to a transverse conveyor gallery leading to the main quay-side shipping gallery. The arrangement of the conveyors serving the shipping bins is shown in Figs. 8, 9, 10 and 11. It will be observed in Fig. 10, and in Fig. 13, that the shipping bins are divided into upper and lower bins by a partition; the lower bins accept any grain which remains in the upper bins after the ships have been loaded. It is also possible to deliver grain directly from the intake system to the shipping gallery without passing through the main storage bins.

The shipping gallery, a reinforced-concrete structure, is approximately $\frac{1}{2}$ mile long and 18 ft. wide, and allows for berthing and loading five ocean-going grain vessels simultaneously. It has two floors, the lower floor being 72 ft. above the quay level. Six lines of shipping conveyors lead to it from the working house through the transverse gallery already mentioned. Each conveyor line has a capacity of 600 tons per hour, giving a total loading-out rate of 3,600 tons per hour. The gallery houses 32 conveyors in all, from which grain is discharged by travelling throw-off carriages into swivelling telescopic loading spouts, controlled from winch

GRAIN-HANDLING PLANT AT BUENOS AIRES.

SIMON HANDLING ENGINEERS, LIMITED, CHEADLE HEATH, STOCKPORT.

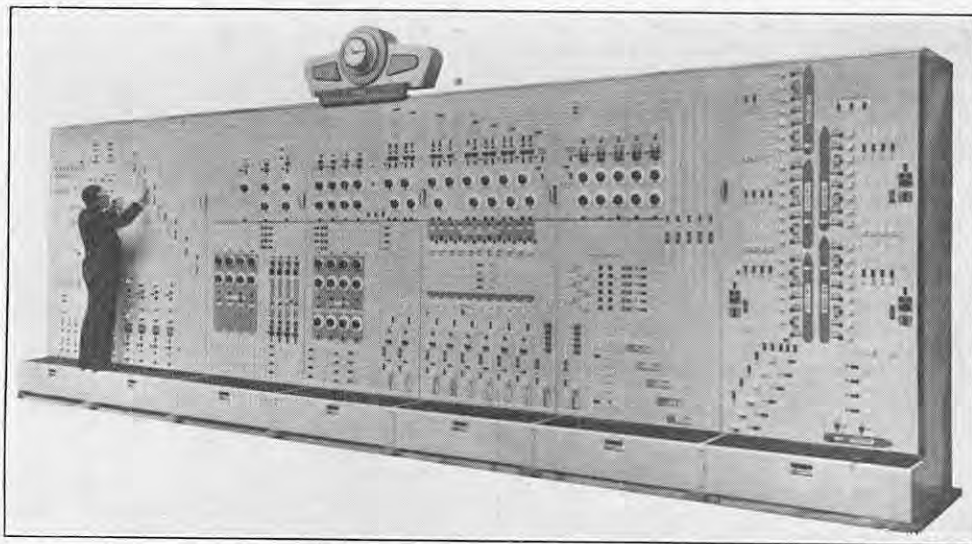


FIG. 12. CENTRAL CONTROL BOARD.

cabins projecting from the shipping gallery. The spouts are placed high enough to allow grain to be delivered by gravity into any part of the ship's hold at any state of the tide.

It is customary for bulk grain cargoes to be "topped off" with a quantity of grain in sacks in order to prevent the bulk cargo from shifting at sea. Facilities are therefore provided at several points in the shipping gallery for weighing the grain into sacks, which are then delivered to the ships' holds down sack chutes from the towers of the shipping gallery. There is also provision for delivering grain in bulk or in sacks from certain bins on the south side of the working house to rail and road vehicles for inland distribution (this is not shown on the flow diagram, Fig. 13, Plate XLV.)

ELECTRICAL CONTROL AND SIGNALLING.

The electrical equipment, comprising some 270 motors in sizes ranging from 3 h.p. to 230 h.p., with a total of 7,700 installed horse-power, transformers, switchgear, control boards, lighting and telephone systems, was supplied by the General Electric Company, Limited, Magnet House, Kingsway, London, W.C.2, as sub-contractors to Simon Handling Engineers, Limited. In a plant of the size and complexity of the Buenos Aires grain elevator, which contains 65 conveyors with a total length of about 5 miles, numerous travelling throw-off carriages, a score of bucket elevators, nearly 300 bin inlets and outlets, and an elaborate grain-cleaning plant, it is essential, in order to avoid mistakes in routing the grain through the plant, that there shall be a comprehensive controlling and signalling system. Fig. 12 shows the central control board, with over 2,000 outgoing terminals, believed to be the largest of its kind in existence. Incorporated in it is a "mimic diagram" of the entire plant; sections of the diagram and appropriate signal lights are illuminated to indicate the sections of the plant which are in operation. Starting and shutting down the plant are controlled from the board.

It is not possible within the limits of this article to describe the whole of the control and signalling system in detail. Some idea of its nature, however, can be given by following the operations involved in the reception and delivery to storage of one wagon-load of grain. When a train of grain wagons arrives, each wagon contains sacks of grain of similar quality, the necessary sorting having been done already up country, though the quality of one wagon load may differ from that of another. Before the train enters the reception shed, the number of each wagon and its position in the train are noted, thus determining which wagon will be located over a particular under-rail intake hopper in the reception shed. Samples are drawn from a number of sacks in each wagon in order to establish the quality of the grain. Any given wagon-load must

be sent either to an empty bin or to a bin already containing grain of a similar quality.

Government officials make out tally tickets for each wagon load; the tickets, which measure about 6 in. by 1 in., are divided into sections corresponding to the operations necessary to receive a wagon load of grain and to control its destination. Four trains of four wagons each are then shunted into the reception shed and each wagon is located over one of the four intake hoppers. The tallies for each line of four wagons comprise three approximately, but not exactly, similar tickets, which are issued to three operators—the signalman at the central control board, the winchman who controls the outlet valves of the intake hoppers, and the weighman in charge of the dormant-hopper scales. As each intake operation is performed, the man responsible imprints his ticket by a manual printing mechanism, duplicating the instructions given on the ticket and thus checking the movement and destination of the grain. The three men are far apart and their tickets are sent to them through a pneumatic-tube system.

The actual operations are as follows. The signalman, knowing from his ticket the wagon number, intake hopper number, and destination bin number of a given wagon load, starts the motors of the appropriate intake, conveyor and elevator by remotely-controlled sequence-interlocked starters. If the grain is to go to a main storage bin, he also starts the appropriate distribution conveyor, and signals to the man in charge, by switching on one of the lights which are placed at each bin inlet, to set the throw-off carriage at the required bin. If the grain is to go to a working-house bin, he gives a similar signal to the operator of the swivelling distribution spouts below the weighers. The correct location of the throw-off carriage, or the insertion of the right spout into the appropriate working-house bin inlet, automatically operates a switch and gives the signalman a return signal. As the machinery comes into action, the corresponding sections of the mimic diagram on the signalman's control board are automatically illuminated. When all the necessary machinery is running and the throw-off carriage or swivelling spout is correctly placed, a complete run from the intake hopper to the bin is shown illuminated on the board.

The signalman then presses a button, upon which the winchman receives a buzzer signal and a green light, the weighman receives a buzzer signal and a red light, and the signalman himself receives the first of a series of red lights on his board to show that he has issued the necessary instructions for discharging one wagon-load of grain from one specified intake hopper. The winchman now stops his buzzer, discharges the specified intake hopper, and closes the hopper outlet valves. This operation automatically extinguishes the signalman's red light and gives him a second red light; simultaneously, the winchman's green light is changed to red and

the weighman's red light to green. All three are thus informed that the intake hopper has been discharged and the wagon-load of grain is on its way to the garner over the dormant-hopper scale.

The weighman then opens the garner, releases the wagon-load of grain into the scale and closes the valve, which automatically switches off the winchman's red light and the weighman's green light, and changes the signalman's second red light for a third red light, thus informing all three that the garner over the scale is empty. The signalman now knows that he can signal the winchman to discharge another intake hopper, the winchman knows that he may expect this signal, and the weighman knows that the garner is about to be re-filled. Meanwhile, the weighman weighs the scaleful of grain and marks the weight on his ticket with a printing mechanism which can only be operated when the steelyard is in balance. Finally, the weighman discharges the grain from the scale, the operation of the discharge valve automatically cancelling the signalman's third red light, thus informing him that the wagon-load of grain is on its journey to the destined bin by way of the conveyor and throw-off carriage, or the swivelling spout, which have already been set to receive it. The tally tickets, imprinted at every stage, give a complete record of which wagon the grain came from, its weight, and the bin that received it.

Broadly similar methods are used for controlling the intake of grain from road vehicles and barges, for cleaning and drying it, and for loading it out to ships. In case of emergency, the signalman can press a switch operating blinking lights at all positions. Apart from operational signalling, the size of the elevator requires a comprehensive communications system. The pneumatic-tube installation used for sending tally tickets to the signalman, winchman and weighman can also be used for sending documents to other points, and there is also a telephone installation throughout the plant.

CONFERENCE ON PROPERTIES OF METALLIC SURFACES.

An all-day symposium on the "Properties of Metallic Surfaces," arranged by the Institute of Metals, will be held in the lecture theatre of the Royal Institution, Albemarle-street, London, W.1, on Wednesday, November 19, from 9.45 a.m. until 5 p.m.

The papers contributed to the symposium will be discussed at two sessions. Those dealt with at the morning session comprise: "Specialised Microscopical Techniques in Metallurgy," by Professor S. Tolansky, F.R.S., Royal Holloway College, London; "Radioisotopes in the Study of Metal Surface Reactions in Solutions," by Dr. M. T. Simnad, Carnegie Institute of Technology, Pittsburgh, U.S.A.; "The Crystalline Character of Abraded Surfaces," by Dr. P. Gay and Dr. P. B. Hirsch, Cavendish Laboratory, Cambridge; "Diffusion Coatings," by Mr. D. M. Dovey, Dr. I. Jenkins, and Mr. K. C. Randle, Research Laboratories of the General Electric Company, Limited; "The Nature and Properties of the Anodic Film on Aluminium and its Alloys," by Mr. H. W. L. Phillips, research laboratories of the British Aluminium Company, Limited; "Chemical Behaviour as Influenced by Surface Condition," by Dr. U. R. Evans, F.R.S., Cambridge University; and "Effect of Method of Preparation on High-Frequency Surface Resistance of Metals," by Dr. R. G. Chambers and Dr. A. B. Pippard, Royal Society Mond Laboratory, Cambridge.

The six papers to be discussed at the afternoon session comprise: "Influence of Machining and Grinding Methods on the Mechanical and Physical Condition of Metal Surfaces," by Mr. P. Spear, Mr. I. R. Robinson and Mr. K. J. B. Wolfe, B.S.A. Tools Limited; "Effect of Lubrication and Nature of Superficial Layer after Prolonged Periods of Running," by Dr. F. T. Barwell, Mechanical Engineering Research Organisation; "Effect of Surface Conditions on Mechanical Properties of Metals," by Professor E. N. da C. Andrade, F.R.S.; "Effect of Surface Condition on Strength of Brittle Materials," by Professor C. Gurney, University College, Cardiff; "Influence of Surface Condition on Fatigue Strength of Steel," by Mr. R. J. Love, Motor Industry Research Association; and "Influence of Surface Films on Friction and Deformation of Surfaces," by Dr. F. P. Bowden and Dr. D. Tabor, Cambridge University.

The meeting will be open to all interested in the subject. Non-members of the Institute should apply to the secretary, 4, Grosvenor-gardens, London, S.W.1, for a programme and registration form which will be available in August.

LAUNCHES AND TRIAL TRIPS.

