THE ENGINEER

A Seven-Day Journal

The Birthday Honours

In the Birthday Honours List, which was published on Thursday, June 7th, it is announced that knighthoods are conferred upon Dr. David Anderson, M.I.C.E., senior partner of Messrs. Mott, Hay and Anderson; Mr. Gerald Barry, Director-General of the Festival of Britain; Mr. Roger Duncalfe, chairman of the British Standards Institution; Professor E. K. Rideal, F.R.S., president of the Chemical Society; Mr. Richard Snedden, general manager of the Shipping Federation; Dr. H. W. H. Warren, M.I.Mech.E., M.I.E.E., managing director, Associated Electrical Industries, Ltd., and Mr. J. Reid Young, director of Vickers, Ltd., and Vickers-Armstrongs, Ltd. In the Order of the Bath, the following become Companions: Mr. T. E. Harris, M.I.Mech.E., M.I.E.E., chief superintendent, Royal Ordnance Factory, Woolwich; Colonel Frank Hibbert, M.Eng., M.I.C.E.; Mr. H. E. Watts, F.R.I.C., Chief Inspector of Explosives, Home Office; Rear-Admiral (E) Sydney Brown, and Major-General S. W. Joslin, M.I.Mech.E., M.I.E.E. The C.M.G. is awarded to Mr. H. A. Gill, Chartered Patent Agent. The list of those receiving the honour of K.B.E. includes the names of Rear-Admiral (E) W. S. Johnson, Major-General C. M. Smith, A.M.I.Mech.E., late R.A.S.C., and Mr. H. D. MacLaren, M.I.E.E. Director of Electrical Engineering, Admiralty. Among those upon whom the honour of C.B.E. is conferred are: Rear-Admiral (E) H. J. B. Moore; Mr. W. K. Brasher, M.I.E.E., secretary, Institution of Electrical Engineers; Mr. H. T. Chapman, M.I.Mech.E., managing director, Armstrong-Siddeley Motors, Ltd.; Mr. W. H. Chatten, M.I.E.E., Assistant Director of Dockyards, Admiralty; Mr. E. Crowther, M.I.C.E., chairman, Northern Gas Board; Mr. G. F. Earle, chairman, Associated Portland Cement Manufacturers, Ltd,; Mr. A. N. East, M.I.Mech.E., M.I.E.E., chief engineering inspector, Ministry of Fuel and Power; Mr. J. W. Elliott, chairman, Swan, Hunter and Wigham Richardson, Ltd.; Mr. G. W. H. Gardner, M.I.Mech.E., Director of Guided Weapons Research, Ministry of Supply; Mr. G. W. Harriman, deputy managing director, Austin Motor Company, Ltd.; Dr. F. Y. Henderson, Director of the Forest Products Research Laboratory; Mr. H. A. Hepburn, M.I.Mech.E., Deputy Chief Inspector of Factories; Mr. Leonard Howles, M.I.E.E., chairman, South Wales Electricity Board; Mr. V. A. G. Lambert, M.I.Mech.E., Director-General, Armament Production, Ministry of Supply; Mr. W. T. Ottway, chairman and managing director, W. Ottway and Co., Ltd.; Mr. W. E. W. Petter, F.R.Ae.S., deputy managing director, Folland Aircraft, Ltd.; Mr. G. Wood, chairman, Thos. W. Ward, Ltd.; Mr. L. R. East, M.I.C.E., chairman, State Rivers and Water Supply Commission, State of Victoria; Mr. A. Campbell, M.I.Mech.E., M.I.Loco.E., chief mechanical engineer, Crown Agents for the Colonies.

Retirement of Mr. H. F. Carpenter

The British Electricity Authority states that Mr. H. F. Carpenter, F.C.I.S., F.S.A.A., will relinquish his appointment as Secretary to the Authority on reaching superannuation age (sixty in his case) in the autumn, but the Authority hopes to have the continued benefit of his experience in another capacity. The four years during which Mr. Carpenter has filled this post have been the particularly difficult and important formative period of the new nationalised electricity supply service. Mr. Carpenter, who was educated at Bancroft's School, joined the staff of the Metropolitan Water Board in 1908 and worked there for eighteen years, apart from war service in Gallipoli, Egypt and Palestine. On the formation of the West Midlands Joint Electricity Authority, in 1926, he was appointed one of the two principal officers, with the title of Secretary and Treasurer, subsequently amended to Clerk and Treasurer. Following the death, in 1938, of Mr. E. F. Hetherington, the Chief Engineer and Manager of the West Midlands J.E.A., the Authority decided that instead of two principal officers as hitherto, there should be one principal officer. Mr. Carpenter was thereupon appointed to that position as Clerk and Manager, a position he held until appointed Secretary to the British Electricity Authority. In 1947 Mr. Carpenter was President of the Chartered Institute of Secretaries and also Chairman of the Council of the British Electrical Development Association. In the former capacity he visited Australia and New Zealand to preside over the formalities and attendant ceremonies connected with the fusion with the Chartered Institute of Secretaries of the two organisations serving the professional interests of secretaries in Australasia. Mr. Carpenter's tour also embraced Canada, where he visited branches to discuss the organisation of the C.I.S.

The Glen Shira Tunnel

The last plug of rock in the 4½-mile long main tunnel of the North of Scotland Hydro-Electric Board's Glen Shira scheme, which when completed will have an annual output of 80 million units, was blown through on June 1st. The 10ft diameter tunnel, on which work started in November, 1949, will lead water from the lower dam of the scheme to the power station now under construction at Clachan. The tunnel was driven mainly from six independent faces with a maximum of ten squads of eight men working simultaneously. In November last year 245ft were driven in one face by two squads working twelve-hour shifts over seven days and in January a drive of 247ft was achieved. A total of more than 85,000 cubic yards of rock had to be excavated to complete the tunnel, an unusual point in the design of which is the inclined pressure shaft, 2060ft in length, which is the first of its kind in Britain. The shaft, which descends at the rate of 1 in 1¼, was one of the first sections of the tunnel to be started.

Transfer of Work from the N.P.L.

We learn from the Department of Scientific and Industrial Research that some of the work being done in the Engineering Division of the National Physical Laboratory is being transferred to the new laboratory of the Mechanical Engineering Research Organisation at East Kilbride, near Glasgow. The main section of the research work to be transferred is that concerned with the strength of materials at ordinary temperatures, including fatigue of materials, failures in service, mechanical design problems, gas cylinders, mechanical tests on metallic and non-metallic materials, and general mechanical testing techniques. For the time being the work on the strength of materials at high temperatures will remain at the N.P.L., but it is scheduled to move to Scotland in due course. The move involves the transport to Scotland of about 120 tons of machines and scientific equipment; this is planned to start about mid-June and will probably take about one month to complete. At the N.P.L. there are also sections of M.E.R.O. working on fluid mechanics and mechanics of formation; they will be transferred to Scotland in August. The headquarters of the Organisation, together with the Lubrication Division, the Machine Shaping Section and parts of the Mechanisms and Formation Section, have been at Thortonhall, Glasgow (a few miles from East Kilbride) for some time. From July 1st enquiries relating to the strength and properties of materials at ordinary temperatures should be addressed in the first place to the Director, Mechanical Engineering Research Laboratory, East Kilbride, Glasgow.

The Late Sir Walter Jenkins

We have learned with regret of the death of Sir Walter St. David Jenkins, a former director of Navy Contracts, Admiralty, which occurred on Thursday, June 7th, at 8, Rutland Court, London, S.W.7. Sir Walter was born in 1874 and was educated at Carmarthen Grammar School, Oswestry School and Jesus College, Oxford, where he was Meyricke Exhibitioner. He first joined the staff of the Admiralty in 1898, and from 1902 to 1906 acted as secretary to the oil fuel committee, which examined the possibilities of oil as fuel for warships. Sir Walter became Assistant Director of Navy Contracts in 1912 and in the following year served as secretary to the Admiralty Committee of the Royal Commission on Oil Fuel and Engines. In the first World War he took an important part in the work of maintaining coal supplies from South Wales to the British, French and Russian Navies, and was also Admiralty Secretary of the Railway Communications Board set up by the Committee of Imperial Defence. In 1918 Sir Walter was appointed Government director of the Anglo-Persian Oil Company, Ltd., an office which he relinquished some months later on becoming Director of Navy Contracts, Admiralty. Sir Walter retired from the Admiralty in 1936, in which year his knighthood was conferred. Following his retirement from the Admiralty he took up a number of positions in commercial undertakings in this country, among them being the independent chairmanship of the National Federation of Iron and Steel Merchants, which office he relinquished in 1944.

The Institution of Metallurgists

The annual general meeting of the Institution of Metallurgists was held in London on Thursday of last week, the retiring President, Mr. E. W. Colbeck, occupying the chair during the early part of the proceedings. The newly-elected President, Dr. C. J. Smithells, was inducted to the chair by Mr. Colbeck, and, in the course of his presidential address, stated that the membership figure now stood at 2207, compared with 1110 at the first annual meeting of the Institution in 1946. Dr. Smithells said that applications for membership were still coming in at the rate of about 200 a year, and although not all the applicants were successful, there were indications that the membership total would soon reach the 3000 mark. Later in his address, Dr. Smithells spoke about the work of the Institution, referring in particular to its examinations and the value of the qualifications conferred. He said that the holding of examinations of a standard equal to, or higher than, a University honours degree was not a simple matter to organise, and it was not until 1947 that the Institution was able to decide finally on the syllabus for each grade, appoint examiners and make all the arrangements necessary. Last year, Dr. Smithells added, 111 candidates were examined, and this year's entries numbered 155.

The South Bank Exhibition

No. VII—(*Continued from page 745, June 8th*)

Minerals of the Island

In the building devoted to showing the Minerals of the Island, a majority of the space and most of the larger exhibits are mainly concerned with the coal and iron industries; other minerals and their uses which are also dealt with include salt, limestone, clay, &c.

The fact that this country owes its position amongst the great industrial nations of the world to the development of its vast stores of coal has made it appropriate that coal, its mining, treatment and by-products are given particular prominence in the exhibition. By means of murals, working models and some actual equipment an impression is given of the historical background, working conditions, plant lay-out and the processes and equipment involved in the coal industry. A general exhibit shows a typical mine installation with the main buildings, pithead, &c., and a number of mine workings positioned in a typical landscape.

The development of coal-mining through the ages is graphically illustrated in a series of large wall diagrams. They show first the means used by early man to obtain his coal from small outcrops and the "Bell" pit mining methods of the fifteenth century, which were used to win coal from seams a few yards below the surface. The next diagrams show the seventeenth century pit with its cog and rung gin for winding coal from still greater depths, and then the still deeper mines of the nineteenth century. Finally, there is a typical deep mine of the present day with its comprehensive system of workings and handling equipment. The lack of any particular reference to the development of the steam pumping engine in this section is somewhat surprising, in view of the important part it played in the history of mining, and, indeed, most other industries, not only in this country, but in all parts of the world.

Visitors are given a good impression of working conditions at the coal face in a modern mechanised mine by one of the exhibits which shows a "Meco-Moore" cutter loader made by the Mining Engineering Company, Ltd., of Worcester. This machine, which is widely known to mining engineers, combines the functions of a coal cutter and a loader, and basically consists of a cutter unit coupled to a loader unit, which has a shear jib mounted at the end of its structure. The general construction of the machine was shown in one of the photographs on page 752 last week, and another illustration on this page shows the machine at the coal face where it is completing a working cycle.

The double motor-driven cutter unit has a gear case at one end housing the haulage gear mechanism, and a gear head at the other end on which is mounted horizontal undercutting and overcutting jibs. The loader unit projects at right angles and is detachably mounted on the cutter unit. It consists of driving gearboxes and a transverse slat conveyor combined with a rotary loading bar carried on a rigid structure having a triangular shaped shearing jib bolted on a rigid angular plate at its outer end.

Two 60 h.p., a.c. motors, used to drive the machine through gearing on the cutter head, are arranged side by side in the motor frame. One motor drives the horizontal cutting chains and the other the loading unit. The cutter chain drive is so arranged that either or both of the cutting chains may be engaged as conditions dictate. By using different heights of jib bracket the height of cut of the upper jib can be varied, the minimum height being 2ft 1in from the floor to the bottom of the picks. A modified form of gear head can be fitted which allows the height of the upper jib to be adjusted hydraulically within a limited range for use in special conditions.

The conveyor consists of an endless rubber belt fitted with steel slats and driven through chains from the sprockets on the driving shaft. A rotating loading bar which extends along the length of the conveyor frame is fitted with a series of picks arranged in double helical formation. As the bar rotates the picks pass through a comb in the leading edge of the conveyor frame and lift the bottom coal to transfer it on to the conveyor belt. These picks at the same time help to break up the bottom coal into suitable sizes for loading. It should be pointed out that the loader bar is of larger diameter than the width of the kerf cut by the lower horizontal cutter chain, and its action also serves to accelerate the fall of the coal from the cut-away sections of the face.

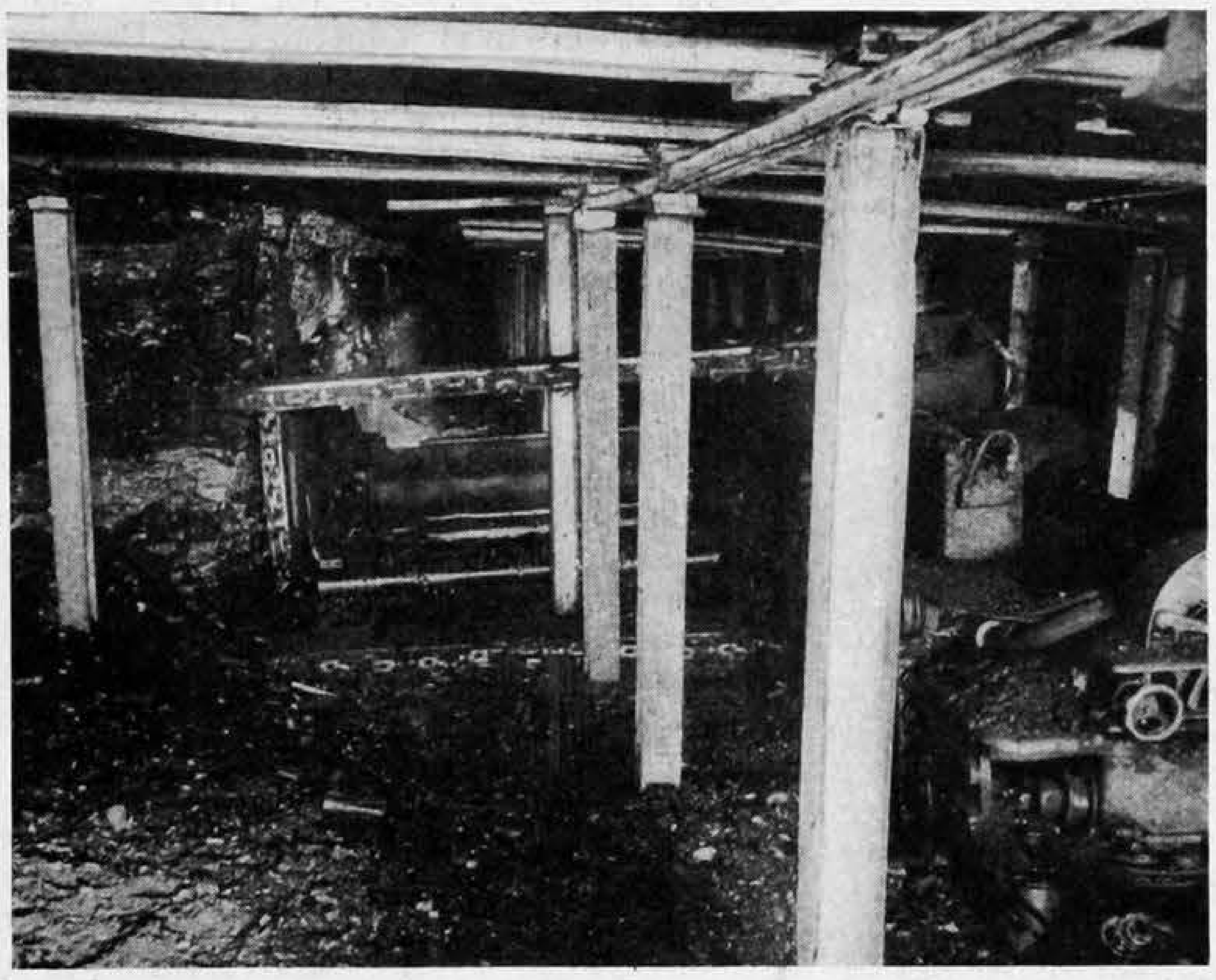
To remove fines which would tend to pack up the conveyor belt, a long worm fitted on the underside of the discharge end at right angles to the belt discharges the fines to one side, to be dealt with by one of the gummers. The gummer is a single-worm equipment, situated adjacent to the bottom cutting chain to remove the gummings and discharge them directly on to the main face conveyor.

Double-rope haulage is employed on the machine and a large-diameter haulage drum is designed to take 45 yards of ⅝in diameter rope. This haulage drum is driven through a multi-plate friction clutch, which serves both as a control and a safety device. The maximum haulage speed normally provided for the machine for cutting purposes is 27in to 30in per minute, which can be varied in steps by means of an adjustable ratchet feed to give a minimum speed of 4½in per minute. A fast flitting speed of 40ft per minute is also provided.

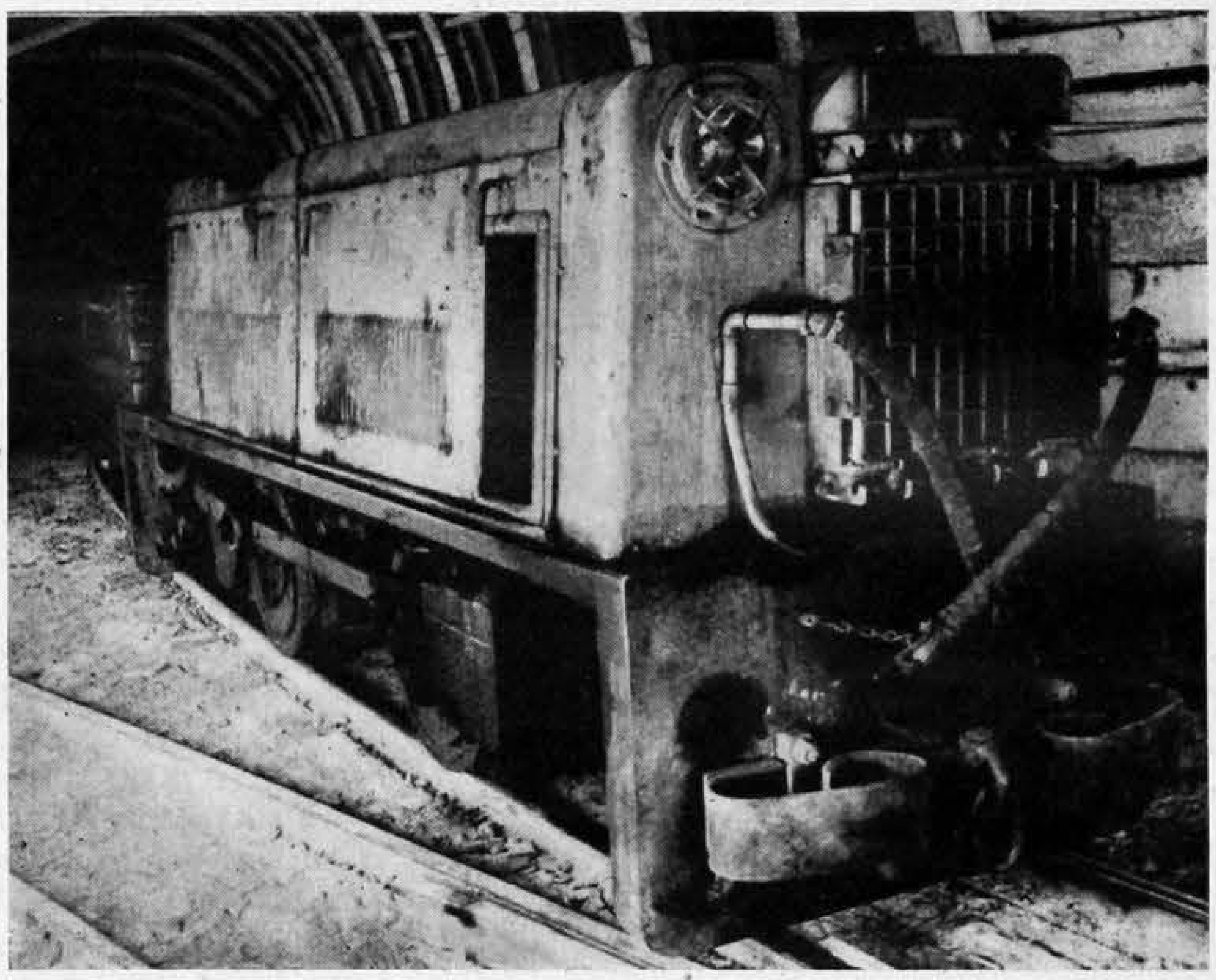
The machine is designed for working in both directions, and when it has reached the end of a run the cutting unit can be disconnected and transferred to the opposite side of the loading unit. When this reversal takes place, the shearing jib on the loading unit is also reversed to cut in the opposite direction. To make this possible the jib is mounted on a swivel joint on its supporting angle plate. By undoing the holding bolts the jib can first be swung into a horizontal position, moved through an angle of 180 deg., and then swung back into its operative position facing the opposite direction. At the same time, the driving shaft for the shearing jib is transferred to the other side of the unit. The duplication of the gummer, loading bar and loading unit gear reduce the amount of work involved when preparing the machine for return cutting.

The photograph we reproduce of the cutter loader in operation shows clearly the clean nature of the face at the end of working and the manner in which the props are set behind the machine ready for the return run. In the foreground is the "stable" in which the machine is turned.

Another coal-cutting machine displayed is a 15in "Ace" longwall cutter made by British Jeffrey-Diamond, Ltd., of Wakefield, which can be driven by either electric motor or compressed air. This machine is built up of three separate units—the haulage unit, the driving unit and the cutting unit—each of which is located on the other by



CUTTER LOADER COMPLETING A CUT



70H.P. DIESEL MINE LOCOMOTIVE

spigot-faced joints and held by high-tensile steel bolts. It is similar to a unit exhibited at Kelvin Hall and dealt with in these columns last week.

A full-scale model of a "Samson" coal stripper made by Mavor and Coulson, Ltd., is also shown in its working position at the coal face. This machine is designed as a "continuous mining" unit which strips coal off the face without prior preparation and loads it on to a conveyor.

It is a well-appreciated fact in mining operations that effective roof support is essential to efficient working and safety of the miners, and amongst the various types of supports shown in the pavilion there is to be seen the hydraulic pit prop made by Dowty Mining Equipment, Ltd., of Cheltenham, Glos. These props are, in effect, compact, self-contained hydraulic jacks so designed that at the time of setting they begin to offer a resistance of 5 tons to the roof. This resistance increases to 20 tons as the roof settles, at which stage a prop will yield whilst still maintaining the same resistance. When the limit of yielding has been reached a prop will withstand a load of 50 tons and become rigid.

The construction of one of these hydraulic props can be seen in an illustration overleaf. It consists essentially of two concentric tubes, the outer one of which forms a pressure cylinder within which slides the reservoir tube *A*. The lower end of the reservoir tube is closed by a piston head which carries a bearing ring and a sealing gland. The pressure cylinder is enclosed in a protective tubular casing.

A small pump *B* at the lower end of the reservoir is actuated by a connecting-rod *C* and a crank *D* with a square external boss on which is fitted a removable handle. Operation of the pump transfers oil from the reservoir to the chamber in the pressure cylinder to extend the prop and set it at an initial load of 5 tons.

Fluid pressure in the pressure cylinder is communicated to a "yield valve" *E* in the head of the prop through a tube *F*, and when the roof weight exceeds 20 tons this valve relieves pressure by allowing a small quantity of oil to pass into the reservoir, permitting the prop to shorten. Resistance is maintained at 20 tons and yielding continues intermittently until the prop is withdrawn.

When it is required to withdraw a prop, the release link *G*, which forms part of the yield valve assembly, is pulled and as oil in the pressure cylinder escapes back to the reservoir the prop shortens. When necessary, operation of the release link can be done from a safe distance by means of a light cable or chain.

One of the early portable power tools made available by the compressed air industry for underground mining was the pneumatic coal pick, and this class of tool has been selected as a representative product of the compressed air industry.

The pneumatic coal pick is essentially a percussive tool with an air-operated piston striking rapid hammer blows on the pick steel. Its main characteristic is the positioning of air ports to provide a "cushion" of air on each stroke of the piston. This cushion absorbs shock and enables the tool to be used without discomfort to the operator. In recent years picks have been introduced for "wet" operation as a means of suppressing dust for the prevention of silicosis. Those wet machines have an additional connection for a hose feeding water under pressure, and in most cases the air trigger controls both the air and water feed. Unlike the usual "wet" drilling tools which provide a continual stream of water to the point of drilling, the wet picks are designed to provide a "tent" of "mist" around the pick steel which effectively blankets the dust.

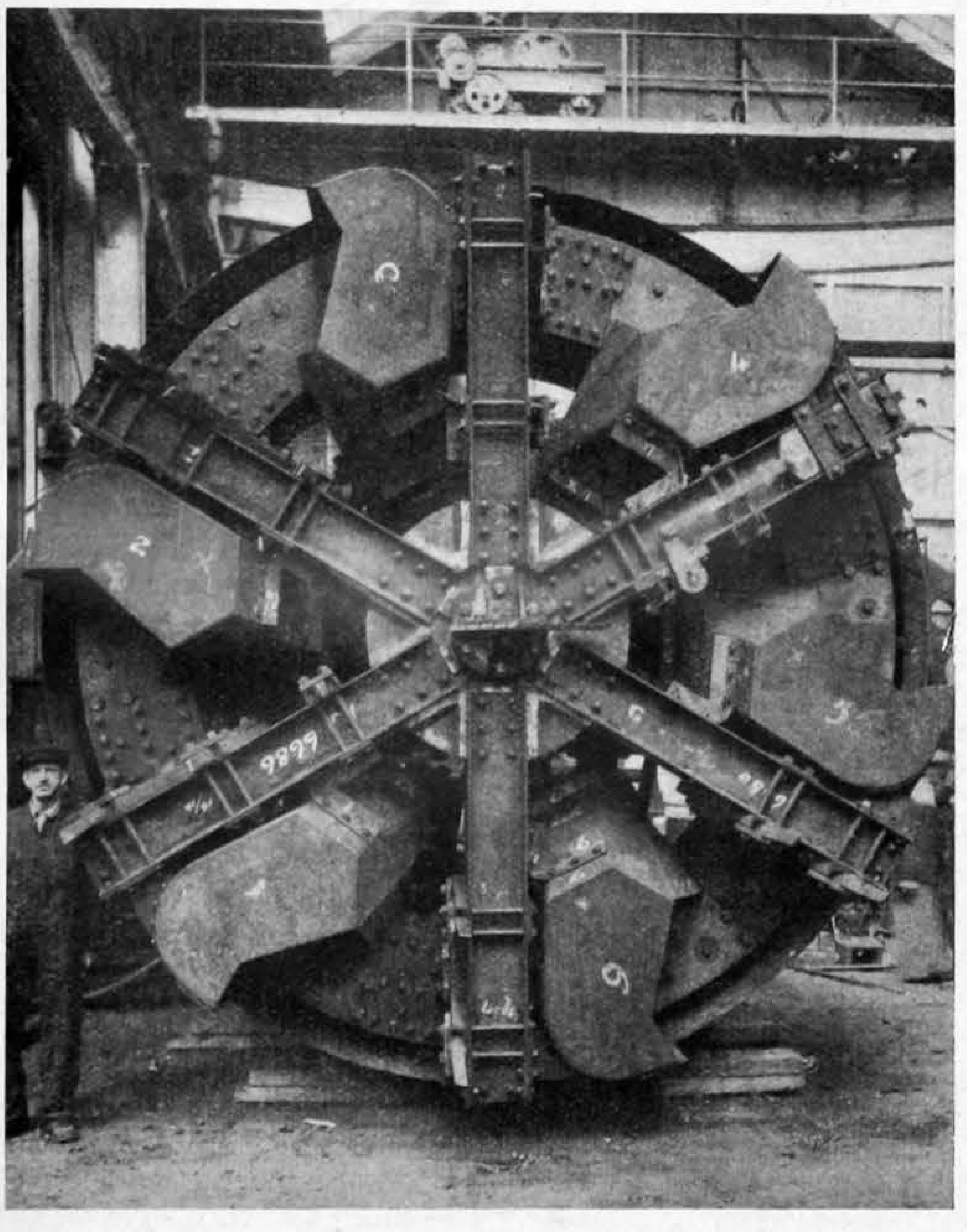
Typical examples of both the dry and wet pneumatic coal picks have been supplied by various makers to form a display arranged by the British Compressed Air Society.