H.M.S. "DIANA."—Built by Yarrow & Co., Ltd., Scotstoun, Glasgow, the vessel is the eighth of the Daring class of destroyers and was laid down in 1947. Overall length, 390 ft.; beam, 43 ft.; displacement, 2,600 tons. To carry 12 guns, including six of 4.5-in. calibre, and two pentad torpedo tubes. Geared steam turbines, constructed by the shipbuilders, and boilers designed for super-heat control. Launch, May 8.

S.S. "CARL SCHMEDEMAN."—Single-screw self-unloading cargo vessel for carrying bauxite ore, built by Vickers-Armstrongs Ltd., Barrow-in-Furness, for Reynolds Jamaica Mines Ltd. Main dimensions: length, 518 ft. overall; beam, 66 ft.; gross tonnage about 10,000; deadweight capacity, 13,150 tons on a draught of 27 ft. 9 in. Brown-Boveri geared steam turbines, constructed by Richardsons, Westgarth & Co., Ltd., Wallsend-on-Tyne. Service speed, 15 knots. Launch, May 12.

M.S. "TJIBANTJET."—Single-screw cargo vessel, with accommodation for four passengers, built by Bartram and Sons, Ltd., Sunderland, for Koninklijke Java-China-Paketaartlijnen, N.V., Amsterdam, Holland. Main dimensions: 440 ft. between perpendiculars by 61 ft. 3 in. by 38 ft. 3 in. to shelter deck; deadweight capacity, 8,900 tons on a draught of 26 ft. 2 in. N.E.M.-Doxford six-cylinder opposed-piston airless-injection oil engine, developing 6,800 b.h.p. at 116 r.p.m. in service, constructed by the North Eastern Marine Engineering Co. (1938), Ltd., Wallsend-on-Tyne. Loaded speed, 16½ knots. Trial trip, May 27.

M.S. "HILDINA."—Single-screw trawler, built by Cook, Welton and Gemmell, Ltd., Beverley, Yorkshire, for J. Marr and Son, Ltd., Hull. First vessel of a series of four. Main dimensions: 123 ft. 6 in. between perpendiculars by 26 ft. 6 in. by 13 ft.; gross tonnage, 296. Five-cylinder Diesel engine, developing 700 b.h.p. at 220 r.p.m., constructed by British Polar Engines, Ltd., Glasgow, and installed by Charles D. Holmes & Co., Ltd., Hull. Trial trip, June 3.

S.S. "DUNELMIA."—Single-screw cargo vessel, built and engined by William Gray & Co., Ltd., West Hartlepool, for the Metcalfe Shipping Co., Ltd., West Hartlepool. Main dimensions: 406 ft. between perpendiculars by 56 ft. by 27 ft. 10½ in. to upper deck; deadweight capacity, 8,900 tons on a draught of about 25 ft. Triple-expansion steam engine with Bauer-Wach exhaust turbine and two oil-fired boilers. Service speed, 10½ knots. Trial trip, June 6.

M.S. "CALTEX TANGANYIKA."—Single-screw oil tanker, built and engined by William Doxford & Sons, Ltd., Sunderland, for the Overseas Tankship (U.K.), Ltd., London, W.1. Second vessel of an order for four. Main dimensions: 490 ft. overall by 61 ft. 9 in. by 36 ft. 3 in.; deadweight capacity, 12,300 tons on a draught of about 28 ft. 2½ in. Doxford five-cylinder opposed-piston balanced oil engine, developing 5,150 b.h.p. at 108 r.p.m. Speed, 13½ knots, fully loaded. Trial trip, June 9.

M.S. "GRETAFIELD."—Single-screw oil tanker, built by the Furness Shipbuilding Co., Ltd., Haverton Hill, County Durham, for the Northern Petroleum Tank Steamships Co., Ltd., Newcastle-upon-Tyne. Second vessel of an order for two. Main dimensions: 496 ft. between perpendiculars by 67 ft. 6 in. by 36 ft. 5 in.; deadweight capacity, about 16,500 tons on a summer draught of 29 ft. 1½ in.; oil-tank capacity, about 15,600 tons. Hawthorn-Doxford five-cylinder single-acting two-stroke reversible oil engine, developing 5,500 b.h.p. at 112 r.p.m. in service, constructed by R. and W. Hawthorn, Leslie & Co., Ltd., Newcastle-upon-Tyne. Speed, 14 knots. Launch, June 9.

S.S. "CAESAR."—Single-screw trawler, built and engined by Smith's Dock Co., Ltd., South Bank-on-Tees, for the Devon Fishing Co., Ltd., Hull. Main dimensions: 185 ft. between perpendiculars by 32 ft. by 17 ft. 10 in. Triple-expansion steam engine and one three-furnace boiler. Launch, June 10.

S.S. "AJASA."—Single-screw self-trimming collier, with accommodation for eight passengers, built and engined by Hall, Russell & Co., Ltd., Aberdeen, to the order of the Crown Agents for the Colonies, for the Government of Nigeria. Main dimensions: 347 ft. 6 in. overall by 46 ft. by 21 ft. 6 in. to upper deck; deadweight capacity, about 4,000 tons on a summer draught of about 19 ft. 3 in. Triple-expansion steam engine, developing 1,850 i.h.p., and three cylindrical boilers designed to use quick-burning West African coal. Launch, June 10.

INSHORE MINESWEEPER.—Second of a new series of minesweepers for the Royal Navy, built by Brooke Marine Ltd., Lowestoft, for the Admiralty. Length, 106 ft. 5 in.; beam, 20 ft. 6 in. In addition to carrying minesweeping equipment, the vessel carries one small gun. Propelling machinery constructed by Davey Paxman & Co., Ltd., Colchester. Launch, June 12.

LABOUR NOTES.

PLEAS by the Government for the exercise of restraint in the presentation of new wage claims were discussed by the executive committee of the Transport and General Workers' Union at its quarterly meeting on Friday last. In a statement issued subsequently, Mr. Arthur Deakin, C.H., C.B.E., the general secretary of the union and chairman of the Trades Union Congress, reported that it was the council's view that restraint in making wage claims was necessary, but that the council also considered that it was essential that claims should be pursued at least to the extent of offsetting the price increases which had taken place owing to the budgetary policy of the Government. When considering the matter, the executive council had had special regard, Mr. Deakin stated, to the discussions between Mr. R. A. Butler, the Chancellor of the Exchequer, and the General Council of the Trades Union Congress. Some members of the executive council had expressed the view that, in many cases, far too high a profit was being taken out of industry and that that problem should be dealt with effectively by reducing prices and passing on the benefit to the consumer. Such a policy would, on its own account, encourage a tendency to lower prices generally.

At its meeting, the union's executive council also considered the problem of unemployment and under-employment in industry. While recognising that the present economic situation arose from difficulties associated with the country's international balance of payments and that the nation was passing into a buyer's market in many industries, the executive council, Mr. Deakin said, felt that the situation called for Government policies which would provide the most favourable conditions for export trade and for expanding the home market. The executive council urged the Government to take steps to remedy the slump in the textile industry by stimulating the demand in the home market, by re-opening overseas trade, especially within the Commonwealth, and by placing re-armament orders with all sections of the industry.

Mr. Deakin reported that the executive council had expressed its complete opposition to the de-nationalisation of the iron and steel and road-transport industries. At its meeting the executive council had debated the question of re-armament and had decided to give its approval to the recent declaration on the subject issued by the Trades Union Congress General Council.

Warnings that moderation in wage claims was essential, if Britain was to avoid further inflation, were made at the opening session of the annual conference of the National Union of General and Municipal Workers, on Monday last, at Whitley Bay, Northumberland. On this subject, Mr. Hugh Gaitskell, former Chancellor of the Exchequer, considered that, owing to the increasing cost of living, as a result of the cuts in food subsidies, lower-paid employees could hardly be expected to refrain from pressing for wage increases. Such persons were already paying little or no income-tax, and consequently, received no benefit from the recent reductions in the tax. At the same time, to maintain full employment and avoid inflation, there should be no slipping back by the trade-union movement from the responsible attitude adopted when the Labour Government was in power. There was no easy solution to the problem of wages, but he hoped that it would be possible for the political and industrial sides of the movement to combine to find a satisfactory solution. A continuing spiral of inflation was a serious danger under conditions of full employment.

Mr. Gaitskell condemned those who clamoured for large cuts in the nation's re-armament programme and said that it was his impression that the same demands would be forthcoming whatever level of re-armament was fixed. Such people did not consider the military or economic consequences, or the figures involved. They did not suggest where, or by how much, the cuts ought to be made. The same indiscriminate clamour came from isolationists in the United States, but this country could not afford isolationism here or to do those things which encouraged such an outlook there. No one denied that re-armament imposed a heavy burden, but it need not, he thought, involve any drastic reduction in the nation's standard of living. Its direct effect fell primarily on the engineering industry, and, therefore, it restricted supplies of machinery for civilian purposes and for export. The main danger came from possible repercussions on the nation's export trade, without which imports could not be purchased. If Britain's foreign-trade difficulties could be overcome only by expanding her engineering exports, and if that could be achieved only by curtailing

defence orders, then there would certainly be cause for grave anxiety, but he did not believe that this was true at present.

Mr. W. E. Hopkin, the chairman of the N.U.M.G.W., in his address to the conference, criticised appeals which had been made to employees to work overtime and increase their outputs, so that their wages could keep pace with advances in the cost of living. He considered it an insidious and dangerous attack on trade-union standards. The unions had not disputed demands for overtime when these were made in the interests of greater production, and there had been no serious opposition to the introduction of incentive schemes. The most serious consequence of the policy was on those workpeople who had no opportunity of increasing their earnings by greater efforts. There could be no acceptance by the union of a stabilisation of wages, but it was essential that trade unionists, when making claims for wage increases, should act with a full sense of their responsibility. He firmly condemned the use of strikes and go-slow action for political purposes.

Seamen's wages and conditions of work were considered at length at the annual conference of the National Union of Seamen in London on June 13. A resolution instructing the union's executive committee to continue its policy of concentrating its attention on obtaining a basic wage for the industry and on the well-being of seamen in regard to their accommodation, feeding facilities and port welfare, was carried unanimously and without discussion. It was declared in the resolution that wages should not be the "sum total" of the union's efforts, that there should be "a general trend towards making the atmosphere in which a seaman lives and works, when at sea or in foreign ports, something beyond criticism." A motion was introduced asking for a general wage increase for seamen, "because the effects of the recent Budget had nullified the wage increase granted in January last," but no second came forward. Mr. Tom Yates, the union's general secretary, suggested that the probable cause of the lack of support for the motion was that the conference felt, as he did, that the time was not opportune for making new wage demands.

In a statement made at the close of the session, Mr. Yates reported that his union, having successfully negotiated an eight-hour day for deep-sea merchant seamen, was now urging that similar conditions should be accorded to men serving on tramp ships, and to those employed in the catering departments of ships, including small vessels as well as large ones. He said that it was the policy of the union's executive committee to secure an eight-hour day for all sea-going personnel. The union was committed to pressing for that concession and was determined to obtain it for men employed on tramp steamships. The conference approved a recommendation that bank holidays spent at sea should count for extra leave, in the same way as Sundays. It was also agreed to ask the employers to approve that the eight-hour working day for boy ratings should be limited to a twelve-hour period and not be spread over 14 or 16 hours, as at present.

The most interesting event at the annual conference of the Post Office Engineering Union, which was held during the past week at Eastbourne, was the rejection on Monday last of a motion proposing the alteration of the union's rules, to allow it to take strike action in certain circumstances. The suggested amendment to the rules was put forward on behalf of the Birmingham (testing) branch, which was stated to regard strike action as an essential weapon in the union's armoury. Other speakers, however, considered that the right to strike would be dangerous, and there was a reference to "people in the union who were strike happy." The motion was rejected, on a card vote, by 22,225 votes to 17,799. These figures represent about two-thirds of the union's membership.