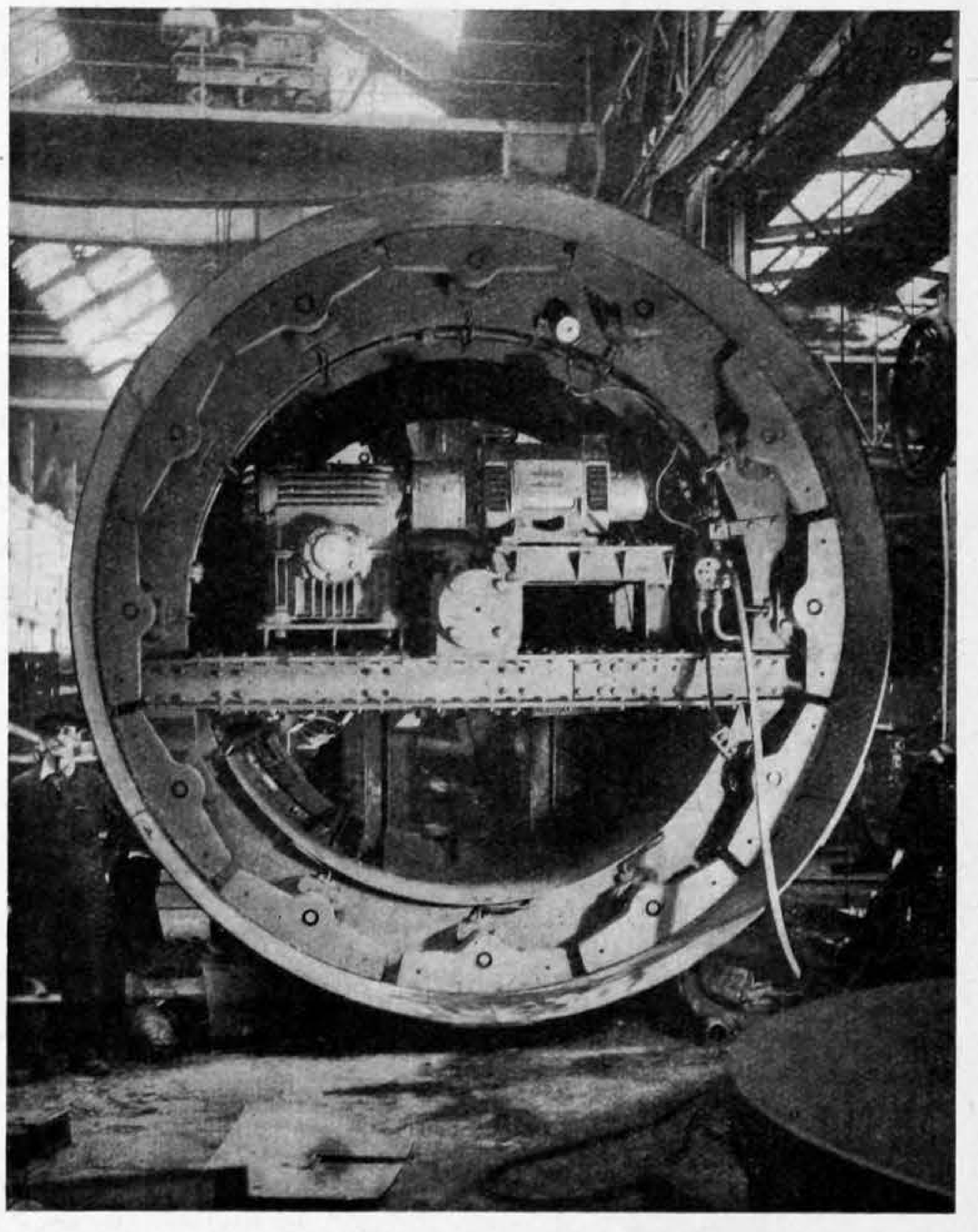
Mine haulage power equipment is represented by one of the standard 70 h.p. diesel locomotives of the Hunslet Engine Company, Ltd., similar to that shown in operation in the illustration opposite. This locomotive, which is made for gauges from 1ft 11½in to 3ft 6in, has a top speed of 14½ miles an hour, and a tractive effort of 5400 lb on bottom gear. It is one of four standard types of mine locomotives made by the company.

Power is supplied by a four-stroke, four-cylinder Meadows engine through a four-speed gearbox giving track speeds of just over 4, 6, 9 and 14½ miles an hour. A Westinghouse straight air brake and a screw-operated hand brake are fitted. The engine exhaust fumes are first passed through a water bath conditioner and then through a flame arrester before being released to the atmosphere. Unit construction and easy accessibility to all working parts facilitate maintenance and repair work on the locomotive.

In addition to these larger exhibits, various tools, mine lighting equipment, safety clothes for miners, &c., are shown.

Models and diagrammatic murals are used to show iron and steel making processes, and a group of models supplied by the United Steel Company, Ltd., show a tilting open-hearth furnace, a blast-furnace and an ore-crushing and screening plant. Various forms of steel are shown in typical applications, and a control stand illustrating the use of metals has on it a Perkins "P 6" diesel engine, a Girdlestone diaphragm pump, an Ascot gas water heater, and an electric washing machine made by the English Electric Company, Ltd.



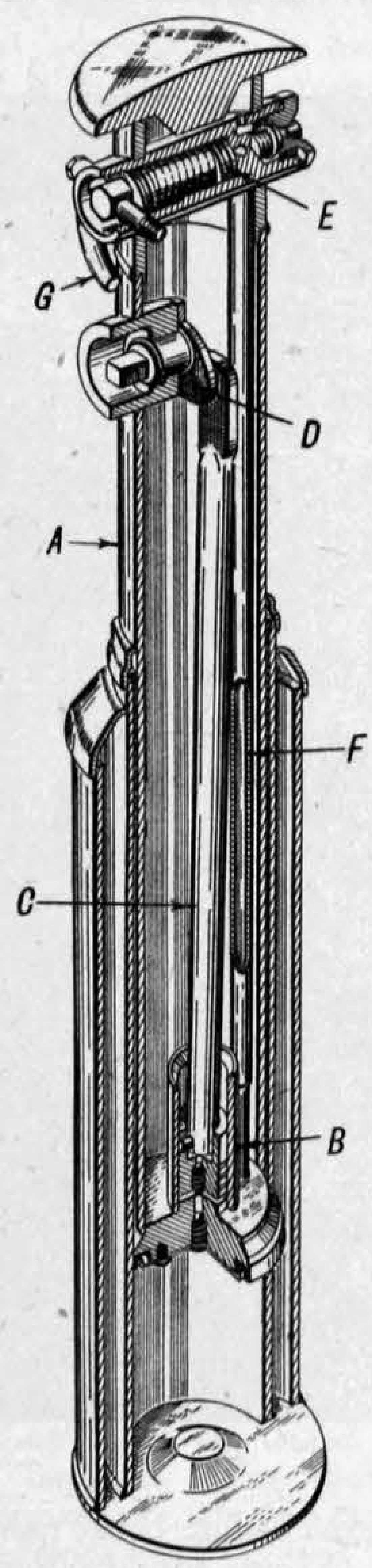


EXCAVATOR SHIELD, 12FT 3IN INTERNAL DIAMETER

Rotary Tunnelling Shield

The rotary tunnelling shield on view in one of the arches of Hungerford Bridge, adjoining the Transport and Communications Pavilion, was used before the last war to drive London Tube railway tunnels for the London Passenger Transport Board at Highgate on the Northern Line, and at Bethnal Green on the Central Line. Two of the photographs accompanying this article illustrate the shield as erected in the maker's works. It will be seen that it consists essentially of a Greathead shield embodying, in addition, a rotary cutting head which mines the tunnel face by mechanical means instead of by hand.

The shield has an external diameter of 13ft 2¾in and an overall length of 9ft 8¾in. The cutting edge and ram segments are of cast iron and the skin plates of mild steel. There are twelve 7in diameter hydraulic rams capable of exerting a total force of



HYDRAULIC PIT PROP

approximately 400 tons. The normal stroke of the rams is 20in, corresponding to the width of the segmental rings of the permanent cast iron tunnel lining, the internal diameter of which is 12ft 3in.

The operation of the rams is individually controlled by a battery of valves mounted on the shield, an arrangement which allows the shield to be steered by the use of the rams over the lagging portion of the periphery only. Hydraulic power is supplied to the rams by a compressed-air-driven hydraulic pump with cylinders 7in and 1in diameter and 7in stroke.

The rotary cutting head comprises six radial arms carrying a series of knives for breaking up the clay face. These knives are so disposed that each travels on a slightly different radius from the centre of rotation so that the whole area of the face is traversed during a complete revolution of the head. The radial arms also carry buckets which collect the excavated material and deliver it rearwards, by means of a chute and a belt conveyor, to wagons for its removal from the tunnel.

A further aid to steering the shield is incorporated in the head in the form of an eccentric cutter which can be arranged to cut wide of the cutting edge of the shield at any desired portion of the circumference, thus forming a void on the side towards which the shield is required to travel. The rotary head is driven by a 60 h.p. electric motor through a train of reduction gearing, the final speed of rotation being two revolutions per minute.

The method of operation for tunnelling is as follows. With the rams fully retracted a ring of cast iron segments 20in wide is built on the skin of the shield. The rams are then extended to bear against the leading flange of the lining and the pressure increased so as to push the shield forward into the face. At the same time, the cutting head is started and the gradual advance continued until there is room to build another ring of lining behind the shield. The rams are again retracted and the process is repeated. The time taken to advance the shield by 20in is normally thirty to forty-five minutes, depending on the nature of the ground and a weekly progress of 200ft of tunnel is readily attainable.

The exhibit at the South Bank is designed to present the shield as nearly as possible under working conditions with the cast iron lining, the shield pump and the spoil conveyor in place. The shield and the cast iron lining have, however, been specially sectioned off so as to make the working parts readily visible.

The shield and the ancillary plant are the property of Charles Brand and Son, Ltd., The shield was designed and manufactured by Markham and Co., Ltd., of Chesterfield, whilst the hydraulic shield pump was made by Hayward Tyler and Co., Ltd., of Luton, and the belt conveyor by the Mining Engineering Company, Ltd., of Worcester. The cast iron lining to be seen with this interesting exhibit has been loaned by the Stanton Ironworks Company, Ltd., of Nottingham.

(To be continued)

North of Scotland Hydro-Electric Schemes

No. III—THE FANNICH PROJECT—PART II*

(Continued from page 749, June 8th)

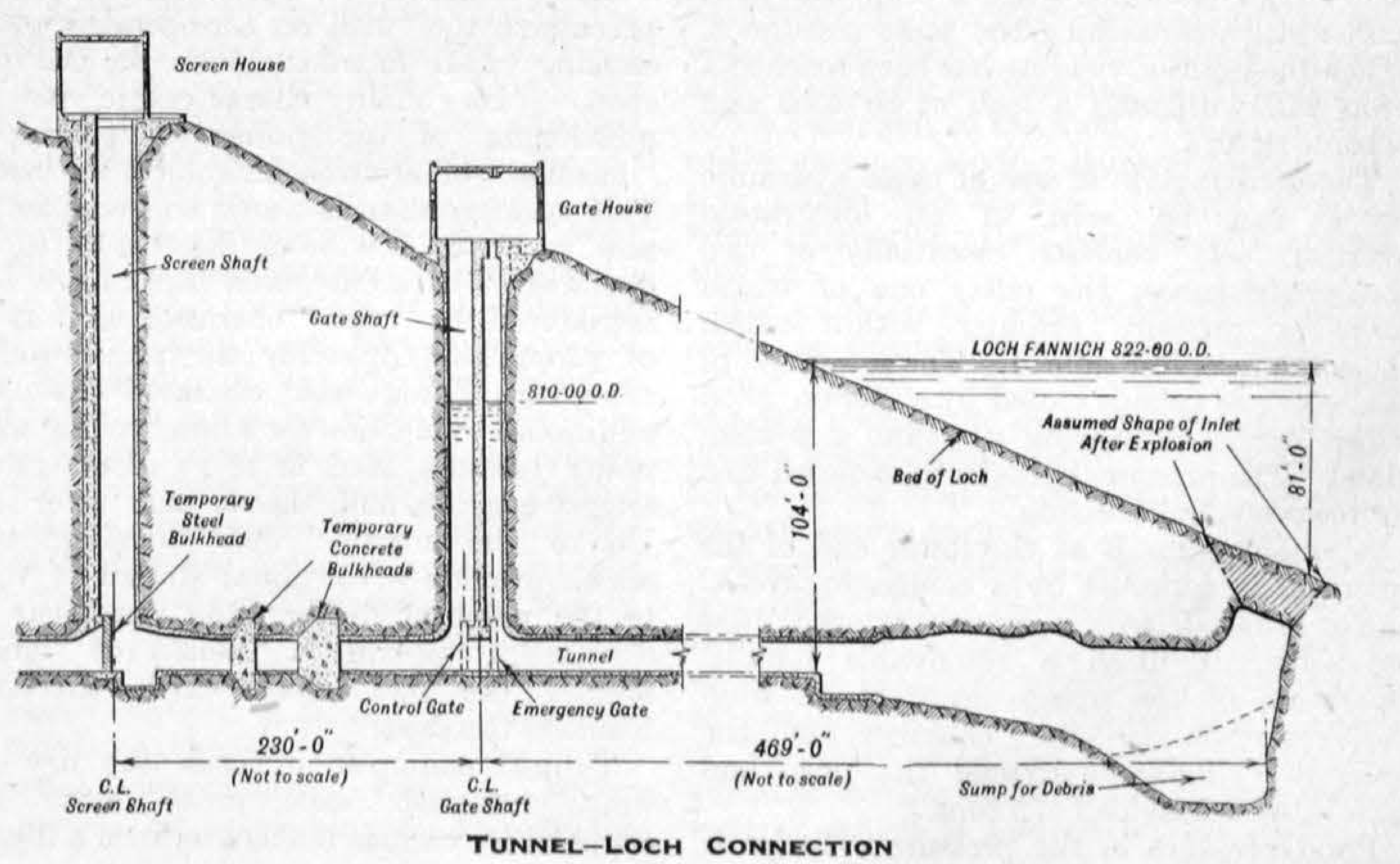
THE method of connecting the loch to the tunnel was one of the most interesting points of the Loch Fannich scheme, and involved the driving of the tunnel to within a few feet of the loch bed and then blowing out the remaining plug of rock. The completion of the tunnel was described briefly in THE ENGINEER of September 22, 1950, but for the sake of completeness the main points are again given herewith.

Reference to the accompanying diagram shows that the tunnel, which was some 90ft below loch level, was gradually driven towards and underneath the loch from the gate shaft until it reached a position as close to the bed of the loch as safety requirements would allow. After the tunnel reached this terminal point it was deepened to form a large sump, 140ft below loch level, to contain the debris from the rock plug still remaining between the loch and the tunnel. An idea of the size of the "tunnel" at this sump is given in the photograph reproduced herewith—it was 45ft deep and 17ft wide and was arranged to hold at least twice the estimated amount of rock which would fall into the sump as the result of the explosion, thus ensuring that there was no risk of the tunnel entrance being blocked with debris.

Prior to this excavation an extensive programme of scraping loose materials from the bed of the loch was carried out over the area affected, to expose the rock, the levels of which were carefully surveyed. The dredging was done by a dragline on the shore of the loch, the dragline bucket being hauled out by a winch on a barge anchored in the loch, to get the extra reach required to cover the area of the blow-through.

The 11ft equivalent diameter tunnel was driven by heading and bench to the farthest point shown. Drilling was from column bars and mucking of the bench was carried out by hand, but the enlargement was mucked by loader. The sump was then excavated with a Holman scraper. Finally, the upturned piece of excavation up to the underside of the plug was excavated and the plug drilled and charged, by filling the sump and tunnel with water to a convenient level and working

* No. I, "An Introductory Survey," appeared on July 14, 1950, page 28. No. II, "The Loch Sloy Project," appeared July 21, 28 and August 4, 1950, pages 57, 87 and 115.

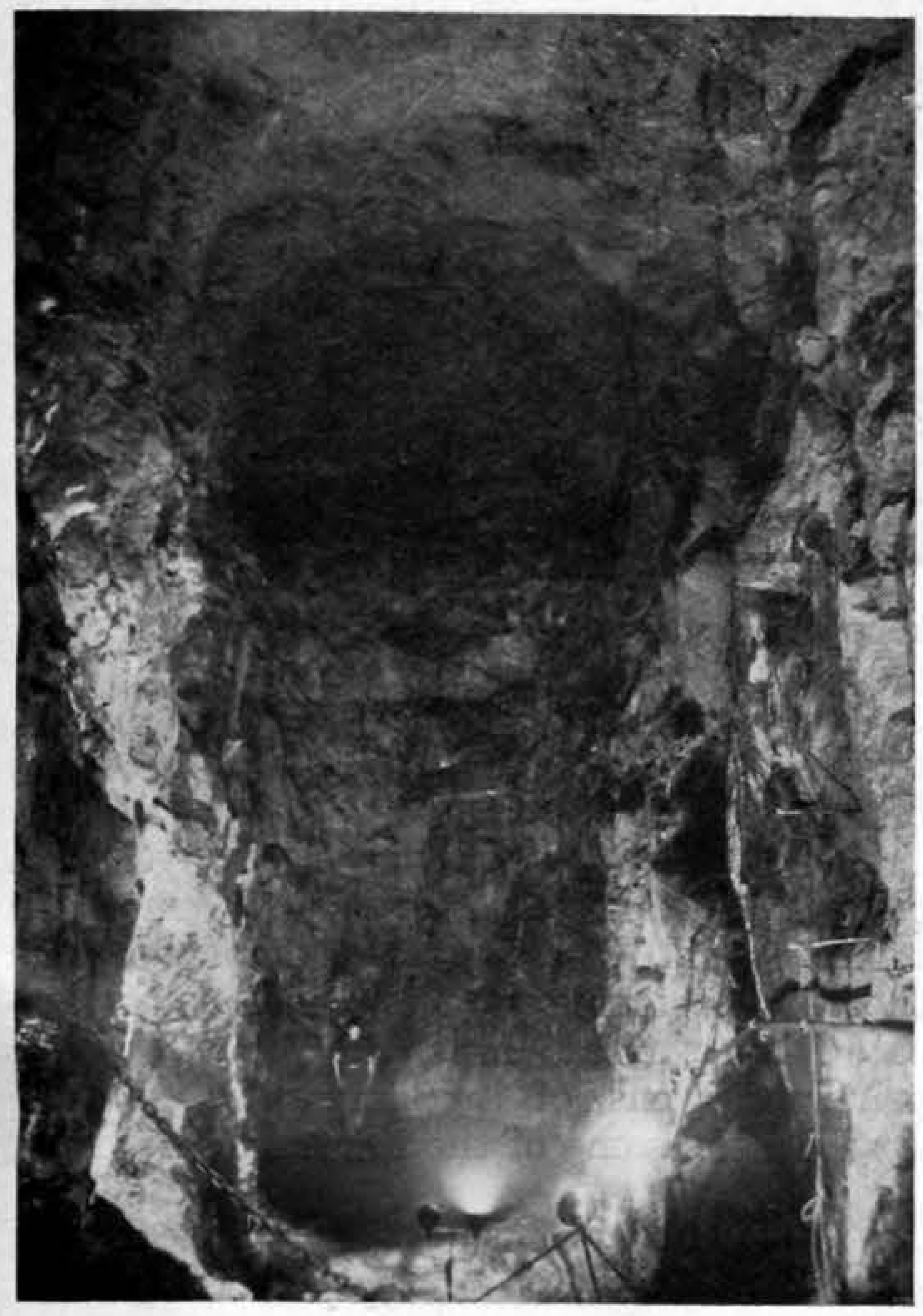


TUNNEL—LOCH CONNECTION

from a floating staging, the spoil being dropped in the sump.

The spoil from the tunnel and sump had to be double handled at the bottom of the gate shaft into a special skip designed to fit the main control gate compartment. Temporary guides were fixed in the gate shaft for this skip and a timber crib, lined with steel plate, was built at the top to guide the skip into the shaft. The emergency gate compartment was used for ladder access and for the usual service pipes.

Great care was taken as the work progressed and a number of exploratory diamond



SUMP AT TUNNEL–LOCH CONNECTION

drill holes about 70ft long were drilled ahead of the tunnel to confirm the accurate survey which had been made of the loch bed at this point. On two or three occasions these holes encountered water-bearing fissures, which were grouted up, thus keeping the working as dry as possible.

It was decided to leave a thickness of 15ft of rock as a minimum, and this plug had over 100 holes drilled into it, each terminating about 2ft from the loch bed. The amount of rock blown by the explosion was about 400 tons. Again, in removing the last stage of excavation up to the plug, exploratory holes were drilled through to the rock and then plugged with tapered wooden plugs. The plugs were pushed into the holes to the required depth by a small pipe and then tapped with a bar placed inside the pipe to expand the wedge.

Having thus proved the position of the loch bed, the last excavation was taken out in easy stages. Probably the most noteworthy point about the work was the soundness of the rock, and the leakage into the tunnel was, considering the circumstances, remarkably small throughout the work.

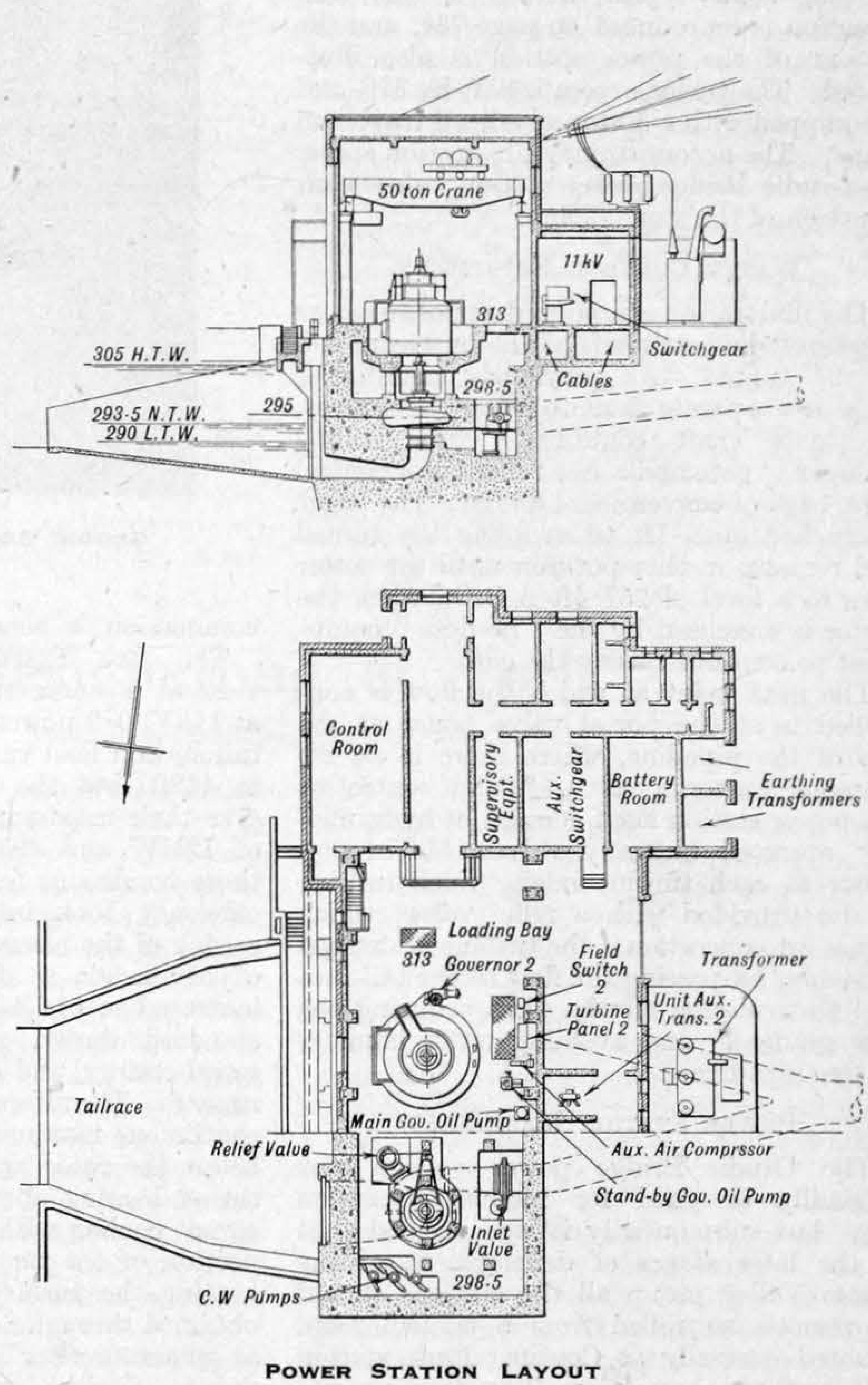
The plug was drilled with 102 holes spaced at about 1ft 6in centres across the surface with nine holes at the centre forming a burn cut. The charge totalled just over 2000 lb and the face was divided into five sectors, each sector being separately initiated and connected so that the firing of one initiator would ensure the firing of the remaining four. As far as could be ascertained the tunnel, after the underwater explosion, followed very closely the assumed lines.

To minimise the effect of the explosion on the tunnel structure itself, and to avoid a dangerous inrush of water from the loch, the tunnel from the gate shaft towards the loch was filled with water, as may be seen from the diagram, to a level some 12ft below the level of the loch. This negative head encouraged the debris to fall back into the sump. It was estimated that the force generated by the explosion would be of the order of 120 tons per square foot. The diagram shows the three protective bulkheads which shut off the tunnel from the loch and resisted the force of the explosion.

No 1, nearest the loch, consisted of a concrete plug containing 85 tons of concrete. A second concrete bulkhead, 6½ft thick and containing 40 tons of concrete, was provided 36ft from the main bulkhead. If for any reason the instantaneous explosive shock pressure of nearly 10,000 tons on the face to No. 1 bulkhead had caused it to fracture, then No. 2 bulkhead would have come into play. In addition to these two concrete bulkheads a third and final emergency bulkhead was provided, consisting of steel joists placed at the bottom of the screen shaft. In fact, the concrete bulkheads were undamaged by the explosion and were demolished, using a "Siskol" cutter, after completion of the blow-through.