A trade-union wage dispute, which may result in the banning of overtime working at Yorkshire collieries, was announced on Monday last. The executive committee for the Yorkshire area of the National Association of Colliery Overmen, Deputies and Shotfriers, decided at a meeting at Barnsley on that day to adhere strictly to the five-day week agreement for the coal-mining industry, as from July 1. This decision followed the unanimous rejection by the committee of an increased wage offer from the National Coal Board. It is understood to have been an improvement on a previous offer and to have represented wages of from 14l. to 16l. 10s. a week for deputies. Colliery overmen would have received rather higher wages than this, and shotfriers slightly less.

PRE-ERECTED REINFORCEMENT FOR CONCRETE STRUCTURES.

T. C. JONES AND COMPANY, LIMITED, LONDON.

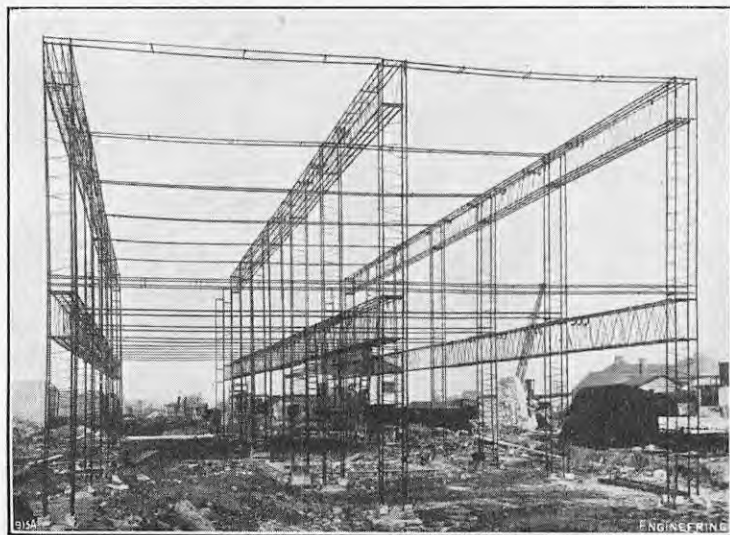


FIG. 1. REINFORCEMENT FOR FIRST FULL-SCALE STRUCTURE.

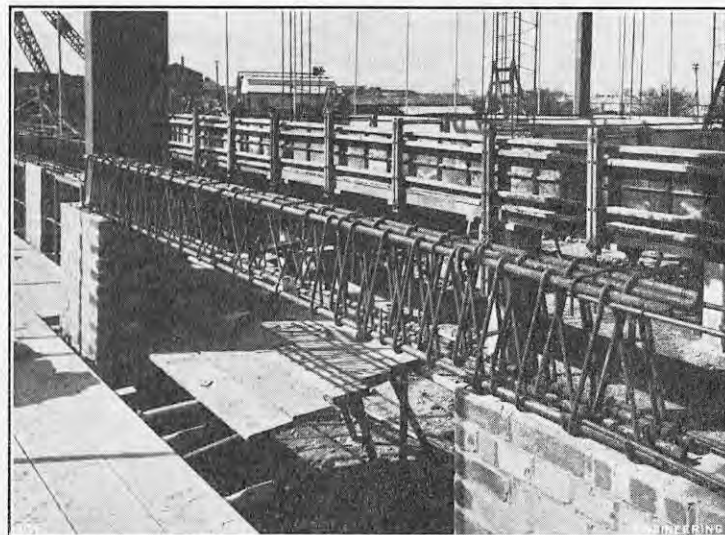


FIG. 2. EXTRA SHEAR REINFORCEMENT OVER DOORWAY.

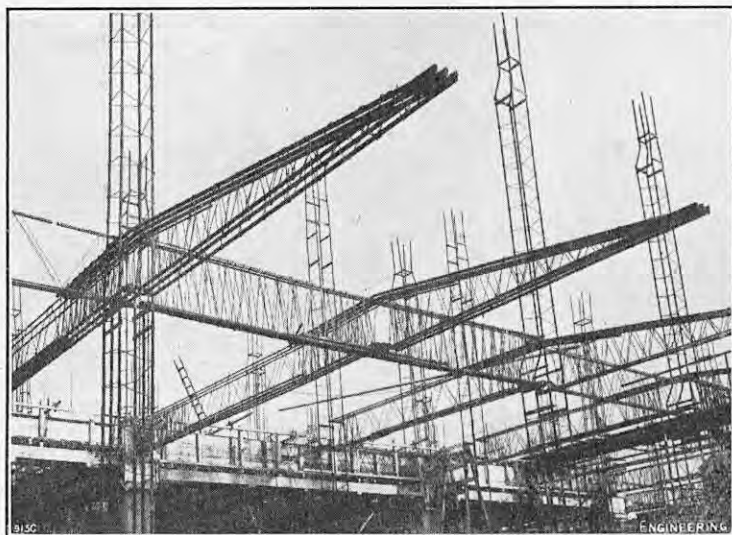


FIG. 3. REINFORCEMENT FOR FACTORY EXTENSION.

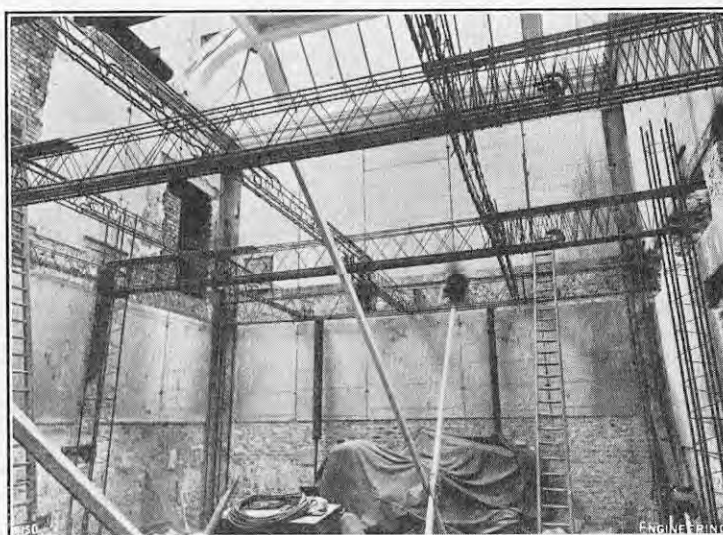


FIG. 4. REINFORCEMENT ERECTED IN ST. GEORGE'S HOSPITAL.

PRE-ERECTED REINFORCEMENT FOR CONCRETE STRUCTURES.

FOR reinforced-concrete structures, the novel idea of erecting prefabricated units of reinforcement before any forms are constructed or any concrete is placed has been developed during the past four years by Messrs. T. C. Jones and Company, Limited, 95, Woodlane, Shepherd's Bush, London, W.12. The principal advantages are a substantial saving in site labour for erecting the reinforcement and a reduction of construction time at the site. Several buildings have now been constructed in this way; the framing for the first such job is shown in Fig. 1, on this page. The system is known as Frameweld reinforcement and is protected by Patent No. 589066.

The reinforcement is prefabricated in the shops in beam and column units, which are then dispatched, in the required lengths and exact detail, to the construction site. Here they are erected as a self-supporting frame, as though they were for a steel-framed building, except that in most cases less special plant is required. In the early stages of development the beams were fabricated from a series of units, each complete in itself and composed of a top bar and a bottom bar connected by a continuous wire passing under the bottom bar and over the top bar to form a vertical frame. After careful study it was decided to investigate four probable improvements: that rigidity could be obtained by welding the diagonal wires to the top and bottom bars at each point of contact; that, to obtain the required strength, the welded components could be arranged singly, or in a series of two or more, to provide the reinforcement for the beam; that columns could be fabricated by welding a continuous helical wire to the main bars; and that, since the welding might be slightly more expensive than the ordinary methods of hooking, bending and

wiring, it was desirable to make as many economies as possible in the fabrication. It was thought that an economy might be achieved by omitting all hooking at the ends of the beam bars and omitting bent-up bars and transverse stirrups, since sufficient bend could be obtained from the diagonal wires at their welded points of contact with the main bars and adequate shear reinforcement would be provided by these diagonal wires.

A simple trial frame, as light as would be required in practice, was erected; it proved to be remarkably rigid. The columns were provided with flats welded to the main bars to act as supports for the beam units, and grooves were cut in the top edges of the flats to receive the bars. Special clips edged the beam units to the column units, and distance pieces preserved the correct spaces between the vertical beam components at convenient points along the top and bottom. No transverse stirrups were used. Plumbing and levelling this frame presented no difficulties, and the experiment was sufficiently encouraging to justify a series of laboratory tests to determine whether concrete beams reinforced with Frameweld units, having no hooked ends and transverse stirrups, would be as effective as beams reinforced by conventional methods. The tests were carried out at the Building Research Station, Garston, Hertfordshire.

Twenty-four beams were tested, eight with ordinary reinforcement and 16 with shop-welded frames. The beams were 12 in. deep and 6 in. wide, with lengths of either 10 ft. 6 in. or 5 ft. 6 in. A cover of 1 in. of concrete was used over the longitudinal bars in all beams. The main longitudinal reinforcement for one series of beams consisted of two $\frac{5}{8}$ -in. diameter mild-steel bars, and for the other series two 1-in. diameter bars. Tests on the 10-ft. 6-in. beams, supported on a 10-ft. span, showed that beams with Frameweld units had bending strengths as good as those of beams with

ordinary longitudinal bars and stirrups, in spite of the fact that the Frameweld bars were not provided with hooked ends. The tests made on a series of beams with 5-ft. spans were planned so that shear resistance would be the criterion of strength and so that the strength of a standard welded lattice of the Frameweld units, in comparison with that of normal reinforcement, would be revealed. In practice, additional shear reinforcement would be provided for short spans of this type by reducing the angle or increasing the size of the diagonal wires where required. For test purposes, however, the standard design for Frameweld units was used. The results showed that, except where the Frameweld unit with 45-deg. diagonal wires was compared with heavily reinforced beams, the load capacity was very close to that of the normal beam, even though the shear reinforcement is much less in the Frameweld units than in ordinary beams.

The table below gives the load capacity and weight of shear reinforcement for those beams, for 60-deg. and 45-deg. Frameweld units, as percentages of the values for normal reinforcement. It will be seen that,

Test Beam No.	Type of Shear Reinforcement.	Load Capacity, Per cent.	Weight of Shear Reinforcement, Per cent.
First Series; 0.96 per cent. of main reinforcement	Normal reinforcement	100	100
	60-deg. Frameweld ..	89	62
	45-deg. " ..	94	42
Second Series; 2.5 per cent. of main reinforcement	Normal reinforcement	100	100
	60-deg. Frameweld ..	80½	78
	45-deg. " ..	60	42

in general, a large saving in weight of shear reinforcement is effected for a comparatively small reduction of load capacity.

Load/deflection curves for the two types of reinforcement showed that there was no significant difference between them with regard to stress in the main bars, or in cracking, up to the failing load. At the design loads, the deflection at mid-span in no case exceeded 1/770th of the span, and the maximum crack width was only about 0.003 in. at the surface of the concrete.

During the tests at the Building Research Station, the times required for wiring and placing the reinforcement in the moulds were recorded. The results showed the great saving in placing Frameweld reinforcement, though they could only be accepted as an indication as the tests were carried out under laboratory conditions, and the placing operation in beam reinforcement is only part of the total operations in fixing reinforcement. In general, however, Frameweld units require only 1/12th of the time for assembly and fixing on site of normal arrangements of bars and stirrups. The results of the tests showed that the site labour per ton of steel was 33 hours for normal reinforcement and 2.5 hours for Frameweld.

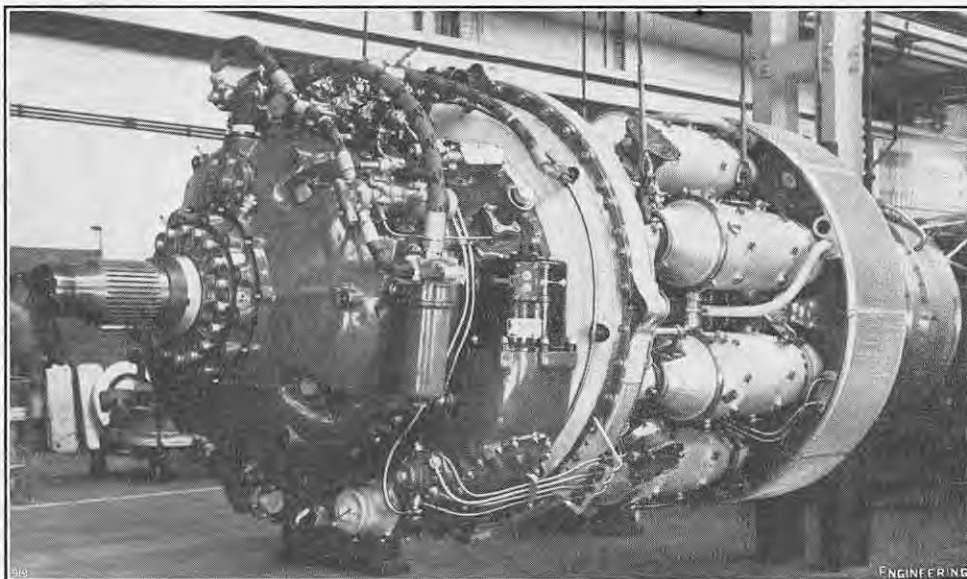
The first full-scale trial of the system is shown in Fig. 1, before the main body of carpenters and concreters started work on the site. The building was designed as an inner frame with outer load-bearing walls. The inner frame was constructed with columns and beams, and the suspended floors were in pre-cast units. Fig. 2, page 791, shows the extra shear reinforcement provided in the welded units for beams over the doorways by increasing the size and decreasing the pitch of the diagonal wires. During concreting, the contractors found that there was much greater freedom in tamping the concrete in the beams, due to the absence of transverse stirrups; this had the effects of saving time and reducing costs. Another advantage of the Frameweld system is that, since the reinforcement is erected well in advance of other site work, there is a reduction in those costs which arise when the work of several trades overlap.

Of several other buildings which have since been constructed on this system, the extension to the wax-polish factory of Messrs. S. C. Johnson and Son, Limited, at West Drayton, is worth mentioning. Fig. 3 shows part of the frame. A small labour force kept the erection of the reinforcement well ahead of the concreting work, and it was confirmed that the system eliminates the possibility of the rods being displaced after erection. The work was carried out during an abnormally wet period, but no fine days were wasted in placing reinforcement. Frameweld units have also been used in building the new laboratories at the St. George's Hospital, London, S.W.1, as shown in Fig. 4. Here, the reinforcement had to be erected within the shell of an existing building, and as there was very little space for storing building materials it was a great advantage to be able to erect the frame immediately it arrived at the site. Frameweld units are also proving satisfactory for reinforcing the concrete rafts used for house foundations when the ground is of low bearing value, and for the type of raft that is used when a whole housing site is liable to subsidence due to mining operations.

"DIRECT CURRENT."—We have received a copy of a new quarterly journal with this title, which made its first appearance this month. The first number includes a foreword by the Divisional Controller for the British Electricity Authority in South-West Scotland, in which the view is expressed that high-voltage direct current will ultimately prove the best form of electricity for long-distance land transmission or medium-distance submarine transmission. Among other contributions on this subject in the present issue are an article on the projected transmission of direct current at a high voltage from the Swedish mainland to the island of Gotland; a discussion of the advantages of high-voltage direct current in the transmission of small amounts of power over relatively long distances; and a review, by the chief engineer of the Brown, Boveri Company, of the Swiss viewpoint on high-voltage direct current. The future of electrical transmission is discussed by the chairman of the British Electrical and Allied Industries Research Association's committee on transmission of power at high voltages, and the director of the same organisation reviews its activities in the high-voltage direct-current field. Other articles deal with the possibility of generating useful amounts of power thermo electrically, and improving the power factor of converters by forced commutation. For the benefit of foreign readers, a summary in French of each article is included. The journal will also deal with such subjects as direct-current electric traction, low-voltage direct-current generation and application, and research and development in the direct-current field. Further particulars and details of subscription rates may be obtained from the publishers, Garraway, Ltd., 11a, Kensington Church-street, London, W.8.

"PROTEUS" 700-SERIES PROPELLER TURBINE.

BRISTOL AEROPLANE COMPANY, LIMITED, BRISTOL.



"PROTEUS" 700 SERIES PROPELLER TURBINE.

DETAILS of the Mark III version of the Proteus propeller turbine engine, also known as the Proteus 700 series, have recently been released by the Bristol Aeroplane Company, Limited, Filton, Bristol. It is shown in the above illustration. The Proteus 700 series engine, which has recently been undergoing trials, is in production for the Britannia air liners being constructed by the same company for service with the British Overseas Airways Corporation. It may be recalled that a description of the earlier version, now known as the Proteus 600 series, was published on page 269 of our 168th volume (1949). Engines of this type are being fitted in the prototype Britannia aircraft, and in the first of the Saunders-Roe Princess flying boats. The 700 series Proteus has been re-designed to give a better performance in a lighter and more compact form than the original Proteus. In this article, we shall describe only those features in which the series 700 engine differ from the series 600.

The calculated performances, under standard atmospheric conditions, of the Proteus 700 series engine under sea-level static conditions, and at 300 knots at an altitude of 35,000 ft., are given in the accompanying table. On test, on the dynamometer, using a 20-in.

Calculated Performance of Proteus 700 Series Engine.

	Sea-level static Conditions.		At 300 Knots at 35,000 Ft.
	Maximum Power, 5 Minute Limit.	Maximum Continuous Power.	Maximum Continuous Power.
Propeller shaft h.p. . .	3,320	2,920	1,240
Jet thrust, lb. . .	1,200	1,100	275
Total equivalent h.p. . .	3,780	3,345	1,555
Fuel flow, lb. per hour . .	2,350	2,130	770
Specific fuel consumption, lb. per s.h.p. per hour . .	0.71	0.73	0.62
Specific fuel consumption, lb. per equivalent h.p. per hour . .	0.62	0.64	0.495
Compressor r.p.m. . .	12,000	11,700	11,700
Power turbine r.p.m. . .	10,700	9,500	9,500
Propeller r.p.m. . .	963	855	855

final exhaust nozzle, the engine has surpassed these figures, and at a compressor speed of 12,000 r.p.m. has developed 4,100 b.h.p. plus 920 lb. jet thrust, at a jet-pipe temperature of 485 deg. C., with a specific fuel consumption of 0.59 lb. per brake horse-power per hour; the latter figure is based on the dynamometer recording, and takes no account of jet thrust. At 11,500 r.p.m., the engine under test developed 3,350 h.p. plus 770 lb. jet thrust, at a jet-pipe temperature of 455 deg. C., with a specific fuel consumption of 0.62 lb. per brake horse-power per hour. The overall length of the Proteus 700 series engine is 100.5 in. and its overall diameter 39.5 in., which compares with a length of 113 in. and a maximum diameter of 38.5 in. in the original Proteus engine. The dry weight, including the accessory gearbox drive, but excluding the exhaust duct and "bullet," is 2,650 lb., whereas the original Proteus weighed 2,900 lb.

In the Proteus engine, it may be recalled, air enters the rear end of a 12-stage axial compressor, and passes through it to a single-stage centrifugal impeller. The air flow leaving the centrifugal compressor is reversed in direction and is led into eight combustion chambers around the compressor housing. From the combustion chamber, the hot gases are directed firstly to a two-stage turbine driving the compressor, and cooled by air bled from the compressor, and then through a second turbine driving the propeller through an epicyclic reduction gear. In the original version of the Proteus, a single-stage turbine drove the propeller. This has been replaced in the 700 series engine by a two-stage turbine, the two power-turbine wheels being coupled together by an internal serrated sleeve, as in the compressor-turbine.

The axial-compressor rotor and stator blading originally of light alloy, are now made of steel. Whereas, in the 600 series Proteus, the centrifugal impeller was located forward of the front axial-compressor bearing, and the air leaving the axial compressor was led through an annular duct to the impeller inlet, in the later design the centrifugal impeller is located immediately forward of the last stage of the axial compressor. This modification has reduced the size and weight of the compressor and has also improved its performance. The forward end of the axial-compressor rotor is now carried by a hub on which is mounted the single-sided steel impeller. Forward of the impeller the hub is supported in a stacked pair of ball bearings which resist the rotor thrust load. The rear end of the compressor shaft is supported in a roller bearing.

From the impeller, the air passes tangentially through eight separate diffuser passages, each leading to an elbow; the latter are now fitted with guide vanes to provide a smooth uniform airflow, giving a more even distribution of combustion-chamber temperature leading to longer life. As in the 600 series engine, the combustion chambers are of conventional design, with a centrally-placed burner upstream, and two ignition plugs; they are, however, shorter than those of the earlier engine, as a result of the reduced length of the compressor.

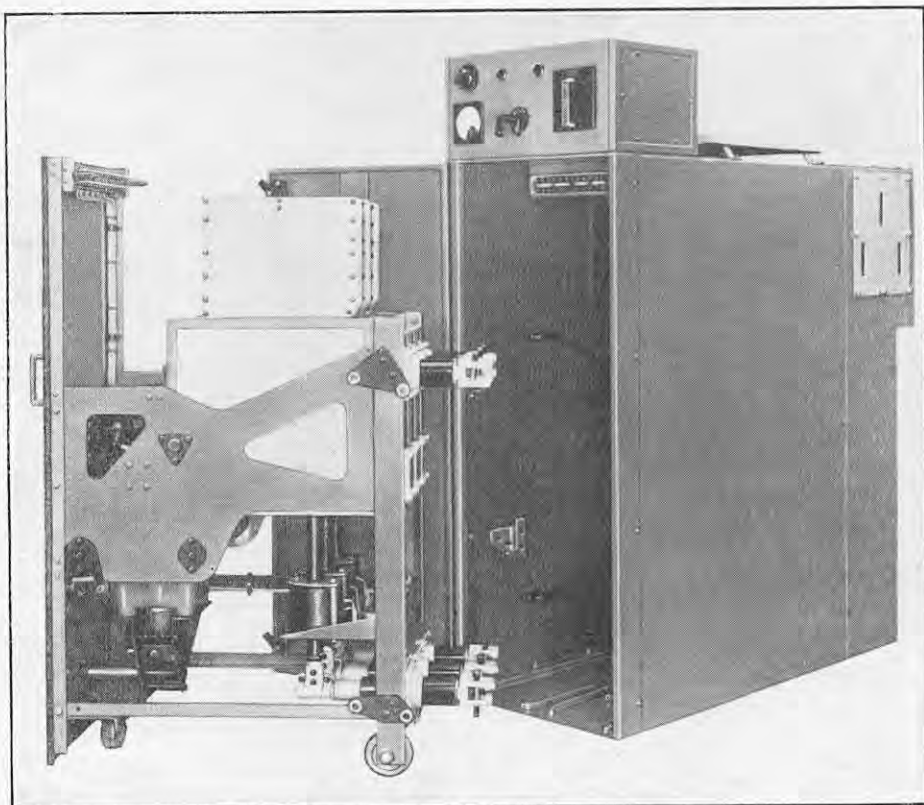
The manner in which the turbines are coupled respectively to the compressor rotor and the propeller driving shaft, and the arrangement of the epicyclic reduction gear train and torque meter is similar to that of the 600 series engine.