PIPE-LINE

It will be recalled that downstream from the surge shaft the tunnel is circular in cross section and of 9ft diameter, the last 400ft before the portal being steel-lined. From the tunnel portal there is a single steel pipe-line, 8ft in



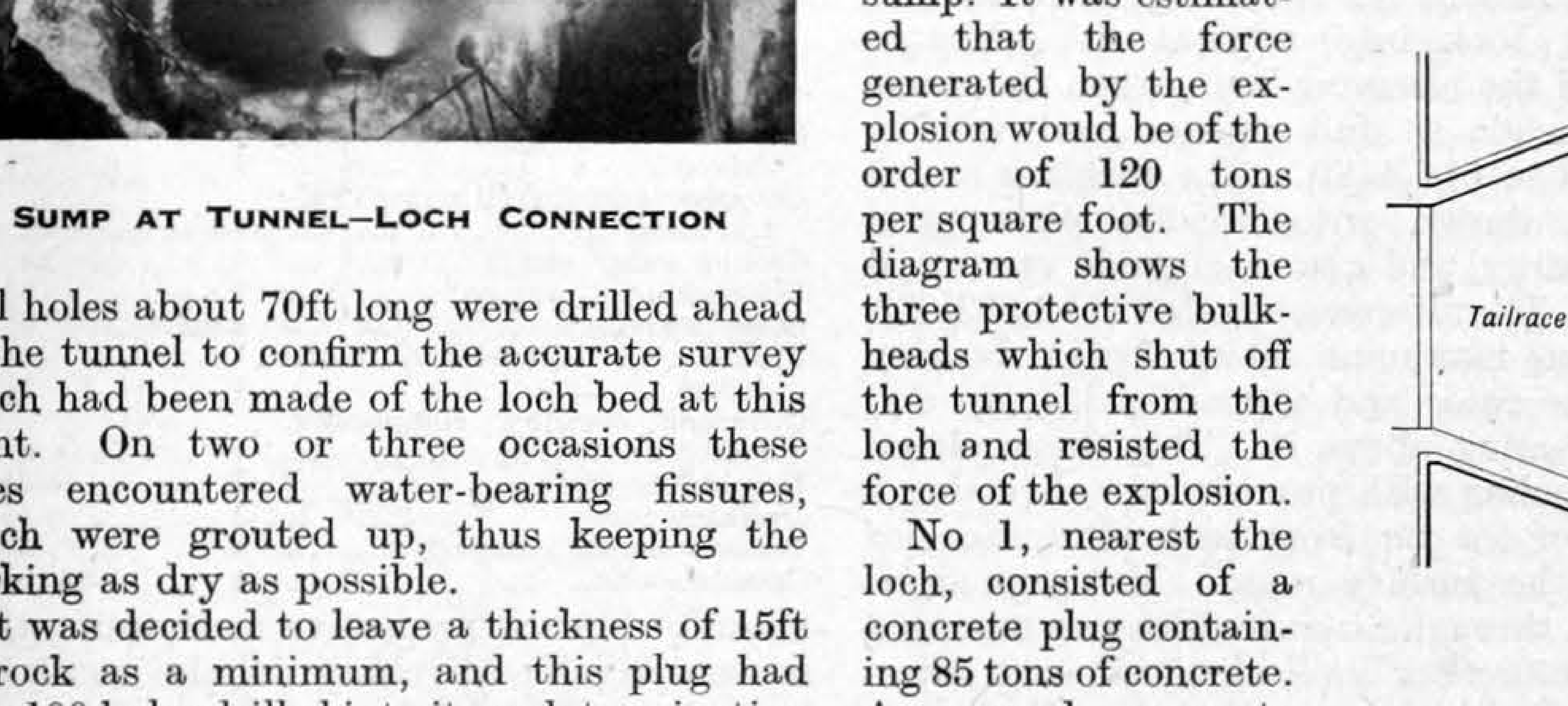
POWER STATION LAYOUT

diameter and about 100ft long, leading to the valve house. The pipe-line continues from the valve house with an external diameter of 7ft 10in, reducing to 7ft 6in at about halfway to the bifurcation, which is close to the power station and some 1400ft from the valve house. From the bifurcation a 5ft 6in diameter pipe leads to each of the two machines.

There are four intermediate anchor blocks between the portal and the bifurcation, with a stuffing box expansion joint just below each one. The pipes are 24ft long and joined by double riveted cover straps. They rest on sliding bearings. A service rail track was laid beside the pipe-line for erection. Each pipe was carried on this track up the hillside from the storage yard by the power station, and then carried down by a transporter on the pipe-line centre line, to be laid in position.

POWER STATION

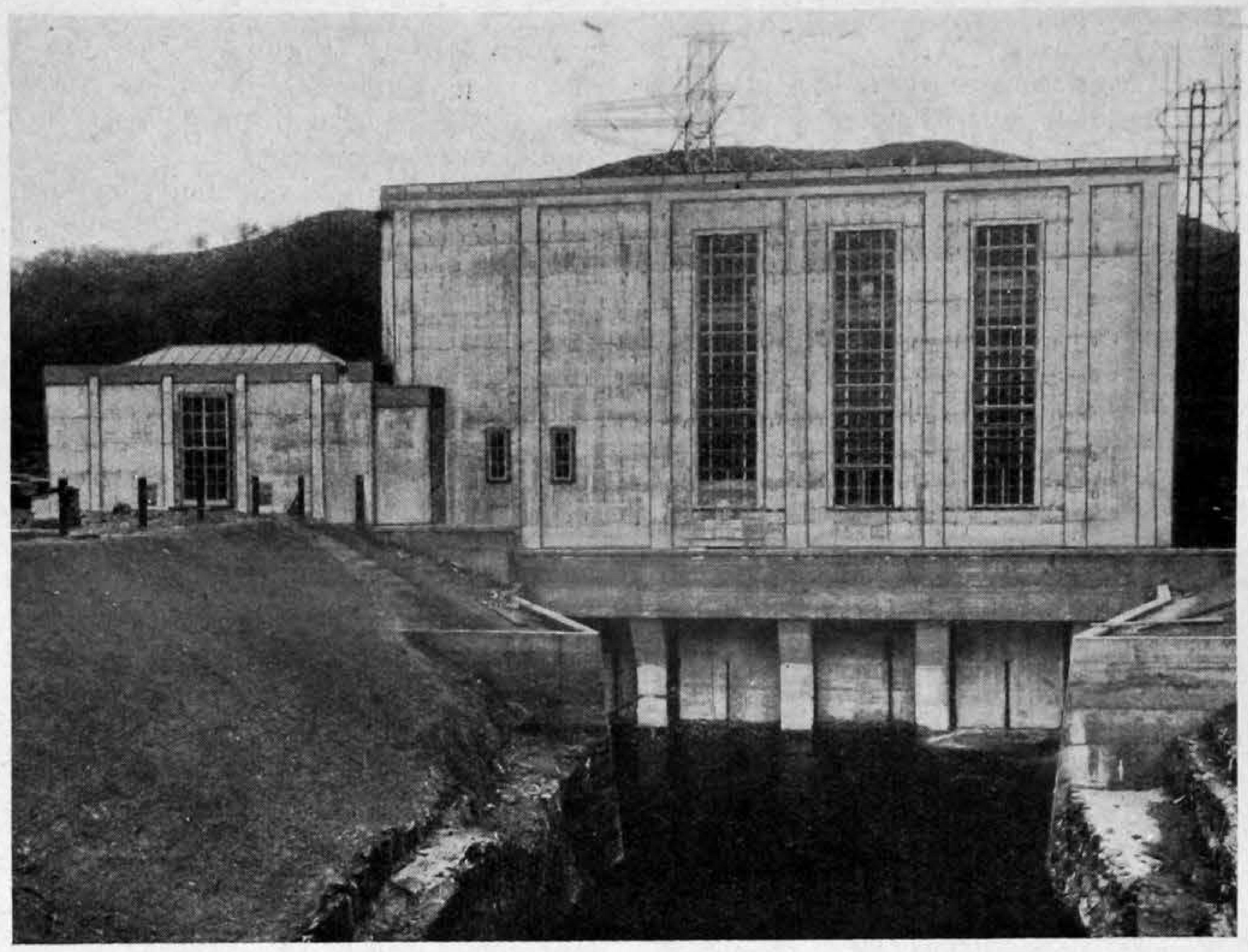
The power station is a steel-framed reinforced concrete structure faced with local stone. During construction the River Grudie was diverted through an open channel, constructed of precast reinforced concrete elements, which were later recovered for re-use.



ALTERNATOR FOUNDATION BLOCK

A reinforced concrete bridge of 60ft span has been constructed across the tail-race to replace an old stone arch bridge, and the structure for a fish-heck has been built just below it.

The two 12MW turbo-alternators are vertical Francis turbine sets. Each alternator rests on a massive reinforced concrete frame, consisting of a slab supported on six columns spaced around the well between the turbine and the alternator. A cross section showing some typical details of this construction is reproduced on page 781, and the lay-out of the power station is also illustrated. The turbine room is 85ft by 37ft and is equipped with a 50-ton overhead travelling crane. The accompanying illustration shows the Grudie Bridge power station before construction of the stone facing.



GRUDIE BRIDGE POWER STATION BEFORE CONSTRUCTION OF STONE FACING

WATER CONTROL EQUIPMENT

The illustration reproduced opposite shows details of the gate shaft at the upstream end of the tunnel. As previously mentioned, there is a separate shaft to house the screens. The gate shaft contains a tube rolling emergency gate and a free roller main control gate, both of conventional design. The latter is cracked open 1ft when filling the tunnel and remains in that position until the water rises to a level of 757·4ft A.O.D., when the motor is energised by the "no-flote" equipment to continue raising the gate.

The next point at which the flow is controlled is at the portal valve house at the top of the pipe-line, where there is an 8ft diameter butterfly valve. Water control at the power station itself consists of hydraulically operated butterfly valves, 5ft in diameter at each turbine inlet. Each turbine is also provided with a relief valve, which comes into operation if the turbine is stopped suddenly, by-passing the flow to the tail-race and then closing slowly, thus reducing the flow gradually and avoiding water hammer in the pipe-line.

POWER STATION MACHINERY

The Grudie Bridge power station was originally designed for manual operation only, but subsequently it was decided that in the later stages of development of the Conon Valley group all the stations should be remote controlled from a control room situated centrally at Contin. Each station will, however, have a small operating room, from which it can be manually operated if desired, and the Grudie Bridge power station, being the first of the group to be put into commission, is being so operated at present.

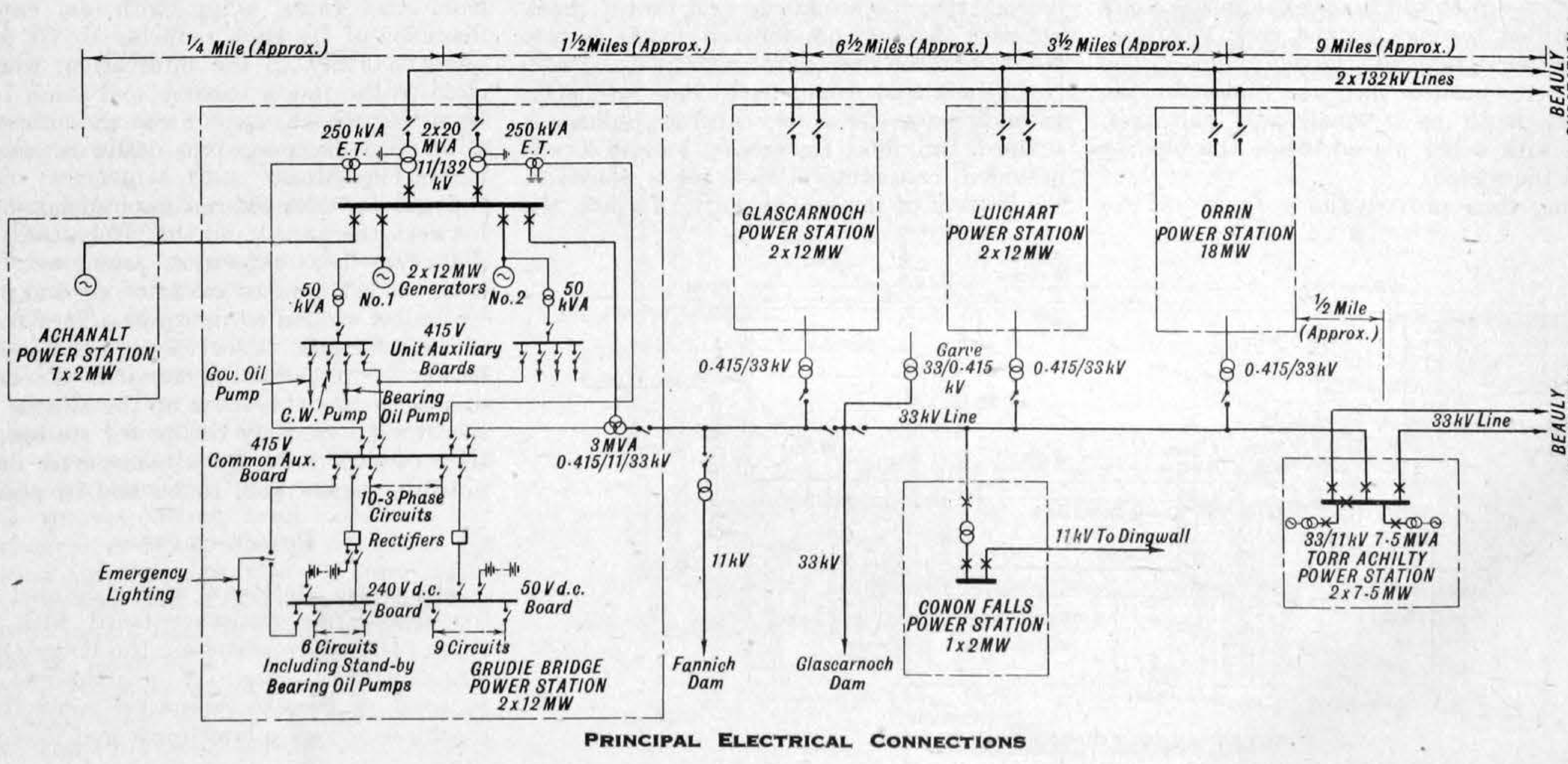
The two 12MW, M.C.R., 500 r.p.m., vertical Francis turbo-alternators generate at 11kV, 0·9 power factor. The net head at full station load varies at present from 480ft to 448ft, but the turbines are designed to give their maximum efficiency at an output of 12MW and 495ft head. The choice of those conditions for the designed maximum efficiency took into account the ultimate raising of the reservoir level, when the range of net heads at full station load will be increased to 514/448ft. The turbines are of standard design with welded plate steel spiral casings, and cast steel guide vanes and runners. The alternators, rated at 13,333kVA continuous maximum, have a guide bearing below the rotor and a combined guide and thrust bearing above it. They have closed circuit cooling with provision for diverting a portion of the air from each alternator for heating the turbine room. Make-up air is obtained through filters and louvres mounted at generator floor level alongside each alternator. Cooling water, both for the alternators and the main 11/132kV, ON/OFW, step-up transformers, is pumped from and returned to the tail-race by three electrically driven pumps, one being standby to either of the other two.

The power station auxiliaries of any hydro-electric station are relatively small in number and capacity as compared with those in a steam power station, as is indicated by the accompanying table of the principal items of auxiliary plant in the station. As some of the items are, however,

	No.	Capacity of each, h.p.
Governor oil pumps, electrically driven...	2	$7\frac{1}{2}$
Governor standby oil pump, Pelton wheel driven	1	12
Cooling water pumps ...	3	24
Lubricating oil pumps...	2 a.c.	$3\frac{1}{2}$
Ditto (standby) ...	2 d.c.	5
Brakes, air compressor, motor driven...	1	$1\frac{1}{4}$
Governor standby compressor, Pelton driven ...	1	5
Dewatering pump...	1	$7\frac{1}{2}$
Drainage pump ...	1	$1\frac{1}{2}$
Transformer oil pumps	4	5
Crane motors...	4	85 (total)

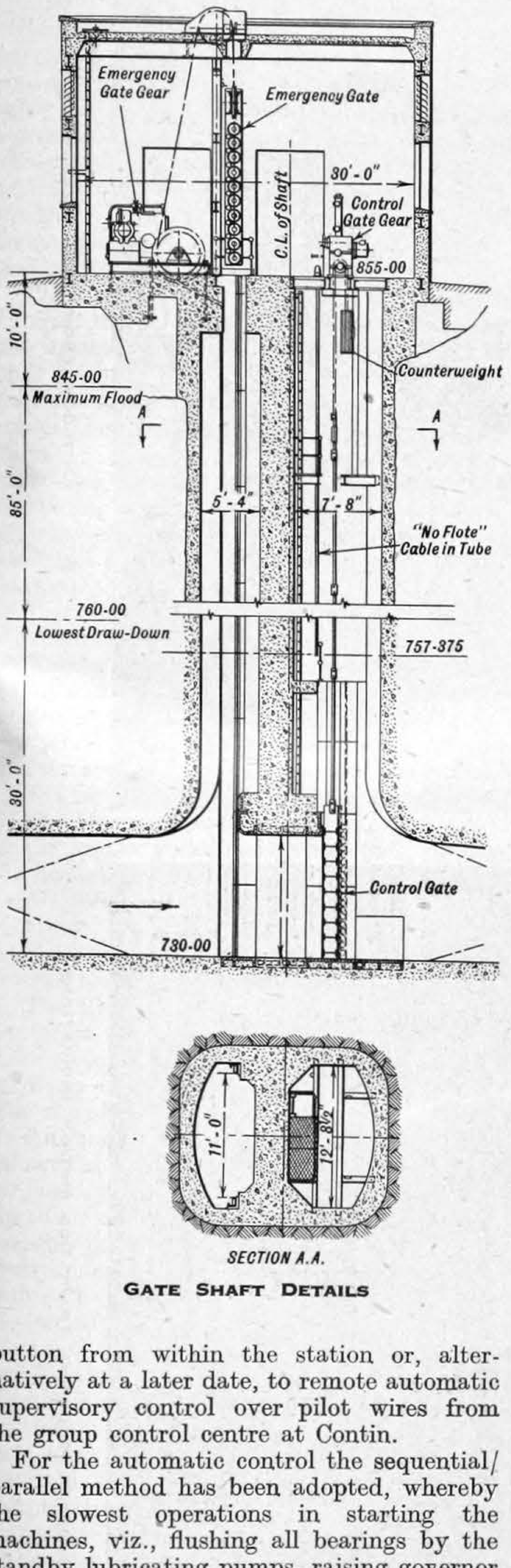
standby to their respective main units, there is considerable diversity in the total connected auxiliary load.

The auxiliaries are arranged and supplied on the unit auxiliary system in a similar manner to the auxiliaries of the Clunie and



PRINCIPAL ELECTRICAL CONNECTIONS

Pitlochry power stations, and the starting of the machines when performed manually is also similar. A diagram of the main electrical connections, which also shows the method of supply of the auxiliaries at the station, is given in the illustration opposite. Provision is made on the turbine control panels for changing over from manual to either local automatic control by push



GATE SHAFT DETAILS

button from within the station or, alternatively at a later date, to remote automatic supervisory control over pilot wires from the group control centre at Contin.

For the automatic control the sequential/parallel method has been adopted, whereby the slowest operations in starting the machines, viz., flushing all bearings by the standby lubricating pumps, raising governor oil pressure, and the opening of the turbine inlet valves, are carried out in parallel as a first stage, thus minimising the overall starting time. Pressure switches and flow relays on the oil systems and limit switches on the inlet valves indicate that the first stage is complete and control the opening of the turbine guide vanes in the second stage. When a machine has run up to speed the normal lubricating and governor oil pumps take over automatically from the standby pumps and the final stage of the sequence includes proof of delivery from the normal pumps coupled with operation of a voltage relay energised by the pilot exciter when the alternator has developed full voltage. At this stage a signal is transmitted to the control room that the machine is ready to be synchronised, which, together with loading, is at present done from the local control room and will in the future be by remote control from the group control centre. Provision is made that if any of the various individual operations in the starting sequence fails an alarm is given, the whole operation is cancelled, the machine returned to its normal shut-down position, and a signal transmitted to the control room that the machine has failed to start.

The output of the station is taken by two single-circuit steel-tower, 132kV, S.C.A., overhead lines to a new 132kV substation constructed at Beauly, 9 miles west of Inverness. The outputs of the other stations of the group, with the exception of Torr Achilty, will also be fed into these lines, as shown in the illustration. The output of Torr Achilty power station is to be taken by an existing 33kV line, which transmits the power from Conon Falls power station to Beauly. This line will be duplicated between Torr Achilty and Beauly, and it has been extended in the reverse direction up the Conon Valley to Grudie Bridge to provide an alternative means of disposing of part of the output of that station and also to give a standby source of auxiliary power to all the stations of the group. It will be used initially for providing power supply for the various civil engineering works on the construction sites.

The consulting engineers responsible to the North of Scotland Hydro-Electric Board for the Fannich project were Sir Alexander Gibb and Partners, for the civil engineering, and Messrs. Merz and McLellan for the electrical and mechanical work. The architects were Messrs. James Shearer and Annand, and the various contractors are given below.

Civil engineering contractors:—Tunnel, Balfour, Beatty and Co., Ltd.; pipe-line, Mechans, Ltd.; power station building, J. Bissett and Sons, Ltd.

Electrical and mechanical engineering contractors:—Turbines, The Harland Engineering Company, Ltd.; governors, The Woodward Governor Company; inlet and relief valves, Glenfield and Kennedy, Ltd.; water pumps, The Harland Engineering Company, Ltd., Drysdale and Co., Ltd.; oil pumps, Mirrlees, Bickerton and Day, Ltd.; compressor, Broom and Wade, Ltd.; alternators and exciters, Bruce Peebles and Co., Ltd.; turbine-house crane, Sir Wm. Arrol and Co., Ltd.; 11kV and auxiliary switchgear, A. Reyrolle and Co., Ltd.; main and auxiliary transformers, Bruce Peebles and Co., Ltd.; 11kV cables, Standard Telephones and Cables, Ltd.; lighting, heating and auxiliary cabling, Matthew Hall and Co., Ltd.; alarm and relay system and automatic control equipment, Standard Telephones and Cables, Ltd., Contactor Switchgear, Ltd.

Resignalling at York

No. II—(*Continued from page 751, June 8th*)

THE particular example taken for detailed description of the working is that of the subsidiary route 109–8, leading to the ground shunt signal No. 76, in which seven pairs of points are involved. The opposing signals, as will be seen from the track diagram, Fig. 7 in last week's issue, are 77 and 102, and all the routes concerned with these signals must be proved normal before route 109–8 can be set up. The circuits concerned are shown in Fig. 12 (*a*) to (*e*). At the commencement, as can be seen from Fig. 12 (*a*), the normal lock relay of route 109–8 is energised, but the turning of the thumb switch from normal to reverse energises the reverse lock relay, providing that the lock relays of all opposing and conflicting routes are proved normal.

The next diagram, Fig. 12 (*b*) shows how, the setting of a pair of points is effected, after the route relay concerned, such as "109–8 Lock Relay reverse," has been energised. To enable any pair of points to be operated individually in case of emergency separate point switches are provided on the control panel. Normally these point switches remain in the centre or route-setting position and the point relay is de-energised until the relay of one of the routes requiring the particular points set is reversed. The circuit necessary to hold points 473 normal is taken through normal contacts of the relays of all routes requiring 473 points reversed, through the reverse contact of any one route requiring 473 points normal, and through the centre position contact of the emergency point switch on the panel. A similar circuit is used for setting points 473 to reverse, and the alternative circuits for individual point setting will also be noted. There are also the usual track circuit controls.

After all points in the route are set, and detection is made, a circuit is completed through appropriate contacts of all the point indication relays concerned, through the point lock relays, and through the route relay to energise the control relay of the signal concerned, in this case No. 109. In practice the time taken for a route of twelve or fourteen pairs of points to be set and the signal to be cleared is about five seconds. The matter of holding the road once a route is set up is one of great importance; on reference to Fig. 12 (*a*) it will be seen that restoration of the route to normal, by energisation of the normal route lock relay, is controlled by the approach locking stick relay, and the control circuit for this relay is shown in Fig. 12 (*d*). The reason for this apparently elaborate control is to prevent a signalman changing his mind and initiating a reversal of any points in a route while a train is approaching.

The stick relay 109 ALS is controlled directly over de-energised contacts of both main and subsidiary signal control relays, and so will drop away if either of these signals is cleared. If a signalman should restore the route switch to normal before 181 track circuit becomes occupied the stick relay would pick up again as soon as the signal control relay became de-energised. The route relay would then restore to normal and any points on the route would be freed. If the route switch should, however, be restored to normal as a train is approaching signal 109 and track circuit 181 is occupied, then the direct circuit for energising the stick relay will not be available, but an alternative will be made up after an interval sufficient to ensure that the approaching train has come to a stand at signal 109. This time interval is provided for by use of a thermal unit TH, which is heated by passage of current via the circuit made through a de-energised contact of the approach lock stick relay 109 ALS. When the thermal contacts close the time element stick relay JS is energised, and is held energised by the stick circuit over one of its own front contacts. Current to the thermal unit is then cut off, and through a de-energised thermal contact a feed is provided to pick up the approach lock stick relay 109 ALS once again.

It will be seen from Fig. 12 (*d*) that, in normal working, relay 109 ALS is energised after the train has cleared track circuit 182. This does not, however, represent the full extent of the route, and the points in the route not yet held by direct track locking—

RAILWAY SIGNALLING INSTALLATION AT YORK

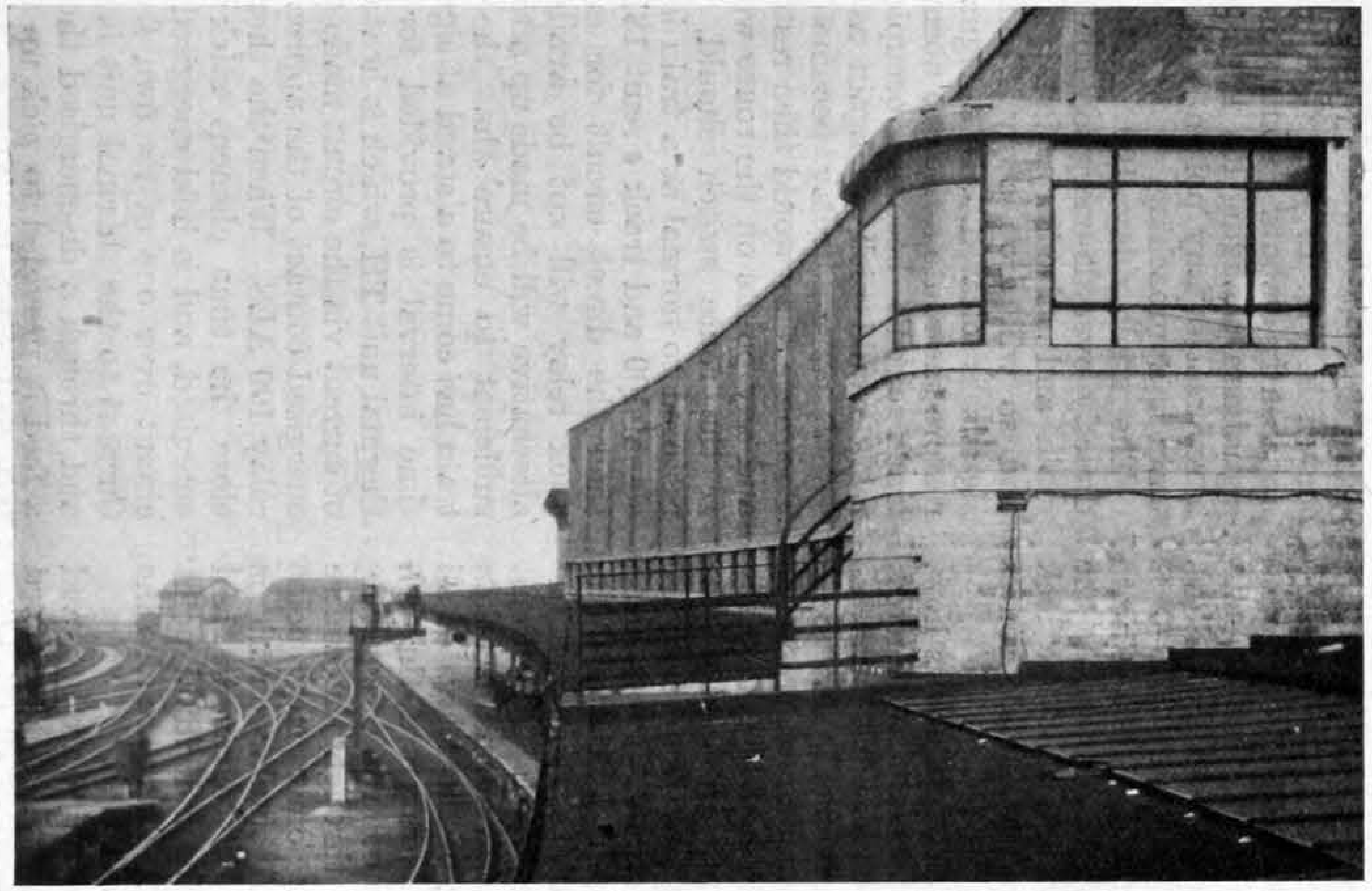


FIG. 8—NORTH END OF STATION

FIG. 9—RELAY ROOM

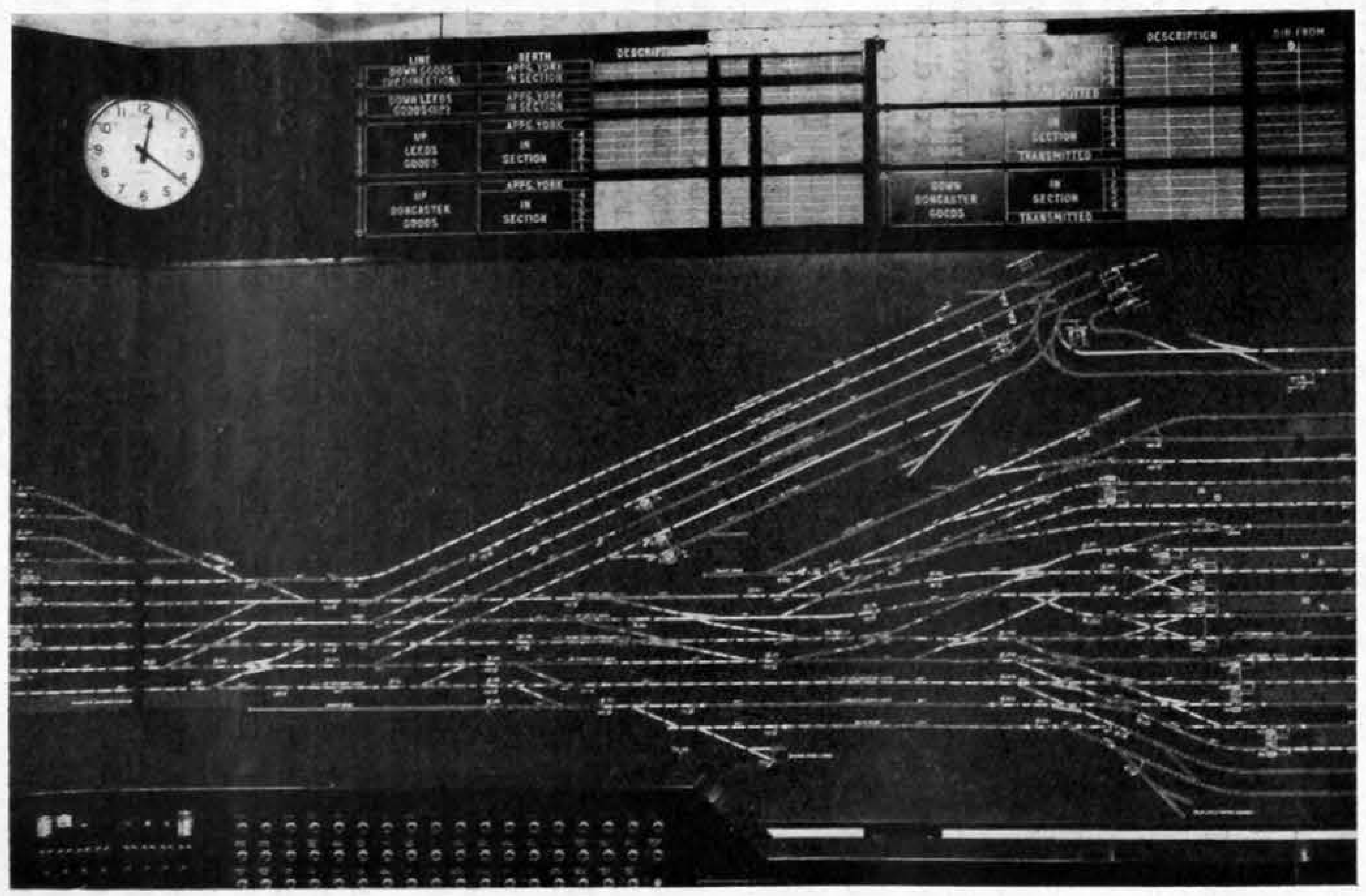


FIG. 10—PANEL DETAIL SHOWING TRAIN DESCRIPTION INDICATIONS

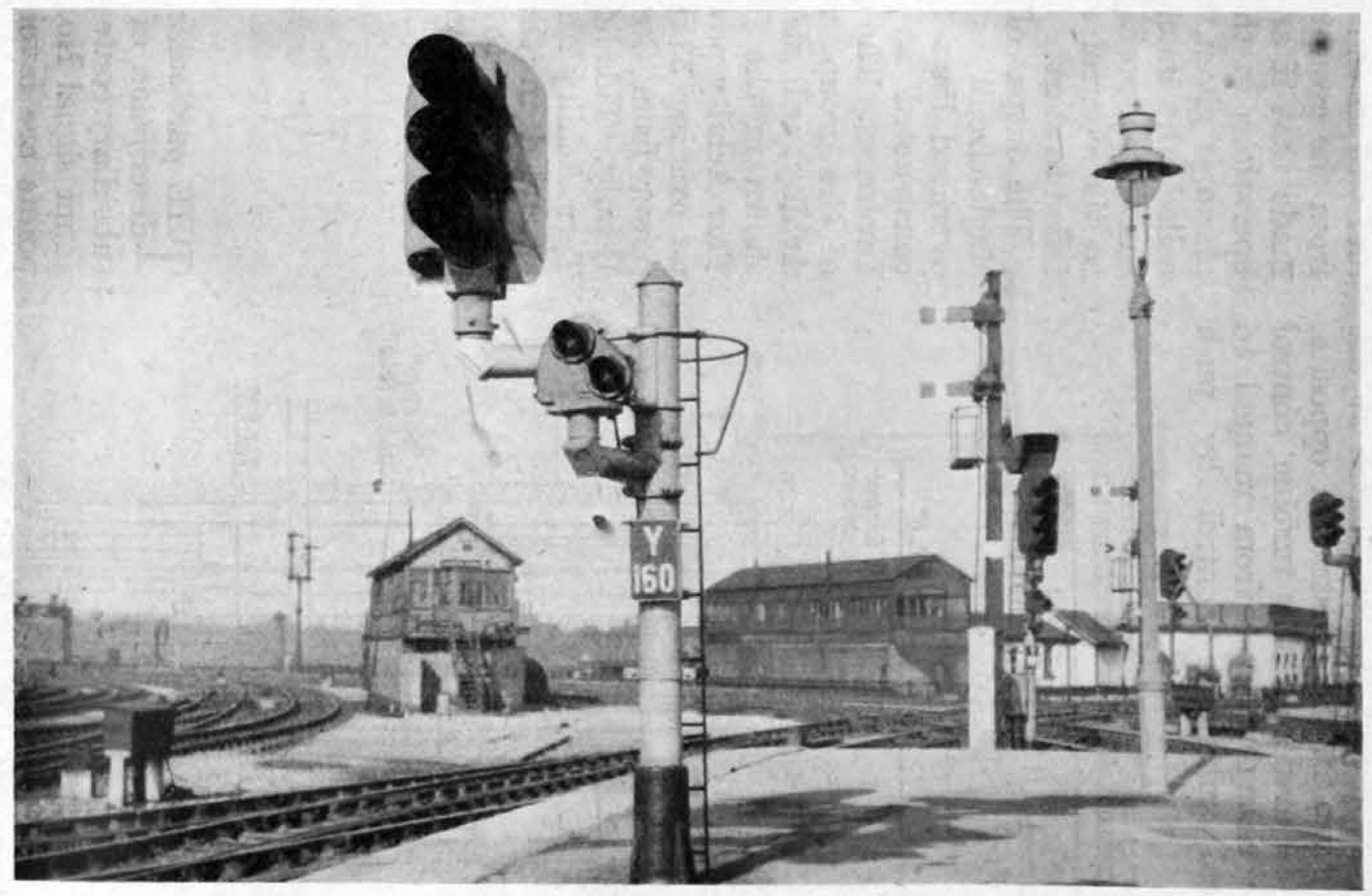


FIG. 11—OUTLOOK FROM NEW SIGNAL-BOX

through the presence of the train—have still to be held. This is accomplished by use of a sectional release route relay (US), the control circuit for which is shown in Fig. 12 (*e*). This relay is de-energised as soon as the route relay 109–8 is cleared; it is prevented from picking up again by the control circuit being taken through front contacts of the track circuit relays 169 and 154. The train would have entered upon 169 before 182 clears, and similarly 154 would be entered before 169 clears. Thus the US relay is held de-energised during passage over the whole route, while the early release of the route relay 109–8 permits the setting up of other routes over that part of the track cleared by the moving train. As at Northallerton, when a route is set up its extent is indicated on the panel diagram by a series of white lights, as shown on the photographic illustration Fig. 13.

The routes associated with 109 signal are typical, and do not by any means represent the upward limit in the number of functions that are operated by one route switch. The two centre roads in that part of the station under the great arched roof, between platforms 8 and 9, are signalled for either-direction running and, in the northbound direction, routes extend from the "home" signals on the Holgate bridge gantry to starting signals at the north end of the station.

The control panel is remarkably compact considering the extent and complexity of the signalling it controls; there are 827 routes in all and the switches for these are mounted on the sloping keyboard, as shown in Fig. 14. Switches for individual operation of the points are mounted on the vertical portion of the instrument. Their uses are as follows:

(1) For maintenance purposes;

(2) As the points are "stay put" it may be necessary to reverse them to free a route;

(3) Where there is conditional locking between two routes the use of the point switch may be necessary to enable both routes to be used simultaneously.

The illuminated track diagram, owing to its great size, is set a little way back from the control instrument itself, in order to provide a better view of the indications for the signalmen.

An innovation on the panel is the provision above the point switch of a third lamp giving a flashing indication, which is illuminated in the event of the point detection being lost or the position of the points being out of correspondence with the point lock relay for more than a few seconds. This facility has been provided (along with the route lights) to assist the rapid location of a point failure, such as that caused by an obstruction in the switch blades.

Within the York control area block working has been abolished, and the signalmen are advised of the class and route of approaching trains by means of train description apparatus. The indications provided by this apparatus are displayed above the illuminated diagram. The control room of the signalbox is provided with look-out platforms, so that the traffic regulator may observe the working in the station. Generally, however, reference to the illuminated diagram is enough for all working purposes.

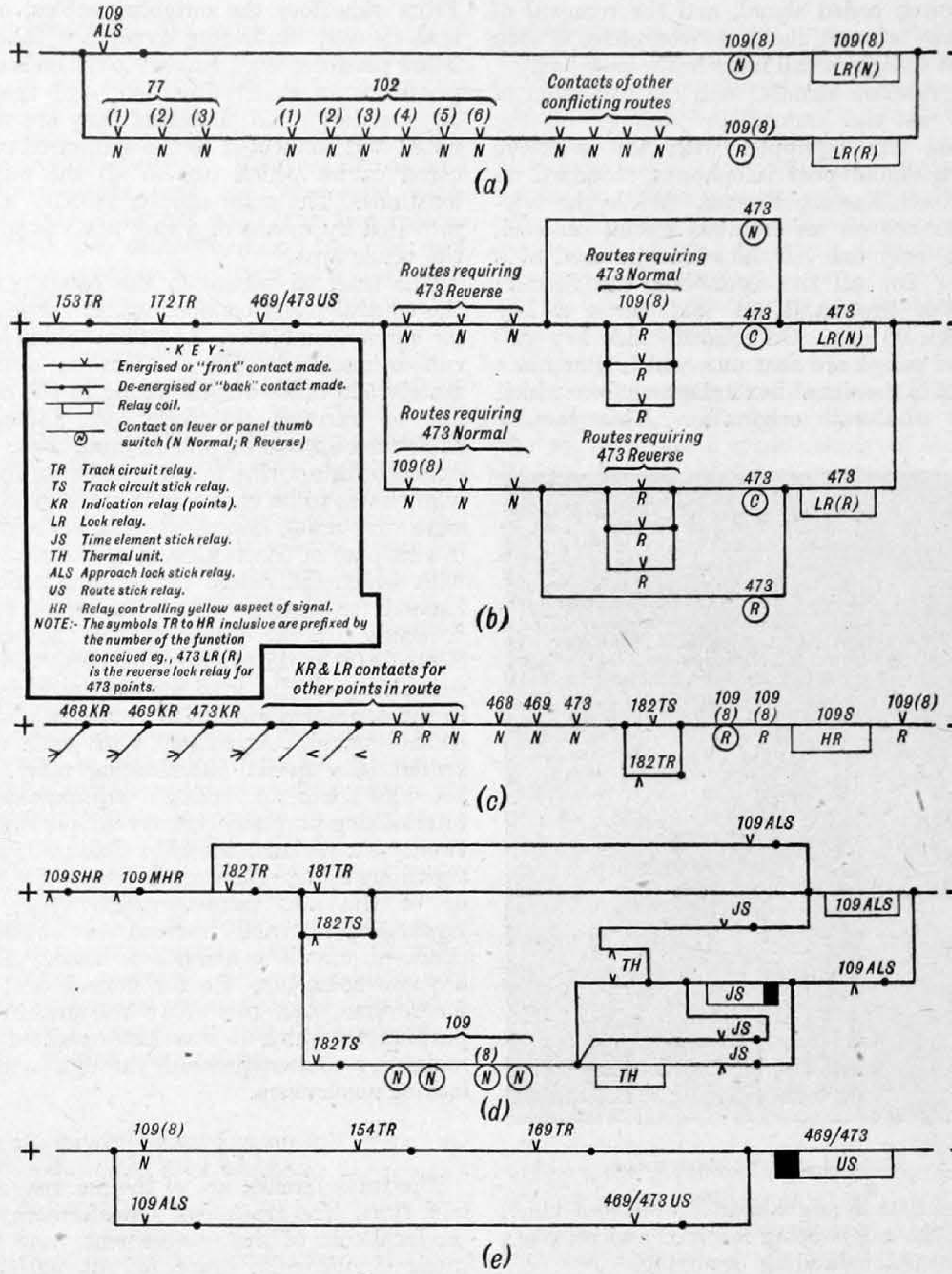


FIG. 12—TYPICAL CONTROL CIRCUITS

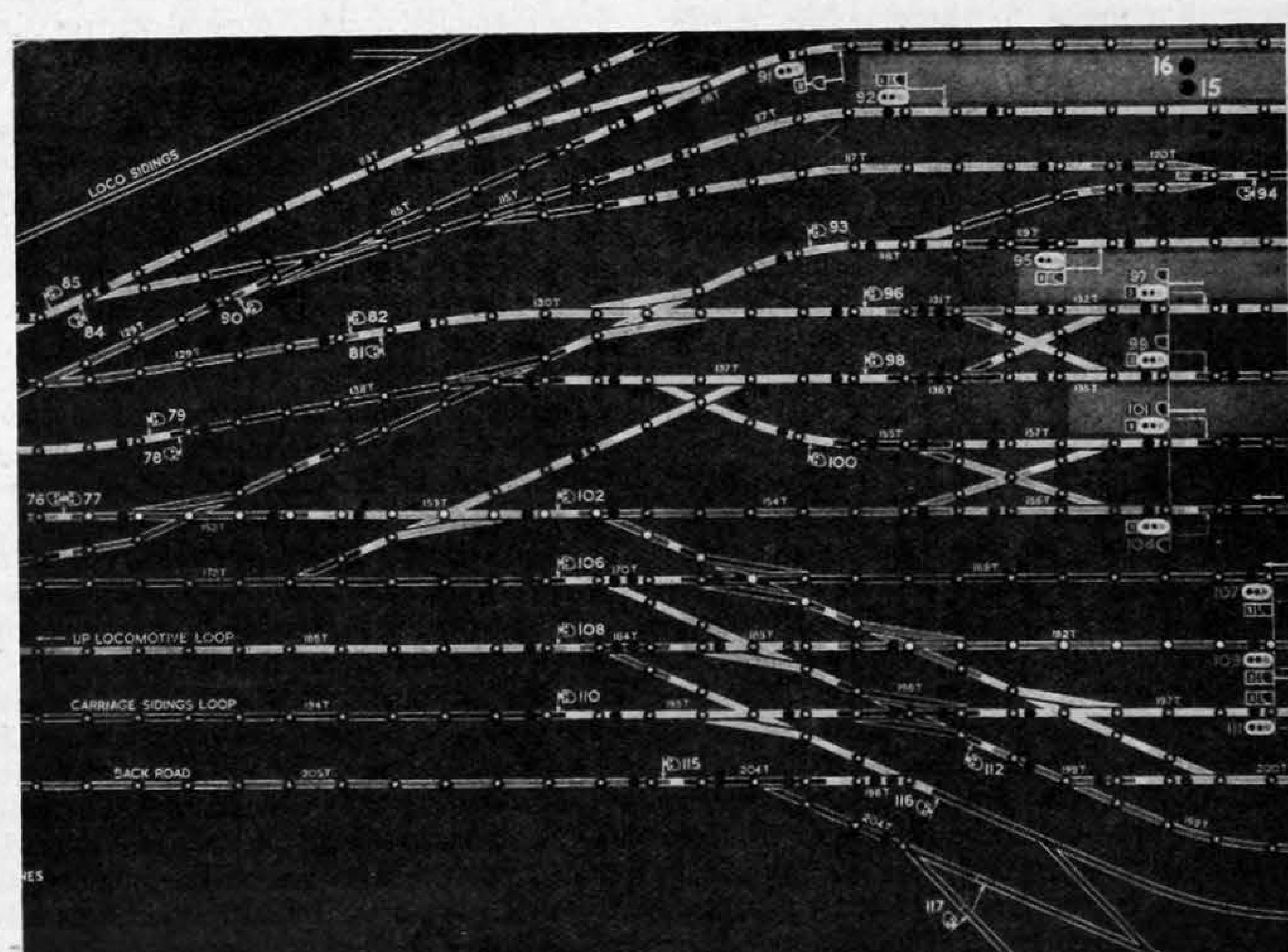


FIG. 13—DETAIL OF PANEL SHOWING ROUTE LIGHTS

TELEPHONES

While every effort has been made to reduce to a minimum the use of telephones, it has been necessary to provide a comprehensive system to cater, not only for normal, but also for emergency requirements. These requirements fall into three main groups:—

(*a*) Operational circuits to "controls" and adjoining signal-boxes.

(*b*) Signal telephones for the use of enginemen.

(*c*) Maintenance circuits.

In addition to circuits for both main line and district control, which are concerned with the operation of passenger and goods traffic in the York area, entirely new omnibus circuits have been provided on the various lines. The new signal-box can call any other place on a circuit by the transmission of a high-pitch coded signal, and the removal of any way station hand set completes a loop circuit to light a call lamp in the new box.

All running signals, with the exception of those in the immediate vicinity of the station, are equipped with the selective ringing signal post telephones, standard on the North-Eastern Region. While the telephones are on an omnibus circuit on each group, only one telephone can be used at a time. To call the signal-box the fireman removes the hand set and turns a key through 90 deg. On releasing this key two sets of pulses are sent out, which illuminate a lamp in the signal-box indicating from which signal the call originates. This facility

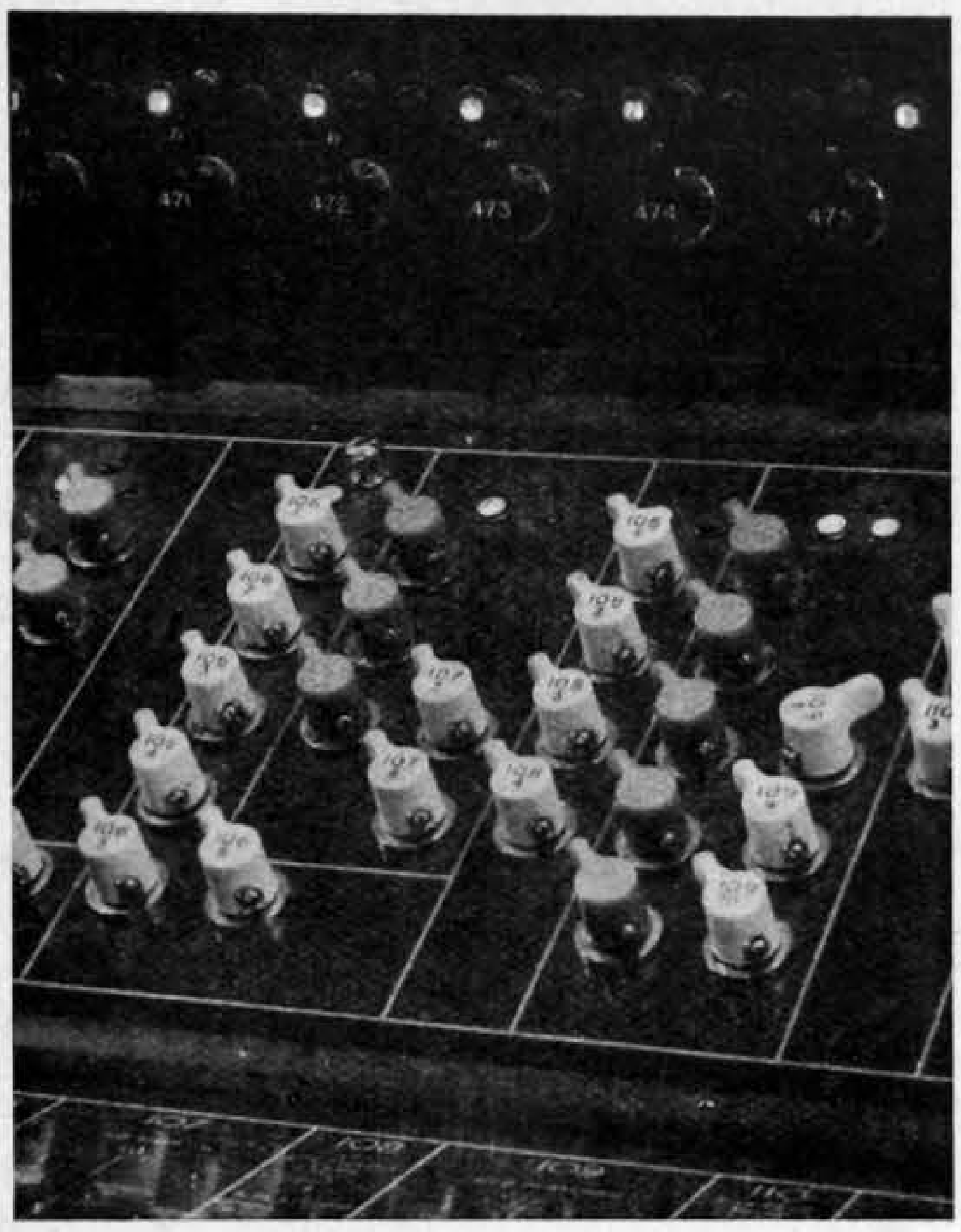


FIG. 14—ROUTE SWITCHES

ensures that the signalman knows from which signal the call is being received and prevents any misunderstanding occurring.

For maintenance purposes a separate switchboard has been provided in the relay room with circuits to three points in the signal-box control room and to various other parts of the signal-box building. A loud-speaker paging system is provided for calling linemen working out on the track. The linemen are provided with hand sets, which can be plugged into sockets provided adjacent to the more important point locations and other strategic points outside. Provision is made to switch these circuits through to the control room as required.

THE NEW SIGNAL-BOX

While the control panel is the heart of the new installation, the vast amount of wiring connected with it, and the presence in the signal-box alone of some 2885 relays made the design of the box, and of the cable runs, one of the major items of the whole scheme. The new signal-box, as shown in Fig. 15, is built into one of the station walls and the structure follows generally the curve of the platforms. The relay room alone is 150ft long by 32ft wide, and from this room control wires pass to the 827 route switches of the panel, each of which has anything up to six contacts. At an early stage in the working out of the scheme it was decided to build a mezzanine floor below the control room and relay room, and a scale model was built in wood to determine the best lay-out for the numerous relay racks, the power supply switchboard, and the control panel itself. The position of the main cable entry had to be decided. As finally arranged, the incoming cables terminate and deploy in the mezzanine. From this floor the outgoing cables, of the lead-covered multi-core type, are taken to below platform level, carried to the ends of the platforms in either direction, and there in large underground chambers they are terminated and connected to the armoured multi-cored cables which run to all the outdoor locations. The main supply, at 660V a.c., is provided by means of a ring main supplying the whole area.

The internal wiring in the cabin, except the control panel connections, is carried out in single conductor, 1/·044in, flameproof, rubber-insulated cable. There is approximately 500 miles of this wiring in the cabin, not to mention the forty-core flameproof cable used for control panel connections. The extent of this wiring made it essential for the wire chases to be very carefully designed; we were very much impressed with the neatness of this part of the work and of the readiness with which individual connections could be located for testing or the tracing of faults. A study of the basic circuits shown in Figs. 12 (*a*) to 12 (*d*) is sufficient to indicate something of the intricate wiring involved in the concentration of 827 routes in a single control panel. Associated with each route switch is a special interlocking relay. To provide adequate contact equipment for interlocking purposes (twenty-six normal and twenty-six reverse) the conventional type of signalling relay, either of the simple d.c. type or of the a.c. vane-armature type, was impracticable, and instead a solenoid-operated circuit controller is used. There are two solenoids, one for normal and one for reverse, and this relay remains in the position to which it was last operated and maintains contact pressure through a toggle locking mechanism.

OUTDOOR EQUIPMENT AND POWER SUPPLY

The track circuits are of the a.c. reactance feed type. The track feed transformers, and the local coils of the two-element vane type track circuit relays, are fed at 100/110V, 50 c/s; the transformer secondary has taps of 8V, 10V and 12V, used according to circumstances, and the normal control current through the "controlled" element of the track relay is 2V. Electric power for signalling purposes is obtained from a Railway Executive substation supplied from the B.E.A. York power station on a 6000V ring main. Transformers and associated gear are installed to give two separate 660V, single-phase supplies for the general signalling services and a 400V, three-phase supply for the air compressors.

The 660V supply is normally fed via the power-house switchboard direct to the cabin switchboard, situated at the end of the relay room, for distribution to cabin and lineside functions. In the event of failure of the twin mains supply the signalling load is automatically, within nine seconds, supplied by an 85kVA standby diesel-driven alternator set. The alternator set also starts if the mains voltage falls 10 per cent below normal. Alarm circuits warn operators in the control room if the standby set is started and, on restoration of main supply, the set is stopped by hand. Lamp indication on the control panel shows main or standby supply, and an alarm bell rings for each change-over.

In the power-house two vertical, two-stage, intercooling main compressors having a capacity of 200 cubic feet of free air per minute operate automatically; one on duty and one on standby duty alternately. These compressors cut in when mains pressure falls to 55 lb per square inch and out when it reaches 65 lb per square inch. The compressed air is fed to a 2in diameter ring main between the north end of Dringhouses and Clifton and supplies all pneumatic point motors. Individual pipes from ring main to point cylinder are ½in diameter B.S.P.