In the engines destined for installation in the production Britannia air liners, the engine accessories are grouped around a gear casing immediately aft of the main reduction gear. The starter motor, on the port side, drives the compressor shaft through bevel gearing, a dog clutch, and spur gears. Accessory drives taken from the compressor shaft include the compressor tachometer generator, the fuel pump, the main oil scavenge and pressure pumps and the oil-metering pump which feeds the turbine and compressor bearings. From the rear of the propeller reduction-gear cage are driven, through gear trains, the propeller control unit, an auxiliary-drive gearbox, the propeller synchronising alternator, and the torque-meter pump.

The fuel is supplied by way of a manifold to the burners by a Lucas variable-displacement fuel pump. The delivery of fuel is automatically regulated to compensate for altitude by a Lucas barometric control. The pilot controls the fuel flow in the high-pressure

3.3-KV AIR-INSULATED CIRCUIT-BREAKER.

FERGUSON PAILIN, LIMITED, MANCHESTER.



line through a conventional throttle control unit. For starting, an additional electrically-driven fuel pump feeds high-pressure fuel into the output side of the main fuel pump until the engine gains sufficient speed for the latter to become effective.

The light-alloy compressor- and air-intake castings on the 700 series engines are of stronger construction than those of the original engine, and this has made it possible to eliminate the built-up mountings for the turbine and compressor. The engine is mounted, through two sheet-metal cones attached to the compressor casing, on a ring provided with eight pick-up points to suit a conventional supporting structure.

150-MVA 3.3-KV AIR-INSULATED CIRCUIT-BREAKER.

The accompanying illustration shows an air-break single 'bus-bar air-insulated circuit-breaker recently designed by Messrs. Ferguson Pailin, Limited, Higher Openshaw, Manchester, 11. It has a rupturing capacity of 150 MVA at 3.3 kV with currents up to 2,400 amperes and is of the class which is widely used for the control of power-station auxiliaries and the heavier industrial plant. Care has been taken in its design to keep the unit as small as is consistent with a flexible arrangement of the parts, while the lay-out is such as to reduce the amount of maintenance necessary to a minimum and to ensure easy access to all apparatus requiring attention or replacement. The individual sections of the mechanism, as well as the unit as a whole, have been subjected to rigorous electrical and mechanical tests.

The housing of the unit is fitted with a flush-fronted door, so that the ingress of dust and vermin is prevented. The circuit-breaker need only be withdrawn for inspection purposes or transfer to another housing. It is isolated by means of a racking mechanism and the door can be re-closed when the circuit-breaker is in this position. The unit as a whole is interlocked to prevent incorrect operation. Special attention has been given to the design of the circuit-breaker truck to produce good balance. For this purpose, it is fitted with two rear wheels and a front wheel of the castor type, which run on guide rails inside the housing. Most of the weight of the truck is taken by the rear wheels, and this arrangement, in combination with the castor action of the front wheel, gives good manoeuvrability. The truck can, in fact, be turned as it is withdrawn, which is a useful feature where space is restricted.

The arc chutes embody metal splitter plates which, combined with other plates of insulating material, form a baffle stack, thus ensuring that the arc is extinguished inside the chute; there is one chute over each set of contacts. Permanent interphase barriers of insulating material are fitted inside the unit. These

barriers come between the arc chutes when the truck is in the operating position and produce a chimney effect which dispels the gases generated by the arc through a drip-proof cowled vent in the top of the unit. They also provide a certain amount of phase segregation. The moving parts of the circuit-breaker are brought smoothly to rest at the end of each opening stroke by piston-type dash-pots, the design of which greatly assists quietness in operation.

Accommodation is provided for ring or wound-type insulated current transformers for metering and protective purposes. A core-balance type of transformer can also be fitted in the cable connection chamber of the housing, if required. Air-insulated circuit voltage transformers can be supplied and are mounted in the base of the truck, while the 'bus-bar voltage transformers, if used, can be accommodated in a separate panel or mounted in top of the unit. The 'bus-bars themselves, which have a current-carrying capacity of 3,000 amperes, are totally enclosed in a separate compartment in the fixed position of the unit. Automatic shutters, which can be locked independently in either the open or closed positions, are fitted.

The cable box, which is normally filled with compound, is mounted at the rear of the unit and is suitable for the various sizes and types of cables likely to be required. The wiring cabinet and wiring trough are fitted with detachable covers, thus simplifying the wiring and facilitating the carrying out of extensions. The control switches, indicating instruments and lamps can be accommodated on the front panel of the wiring cabinet.

ELECTRONICS EXHIBITION.—The seventh annual electronics exhibition, organised by the North-Western Branch of the Institution of Electronics, will be held at the College of Technology, Sackville-street, Manchester 1, on Tuesday, July 15, from noon to 9 p.m.; on Wednesday and Thursday, July 16 and 17, from 10 a.m. to 9 p.m.; and on Friday, July 18 from 10 a.m. to 5 p.m. Both the research section of the exhibition, comprising displays by universities and scientific associations, and the commercial section, devoted to manufacturers' products, have been extended this year, and, altogether, over 40 exhibitors will have displays on view. An extensive programme of lectures, presented by exhibitors and dealing, in the main, with their products, has been arranged. There will also be a number of film shows on subjects ranging from the elementary principles of electronics to television, and including the electron microscope and atomic physics. Exhibition tickets, lecture tickets and programmes may be obtained from Mr. W. Birtwistle, honorary secretary of the Branch, 17, Blackwater-street, Rochdale, Lancashire, by forwarding a stamped addressed envelope. Catalogues will be available early in July, price 1s. each, postage 3½d.

PROPHECY AND ACHIEVEMENT IN AERONAUTICS.*

By SIR HARRY M. GARNER, K.B.E., C.B., M.A., F.R.Ae.S.

(Concluded from page 712.)

THE state of knowledge in the years after the second World War, when attention began to be focused on transonic and supersonic flight, is shown by the curve in Fig. 4, page 794, of drag coefficient for an aeroplane with straight wings, plotted against Mach number. At speeds up to 0.9 times the speed of sound, the value was known fairly accurately from the results of experiments in flight and wind tunnels. The part of the curve above 1.2 times the speed of sound could be calculated fairly well from supersonic theory supported by wind-tunnel tests. Between 0.9 and 1.2, theory could do no more than give broad indications, no flight tests had been made, and wind tunnels could not be controlled to give steady conditions. The state of our ignorance in this region is indicated by the portions of broken lines in the curve of Fig. 4 and the gap between about 1.0 and 1.1 where the drag was quite unknown. At best, it appeared that the drag coefficient round about the speed of sound would be at least six times that at low speeds.

Within a few years, experimental evidence had been obtained which enabled the gap to be filled in. This came from the flight testing of rocket-propelled models, particularly by the National Advisory Committee for Aeronautics in the United States. Additional evidence was provided from wind tunnels, in which the difficulty of controlling the flow of transonic speeds has been largely overcome during the past few years.

The picture as seen to-day is given in Fig. 5, where the drag and thrust curves of two hypothetical modern aeroplanes with equal wing areas are compared. The information lacking in Fig. 4 has been filled in, and it is seen that the peak drag for a straight-winged aircraft is not so high as had been feared. The result in practice is that, although the changes in the air-flow pattern round an aeroplane flying through the speed of sound are considerable, they do not lead to impossible conditions either in drag or control. The straight-winged experimental aeroplane XS-1 has made a number of flights in the United States at, and near, the speed of sound without undue difficulty.

The drag curve for an aeroplane with the wings swept back 45 deg. is also given in Fig. 5. The use of swept-back wings in effect delays the rise in the drag curve until a higher speed is reached. As compared with the straight-winged aircraft, the drag starts to rise later; the peak drag coefficient is reduced to half, and it occurs at a Mach number of about 1.4 instead of a Mach number of 1.1. The advantages of sweepback for speeds up to $M = 1.5$ are evident, and are confirmed by flight tests up to the speed of $M = 1.1$. Beyond $M = 1.5$ the swept wing has no advantage.

The components that go to make up the profile drag are shown in Figs. 6 and 7 for straight-winged and swept-winged aircraft, respectively. The preponderance of the wave drag of the wing is clear for both types. The wave drag is proportional to the square of the thickness of the wing, and an intensive effort can be expected to reduce this, even at the expense of increased weight. The other components of drag will become more important as wing drag is reduced and there will be a reduction of the frontal area of the body and an increase in length as a further extension of the slimming process. The swept-back wing gives a higher stalling speed than the straight wing and it is not a good structural shape. Thus, in a fair comparison, the area and thickness of a swept-back wing should be greater than those of a straight wing.

In Fig. 8, a forecast of what may be achieved in the near future is given. The scale of drag coefficient in this figure is double that of Figs. 4, 5 and 6. Three hypothetical aircraft have been designed with very thin wings and with wing areas adjusted to give the same landing speed. The thickness of the straight wing is half that of the straight wing in Fig. 5 and the wave drag has therefore been reduced to one quarter. The thickness of the swept-back wings has been reduced, but to a less extent. The new comparison shows that the advantage of the aeroplane with 45-deg. sweepback is confined to speeds below $M = 1.2$. A sweepback of 60 deg. gives an advantage up to $M = 1.3$. Beyond these speeds, the straight wing is superior.

In Fig. 8, two thrust curves are shown, corresponding to present thrusts (curve A) and those which might be expected in the future (curve B). With the lower thrust the advantage of sweepback is seen. With 60-deg. sweepback the top speed can be increased by about 20 per cent. With the thrust given by the higher curve the straight wing has an overwhelming

* Fortieth Wilbur Wright Memorial Lecture, presented before the Royal Aeronautical Society in London on Thursday, May 29. Abridged.

ACHIEVEMENTS IN AERONAUTICS.

Fig. 4. WING DRAG THROUGH THE SPEED OF SOUND.

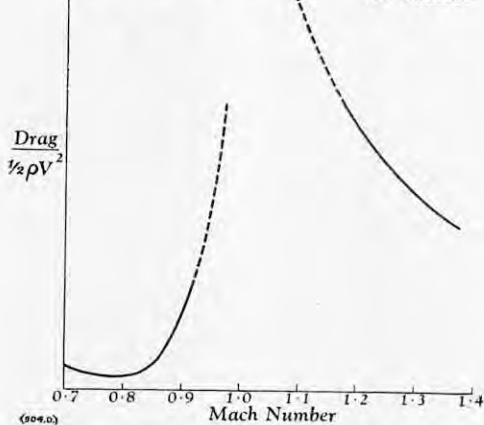
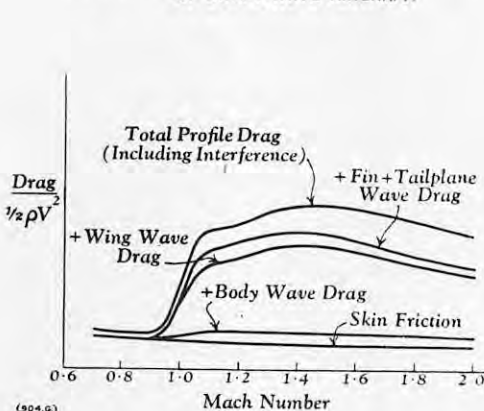


Fig. 7. PROFILE DRAG COMPONENTS OF SWEEP-WING AIRCRAFT.



advantage. In fact, the thrust curve at high speeds is almost parallel to the drag curve, and it would seem that once the difficulties of overcoming the peak drag have been surmounted, small increases in thrust may produce large increases in speed. Whether this will lead to some new type of longitudinal instability in the future is an interesting speculation.