If air pressure falls so that the second compressor cuts in an alarm is given in the control room and an emergency diesel-driven compressor of 22 b.h.p., of 100 cubic feet capacity, is available in the power-house to

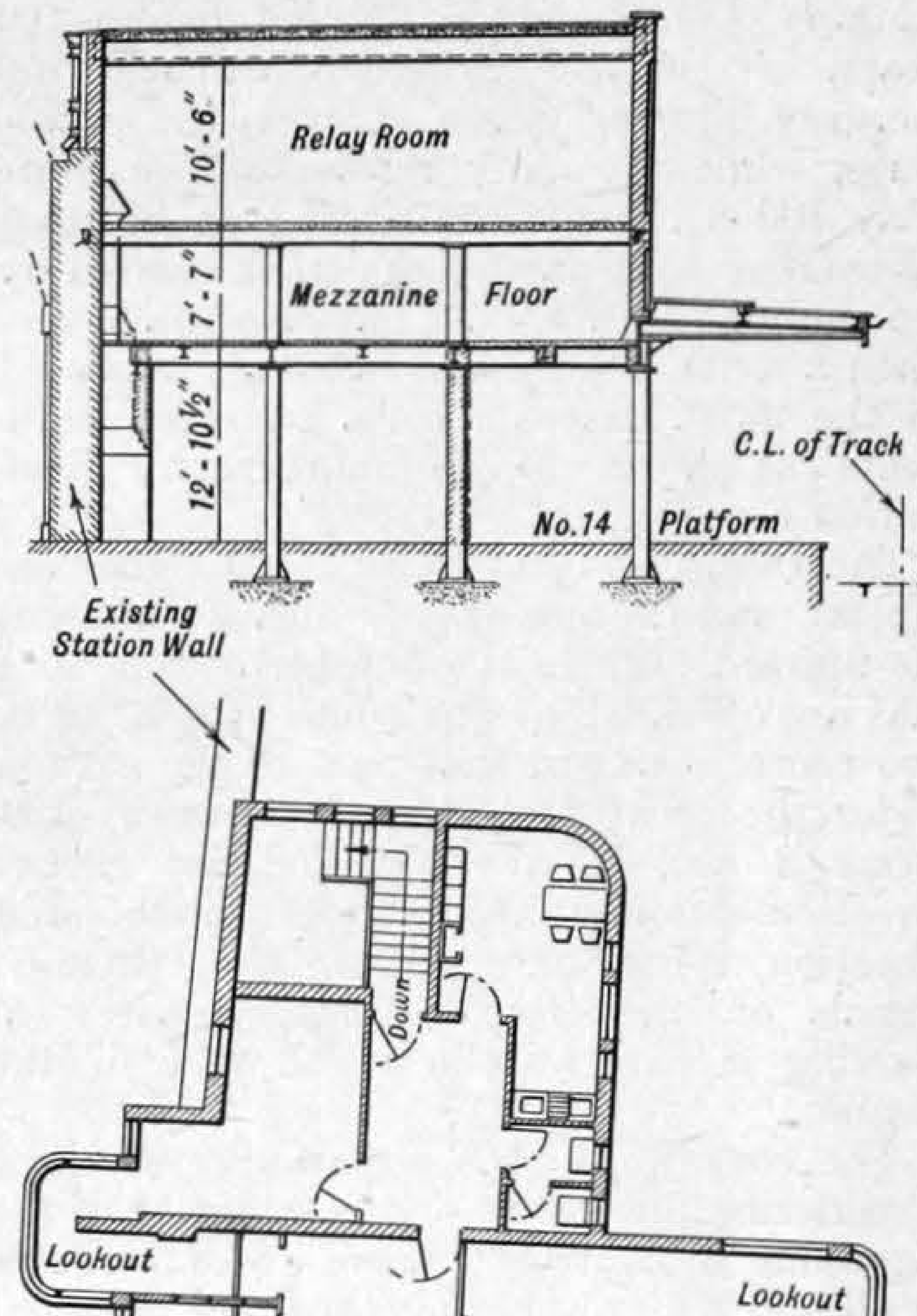


FIG. 15—NEW SIGNAL-BOX

supply the air ring main. The air compressors are fitted with Westinghouse anti-freeze devices, and the standby alternator set is specially warmed in winter to facilitate starting.

CHANGE-OVER WORK

In signalling work of such magnitude as this it is one thing to draft a scheme itself and yet another to work out the design in detail, but the work of installation and change-over has to be carried through with the least interruption to traffic, even though there are changes in permanent way, improvements to station facilities, lengthening of platforms, and other major structural works to be carried out. At York some of the early stages of the change-over involved the rearrangement of running lines at the north end of the station in order to provide better access to and from the Scarborough line. This affected the signalling to such an extent that the original waterworks signal-box had to be demolished to make room for a new approach line, and a temporary mechanical box was built to cover the period until the new route relay interlocking was ready to be put into service. Other track modifications have taken place at the south end of the station, though not to the extent of involving the use of temporary signal-boxes.

To lessen the amount of work involved in the final change-over it was arranged to bring the air compressor plant into operation, and for some time before the final opening nearly all the points were operated by power and controlled by circuit breakers coupled to the lever tails of the existing mechanical signal levers. This has obviated the need for any point fitting at the time of the major change-over, and the alterations, in the case of points, consist entirely of changing the control from one circuit to another. The electro-mechanical interlocking at Skelton was brought into service in June, 1941, and the final change-over, bringing the York control panel into service, took place on Sunday, May 27th.

A major complication of the change-over period was that direct connections from the main receiving lines at the south end had to be made to platforms 15 and 16 across the site of the old Locomotive Yard Signal-box, previously the largest in the York area and reputed to be the largest mechanical signal-box anywhere in the world. Since the reconstruction of the station the two platforms concerned had been worked as dead ends, and at the second stage of the "opening" of the new signalling the Locomotive Yard box was taken out of service. This took place on Sunday, May 20, 1951, when Waterworks, Leeman Road, Clifton and Platform boxes were also dispensed with. During the following week the Locomotive Yard box was demolished and the new running lines were laid in, so that on Sunday, May 27th, Nos. 15 and 16 platforms were brought into full use as through lines and the signalling change-over completed.

The original scheme, initiated in London and North-Eastern days, was worked out under Mr. C. Carslake, signal and telegraph engineer, North-Eastern area, London and North-Eastern Railway, to the requirements of the Superintendent, North-Eastern area, and the work has been completed under the direction of Mr. J. H. Fraser, signal and telecommunications engineer, North-Eastern Region, British Railways. The contractors for the signalling work were the Westinghouse Brake and Signal Company, Ltd.

Already the new signalling is proving very effective in service. The considerable reduction in the total number of signals employed and the use of four aspect signals has resulted in a notable increase in the average speed of trains passing through the area, particularly in the case of non-stopping freight trains. When recently we were enabled to inspect the work, less than a week after the final opening, the control panel was being operated with confidence and speed, and we concluded that the installation as a whole ranks as an achievement in British railway engineering.

The Iron and Steel Institute

No. II—*(Continued from page 764, June 8th)*

We continue, below, our report of the discussion on Dr. Mont. Ing. Bernhard Matuschka's paper entitled "The Present Position of the Converter Process," at the annual general meeting of the Iron and Steel Institute, in London, on Wednesday, May 30th.

Mr. H. Parnham (General Refractories, Ltd.): I should like to raise one or two points in connection with refractories. The fact that dolomite is used for lining the basic Bessemer converter makes this process applicable in most of the countries of the world, and, being a cheap basic raw material, it has a great effect on the process itself. I should like the author to state what is the relative cost of the refractories used in the basic Bessemer converter and in the open-hearth furnace, bearing in mind that large quantities of chrome ores and magnesite, both of which are costly raw materials, are used in the latter process.

The life given in basic Bessemer converters, with the present rise in costs of installation, appears to me to be very important. I wonder whether on the Continent there have been any developments in improving both the life of the side wall and that of the tuyere section. Mr. Kerlie mentioned the difficulties which may be connected with induction heating, and I agree with him. I should like to know the minimum lining thickness envisaged for this type of construction. The fact that oxygen blowing is applied to the surface of the bath does, I think, reduce some of the tuyere problems. I wonder what, with this type of blowing, is the damage done to the lining, and whether repairs can be carried out quickly and effectively to keep the refractories costs down.

Dr. T. P. Colclough (British Iron and Steel Federation): We have been privileged during the last few years to have additional quantities of scrap, far beyond those which are normal. The picture which is sometimes drawn of what we shall have to face in the next four or five or more years is, in my opinion, not realistic, in the sense that we must, after all, get back to a position which is uniform over a long period of time. Before the war the use of scrap in the world was obviously limited to the amount of scrap available. There is no natural process which produces scrap, other than human use and human steel production, and therefore we must get back to a balance, and it will be of the order given in this paper. The author draws attention to the fact that with the marked increase in steel production in Europe, from about 50 million to about 60 million tons, we are going to be short of scrap. That, I think, should be regarded realistically in this sense, that nobody is going to say "To-day we are making 50 million tons, and tomorrow we are going to make 60 million." The increase must be gradual, and so we shall have our return scrap coming in, I agree after an interval of a few months, but there should not be a serious position there.

There is one general remark which I should like to make. I wonder what some of our friends in certain districts in this country will say about the sentence which reads, "The essential condition for using the open-hearth process is that the price of scrap should be lower than that of pig iron," because we have certain people in this country who have traditionally and always used 70 to 80 per cent of pig iron, irrespective of the scrap price. I think that some comparison might be made with the use of the large tilting furnace, as compared with the ordinary cold metal melting open-hearth furnace. The real backbone of this paper is that a review of the steelmaking processes is advisable. That must be done from time to time. We shall all agree that there is no one process of steelmaking which is to be made universal. There must always be a balance struck between one process and another, and to-day is a time of revision.

I should like to comment on what is said under the heading "Utilisation of Manganese Content." It was my business before the war to make a special study of the conditions for steelmaking in Austria. The fundamental question had to be determined as to the steelmaking to be put into operation in that country. As the members of the Institute who will go to Austria in September will find, the main source of ore is the Erzberg, with the ankarit ore, which has the special value of making pig iron which, with suitable blast-furnace operation, can be made to give a pig iron of 3 per cent manganese with low phosphorus content. In the work which I carried out with my colleagues in studying that problem we came to the conclusion that with a 3 per cent manganese iron it would definitely pay to blow that iron and to make a use of the Bessemer process, which at that time was almost unknown but has since developed considerably. We laid down a blowing time of four to five minutes, in which we would leave about 1 per cent of carbon and 1 per cent or a little less of manganese in the blown metal, and we should get a slag of 30 to 35 per cent of manganese. I am particularly interested to know that that suggestion has been carried out and has proved successful. I am of opinion that that will be a prolific source of material for making low-grade ferro-manganese.

At the same time, we made an investigation into the blowing of the metal by oxygen. We all know that we can blow metal by oxygen. We all know that if we blow with oxygen we shall have a nitrogen content which is of the same order as that of open-hearth steel, if not slightly lower. We all know that if we blow oxygen instead of air the temperature will be much higher, because there is less dissipation of heat. We all know that the metal will get far too hot, and that it must be cooled by some method or other. You can cool it with scrap, utilising the scrap in that way, or you may have to use some addition to cool it, that addition being steam or CO_2. Those facts are not new. We are also fully aware that if we take a side-blown converter and blow it with air, not oxygen, the nitrogen content is of the order of 0·003 per cent. That was proved by our operations during the war. Our friends in B.I.S.R.A. have already proved that the blowing of converters by oxygen is perfectly practicable. The essential factor is cost, and no other factor is of the same importance. I would warn the members of the Institute that the practical difficulties are not yet ironed out. There are troubles with the tuyeres and there are troubles with the refractories. Moreover—and this is particularly important in these days—there is the question of public nuisance. There is no question whatever but that the blowing of metal with oxygen is going to lead to a tremendous disturbance of the atmosphere by red fumes, and so far as industrial conditions in Britain are concerned, in the centres of population that is a problem that requires very careful consideration indeed.

Mr. C. Danielsson (Domnarvet Iron and Steel Company, Sweden): There are some difficulties in obtaining a low sulphur content when you drive a blast-furnace with pig iron made with a very acid slag. We made some investigations in Domnarvet to find a method of getting rid of that sulphur, and we found a very simple process which is now in commercial use at one of our Swedish works. The method is based on the fact that fine-ground lime powder, thoroughly mixed up with molten pig iron, will produce a considerable reduction of the sulphur content in the iron. At a works making 600 to 800 casts there was a sulphur content in the ingoing pig iron of about 0·1 per cent, and after treatment the pig iron had an average sulphur content of only 0·009 to 0·01 per cent. The method is based on the fact that if you have a simple rotating furnace which could be used as a ladle between the blast-furnace and the mixer you can put it on a special machine and rotate it, and you can, in the same vessel as that in which you transport it, bring the sulphur content down to a very low percentage.

I should also like to say a few words on the question of oxygen blowing on the basic Bessemer process. We made many tests in that field at Domnarvet and decided to build a big oxygen plant, the first step being to blow only with enriched air, with about 30 per cent of oxygen. It has been shown that by blowing with that content of oxygen in the air, 30 per cent, we can get a considerably lower content of nitrogen in the steel. If, in addition to that, you do end blowing with nitrogen-free gas mixtures—CO_2 and oxygen, which has been done, or hydrogen and oxygen, which up to now has not been done—you can get an average nitrogen content in the steel of about 0·006 per cent.

The afternoon session on Wednesday, May 30th, opened with a display of films on "A Study of the Zone in Front of a Blast-Furnace Tuyere by Means of High-Speed Motion Pictures and Models." The films were introduced by Dr. J. B. Austin (director of research, the United States Steel Company).

The following paper was then presented :—

SIGNIFICANCE OF EQUILIBRIUM AND REACTION RATE IN THE BLAST-FURNACE PROCESS

By Dr. J. B. Austin

Synopsis

The blast-furnace process comprises a series of reactions, which are delicately balanced so that it operates at a substantially steady state. On the basis that all the reduction is "indirect," it is possible to set up a thermodynamically ideal, isothermal process, operating at minimum consumption of carbon. Comparison of this minimum with the amount of carbon required as fuel indicates that in a furnace producing the common grades of iron from Mesabi ore the requirement for carbon is determined primarily by the need for a reducing agent. The reaction between slag and metal in the hearth is not at equilibrium in respect to sulphur. The operation of the furnace is influenced by the effective rate of a number of reactions, such as the reduction of iron oxide, the dissociation of limestone or moisture, and the "solution" of carbon.

Discussion

Mr. R. A. Hacking (Richard Thomas and Baldwins, Ltd.): So far as American lake ore practice is concerned, I take it that the statement is always true that a substantial amount of direct reduction is tied to maximum fuel economy, but in this country, accustomed as we are, unfortunately, to very lean ores, we have been striving continuously to cut it down to the minimum. We are climbing the slope, as it were, on the other side of the hill; but with the objectives which we have set ourselves—physical preparation and, in due course, beneficiation, improvement of our fuel, use of higher blast temperatures, and, in due course super-oxygenated blast—we shall eventually reach the crest and come to the other side of the hill, where our United States friends are already.

With regard to the author's conclusion that many modern furnaces are operating close to equilibrium, I would ask him, which equilibrium? I am not sure which of the curves in Fig. 1 he is looking at. There is the Fe–FeO curve, the $FeO–Fe_3O_4$ curve, and then, most significant of all, in my opinion, there is the $2CO=CO_2+C$ curve. There is also the $Fe_2O_3–Fe_3O_4$ equilibrium lower down. Which do we look on as the ultimate target? We have to take into account the existence of the other curves, since most furnaces operate on ores which are essentially Fe_2O_3 as charged.

In his references to the use of super-oxygenated blast, the author's theoretical conclusions coincide fairly well with what has happened in the experiments made in full-scale practice. He concludes, as most of us do, that at the present time it is likely to be helpful only in ferro-alloy manufacture.

One point which he mentions does not seem to correlate with the U.S. Bureau of Mines determinations of tuyere zone slag and metal temperatures, published in the late 'twenties. He expresses the opinion that in ferro-manganese practice the hearth temperature is appreciably higher than in ordinary basic practice. The experiments of the U.S. Bureau of Mines seem to indicate that in ferro-manganese practice, though there was a much higher coke rate and the maximum blast temperature that the stoves would stand was used, the endothermic reactions in the hearth pulled the hearth temperature down in all three locations, tuyere zone, slag and metal, to something a good deal less than in ordinary basic practice.

The section on slag-metal reaction is most interesting. I think that we have come to regard conditions down in the hearth as being relatively static, with the slag layer on top of the metal layer, but when each droplet of iron and slag makes its way down the bosh and through the tuyere zone under the very turbulent conditions which prevail inside the combustion zone proper—i.e., in the centre of the furnace—there is very good opportunity for the droplet of iron to react something like equilibrium with the particular droplet of slag with which it comes in contact on the way down. I think that these tests of the time taken to reach equilibrium with the average of the iron and the average of the slag demonstrate what occurs during the period of travel as between certain droplets of iron and certain droplets of slag and that in these experiments the workers concerned are simply taking the average and determining the time taken to reach equilibrium under static conditions.

Dr. H. L. Saunders (Imperial College): We have long realised that photography through the tuyeres could give us some very interesting information on what is going on inside the furnace. Indeed, as long as three years ago we made a few still photographs through the tuyeres, but they did not give us the true picture. We have also done work on models with the aid of cine-photography. We are making one small contribution at this session which I hope will be the beginning of further work to determine not only the motion as seen by the ordinary cine-camera, but also the dimension in space that the particular particle which we are watching is occupying; in other words, stereo-cine-photography. Mr. Ward, who was responsible for this work, is arranging to show a film of this nature later to small groups of people.

I should like to refer to the author's most interesting results on the sulphur and other constituents of the slag and metal and the equilibria involved.

On page 359 the author asks "Is the consumption of coke determined by the need for carbon as fuel or as a reducing agent?" and the conclusion is drawn that the coke rate is determined mainly by the need of carbon as a reducing agent. If there is a near approach to equilibrium in the blast-furnace this is, of course, largely true, but the point is whether we are always justified in assuming that equilibrium is so nearly approached. The author cites instances from Kinney's paper No. 442 and measurements reported by Wiberg and analysed by Gumz. Both those furnace units would be regarded by modern standards as relatively slow working, and Kinney in his experiments was using a substantial proportion of fines in the burden, so that in both those cases the conditions were highly suitable for a near approach to equilibrium.

It does not seem to me that a similar assumption is necessarily valid with conditions of hard driving or when a good deal of magnetite is being smelted in the burden, and, so far as this country is concerned, we have the wide range of possibilities that exists between lean and rich ore practice. We do not happen to be blessed with Masabi ores or similar ores of such high reducibility and good iron content, and the degree to which equilibrium is approached in British practice is probably a great deal less.

Dr. J. H. Chesters (United Steel Companies, Ltd.): The author and his colleagues have certainly given us a view inside the furnace which very few of us have had the opportunity of having before, but what it all means is still very much a mystery. It will mean that a number of people, including ourselves, will start doing more model work.

Watching the film, certain points occurred to me immediately as possible—I shall not say more than that. First of all, if we have a simple jet of air in air we all know that we have entrainment all along the surface of the jet, but there is very little recirculation. If, however, we put any kind of container round the jet, whether ovoid or cube, we inevitably get suction produced at the lower end, which results in return flow. We also know from some recent work, not yet published, that if we introduce a surface underneath—for example, the bed of the blast furnace—and start to move that up into the field, we inevitably upset the field. The bottom half of the recirculation goes, but the top half is still there.

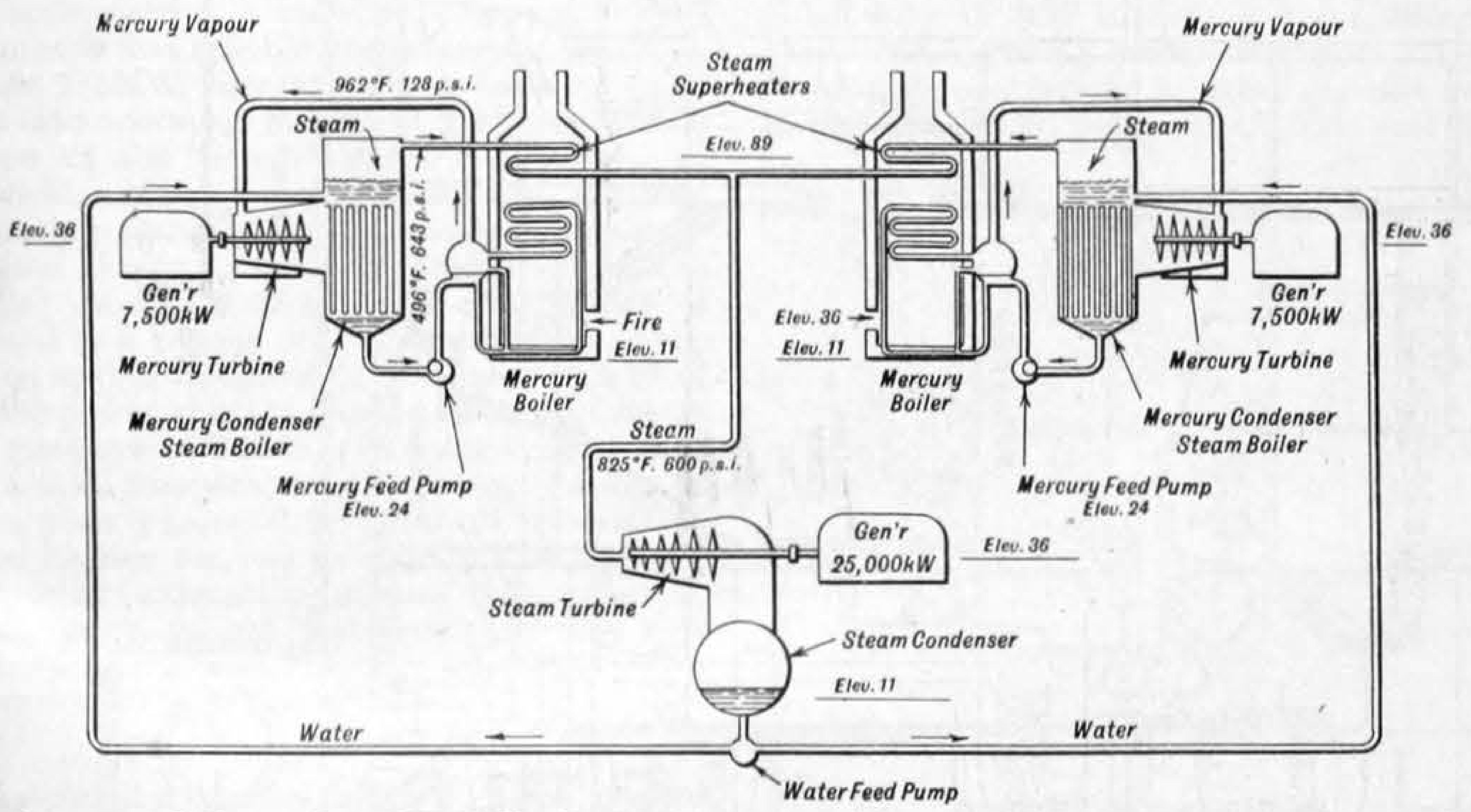
From the film and the model, what we seem to be doing is this. We have a furnace or a model filled with lumps of material, and we have a tuyere and blow a "balloon" up, and the harder we blow, the bigger the "balloon" becomes. If we imagine the point at which the balloon is pricked, we get the situation that the air escapes and the surface will be smaller, but the outward hydrostatic pressure will keep the coke away. Because of the bottom surface, which is the working bed of the furnace, that seems to tally with the author's theory. The author's two dimensional model should, I think, from a perfectionist point of view, be not parallel sided, but wedge-shaped, like a piece of cheese, to take account of the fact that the coke coming back is coming back into a bigger space and the return is easier, and, as we are not correcting for side drag on the model walls, it seems logical that coke should be streaming back at a terrific pace. It will not, incidentally, follow the air stream, particularly if in big lumps; if the air turns, the coke will go straight on and hit the wall and come down.

(*To be continued*)

The Schiller Power Station at Portsmouth, New Hampshire

THE Schiller power station of the Public Service Company of New Hampshire, which began operation recently at Portsmouth, New Hampshire, U.S.A., is probably the latest example of a power plant installation based on the binary-vapour cycle, and, furthermore, is believed to be the first such installation in America to be designed and built as an integral power generating unit. As the major contractor, the General Electric Company, of Schenectady, New York, was responsible for the supply and erection of all equipment, whether mechanical or electrical, as well as the station building proper. It is therefore of interest to survey briefly a number of previous mercury-steam power plant installations by that company.

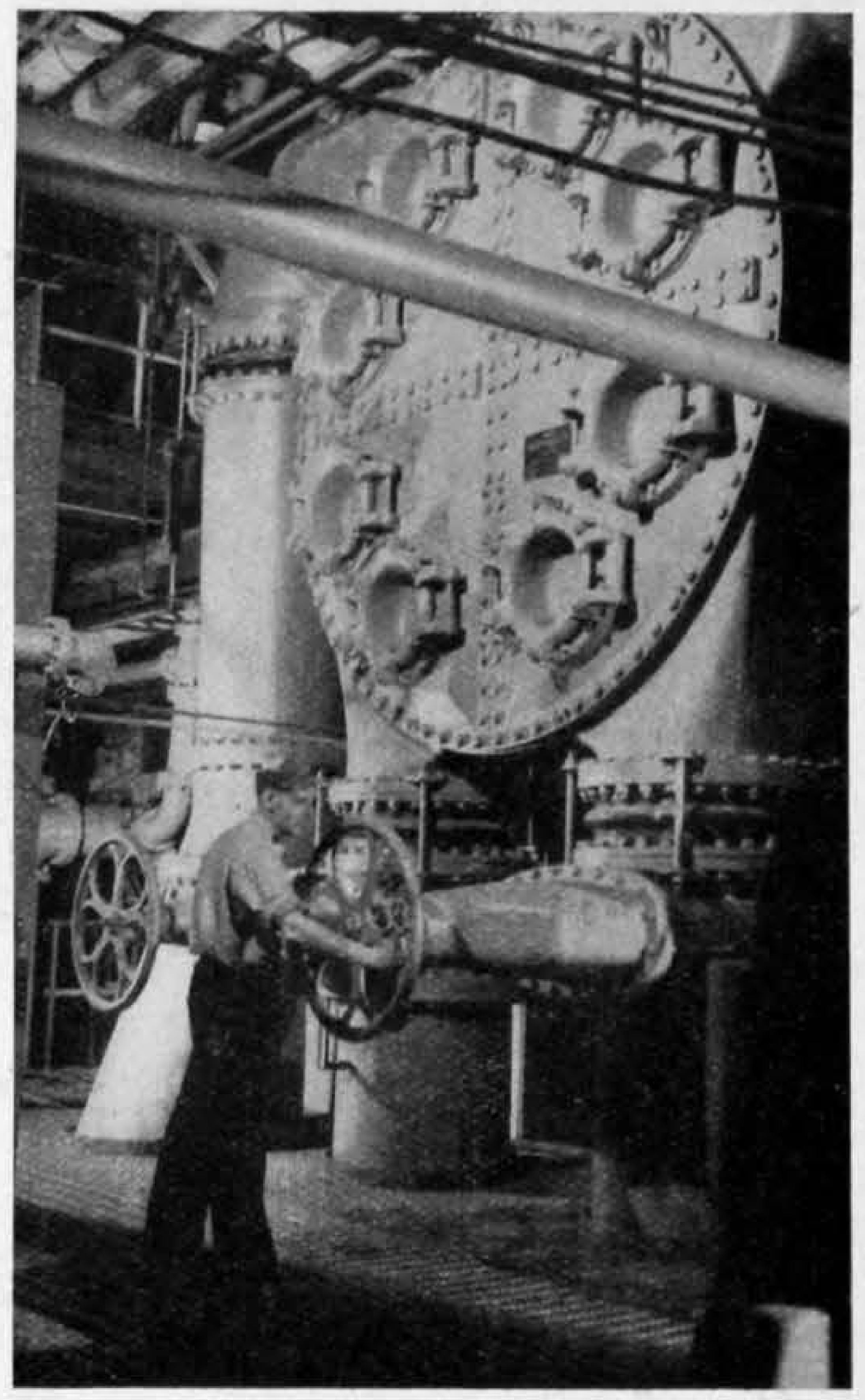
An original 10MW mercury plant, which was installed in 1928 at the South Meadow station of the Hartford Electric Light Company, at Hartford, Connecticut, was taken out of service in the summer of 1947 and was dismantled completely to provide space for a new unit of modern design and of larger capacity. The original unit, built entirely of carbon steel parts, was in operation for more than 119,000 hours during the nineteen years between 1928 and 1947, and produced more than 1,700,000,000kWh of electric energy. This unit was the first commercial application in the United States of the mercury-steam cycle for superposition of existing steam generating equipment, although an earlier plant of only 1800kW capacity had been operated experimentally at the Dutch Point station of the same company. The economic value of the mercury-steam cycle for producing low-cost electric power and steam, together with the very evident obsolescence of the original equipment, caused the Hartford Electric Light Company to purchase and install a replacement unit having a maximum continuously rated output of 15MW and of approximately 200,000 lb per hour of steam at pressures of either 250 lb or 385 lb per square inch gauge and a total temperature of 700 deg. Fah. The new equipment began preliminary operation on January 2, 1949, and was declared to be in service on February 1, 1949, as firm base load generating capacity.