The enormous increases in thrust that have been obtained from the turbo-jet are obtained at the expense of a high consumption of fuel. A still higher thrust for a given size and weight of power plant can be obtained from a rocket motor, which has a much higher consumption than the turbo-jet, arising in part from the fact that the oxygen for the rocket has to be carried in the aircraft instead of being taken from the air. These developments of high thrust, both for the turbo-jet and the rocket motor, may have far-reaching results in the future. Before long, it will be possible to design aircraft in which the engine thrust is greater than the weight of the aircraft. This opens up the possibility of taking off and landing vertically. Aircraft designed for this would be very different from present types in which the provision of adequate lift from the wings for take-off and landing dominates the design. The method of operation of these aircraft might well be revolutionary.

As speeds increase, a new limitation will be imposed by the high temperature reached. When air is brought to rest the rise of temperature is proportional to the square of the speed. At a height of 40,000 ft. and a speed of 1,000 miles an hour the temperature rise is more than 100 deg. C. At higher speeds still, the temperature rise will cause a serious deterioration in the strength of most present-day structural materials.

Referring briefly to developments in materials, titanium has great potentialities both in aircraft structures and engines, not only as a material with good structural properties at moderately high temperatures, but also as a structural material in its own right. At the present time serious trouble is beginning to arise through vibration of highly stressed materials in aircraft structures, but this will be overcome as a better understanding of the crystalline structure of metals is obtained. Developments in non-metallic materials such as plastics, for structural use, and synthetic lubricants capable of working at higher temperatures in jet engines, may be expected to play an important part in future designs.

Until a few years ago, the qualities required of long-range bombers and military transports—low drag, low fuel consumption, ease of take off and landing—were also those needed for efficient civil aircraft. As long as aircraft were flying at speeds at which the compressibility of the air had little effect, the effort made

Fig. 5. TOTAL DRAG AND THRUST OF PRESENT-DAY AIRCRAFT WITH STRAIGHT AND SWEEP WINGS AT 40,000 FT.; EQUAL WING AREAS.

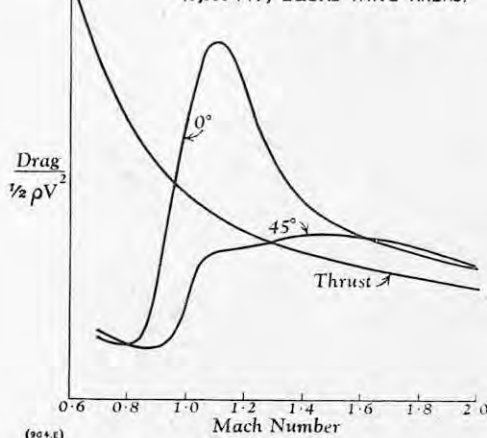
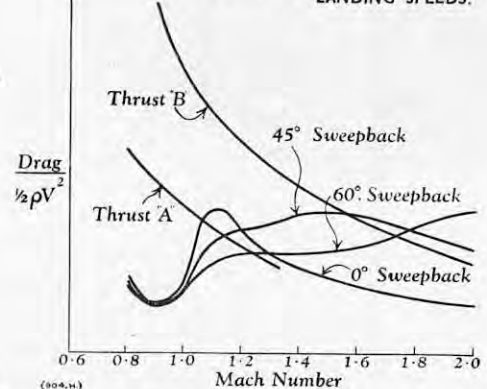


Fig. 8. TOTAL DRAG AND THRUST OF POSSIBLE FUTURE AIRCRAFT WINGS AT 40,000 FT.; EQUAL LANDING SPEEDS.



to reduce drag enabled higher speeds and longer ranges to be obtained. Thus the military aim of high speed met the civil economic need of long range. Even the development of turbo-jets, which at first was undertaken entirely for military purposes, has contributed to improvements in civil aircraft. The parting of the ways has now been reached. The speeds of almost all types of military aircraft are so high that the main problems are those of compressibility. If civil aircraft are to improve they will only do so if research and development adequate for their special needs is put in hand. The speeds of civil aircraft are likely to be kept well below that of sound for many years to come, to ensure economy and to give comfort to the passengers. The main problem facing the designer of civil aircraft, therefore, is that of improving the economy at subsonic speeds.

Most of the power provided by aircraft engines is wasted in creating turbulence in the air. Great progress has been made in understanding the conditions of flow round aerodynamic shapes during the past ten years, although there is still much to be learnt, particularly about laminar flow over swept-back wings. In 1929, Melvill Jones showed that there was a great deal of energy being wasted through the break-away of flow that occurred on wings, fuselages and nacelles. He suggested that careful attention to design should enable large commercial aircraft to fly at the same speed with much less power, which eventually might be as low as one-third of the existing power. This saving in drag was fully achieved in about 20 years. By improved streamlining, profile drag has been reduced until it is almost entirely due to skin friction.

Further improvements can only be obtained by controlling the boundary layer itself and preventing turbulent flow from developing. There are two methods of doing this. The first is by the use of distributed suction applied over the greater part of the exposed surface of an aeroplane and the second by suction at slots distributed along the wing and body. Theoretically, by the use of boundary layer control, the profile drag could be reduced to about one-tenth of that of contemporary aircraft. In order to get this reduction the aircraft surfaces would have to be made to great precision and many difficult structural and mechanical problems would have to be solved. It is known from practical experience that flies picked up on the leading edges of wings can cause a breakdown of laminar flow, and the elimination of this trouble may be one of the most difficult problems to face.

In order to achieve economical flight it would be necessary to obtain a corresponding reduction of

Fig. 6. PROFILE DRAG COMPONENTS OF STRAIGHT-WING AIRCRAFT.

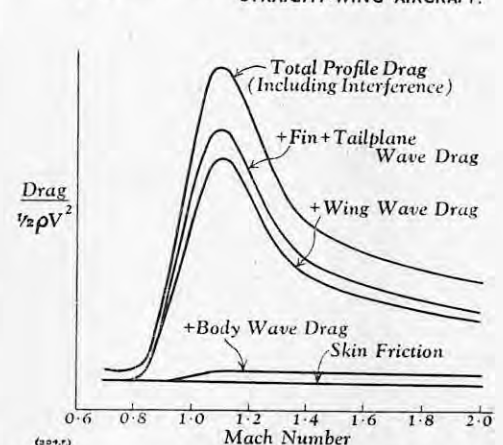
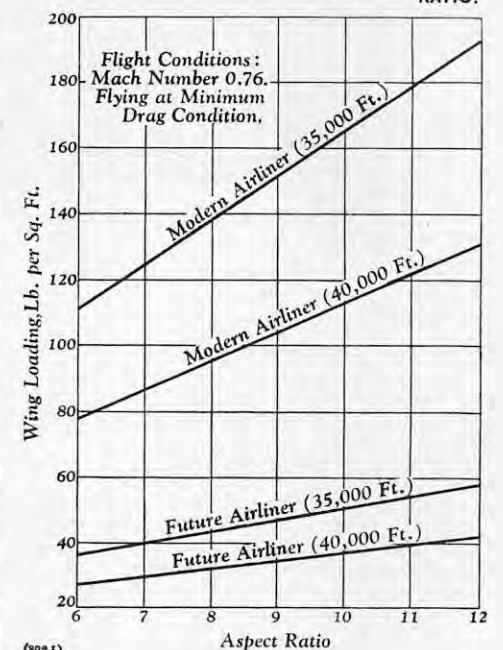


Fig. 9. WING LOADING AND ASPECT RATIO.



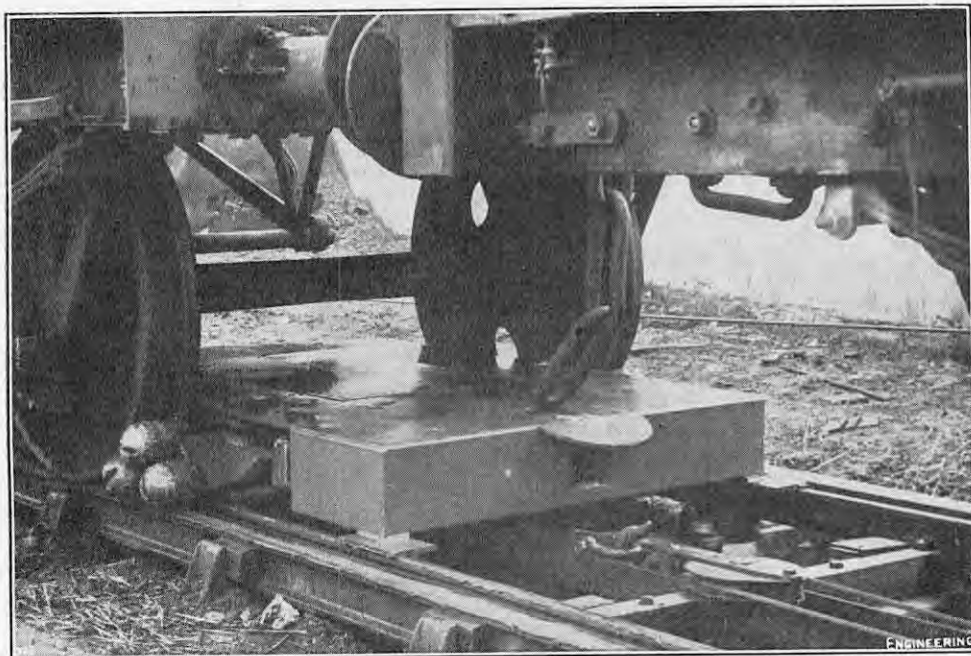
induced drag. In the past a steady reduction of profile drag has been accompanied by a reduction in induced drag in spite of increases in wing loading. The reason for this is that the effect of steady increases of cruising speed has offset the increase in wing loading. A new factor is introduced by the limitation of the cruising speeds of civil aircraft to avoid compressibility troubles. It seems likely that cruising speeds will settle down at a speed between 0.7 and 0.8 times that of sound. Assuming that the long-range civil aircraft is designed to fly at a speed equal to or slightly greater than the speed for minimum drag, it is found that the reduction in induced drag required for the laminar-flow aeroplane can only be obtained by increasing the aspect ratio or wing area. In Fig. 9, the values of aspect ratio and wing loading necessary to give the best range at heights of 35,000 ft. and 40,000 ft. are plotted for two aircraft. The first is a modern airliner, based on the Comet. The second is a future airliner with a profile drag coefficient of one-fifth of that of the Comet.

Since Fig. 7 is based on aerodynamic functions only, it cannot take account of factors such as the increase in structure weight with aspect ratio and the deterioration in take-off with reductions in total engine power required for the laminar-flow aeroplane. This has tended to give larger wing loadings for the modern airliner than are generally the best for all-round qualities. The reductions in optimum wing loading resulting from reductions in profile drag shown in Fig. 9 will enable the passenger to be provided with more roomy accommodation than that available to-day in many airliners.

Estimates, based on present scanty knowledge of the best constructional and mechanical methods of achieving laminar flow, show that, when full allowance has been made for the increased structure weight, ranges of the order of 12,000 miles should be achieved. Griffith has estimated that, with a thick-winged trans-Atlantic aircraft provided with suction, the cost per passenger can be reduced to about half that obtainable for conventional aircraft. The wing loading for his aircraft is about 36 lb. per foot. If the same expendi-

WAGON-MARSHALLING MACHINE.

STRACHAN AND HENSHAW LIMITED, BRISTOL.



ture of scientific and engineering effort that has been devoted to streamlining during the past 20 years is applied to what I may call "laminarising" during the next 20, great progress will be made towards achieving the ideal aeroplane.

The design of an aeroplane with a nuclear power plant is said to be in hand in the United States. At present the weight of such a plant with the shielding devices necessary to protect the crew and passengers is so high that the weight of the aircraft would need to be something like 500,000 lb. I should be surprised if a successful aeroplane of this kind is achieved within the next 15 years. With the development of nuclear power plants, further reductions in drag by the use of boundary-layer control would not be important for the achievement of long range. Any reduction in drag would, however, result in a power plant of longer life, and the aim of scientists should be to reduce squandering the sources of energy that are being used up so rapidly by modern man.

The flying boat, in my view, will play a great part in civil aviation in the future. The construction of large costly land aerodromes, using valuable land that would otherwise be available for agriculture and industrial use, must surely be too great a price to pay for the convenience of civil aviation. There is a possible solution to the problem in military aircraft by the use of excess power, but this solution is not likely to be practicable or acceptable for civil aircraft for a long time to come. Flying boats, using water aerodromes of less cost than land aerodromes and interfering with other amenities far less, must surely provide the ultimate solution. A few years ago the efficiency of the flying boat as a flying machine was only equal to that of a large landplane at weights of about 300,000 lb. or greater. Recent developments, firstly in the design of hulls with a much smaller beam in relation to their length, and secondly, in the use of turbo-jets, have made possible the design of a flying boat at a weight of about 100,000 lb. as efficient as a landplane of the same weight. I see, then, the flying boat as a formidable competitor to the landplane as the long-range transport of the future. It may be that the lightly loaded flying wing seaplane put forward by Roxbee Cox and Coombes in 1935 may provide one of the solutions to long-range transport.

The development of helicopters, with their great potentialities for short-distance travel, has been disappointingly slow, even in the United States, where a large effort has been devoted to them. The ultimate solution may be one of the forms of jet propulsion.

SUMMER SCHOOL ON PHOTO-ELASTICITY.—The department of civil and municipal engineering of University College London, has arranged a summer school on photo-elasticity, which will be held at the college this year from Monday, September 1, to Thursday, September 11. The course is intended for persons already possessing some knowledge of the basic principles of the subject and who intend to set up photo-elastic laboratories for teaching or research. The fee for the course will be 7l. 7s. and applications to attend should be sent to the secretary, University College, Gower-street, London, W.C.1.

WAGON-MARSHALLING MACHINE.

A RECENT development by Messrs. Strachan and Henshaw, Limited, Steelhoist Works, Victoria-road, St. Philips, Bristol, 2, has made it possible, for the first time, for one man to control the reception, unloading by tipping, and dispatch of a rake of full railway wagons. In a system that they are installing for the Tyne Improvement Commission, wagons will be marshalled and tipped at the rate of one a minute. The machine developed for marshalling the wagons, known as the Beetle, which was displayed for the first time at the Mechanical Handling exhibition which closed on June 14, is shown in the accompanying illustration. It consists of a heavy shallow box running on a pair of auxiliary rails inside the normal track rails, and hauled backwards or forwards by an endless chain located centrally between the rails. When the chain is pulled forward towards the tippler, a pair of retractable roller arms protrude at the side of the Beetle and engage the wheel treads and the heads of the rails, and then the Beetle commences to move forward, propelling the line of wagons in front of it. The Beetle runs on wheels or skids which have a resistance to movement greater than the frictional resistance of the movement of the roller arms, so that the latter always commence to move before the Beetle itself. Thus, when the operating chain is pulled backwards, the roller arms are retracted before the Beetle starts running backwards.

The Beetle will exert a pull of 5 tons, considered to be about the maximum force that could be applied to an empty wagon without risk of lifting the wheels, yet sufficient to propel a train of wagons with a total deadweight of 300 tons, equivalent to a train of about 10 or 12 wagons, allowing for a slight hump introduced in the track just before the entrance to the tippler. In a complete marshalling system as envisaged by Messrs. Strachan and Henshaw, the wagon tippler is installed about 6 in. or 8 in. above the rail level so that the empty wagon can be run off the tippler by gravity. The operator's controls, located in a cabin near the forward end of the tippler, consist of a reversing controller for the marshalling Beetle and a starter button for the tippler, which would run on a semi-automatic cycle. On the arrival of a train load of uncoupled wagons, the operator runs the Beetle back to engage the rear wagon, and then causes it to move forward through one wagon length. The leading wagon detaches itself from the train as it is pushed over the slight hump at the entry to the tippler. It moves slowly into the tippler, and exerts a light push on the buffers of the empty wagon, which starts moving off the tippler table under gravity after it has been shifted through about 2 ft. The empty wagon runs down a short incline on to the horizontal track, and as the second pair of wheels leaves the table, a switch is operated which sets in action an automatic cycle of motions in a second Beetle, operating on the re-assembly track, which moves forward about 30 ft., and then returns. In its forward stroke it pushes the whole train of emptied wagons. Thus the re-assembly operation is completely automatic and the operator is concerned only with feeding the wagons one by one into the tippler, then weighing and tipping them.

TRADE PUBLICATIONS.

25-kW Induction Heaters.—A pamphlet recently received deals with a 25-kW induction heater, manufactured by the English Electric Co. Ltd., Kingsway, London, W.C.2.

Control and Relay Cubicles.—A new design of control and relay cubicle is described in a leaflet recently published by the English Electric Co. Ltd., Kingsway, London, W.C.2.

Mercury-Arc Tubes.—Mercury-arc tubes of the Excitron type are dealt with in four pamphlets which we have received from the English Electric Co. Ltd., Kingsway, London, W.C.2.

Heavy Industrial Switchgear.—An illustrated leaflet describing the range of heavy industrial switchgear which they make has been received from Lancashire Dynamo Switchgear, Ltd., Bristol-road, Bridgwater, Somerset.

Air Circuit-Breaker Tests.—The results of tests made on their type OB33L air circuit-breaker, which has a breaking capacity of 150 MVA at 3.3 kV, are set out in a pamphlet received from the English Electric Co. Ltd., Kingsway, London, W.C.2.

Alternating-Current Ammeters and Voltmeters.—Details of the alternating-current ammeters and voltmeters of the moving-iron type manufactured by them are given in a leaflet issued by the English Electric Co. Ltd., Kingsway, London, W.C.2.

200-b.h.p. "Package Type" Drilling Rig Unit.—The 200-b.h.p. "Package Type" drilling rig unit described in a pamphlet received from the English Electric Co. Ltd., Kingsway, London, W.C.2, consists of a six-cylinder Diesel engine with accessories for this type of work.

Quick-Break Knife Switches.—Details of the quick-break knife switches which are made by them in standard sizes with current-carrying capacities from 100 to 3,000 amperes at voltages up to 600 volts, are given in a pamphlet received from the English Electric Co. Ltd., Kingsway, London, W.C.2.

Railway Electrification.—Three pamphlets dealing with the electrification of the suburban lines of the Polish State Railways, of the Liverpool-Southport line, and of the Liverpool Street-Shenfield line, have been received from the English Electric Co. Ltd., Kingsway, London, W.C.2.

Steam Turbines.—The English Electric Co. Ltd., Kingsway, London, W.C.2, have sent us a reference list containing details of the steam-turbine plant with individual capacities of 5 MW and above which they have constructed between 1920 and April, 1952. Steam turbines have, however, been manufactured at the Willans works, Rugby, of the company and alternators at the Stafford works since 1904.

Twin-Arc Welding Process.—A brochure, T.C. 854, describing the twin-arc welding process, has been produced by the Quasi-Arc Co., Ltd., Bilston, Staffs. It contains a full technical description of the twin-arc plant and electrodes, together with deposition data and instructions on how to weld various types of joint. The special advantages of the method, increased speed and ease of welding, with a balanced three-phase load at a high power factor, are illustrated, and a comparison is made between twin-arc and single-arc methods of welding.

Mechanical-Handling Equipment.—An illustrated catalogue has been issued recently by Mechanised Handling Plant and Machinery, Ltd., Maxwell House, Arundel-street, Strand, London, W.C.2, giving particulars of their hopper units, conveyors, bucket elevators, and associated equipment.

Bulldozers and Angledoosers.—Blaw Know, Ltd., 94, Brompton-road, London, S.W.3, have issued two illustrated leaflets giving brief specifications of their hydraulic bulldozer for the David Brown Trackmaster 30 crawler tractor and their hydraulic angledozer for the David Brown Trackmaster 50 crawler tractor.

Solvent-Extraction Plant.—We have received from Rose, Downs and Thompson, Ltd., Old Foundry, Hull, an illustrated brochure describing in some detail a continuous solvent oil-extraction plant that they have installed for the British Extracting Co., Ltd., Bromborough. The plant is designed to extract oil from groundnut kernels, in order to enable the protein in the residual meal to be used for the production of Ardl fibre, which closely resembles natural wool.

Lifting and Handling Equipment.—The Angel Truck Co., Ltd., Meteor Works, 215-219, Albion-road, London, N.16, have issued an illustrated catalogue of their pulley blocks, overhead travelling cranes, winches, lifting trucks, jacks, stackers, jib cranes, and conveyors, and ancillary equipment.

V-Belt Drives, Bushes and Pulleys.—We have received two illustrated brochures issued by J. H. Fenner & Co., Ltd., Hull. One gives specifications of their taper-lock bushes and pulleys, designed for speedy dismantling and re-assembly, and of their V-belts. The other contains photographic reproductions of Fenner V-belt drives installed at various Swiss textile manufacturing firms.

THE INSTITUTE OF BRITISH FOUNDRYMEN.

THE 49th annual general meeting and conference of the Institute of British Foundrymen opened on the evening of Tuesday, June 10, when a reception was held by the Mayor and Mayoress of Buxton, at the Pavilion. All the business and technical sessions were held at the Spa Hotel, the annual general meeting taking place on the morning of Wednesday, June 11, with Mr. Colin Gresty, the President, occupying the chair. The minutes of the previous meeting having been dealt with, the annual report of the Council was presented and commented upon by the President.

REPORT OF COUNCIL.

The report which covered the year ended April 30, 1952, showed that the total membership on that date was 4,917, as compared with 4,773 on the corresponding date last year. The Council deeply regretted to record the deaths of 37 members during the year. These included Mr. E. J. Kelly, a past-president of the Wales and Monmouth branch; Mr. T. W. Markland, a Lancashire-branch member of long standing, who was President of the branch in 1914-15; Mr. G. E. Roberts, J.P., a past-president of the old Coventry branch; Mr. Arthur Sutcliffe, a prominent member of the Lancashire branch for many years, who was awarded the Meritorious Services Medal of the Institute in 1949; Dr. Guido Vanzetti, who was President of the International Committee of Foundry Technical Associations, and Mr. R. D. Welford, who was a past-president of the West Riding of Yorkshire branch. Among other announcements it was stated in the report that Mr. T. Makemson, M.B.E., Assoc.M.C.T., secretary of the Institute, had completed 25 years of service in that capacity on December 1, 1951; he had also completed 25 years of service as honorary secretary of the International Committee of Foundry Technical Associations. Some prominence was given, in the report, to the activities of the Institute's many branches, and it was announced that on the recommendation of the Middlesbrough branch, the Council of the Institute, at their meeting in January, 1952, had agreed that, in future, the branch should be known as the Tees-side branch. The success of the fourth foundry foremen's training course, held at Ashorne Hill, Leamington Spa, from April 3 to 5, 1952, and attended by 235 persons, had been as great as that of the three previous courses.

REPORT OF TECHNICAL COUNCIL.