Each mercury boiler produces 987,000 lb of mercury vapour per hr at 128 p.s.i. at a temperature of 962deg. Fah

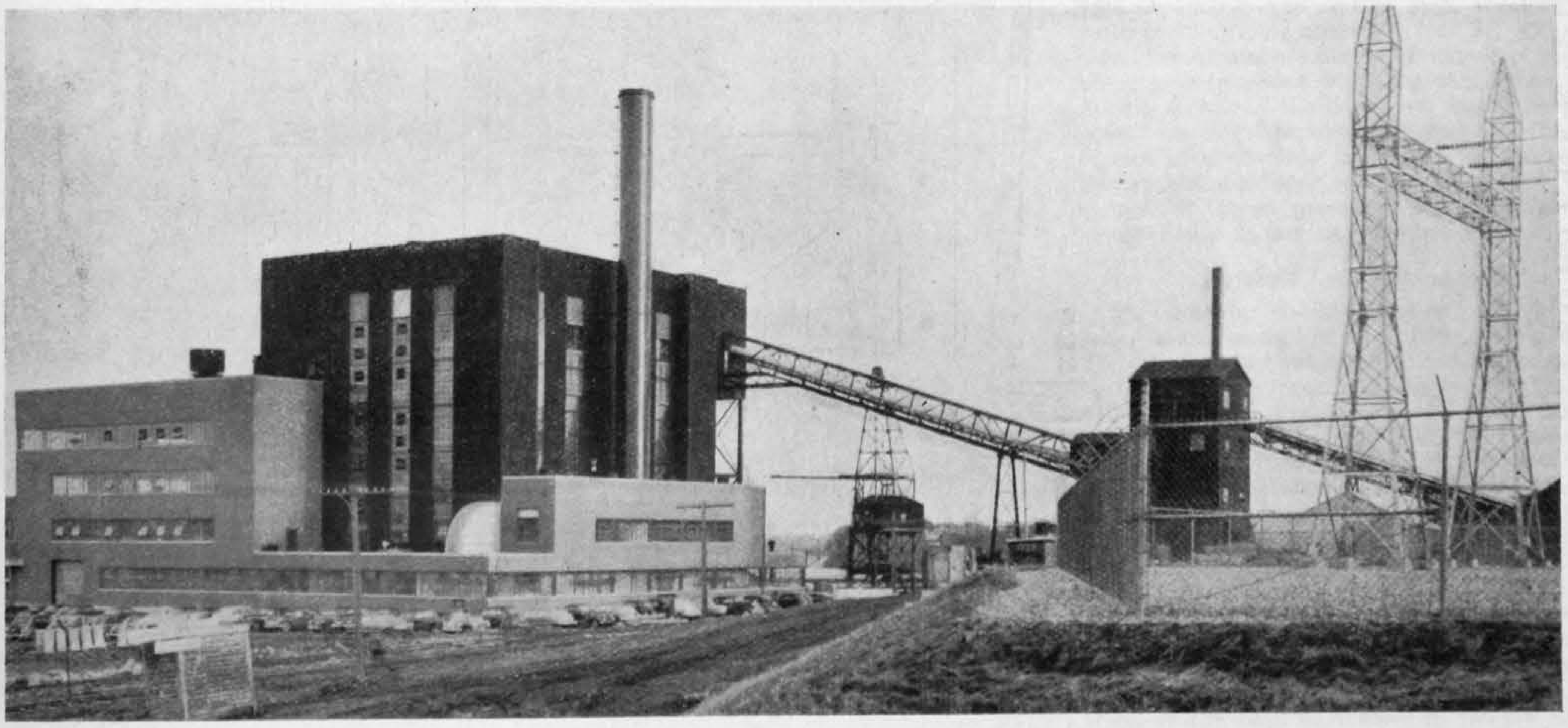
PLANT FLOW DIAGRAM

The 20MW mercury vapour plant, which was installed in 1933 at the Kearny generating station of the Public Service Electric and Gas Company at South Kearny, New Jersey, underwent extensive alterations in 1939 in an effort to modernise the plant and to correct certain faults, which had become evident. The original seven-drum porcupine-tube boiler with its steam producing water-cooled furnace was replaced by a mercury boiler of more conventional design and of sufficient capacity to operate continuously at a guaranteed output. Only the boiler was completely replaced; the steam superheater and coal pulverisers required only minor alterations, while the air preheater and fans were found to be of ample capacity to serve the new boiler. The redesigned plant was placed in operation again in June, 1940, as firm capacity and has produced a gross total of more than 2,180,000,000kWh of electric energy at an average load factor of 86·7 per cent and an average availability factor of 72·7 per cent.

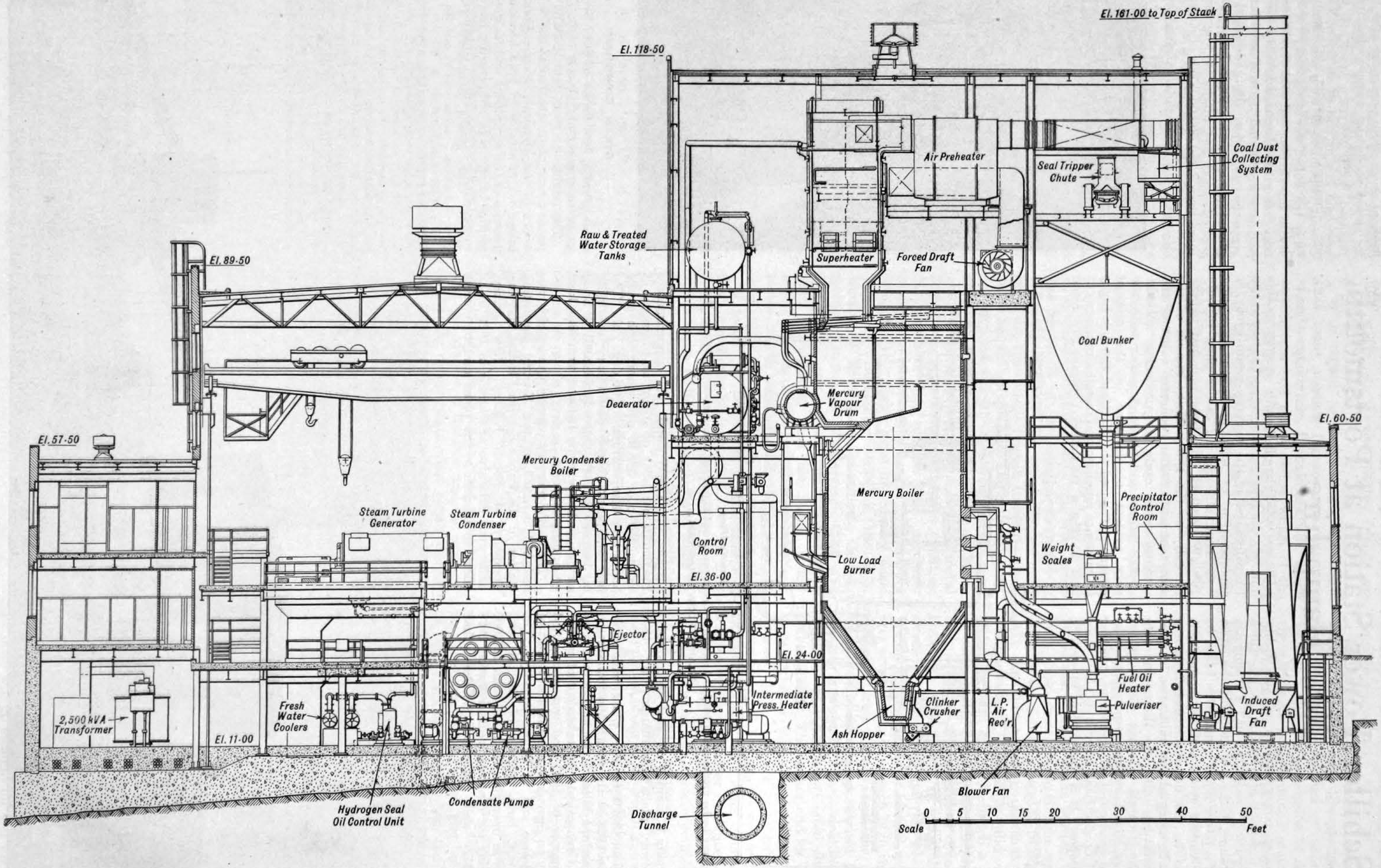


STEAM CONDENSER

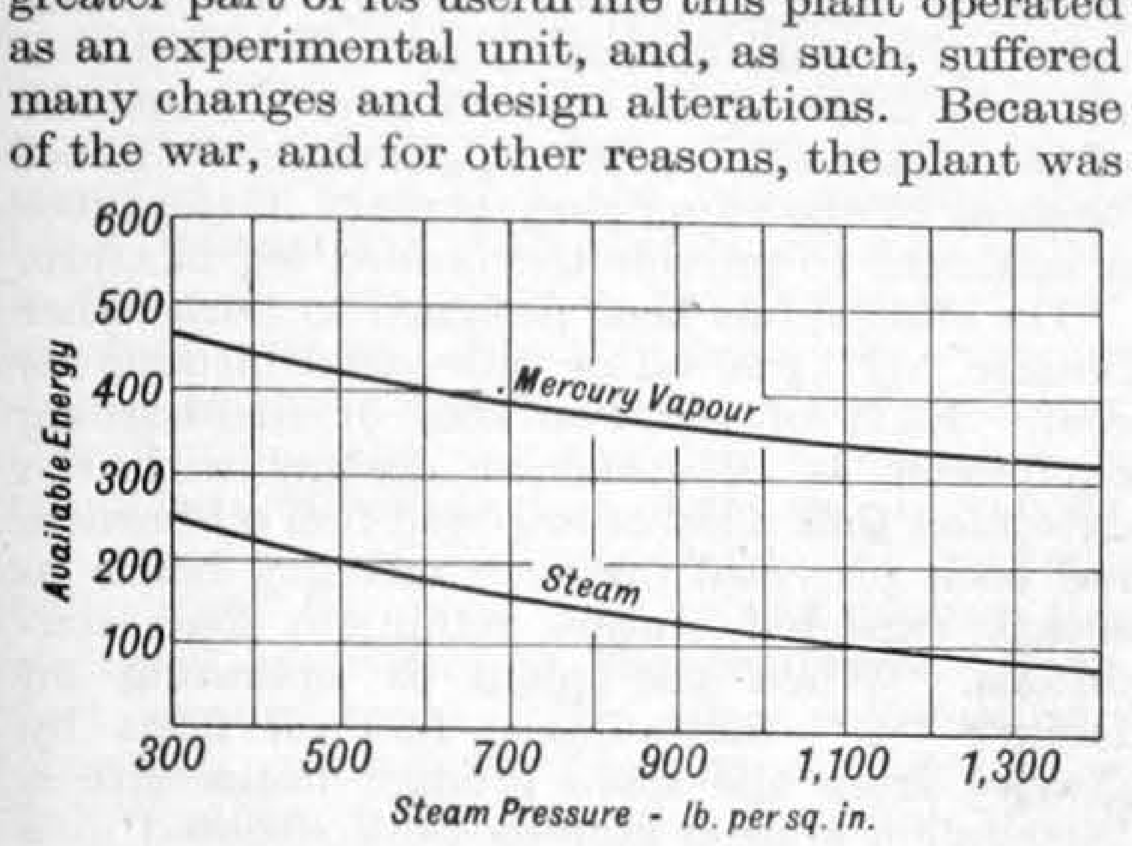
The eighteen years old 20MW mercury-steam power plant situated at the Schenectady works of the General Electric Company was taken out of service in 1948 because of obsolescence of the equipment and fatigue failure of certain of the high-temperature-mercury pressure-resisting components. Unusually frequent



SCHILLER POWER STATION


El. 161·00 to Top of Stack
El. 118·50
Air Preheater
Seal Tripper Chute
Coal Dust Collecting System
Raw & Treated Water Storage Tanks
El. 89·50
Superheater
Forced Draft Fan
Coal Bunker
Deaerator
Mercury Vapour Drum
El. 60·50
El. 57·50
Mercury Condenser Boiler
Mercury Boiler
Precipitator Control Room
Steam Turbine Generator
Steam Turbine Condenser
Control Room
Weight Scales
Low Load Burner
El. 36·00
Ejector
El. 24·00
Fuel Oil Heater
Fresh Water Coolers
Intermediate Press. Heater
Clinker Crusher
L. P. Air Rec'r
Pulveriser
Induced Draft Fan
2,500 kVA Transformer
El. 11·00
Ash Hopper
Blower Fan
Hydrogen Seal Oil Control Unit
Condensate Pumps
Discharge Tunnel
Scale
0 5 10 15 20 30 40 50
Feet

service interruptions caused by these failures made it advisable to discontinue operation of this unit until such a time as new equipment of modern design could be installed. During the greater part of its useful life this plant operated as an experimental unit, and, as such, suffered many changes and design alterations. Because of the war, and for other reasons, the plant was not modernised to a sufficient degree to permit continuous and reliable operation.

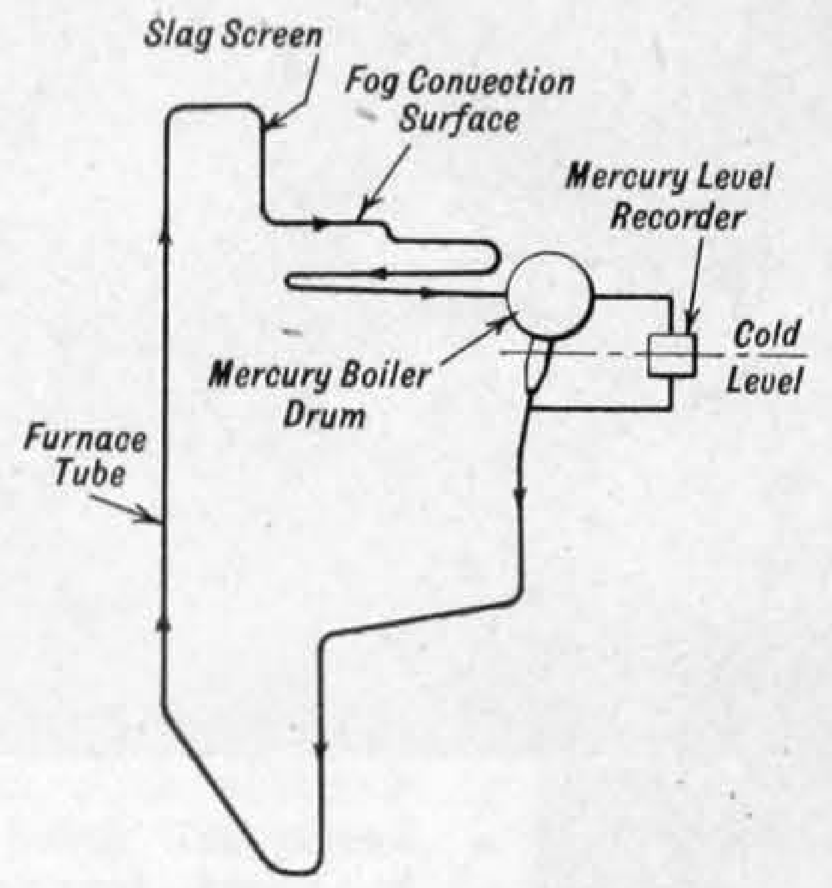


COMPARISON BETWEEN MERCURY VAPOUR AND STEAM

The 7·5MW mercury power plant which went into operation in 1949 at the works power station of the General Electric Company at Pittsfield, Massachusetts, employs mercury generating plant of the company's new standardised design, similar to that used in the Schiller power station. The equipment is situated in a rebuilt part of the existing power station and is designed to produce 8400kW of electric power and 124,500 lb per hour of steam at a pressure of 640 lb. per square inch gauge and a total temperature of 825 deg. Fah. The steam thus produced is piped to the station steam header for use as required by existing condensing extraction steam turbine units, which, prior to the installation of the new mercury plant, were the only source of power generation at the Pittsfield works.

The Schiller Station

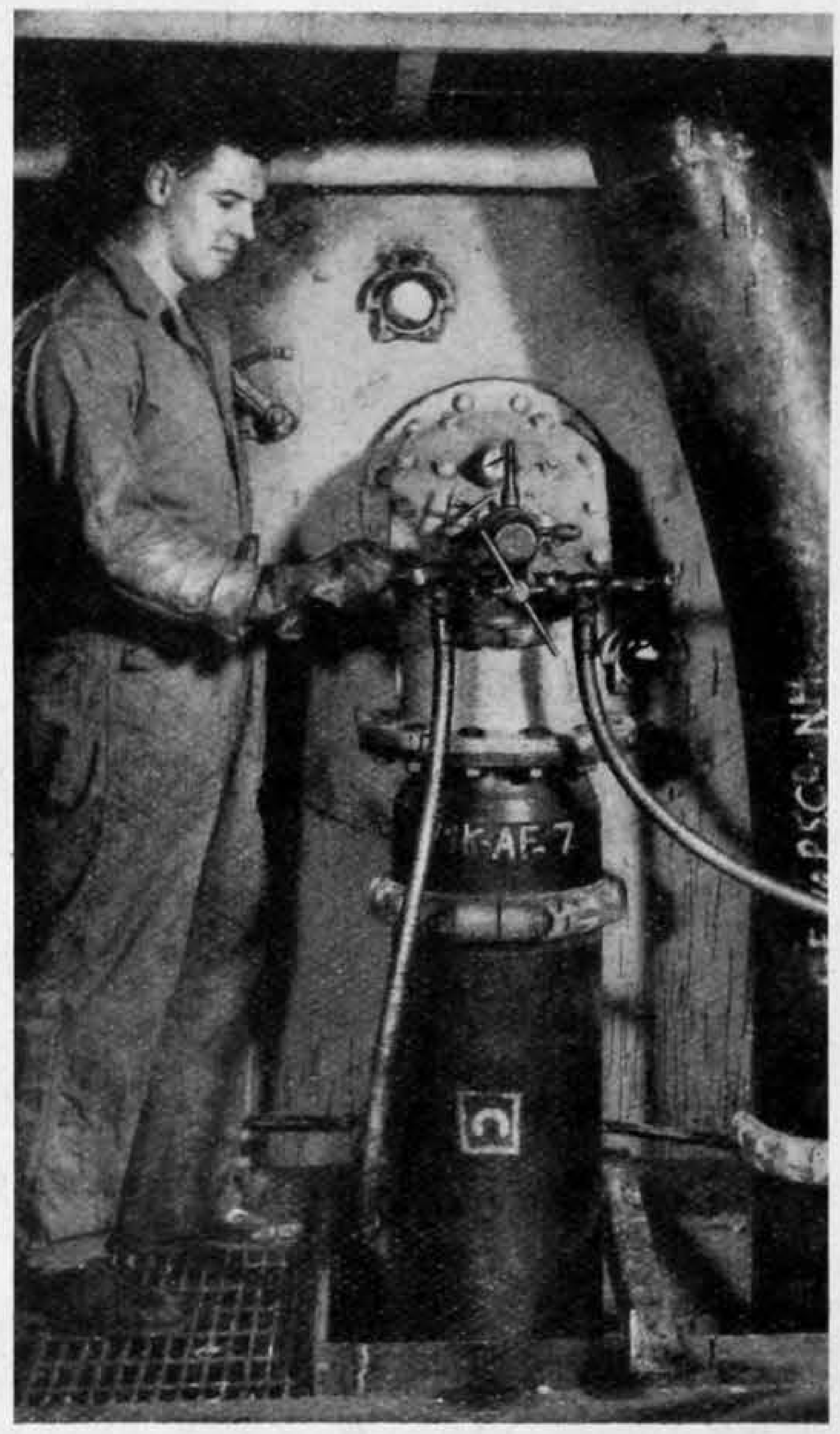
The Schiller station of the Public Service Company, of New Hampshire, consists of two 7·5MW mercury units of standardised design and one 25MW steam turbo-generator set, co-ordinated in design and rating to constitute a power generating unit having a rated capacity of 40MW. A schematic flow diagram of the plant is reproduced on page 789 and shows both the mercury and the steam cycle, indicating also the respective elevations of the boilers and machinery involved. Each of the two mercury boilers is capable of generating 987,000 lb per hour of mercury vapour, which enters the mercury turbines in the dry, saturated state, at an absolute pressure of 128 lb per square inch and at a temperature of 962 deg. Fah. After leaving the turbines at an absolute pressure of 2·53 lb per square inch and a temperature of 528 deg. Fah., the mercury vapour enters the mercury-condenser steam boilers, where, in giving up its latent heat, it generates steam at a temperature of 496 deg. Fah. and a pressure of 643 lb. per square inch. The liquid mercury is fed back to the mercury boilers by two 200 h.p. feed pumps, and the steam is passed through two superheaters situated at the top of the mercury boilers. The superheated steam enters the steam turbine at the rate of 248,700 lb. per hour and at a total temperature of 825 deg. Fah. and a pressure of 600 lb per square inch. The steam turbine exhausts into a surface condenser maintained at a temperature of 79 deg. Fah. and an absolute pressure of approximately 0·5 lb per square inch. Finally, the steam condensate is pumped back to the mercury condenser-steam boiler. Taken as a whole, the Schiller power plant has a fuel rate of 9420 B.Th.U. per net kilowatt-hour, when burning pulverised West Virginia bituminous coal having a higher calorific value of 13,500 B.Th.U. per pound. This fuel rate, it is claimed, makes this installation the most efficient 40MW generating unit in the United States.



BOILER TUBE CIRCUIT

Cycle Efficiency

The mercury portion of a mercury-steam cycle is usually considered as a topping cycle, regardless of whether the lower steam portion is used to produce additional power, as in the case of the Schiller station, or for process work. In order to illustrate the reasons for the high mercury topping power ratios, and, hence, the low overall plant heat requirements in such installations as the Schiller station, the total heat of the mercury vapour and of high-pressure steam have been plotted in the graph reproduced herewith corrected to the same total heat which is contained in 1 lb of steam at 2300 lb per square inch absolute and 1050 deg. Fah. (1497·1 B.Th.U.). For this total heat 9·7 lb of mercury vapour must flow through a mercury turbine for each pound of 2300 lb per square inch absolute steam flowing through a 2300 lb per square inch absolute steam turbine. As a basis for comparing the topping capabilities of these two cycles, the upper curve is a plot of the available energy of approximately 9·7 lb of mercury vapour when used to produce topping steam at various pressures in the mercury condenser boilers. The lower curve is a plot of the available energy of 1 lb of 2300 lb per square inch absolute steam used in a turbine, exhausting at various back pressures.

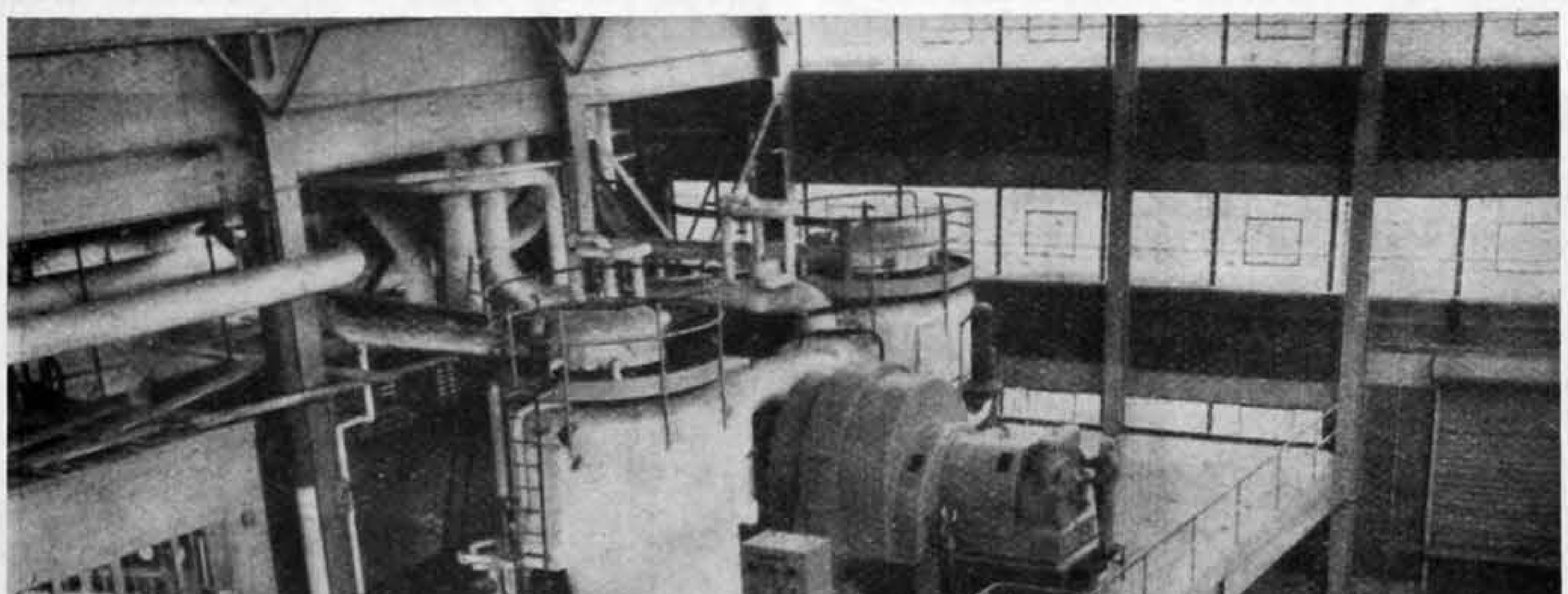


FUEL OIL BURNER HEAD

At 400 lb per square inch absolute steam pressure the available energy ratio of mercury to steam is 442/220, or almost exactly 2 to 1, and at 1250 lb per square inch absolute the ratio is 320/87, or almost 3·7 to 1. The fact that the available energy of mercury vapour changes only about 27·5 per cent when producing steam in the condenser boiler at pressures varying from 400 lb to 1250 lb. per square inch absolute has made it possible to design standardised mercury units for wide ranges of steam pressures with a relatively small change in mercury-turbine output.

Boilers and Machinery

The drawing on the opposite page shows a longitudinal section of the station, facing south. The physical lay-out of the plant was arranged to facilitate equipment operation and to take full advantage of site conditions with regard to supplying the plant with the necessary cooling and condensing water and with fuel. The condensing water intake screen house is situated on the river bank east of the main building; the coal and fuel oil storage yards and the high-tension switch yard have all been erected on high ground beyond the railway tracks, west of the power-house. The station building was designed with the main entrance, the station supervisory offices, the testing laboratory, and the electrical control and electrical switch bays all housed in the low extension on the east side of the plant. The two



TURBINE ROOM WITH MERCURY TURBO-GENERATOR IN BACKGROUND mercury turbo-generators and condenser-boiler sets and the steam unit, with their necessary auxiliaries and accessories, are situated in the large turbine room.

The two mercury boilers, together with their coal and alternative fuel oil supply systems and other associated equipment, are housed in the high boiler and coal preparation rooms adjacent to and west of the turbine room. Also situated within this area are the various water treating, water storage and feed water heating equipments, auxiliary power supply equipment and other accessories. The two induced draught fans, with their one centrally placed stack, and the ash precipitation equipment, are mounted in the low extension at the extreme western end of the building.

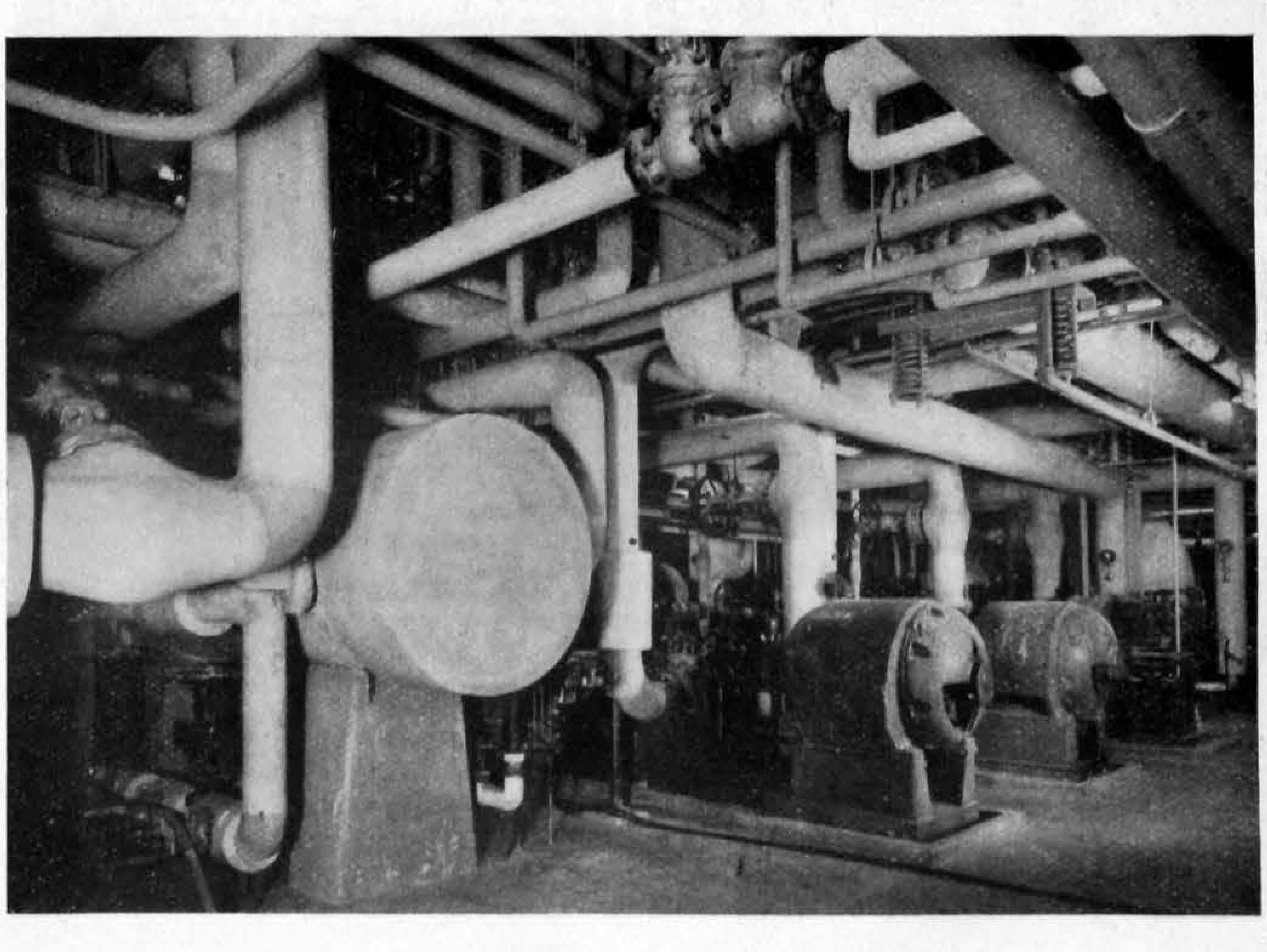
On page 791 is a diagram showing a typical front wall tube circuit as used in the two mercury boilers. The mercury flows upward through the furnace portion of the circuit, then flows horizontally in the roof section, downward through the vertical slag screen elements and again horizontally through the fog convection surface. It thus reaches the boiler drum, where final separation of the vapour and the entrained liquid occurs. An identical circuit was used in the boiler of the Pittsfield works power station and, except for the omitting of the lower sloping end, in the boiler of the South Meadow station. The extensive use of this general type of flow circuit in all modern mercury boiler designs of the General Electric Company has led to single-drum boiler units of simple design, requiring a minimum quantity of liquid mercury for the operation of the unit. The cold, as well as the normal operating level of the mercury, is maintained at or near the inside bottom of the boiler drum, thus leaving the upper several feet of the furnace tubes, the horizontal roof tubes, the down-flow slag screen tubes, and the horizontal fog convection passes entirely empty at starting. When the boiler is fired, heat absorbed by the mercury within the furnace tubes produces circulation as a result of the thermal vapour pump formed therein. As the firing rate increases, circulation improves until a definite and positive flow of mercury vapour liquid mixture is established throughout the entire flow circuit. The previously empty upper portion of each flow circuit has now become filled with a high-velocity heat-absorbing fluid having a density of from 30 lb to 10 lb. per cubic foot, depending upon the portion of the circuit under consideration. Uninterrupted and steady circulation is usually attained at or near 25 per cent of design full-load flow, hence establishing the minimum continuous operating rate of the mercury boiler. A dilute amalgam of magnesium and titanium is dissolved in the boiler mercury and, due to the positive wetting ability of this amalgam in the boiler tubes, the tube circuits remain at safe operating temperatures at lower heat inputs even though the circulation at this low load may be intermittent and erratic. Operating experience gained in the existing mercury power plants, which employ the dissolved amalgam, indicates that heat transfer failures due to non-wetting and the wastage of the internal tube surfaces due to solubility of the tube material in mercury have been entirely eliminated. Any mercury boiler utilising the simple circuit indicated will contain a minimum of mercury, because the only pressure parts which contain mercury at starting are the portion of the surface tubes below the drum and the downcomer supply pipes and lower headers. The quantity of mercury thus required is only a fraction of what would be used if the boiler drum were mounted in the usual position at the top of the furnace and all the tubes were liquid-filled as in the normal steam boiler. Unlike the condition prevailing in the usual steam boiler, cooling for the otherwise empty tubes above the cold level is provided directly from and by the boiling mercury in the furnace tubes. No additional mercury make-up is required as a consequence of the effects of thermal expansion, since direct bloating of the vaporising mercury in the tubes is sufficient to provide the needed fog mixture.

ELECTRICAL CONTROL ROOM

The station has been designed to burn either bunker "C" fuel oil or pulverised bituminous coal. Each of the two sets of fuel-burning equipment is of standard design, with the exception that a set of low-load fuel oil burners has been provided for each mercury boiler to satisfy expected station minimum load conditions. When the plant is operating on bunker "C" fuel oil the fuel oil flows by gravity from the main storage tanks into a 2400-gallon station storage tank situated in a concrete vault at the west end of the building. The fuel oil is then pumped from the storage tank through a fuel oil heating system, is metered, and finally burned in the mercury boiler furnace at the rate required to satisfy the station load demands.

When it is desired to burn pulverised bituminous coal, crushed coal from the storage yard is brought into the station by means of an inclined belt conveyor, which distributes the coal to a 1100-ton coal bunker mounted in the coal preparation bay at the front of the two mercury boilers. The coal flows downward from the bunker through suitable pipes; it is weighed and then pulverised before entering the furnaces. Fly ash produced from the burning coal is caught by fly ash precipitation equipment and is removed from the station by a pneumatic removal system. The entire station follows, to a considerable extent, the general design and arrangement of conventional steam generating stations, with only minor alterations in the arrangement of the equipment to meet the requirements of the mercury-steam cycle.

The electrical control room is elevated above the turbine room floor so that the control room operator has a complete view of the main operating floor, upon which are mounted the two mercury turbo-generator sets and the steam unit. Actual control and operation of the mechanical equipment within the station is performed from the centrally situated supervisory control room on the main operating floor. Practically all of the station auxiliary equipment is started or stopped by suitable control switches in this room; however, the three main turbine sets must be started by hand control on each unit. Once the main equipment is in operation and "on line," the complete control and loading of the units is either by



BOILER FEED PUMPS

manual control or by full automatic control from the supervisory control room.

There are four fuel oil burners per boiler, the firing rate of which is regulated either automatically by the automatic combustion control equipment or manually from the supervisory control room. Unlike conventional steam generating station practice, when the plant is operated at base load, the two mercury turbines operate with their control and stop valves in the wide-open position, thus receiving their mercury vapour directly from the vapour drums of the mercury boilers. The electrical output from the mercury turbo-generator is therefore a direct function of the rate of vapour generated by the fuel supplied to the mercury boiler fuel burners. Hence the greater the electrical load demand, the greater the direct fuel requirements. The effect of such an operating procedure upon the output of the 25MW steam turbo-generator is quite definite and positive, as the steam produced by the rejected heat of the mercury turbine exhaust has to be utilised by the steam turbo-generator to produce some 60 per cent of the total electrical output of the station. Therefore, as in the two mercury-turbine sets, the electrical output of the steam unit and, subsequently, of the entire station is almost a direct function of the rate of fuel burned in the mercury boilers. Thus, an increase or decrease in the load demands upon the station has to be satisfied by an adjustment in the quantity of fuel burned.

If desired, the station can be operated to control the system frequency by appropriate manipulation of the steam and mercury-turbine speed governors. At present the station is operating as a base-load unit, thus utilising this efficient power plant to produce the maximum amount of energy generated at the favourable rate of 9420 B.Th.U. per net kilowatt-hour for use by the system. The electrical energy is generated at 13·8kV, three-phase, 60 c/s, and the output of the three generators is paralleled on the 13·8kV bus, from which outgoing feeders are carried to the step-up power transformers situated in the outdoor substation.

Auxiliary Equipment

Power for operating the station auxiliaries is taken from the main bus through two transformers which supply two groups of 2·3kV auxiliary switchgear. Connected to each one of these groups is a load-centre substation for 460V services. All motors of 100 h.p. and more are supplied at 2·3kV from the 2·3kV switchgear, and the integral horsepower motors of less than 100 h.p. are supplied at 460V. Fractional horsepower motors and the station lighting system are supplied at 115V or 230V through small air-cooled transformers connected to load-centre feeders. Should the main power supply fail, a sixty-cell storage battery supplies energy for station controls and for emergency lighting. Automatic equipment is used extensively for transferring auxiliary supply sources and bringing reserve auxiliaries into operation. An extensive visual indicating system informs the control room operators of the occurrence of abnormal conditions in the operation of the station, while an automatic telephone system and a separate loudspeaker paging system provide intercommunication throughout the station.

While its present capacity is 40MW, the Schiller station has been designed to allow for the building being enlarged to install boilers and generators for four times this output, still using the present dockage and fuel-handling facilities. As now completed, the cost of construction of the station was approximately 13,000,000 dollars.

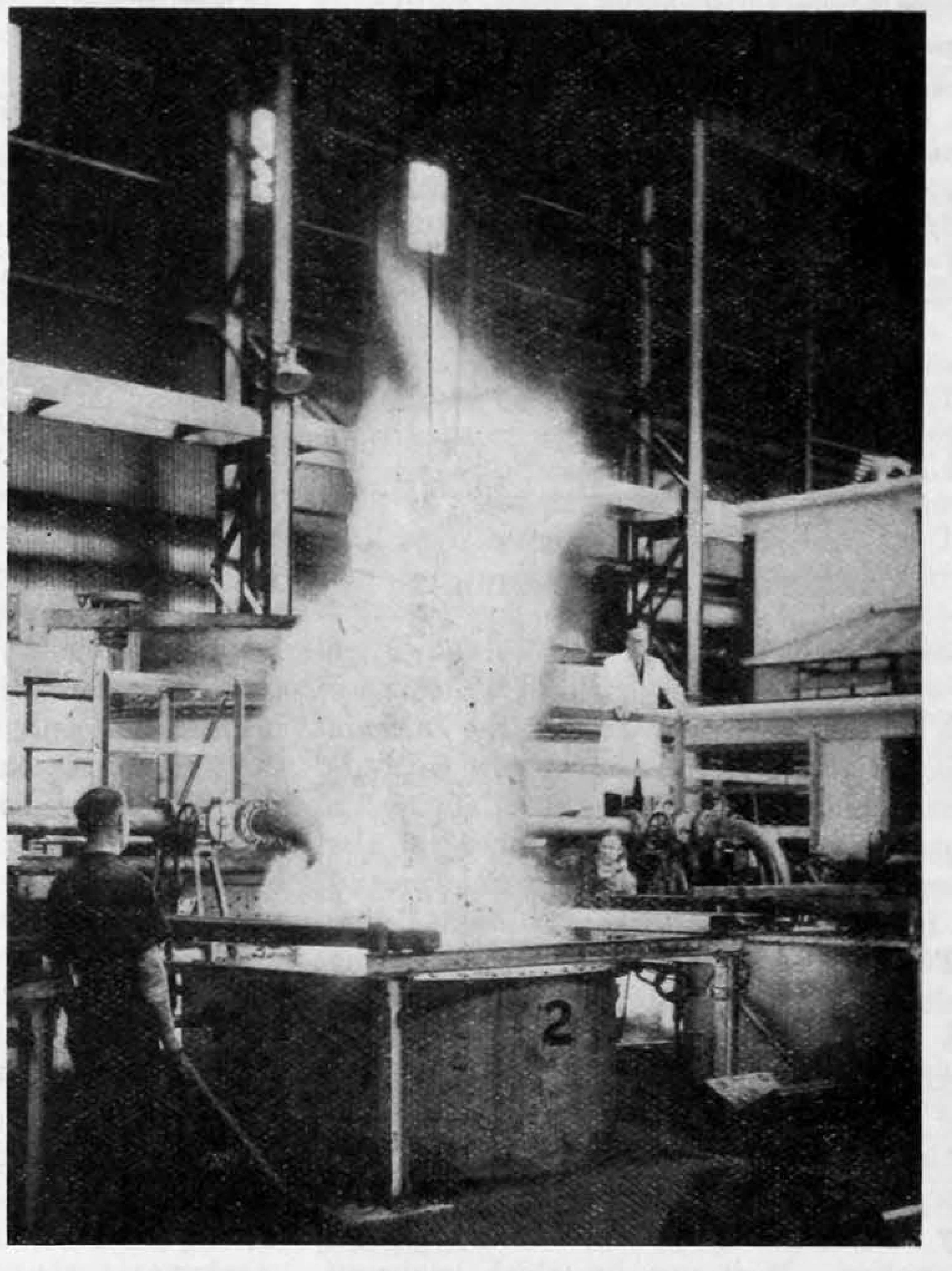
Ministry of Works Building Exhibition at Chester.—The Modern Building Exhibition at the Little Roodee, Chester, will be opened on Friday, June 22nd, and will be open until June 30th. One of the main features of the exhibition will be a demonstration of mechanical aids to building by fifty manufacturers of plant and equipment, and there will be exhibits entitled "Building Research and Housing," "Modern Site Organisation," "Plumbing" and "Careers in Building."

The Royal Ordnance Factory, Nottingham

During our tour of armament establishments we have so far been able to see many of the manufacturing processes associated with the armament, hull and sub-assemblies of the "Centurion" tank on which most of these establishments have been partly engaged. The R.O.F., Nottingham, which we visited recently, is likewise occupied but is also heavily engaged with other armament work and with certain outstanding "civilian" contracts. The main production work of the factory is the manufacture of light and medium anti-aircraft guns and mountings. It is also committed to the complete overhauling of the "Comet" tanks and it undertakes the manufacture of the twenty-pounder gun barrel and other components for the "Centurion" tank.

The factory consists of several buildings, of which one of the largest is the machine shop, containing twenty-three bays and completed in 1939. A new building to be put up will occupy 50,000 square feet.

Amongst the varied civilian work which is now being completed are several kinds of tenoning machines, band saws, paper-making machinery, 4000kW generators and hosiery machines. The latter have a single bed-plate, 56ft long, and comprise twenty-eight stations, upon each of which is formed a fully-fashioned stocking every forty minutes. In the manufacture of the woodworking machinery the establishment designed welded fabricated frames in place of the cast frames normally used, to ease the demand for iron castings.



Soaking and Oil Quenching Pits

A considerable portion of the establishment is engaged upon the overhaul and reconditioning of the "Comet" tank. The tank is stripped of all assemblies down to the hull structure, and different bays are devoted to the reconditioning of the turret and elevation gear, track and other assemblies, which parts finally return to the re-assembly bay.

The single and twin-barrel 40mm "Bofors" anti-aircraft gun, complete with cast aluminium barbette, is also manufactured at this factory. The gun is water-cooled, has a rate of fire of 150 rounds per minute per barrel, and can be fired by remote control or by hand.

Another shop is mainly concerned with the production of track tensioning components, which are drop-stamped. The shop is equipped with gas-fired furnaces, roughing hammers and with Davy drop hammers, ranging from 2 cwt to 5 ton capacity. The stampings finally pass to a finning machine.

In one section of the forging shop are several presses, the largest being a 1000-ton hot hydraulic press, with which tank plating, armoured or otherwise, is shaped. The main bay contains the forging hammers and soaking pits used in the production of the twenty-pounder gun barrel. The barrel is worked from a bloom 14in square by 9ft long and leaves the forge 23ft long with diameters tapering from 12in to 8in. The forging installations consist of two 1500-ton and one 1200-ton forging hammers by Duncan Stewart and Co., Ltd. During the forging sequence the bloom is normally counterbalanced and supported by a single crane using a chain turning sling.

In the machine shop, the barrel is centred and rough external turning is carried out on normal centre lathes using three steadies. The barrel then passes to high-speed boring and trepanning machines. The removal of the barrel core by trepanning is at present under intensive development for this particular gun and the machine used is a converted Urquhart, Lindsay and Robertson Orchar lathe.

The barrel is next heat-treated and is placed in one of a battery of eight Birlec electric furnaces and soaked for four hours at 850 deg. Cent. On removal it is immediately quenched in oil contained in vertical steel-lined concrete pits 30ft deep. These pits lie adjacent to the furnaces and parts of both these installations can be seen in our illustration. A test specimen is sawn off for immediate analysis and, if satisfactory, the barrel is again soaked for four hours at 650 deg. Cent. and oil cooled. There is sufficient metal in excess of the required length to enable the hardening and testing process to be repeated several times if necessary.

In preparation for the auto-frettage process the barrel is further machined to very close limits. To ensure removal of the swarf during boring, the cutting lubricant is supplied internally at a pressure of 200 lb per square inch. The auto-frettage process is followed by further heat-treatment, after which the barrel is prepared for the muzzle brake and breech ring, the bore is rifled and the gun assembled ready for proof firing.

THE ENGINEER

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Contents

EDMONTON AND ENGINEERS

SOME weeks ago the people, the Press and eventually the Parliament of this country were agitated by the attempt of the Durham County Council to force upon new entrants to its teaching staff a rule that all applicants must be or must become members of the appropriate trade union. That rule proved far from welcome to the National Union of Teachers, the union concerned, and the teachers, being a well-organised body, were able eventually to defeat the attempt to interfere with their professional independence and freedom. Under the instruction of the Minister the Council had to withdraw the offending rule. More recently a very similar instance has been brought to our notice. It is one by which engineers are affected. In relation to the appointment of a Borough Engineer and Surveyor, the Edmonton Borough Council has laid it down as a condition that "the person appointed shall, during the term of his employment by the Council, be and continue to be a member of a trade union affiliated to or specified by the Trades Union Congress or eligible for affiliation to the T.U.C."

The parallel with the situation that arose when the Durham County Council attempted to enforce compliance with a similar condition is complete save in one thing alone. Teachers are highly organised to resist encroachments upon their liberties. But professional engineers are not. For the great and very influential engineering institutions to which so many engineers belong are learned societies whose job it is to encourage education and advance the science and art of engineering, and not bodies which can concern themselves with the salaries and conditions of service of their members. The body that brought the matter to our notice, and about whose activities in relation to it we published an announcement last week, was the Engineers' Guild. Unfortunately that body, founded shortly before the war to watch over the interests of its members and of professional engineers in general, is still, upon a count of its members, relatively small and lacking in the power that the National Union of Teachers was able to exert at Durham. It has, however, done very well to draw attention to a matter in which all professional engineers are deeply interested. For though we see no reason why, upon grounds of professional etiquette or upon any other, a professional engineer should not, as an individual, choose, if he so wishes, to belong to a union, or to any other association, we regard it as highly undesirable that his independence should be limited by any fear of dismissal or of loss of status through his failure to join. We cannot, indeed, better express our feelings about the action of the Edmonton Council than by quoting from the letter that the Guild has sent to it. "To require as a condition of employment that professional engineers be members of a trade union or any other organisation, apart from such as are recognised as conferring an appropriate professional qualification, constitutes an unwarrantable interference with their professional and personal freedom, and is contrary to the interests both of the engineering profession and of the public which it serves." Copies of that letter of protest have been sent, as we noted last week, to the Minister of Transport and the Minister of Local Government and Planning; and the Guild, in conjunction with the National Association of Local Government Officers, has, we understand, arranged for a question to be asked in the House of Commons early next week. Remembering the reaction of the Government in the Durham County Council affair, we shall be interested to see what reply is elicited on this occasion.

That two such similar attempts by local authorities to dictate to their employees should have occurred within the passage of a few weeks of time may at first sight seem coincidental. In fact it is not. For the ability of authorities to impose such a condition of employment dates back to the repeal in 1946 of the Trade Disputes and Trade Unions Act of 1927, which was at the time of its enactment so much resented by the socialists. The Act was, indeed, so very much resented that when the Labour Government came into power after the war it found it necessary, despite the appeals of the Opposition that certain clauses ought to be retained, to repeal the whole Act. Thereby the salutary clause in that Act that "it shall not be lawful for any local or other public authority to make it a condition of the employment or continuance in employment of any person that he shall or shall not be a member of a trade union," &c., lost the force of law. It is our impression that upon the repeal of the Act a number of authorities (presumably those whose Councils were ruled by socialist majorities) hastened to insert in all contracts with new employees just such a condition as the Act had banned. If that impression is correct it is likely that in the future a number of other attempts at dictation similar to those at Durham and Edmonton and affecting professional men may occur. In fact the matter raised by the Engineers' Guild may be not an isolated instance of a Council over-zealously using its powers, but merely a particular example of a general trend. If so it seems to us desirable that the whole situation should be investigated. No doubt the Guild and the National Association of Local Government Officers are looking into that aspect of the matter. We feel sure that they will prove ready to draw the attention of Ministers and Parliament to the situation if there seems any likelihood of widespread local authority action of the undesirable kind concerned. They have behind them the very real even if somewhat inarticulate support of the vast majority of professional engineers.

REPORT ON COAL

FINANCIALLY, as the Report of the National Coal Board for 1950, issued last week, reveals, the year 1950 was a successful one. A nationalised industry, we gather, is not permitted to earn anything so immoral as a "profit" but a "surplus" of £8·3 million was made and the accumulated deficit of the Board was thereby reduced to £4 million odd. It is, of course, satisfactory to find that the industry has placed itself upon a sound financial footing even if in order to do so it has had to lift the price of coal to the highest figure on record. But coal users will find little else in the report that is particularly encouraging. It is true that in 1950 there was an increase in output as compared to that of 1949. About 1½ million tons more coal were brought to the surface, so that, allowing for a small fall in open-cast output, a supply of coal increased by 1·1 million tons was made available. But demand increased more rapidly than did supply. Power stations, gasworks, industry and the domestic user all demanded more coal. Only the railways and the iron and steel industry economised sufficiently to reduce their requirements. Inland consumption as a whole increased by 6 million tons and, though there was some reduction in the amount of coal going to exports and bunkers, the net effect by the end of the year was that stocks were drawn down by over 3 million tons. Since the amount of coal in stock at the beginning of a winter has never been really adequate since the end of the war, that reduction led directly to the near-crisis of the spring, when, but for the unusual mildness of the weather and the economies in usage that industrial firms up and down the country were able temporarily to make without much loss of output, there might well have been a really serious need to close down power stations and factories for lack of fuel.

Each year users of coal examine the Coal Board's report predominantly in the hope of discovering what measures that Board is taking to increase output. In a limited sense the present report is encouraging upon that point. One of its chapters reviews "the Year in Each Coalfield." In that section there are repeatedly to be found such remarks as "face output per manshift at Tilmanstone reached 95·3 cwt in 1950 compared with 85·4 cwt in 1949." Again, under the longer term developments contemplated for each division there are many remarks similar to the following, which relates to the North-Eastern Division: "A scheme for the underground development and mechanisation of New Monckton was approved during the year and should through the development of the Kent's Thick seam increase annual output by over 200,000 tons." The impression is certainly given that the Board is energetically pressing on with improvement schemes, reorganisation and mechanisation. But the effects upon total output seem painfully slow in appearing! For the central factor ruling over the whole report is that of manpower. Early in 1950 the "ring-fence" that prevented men leaving the industry was removed by the Government on the advice of the Board. The eventual consequence of that action remains still in doubt. Its immediate outcome was a fall in manpower in every division, reaching, in the West Midlands Division, as much as 6·2 per cent. A total of 75,800 men left the industry during the year. But on the other side of the account the removal of the restriction seems to have encouraged men from other industries to enter coalmining. Some 55,300 joined it and by the end of the year and during the present year the rate of recruitment exceeded wastage. It remains to be seen how long that trend will continue. If it does continue the fruits of the Board's works of improvement may at last become noticeable in a welcome increase in coal output for 1951.

In 1950, thanks to improved methods, mechanisation, &c., and to a small, though very welcome, reduction in voluntary absenteeism, output per man year rose to 293 tons, as compared with 282 tons in 1949. The effect of that improvement, however, was hardly more than sufficient to counteract the fall in manpower so that very little more coal was raised in 1950 than in 1949. Since the manpower situation is now improving again it seems reasonable to assume that the output of coal in 1951 may show some quite considerable increase. But will the output be large enough to meet the demand? Predominantly what this country needs at present is that its floating stocks of coal, those stocks that fluctuate in amount from a maximum in the autumn to a minimum in the spring, should be built up to a figure large enough to give cover against all ordinary hazards, such as an unusually harsh winter; and that they should be so distributed as to make users independent of the disruption of production and distribution when railway workings are temporarily interrupted by snow and fogs. But where is that extra coal to come from? It seems to us possible that some may be found in the present year. For, in consequence of raw material shortages the industrial output of this country in 1951 is likely to be restricted. If so and if, through the influence of increased manpower, more coal than was raised in 1950 is raised in the present year, then some surplus may appear, sufficient, at least, to make a beginning in building up stocks to a safer level. But if the surplus is to be available for that purpose the Government and the Board will need to refrain improvidently from promising export coal to Europe. It is needed here. Indeed, for our part, we doubt whether this country will ever again become a large-scale exporter of coal. Certainly it cannot do so for many years to come. For even if the output of deep-mined coal is substantially increased it can hardly be regarded as so sufficient in amount as to justify exportation until it has become possible to do without the 12 million tons of low-grade, dirty coal at present won annually from uneconomic and undesirable open-cast workings.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

"CASTLE" CLASS ENGINES, W.R.

SIR,—Referring to the letter from Mr. E. C. Poultney in your issue of May 25th, the graphs relate to the work of the "5098," or Hawksworth series of "Castles" operating with the exhaust steam injector, and the fuel was Markham Grade 1, Welsh coal of 14,350 B.Th.U. per pound, as fired, or 14,420 B.Th.U. per pound of dry coal. I may add that the larger superheater in the "5098" series compensates for a shortening of the tubes that was found desirable, to avoid burning; it provides better joints at the header, a freer flue area through the superheater flues, and a somewhat increased thermal efficiency.

Perhaps I may be permitted to add brief details of yet another excellent run with these fine engines, made only a few days ago with one of the new Festival trains—"The Merchant Venturer." The train was heavily loaded to 414 tons tare, 445 tons gross behind the tender, and departure from Chippenham was 7 min late. By dint of a rapid start, with 56 m.p.h. attained in 3 miles of falling 1 in 660 gradient, an increase to 61½ m.p.h. on the subsequent 1 in 660 rise, and a notable climb up Dauntsey bank—1½ miles of 1 in 100 at 50¼ m.p.h.—a minute was regained on the sharp timing of 22 min for the 16·7 miles Chippenham to Swindon. Then the 41·3 miles on to Reading were covered in 39 min 40 sec start to stop, with speed averaging 74·6 m.p.h. over the 14·4 miles from Didcot to Tilehurst, where the gradient is nowhere steeper than 1 in 1320. The arrival at Reading was 2½ min ahead of time. This ability to sustain 75 m.p.h. with a 445-ton train on a virtually level track should be noted, and on arrival at Paddington I learned that this running was made with the reverser in 15 per cent cut-off with the main valve of the regulator just open. The arrival in Paddington was 1½ min early, despite a very long slack for permanent way work near West Drayton. The engine was one of the "5098" series, No. 7019, "Fowey Castle."

O. S. NOCK

Bath, June 9th.

Literature

Elementary Theory of Structures. By J. C. GRASSIE, B.Sc. (Eng.), D.Sc., A.M.I.C.E., A.M.I.Struct.E. London: Longmans, Green and Co., 6 and 7, Clifford Street, W.1. Price 25s.