The twentieth annual report of the Institute's Technical Council was then presented by the chairman of that Council, Mr. A. E. Peace. He stated that the appointment of five new technical sub-committees during the 12 months ended April 30, 1952, had enlarged the activities of the Technical Council to the maximum degree commensurate with the resources at present available. These sub-committees, individually, had been given the tasks of preparing "atlases" of typical microstructures of cast non-ferrous metal alloys, steel castings, and cast irons, of investigating several aspects of cupola development, and of reviewing the value and effect of receivers. During the year, Sub-Committee T.S. 35, which dealt with the "Flow of Metal," and T.S. 36, which was concerned with "Cupolas," had completed their work. The advisory panel of the chairman of the Technical Council had continued during the past year, to give preliminary detailed study to proposed new projects to enable further investigations to be undertaken without delay when the opportunity arose. During the past 12 months, four additional students had been appointed to serve on technical sub-committees under the J. W. Gardom Students' Fund scheme. This continued to afford students a valuable opportunity to study foundry problems.

AWARDS.

The President then announced that the Oliver Stubbs Medal for 1952 had been awarded to Mr. H. G. Hall for his work in furthering the knowledge of malleable-iron founding and in improving foundry technique generally. He then presented the medal to Mr. Hall. Similarly, the President presented other awards. Among these was the E. J. Fox Medal awarded to Mr. A. E. Peace for his work as a technologist on malleable cast iron and for his service, for the past six years, as chairman of the Technical Council. The Meritorious Services Medal was awarded to Mr. John Jackson for his devoted service to the Institute over a period of 30 years. Finally, the British Foundry Medal and Prize for 1952 was presented by Mr. Barrington Hooper, C.B.E., to Mr. K. H. Wright, for his paper "Chilled-Roll Manufacture." On being called upon, the secretary announced that diplomas had been awarded to Mr. S. L. Finch, of the Tees-side branch, for his paper "Process Planning in the Steel-Foundry Industry"; to Mr. J. Gorman, of the Scottish branch, author of "Cross-Section of a Non-Ferrous Metal Jobbing Foundry"; to Mr. E. J. Brown, of the

Lancashire branch, for his paper, "Castings to Resist Abrasion and Wear"; and to Mr. D. F. B. Tedds, of the Birmingham branch, for his paper "Experiments with the Investment Casting Process."

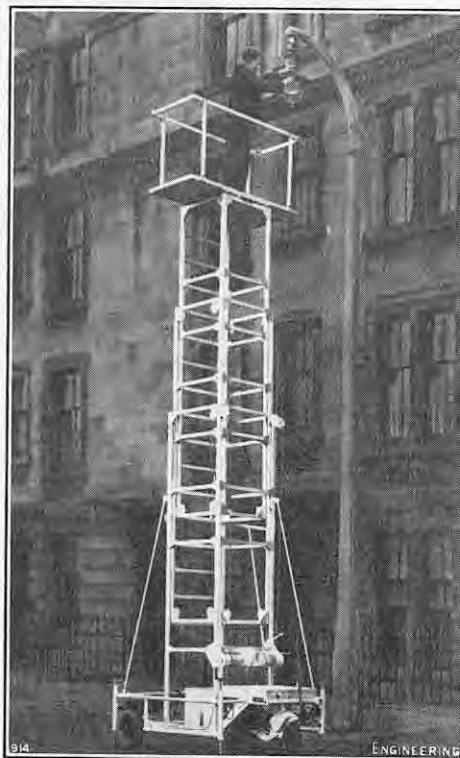
ELECTION OF OFFICERS.

After certificates of honorary membership, conferred upon Mr. C. W. Bigg and Mr. D. Sharpe both past-presidents of the Institute, had been handed to representatives in the unavoidable absence of the recipients, the President announced the election of Dr. C. J. Dadswell, M.I.Mech.E., as President, Mr. E. Longden, M.I.Mech.E., as senior vice-president and Mr. John Bell as junior vice-president. The secretary intimated that the ballot for the selection of five members of the Council, for a two-year period ending in June, 1954, had resulted in the election of Dr. A. B. Everest, Mr. H. G. Hall, Mr. R. L. Handley, Mr. A. E. Peace and Mr. R. C. Shepherd. After a brief interval, Dr. Dadswell delivered his presidential address, entitled "A Sense of Proportion," and this was followed by the delivery of the Edward Williams Lecture on "Fuel and Metal," by Professor R. J. Sarjant, O.B.E., D.Sc. These will be found on pages 758 and 759, ante.

The afternoon and the whole of the following day, Thursday, June 12, were devoted to the reading and discussion of papers, three simultaneous technical sessions being held on the morning and afternoon of June 12. The annual banquet, attended by nearly 600 members and guests, was held at the Palace Hotel on Wednesday evening, June 11. On the last day of the meeting, Friday, June 13, visits were paid to works in Sheffield and its neighbourhood.

ELECTRICALLY-PROPELLED MOBILE TOWER LADDER.

THE mobile tower ladder illustrated below has telescopic frames of aluminium alloy and is propelled along the road by an electric motor to which current is supplied by a 24-volt battery. It is readily steered, extended and lowered by one man, and the battery can be charged overnight by a Legg charging plant. The tower is made by Messrs. John Gibson and Son, Limited, Jameson-place, Leith, Edinburgh, 6, and is fitted with levelling jacks, parking brakes, side-lights and rubber-tyred wheels. The height to the platform is 22 ft. 6 in. when fully extended and 9 ft. when retracted. The chassis runs on three wheels, the front one being fitted with a folding arm for manual steering. The



24-volt Grazeley power unit, which drives the tower at walking speed, is mounted in the chassis. Raising and lowering are effected by means of a hand-operated David Brown winch gear, which has mechanical safety catches. The platform can be rotated through a complete circle, and to reduce the height for stowage the safety rail round the platform can be folded flat. The tower has been designed for the maintenance of street-lighting fittings, clocks, heating and ventilating equipment, and for painting, decorating and structural work. Another tower ladder made by the same firm is intended to be towed behind a lorry and is therefore not fitted with a motor. It is made in two sizes, with extended heights of 22 ft. 6 in. and 28 ft. 6 in.

BOOKS RECEIVED.

- The Gas Welding of Aluminium.* Information Bulletin No. 5. The Aluminium Development Association, 33, Grosvenor-street, London, W.1. [Price 2s.]
- British Railways. Mechanical and Electrical Engineer's Department.* Bulletin No. 1. *Performance and Efficiency Tests With Exhaust Steam Injector. Western Region—"Hall" Class 2-Cyl. 4-6-0 Mixed Traffic Locomotive.* [Price 10s. net.] No. 2 *Performance and Efficiency Tests With Exhaust Steam Injector. Eastern and North Eastern Regions—"B.1" Class 2-Cyl. 4-6-0 Mixed Traffic Locomotive.* [Price 10s. net.] No. 3 *Performance and Efficiency Tests With Live Steam Injector. London Midland Region—Class 4 2-Cyl. 2-6-0 Mixed Traffic Locomotive.* [Price 10s. net.] The Railway Executive, 222, Marylebone-road, London, N.W.1.
- Manual of ASTM Standards on Refractory Materials.* The American Society for Testing Materials, 1916, Race-street, Philadelphia 3, Pennsylvania, U.S.A.
- International Association for Bridge and Structural Engineering. Publications.* Eleventh volume, 1951. Verlag Leemann, Stockerstrasse 64, Zürich 39, Switzerland.
- Dimensional Analysis.* By PROFESSOR H. E. HUNTLEY. Macdonald and Company (Publishers), Limited, 16, Maddox-street, London, W.1. [Price 20s. net.]
- National Physical Laboratory. Report for the Year 1951.* H.M. Stationery Office, Kingsway, London, W.C.2. [Price 3s. net.]
- Allgemeine und chemische Thermodynamik.* By PROFESSOR DR.-ING. ALFRED OPPITZ. Verlag von R. Oldenbourg, Munich, Germany. [Price 27.50 D.M.]
- Society of Chemical Industry. Chemical Engineering Group. Proceedings.* Vol. XXXII. 1950. The Chemical Engineering Group, 56, Victoria-street, London, S.W.1.
- The British Electrical and Allied Industries Research Association. Technical Report No. C/T 106. The Design and Development of Three New Types of Gust Anemometer.* By H. H. ROSENBRUCK. [Price 24s.] No. L/T 258. *Field-Dependence of the Dielectric Constant.* By J. D. O'DWYER. [Price 6s.] No. N/T 261. *Stainless Steel Magnetic Recording Wire.* By PROFESSOR W. SUCKSMITH. [Price 6s.] No. Q/T 117. *Temperature Gradients in Transformer Windings and Rates of Oil Flow in Transformer Tanks. A Critical Review of Published Information.* By B. L. COLEMAN. [Price 6s.] No. Q/T 118. *The Operation of Naturally Cooled Outdoor Transformers as Affected by Weather and Surroundings. Preliminary Review.* By M. R. DICKSON. [Price 18s.] No. Z/T 182. *The A. C. Argonarc Process for Welding Aluminium. An Oscillographic Analysis of Effects of Welding Transformer Open-Circuit Voltage on Arc Re-ignition.* By DR. L. H. ORTON and J. C. NEEDHAM. [Price 5s.] Offices of the Association, Thornecroft Manor, Dorking-road, Leatherhead, Surrey.
- The College of Aeronautics, Cranfield. Report No. 53. An Investigation of the Noise Field from a Small Jet and Methods for its Reduction.* By R. WESTLEY and G. M. LILLEY. [Price 5s.] No. 58. *Dynamic Aeroelasticity of Aircraft with Swept Wings.* By J. R. M. RADOK. [Price 5s.] The Librarian, The College of Aeronautics, Cranfield, Blechley, Buckinghamshire.
- Holzau-Taschenbuch.* Edited by PROFESSOR DIPL.-ING. R. VON HALASZ. Fourth revised edition. Wilhelm Ernst und Sohn, Hohenzollerndamm 169, Berlin-Wilmersdorf, Germany. [Price 19.50 D.M. in paper covers, 21.50 D.M. bound]; and Lange, Maxwell and Springer, Limited, 41-45, Neal-street, London, W.C.2. [Price 34s. 2d. in paper covers, 37s. 9d. bound.]
- Sound Recording and Reproduction.* By J. W. GODFREY and S. W. AMOS. Iliffe and Sons, Limited, Dorset House, Stamford-street, London, S.E.1. [Price 30s. net.]
- Thermal Fatigue and Thermal Shock.* By HELMUT THIELSCH. Welding Research Council Bulletin Series No. 10. The Director, Welding Research Council, 29, West 39th-street, New York, 18, U.S.A. [Price 1 dol.]
- Swedish Cement and Concrete Research Institute. Proceedings No. 15. Loads on Reinforced Concrete Floor Slabs and their Deformations during Construction. Final Report.* By KNUD E. C. NIELSEN. [Price 12 kroner.] Bulletin No. 24. *Stable Concrete Mixes.* By SVEN G. BERGSTROM. [Price 5.50 kroner.] Swedish Cement and Concrete Research Institute, Royal Institute of Technology, Stockholm, Sweden.
- Western Australia. Report of the Inspection of Machinery Branch for the Year 1949.* William H. Wyatt, Government Printer, Perth, Western Australia.
- United States National Bureau of Standards. Handbook No. 50. X-Ray Protection Design.* By HAROLD O. WYCKOFF and LAURISTON S. TAYLOR. The Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., U.S.A. [Price 15 cents.]
- Report of the Astronomer Royal to the Board of Visitors of the Royal Greenwich Observatory. June 7, 1952.* The Astronomer Royal, Royal Greenwich Observatory, Herstmonceux.