IN this book the author has followed the excellent principle of clearly defining the scope of his work and then dealing comprehensively with every aspect of the subject within the limits imposed. The nineteen chapters, written strictly to cover statically determinate structures, deal with geometrical properties of sections, the graphic representation and resolution of forces, the solution of simple and more complex trusses, the detailed analysis of simply supported beams, live loads and the theory and application of influence lines, elastic deformation of structures, the study of columns and simple three-dimensional triangulated frames. The approach to the subject is pleasingly scholarly, yet sufficiently practical to appeal to designing engineers. A characteristic of the book is the wide use which the author has made of graphical methods. In structural engineering, where it is often essential to visualise displacements and the play of stresses, the merits of graphical solutions cannot be overstated. The chapters on elastic deformations in framed structures and Williot diagrams are especially useful and form a sound basis for the study of displacements and prestressing in trussed structures. The classical methods of strain energy are also dealt with, but no mention is made of the neat representation by Mohr's circle.

Much of the book is devoted to the study of influence lines, a notable improvement on many textbooks published on theory of structures, which often do little more than mention this elegant method of solution. Here the author has fully developed the theory of influence lines, extending their application, beyond the study of rolling loads and simple beams, to direct forces, bending moments and shear forces in individual members of complex triangulated structures.

Numerous worked examples are given and each chapter is followed by exercises with answers. The book is well edited, and the subject matter is clearly and concisely dealt with. "Elementary Theory of Structures" will appeal to civil engineering students and to designing staff in consulting and constructional engineering offices.

BOOKS RECEIVED

Pressure Vessels. By William Buchan Ritchie. Manchester: Emmott and Co., Ltd., 31, King Street West. Price 3s.

Handbook of Experimental Stress Analysis. Edited by M. Hetényi. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 120s.

Diesel Engine Manual. Edited by E. Molloy. London: George Newnes, Ltd., Tower House, Southampton Street, W.C.2. Price 15s.

Electro-Plating for the Amateur. By L. Warburton. London: Percival Marshall and Co., Ltd., 23, Great Queen Street, W.C.2. Price 5s.

Automatic Control of Industrial Plant and Processes. Manchester: Emmott and Co., Ltd., 31, King Street West. Price 3s.

Die Tragfähigkeit der Zahnräder. By von A. K. Thomas. Munich: Carl Hanser Verlag, München 27, Leonhard-Eckstrasse, 7. Price 12 Dmk.

Philips Practical Welding Course. Second edition. London: Philips Electrical, Ltd., Century House, Shaftesbury Avenue, W.C.2. Price 7s. 6d.

Surface-Water Sewerage. By L. B. Escritt. London: Contractors Record, Ltd., Lennox House, Norfolk Street, Strand, W.C.2. Price 21s.

Make Your Own "O" Gauge Motor. By E. F. Carter. London: Percival Marshall and Co., Ltd., 23, Great Queen Street, W.C.2. Price 3s. 6d.

Navigation in Coastal Waters

Last week the third chain of Decca navigating stations was brought into use after completing a three weeks' test period. It is known as the North British Chain and was formally opened by Air Chief Marshal Sir Frederick Bowhill, Master of the Honourable Company of Mariners, the ceremony taking place at the Wallasey Corporation's new passenger ferry "Royal Iris." The chain extends the Decca service to Scottish waters and the North-Western approaches and follows the geographical star pattern with the master situated at Kidsdale, in Wigtonshire; the red slave at Clanrolla, in Northern Ireland; the green slave at Low Buston, Northumberland, and the purple slave at Neston, Cheshire. The distance between master and the slave stations is about 100 miles, compared with 70 miles on the English Chain, and the longer base line provides the same degree of accuracy over a wider area. By reason of the station positions, greater advantage can be taken of the lobe areas of high accuracy which lie in the angles formed by the base lines. To complete the coverage a South-West British Chain is projected; it will greatly assist ships making landfall to the north of the Bay of Biscay and in the English Channel approaches.

Annual Report of the North of Scotland Hydro-Electric Board

The North of Scotland Hydro-Electric Board's annual report for 1950, was published on June 12th last. The Board installed, during 1950, hydro-electric generating plant with a total capacity of about 198MW and diesel generating sets with a capacity of 6MW, a total of some 204MW. At the end of the year the Board had in operation thirteen hydro-electric, six steam and twenty-eight diesel stations. Nine hydro-electric schemes were under construction and a start will be made soon on the construction of the following five schemes: Gaur and Lawers (Perthshire), Glascarnoch-Luichart-Torr Achilty (Ross-shire), Moriston and Garry (Inverness-shire).

The Board had under survey last year hydro-electric schemes, which it is estimated will have an approximate capacity of 278·5MW, and an estimated average annual output of 1068 million units. They included the Shin, Orrin, Kilmelfort and Breadalbane schemes (which have been published this year) and also proposals to use the water of the Rivers Farrar and Beauly, the Tay Basin and extensions to the Affric scheme. By the end of 1950 the Board's programme of the development of the water power resources of the Highlands had reached the stage indicated in the accompanying table.

	Total capacity (MW)	Estimated Annual Output (kilowatt hours $\times 10^6$)
In operation	199·7	376·0
Under construction	299·3	465·0
Promoted and just starting	198·2	736·0
Promoted	8·1	27·5
Under survey	278·5	1068·0
	913·8	2672·5

The Board gave supplies during the year to a further 22,140 consumers. From January 1, 1948, to December 31, 1950, 56,700 new consumers have been given a supply for the first time in the Board's area. There are about 120,000 consumers, or about 400,000 people still without a supply of electricity. In three years, therefore, nearly 30 per cent of the potential consumers in the Board's area have been given a supply. The total length of distribution lines at the end of the year was 5808 miles, about 310 miles of which were erected during 1950.

The 132kV Highland grid system in operation or under construction at the end of 1950 consisted of 1120 miles of lines and ten switching stations. The Board has promoted ten schemes for main transmission.

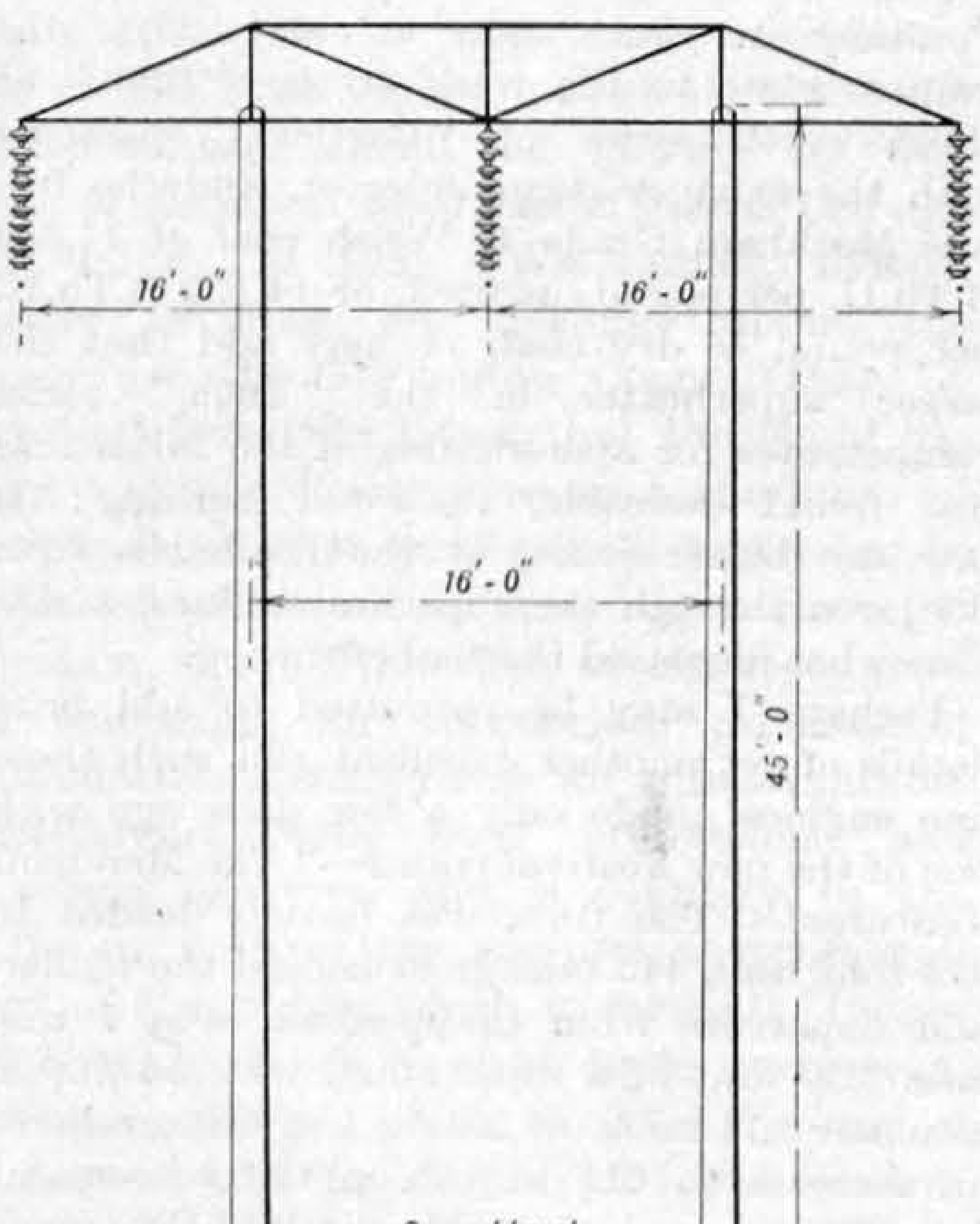
At Caroline Port generating station, Dundee, the rebuilding of an old boiler house for the 15MW closed-cycle gas turbine and the preparation of foundations were completed and the first large component, the air pre-heater, was installed by the end of the year. The turbines, compressor, rotors and casings were being manufactured, most of the blading being already complete; some parts were on the site and others were undergoing tests in the works before being sent to the site.

Research work undertaken by the Board last year included an investigation into new methods of tunnel driving, experiments with an electrical fish screen and an electric enumerator to count fish passing up the fish passes at dams. Research work in connection with a peat-fired gas turbine and the drying of hay by electricity was also carried out. The foundations and steel tower of the 100kW experimental windmill were erected on Costa Hill, Orkney and the machinery after being tested, in the manufacturer's works, was shipped to Orkney in preparation for installation.

132kV Wood Pole Transmission Line

The British Electricity Authority has decided to erect a section of 132kV line to be carried on wood poles. It will be the first departure, since the establishment of the grid, from the standard practice of using lattice steel towers for high-voltage transmission. The two reasons for the adoption of the new construction are the shortage of steel and the possible economies which can be effected in present circumstances.

The first wood pole line is about to be erected for the Authority by British Insulated Callender's Cables, Ltd., to meet the increased loads on the system of the South Wales Electricity Board. It will be a single-circuit line



WOOD POLE TRANSMISSION LINE SUPPORT

with a capacity of 90MVA, between Carmarthen and Haverfordwest—a distance of approximately 30 miles—and it will be carried on "H" supports. For straight-line positions the creosote-impregnated red fir poles will be 45ft "stout" poles to B.S. 139, the spacing between the poles being 16ft. For normal angle positions, a similar construction will be used, but the poles will be suitably stayed. As shown in our illustration, a braced steel cross arm will be secured to the poles by single bolts to form a pin-jointed structure for carrying the insulator strings.

The conductors will be arranged in horizontal formation with 16ft spacing between phases, and the basic span length will be 600ft. Steel-cored aluminium conductors will be used, the size being 37/0·110 (0·175 square inch), which is the standard used for most of the British Electricity Authority's 132kV lines, and the mechanical tension in the conductor at 40 deg. Fah. will be 4370 lb. The designed loading conditions are for a ½in radial thickness of ice on the conductors with a wind pressure of 8 lb per square foot. The factor of safety of the conductor at 22 deg. Fah. under these conditions is 2·2, and for the supports and foundations 3·5. No earth wires will be fitted and the steelwork will be unearthed.

Institution of Civil Engineers' Conversazione

The Institution of Civil Engineers' conversazione was this year arranged to take place during the Joint Engineering Conference, and was held on Friday last, June 8th. According to the usual custom at this event, a display of models was on view in the library, including scale models of engineering works at present under construction or recently completed, models of historical interest, and exhibits of structural and physical testing apparatus. Unfortunately, lack of space prevents the mention of more than one or two examples of this interesting collection; however, the prototypes of a number of the models have already been described in the pages of The Engineer.

One of the models which was exhibited by J. A. S. Rolfe was that of a radio-controlled ship used in hydraulic model experiments for the design of ports. The exhibit was arranged to give a demonstration of the model, which is a replica of the P. and O. liner "Chusan," some 12in long. The radio receiver weighs less than 1 oz, and the model is believed to be the smallest of its kind ever built. It is provided with a full set of controls and may be steered to port or starboard, and can go ahead, be stopped and reversed by remote control. The model was designed for use in a tidal model of a harbour used by the prototype ship, and it has proved to be very useful in demonstrating the effect of various water currents on navigation in the harbour and has enabled a satisfactory design of entrance lock to be evolved.

Some of the work of the Department of Scientific and Industrial Research was exemplified by exhibits from the Road Research Laboratory and the Building Research Station. A model of the junction at Gillette's corner on A.4 showed the magnitude of vehicular and pedestrian flows before and after the opening of a pedestrian subway. For journeys through the subway taking approximately the same time as the surface journey, a high proportion of pedestrians used the subway, but for journeys taking ten to fifteen seconds more than the surface journey, it was used by only 10 to 15 per cent of pedestrians. A second exhibit showed a model street, having one half of the road surface rougher than the other. The backgrounds, hedges, houses, &c., were also different on the two sides. The lighting of the street, however, was symmetrical about the centre line, so that the differences in the visibility on the two sides of the road were due entirely to the behaviour of the surfaces on which the light fell and not to the state of the lighting.

Recently several comparatively light buildings, such as houses and single-storey schools, have been erected in Southern England on short bored pile foundations. Holes are cut to a depth of 8ft to 14ft by a hand or mechanical auger, the holes are filled with concrete; light beams, precast or cast in situ, are used to span between the pile heads and the buildings are erected on this framework. The system is particularly attractive where foundations have to be cut in shrinkable clays of the kind which cover much of Southern and Eastern England. Such clays dry and shrink in summer and swell again in winter, and, while they usually have adequate load-bearing strength, foundations on such a site have to be at least 3ft deep to avoid damage due to the seasonal movements. The exhibit at the conversazione explained a little of the work being carried out at the Building Research Station to provide adequate design data for such foundations.

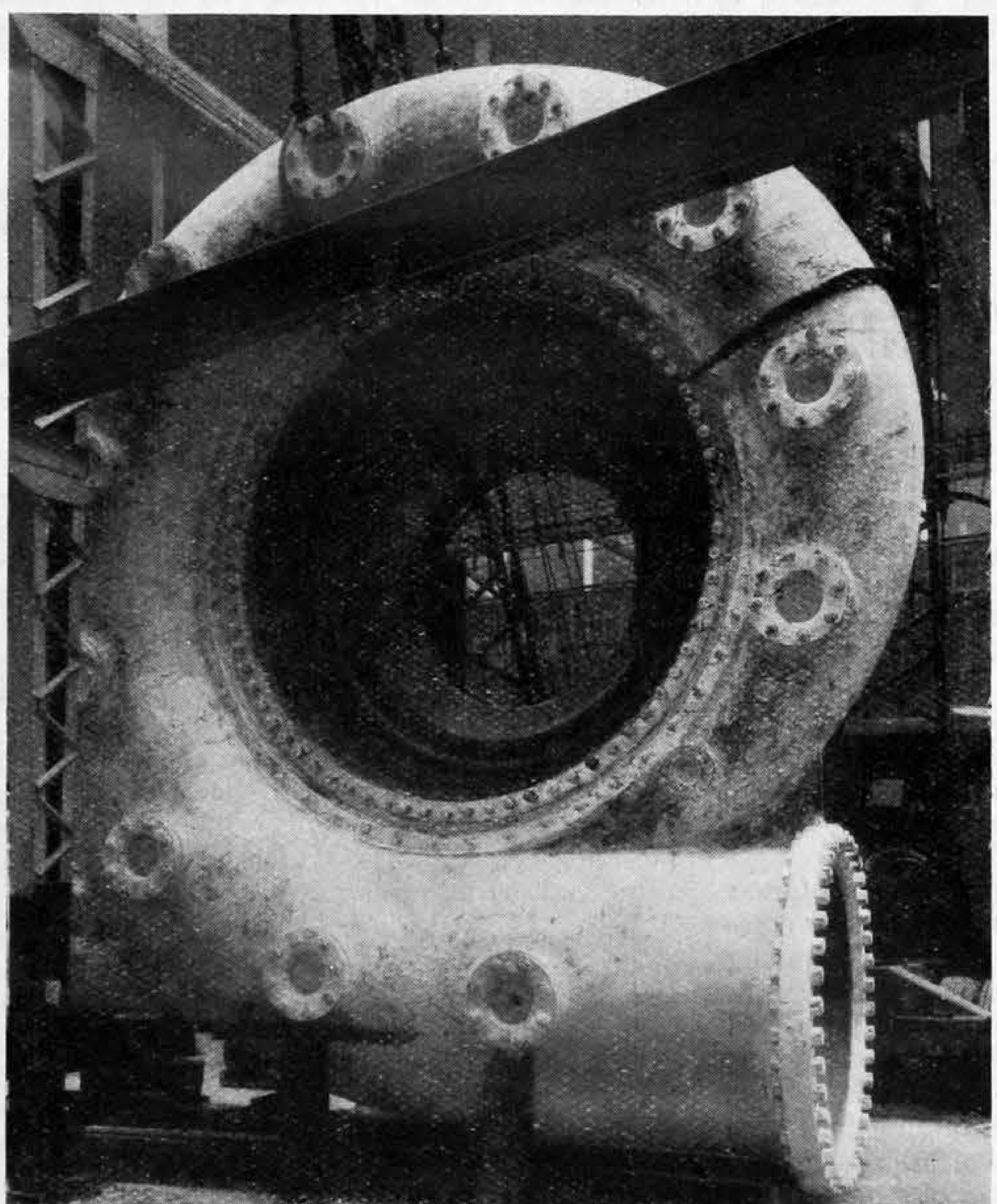
Exhibition of Industrial Power at Kelvin Hall

No. III—(*Continued from page 754, June 8th*)

Hall of Steel

FROM the Hall of Coal the sequence leads to the Hall of Steel through an approach lined with stainless steel sheets. As an example of heavy forging there is a forged steel back-up roll, weighing 31 tons, made by William Beardmore and Co., Ltd., and consisting of a forged steel arbor and an alloy forged steel sleeve, 7½in thick, the barrel being 54in in diameter by 80in long. The roll is specially treated to give a Shore scleroscope hardness of 50/55 deg., and it will be used in the roughing and finishing stands of hot mills in the reduction of wide ferrous strips. The British Gear Manufacturers' Association shows examples of herringbone, spiral bevel and helical gears, while William Jessop and Sons, Ltd., exhibit high-temperature steel gear wheels operating in a furnace chamber raised to 950 deg. Fah. to represent high-temperature working conditions.

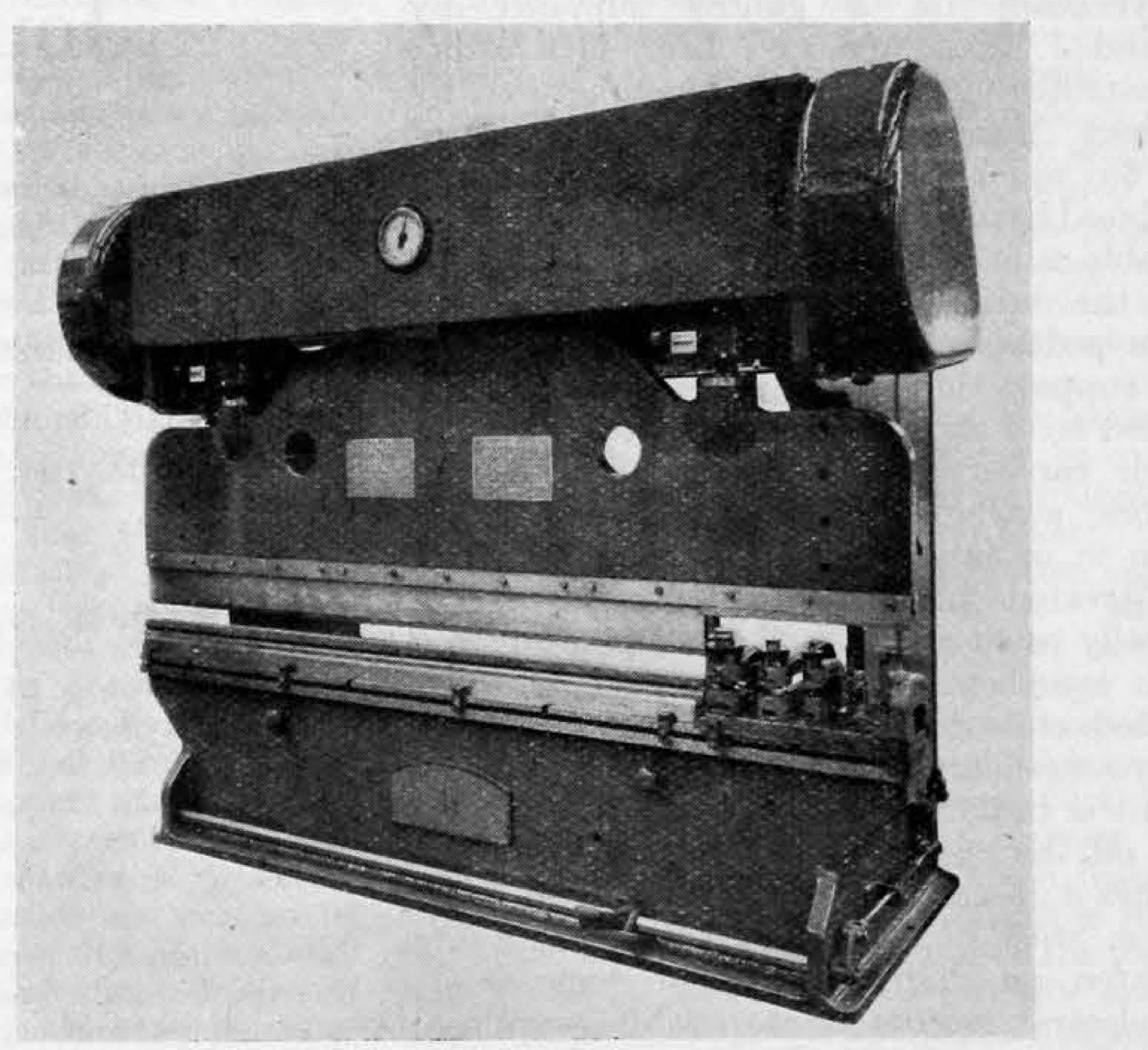
The skill of the foundryman is shown in the form of a cast steel spiral casing for a 56,000 b.h.p., 428 r.p.m., vertical reaction turbine, which will operate on a maximum static head of 953ft. Built by the English Electric Company, Ltd., for the North of Scotland Hydro-Electric Board's Glen Shira scheme, the turbine drives a 50MW alternator. The casing was cast by William Beardmore and Co., Ltd., and machined by Harland and Wolff, Ltd., and has a diameter of approximately 19ft and weighs 38 tons.



FRANCIS TURBINE SPIRAL CASING

To demonstrate the forming of metals there is in operation a blacksmith's shop, fitted with equipment supplied by Alldays and Onions, Ltd. In contrast there is a modern machine shop which is equipped with a "Bronx" 60-ton all-steel press brake manufactured by the Bronx Engineering Company, Ltd., and illustrated herewith.

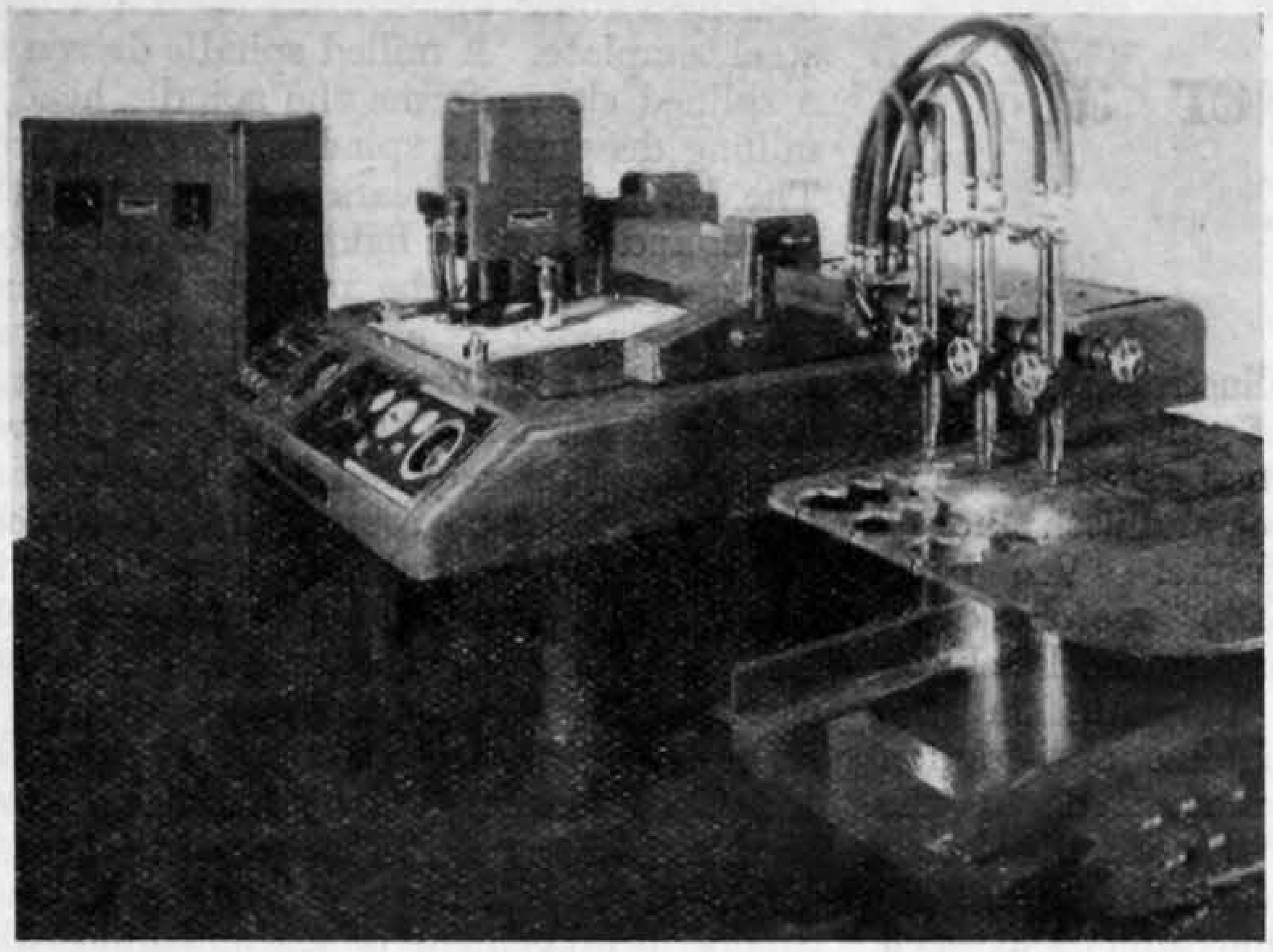
The press brake is of all welded construction of 60 tons normal rated pressure, handles 8ft by ½in mild steel, and with a heavy welded and annealed frame. Vee belts from a 5 h.p. high-slip motor drive a pulley integral with flywheel clutch and lugged brake, all mounted in the first motion shaft, which has anti-friction bearings. Power is transmitted to the second motion shaft, also on anti-friction ball and roller bearings, through steel helical gears and double reduction pinions at each end of the frame take the final drive to twin eccentric solid steel forged shafts. These are carried in a steel crown in large-diameter phosphor-bronze bearings and cast iron pitmans fitted with phosphor-bronze worm wheels, and high-tensile spherical ended screws transmit the power to the steel plate top beam. The press will single stroke by the operation of a ram stop mechanism, which has a lever to disconnect the gear and so allow normal brake press working. A multi-plate dry clutch permits inching to be carried out and a 2 h.p. motor, fitted with safety limit switches, provides for power control of the top beam for die opening adjustment. Lugs cast on the outside of the overhung brake casting provide for barring up in the event of the top beam tool sticking.



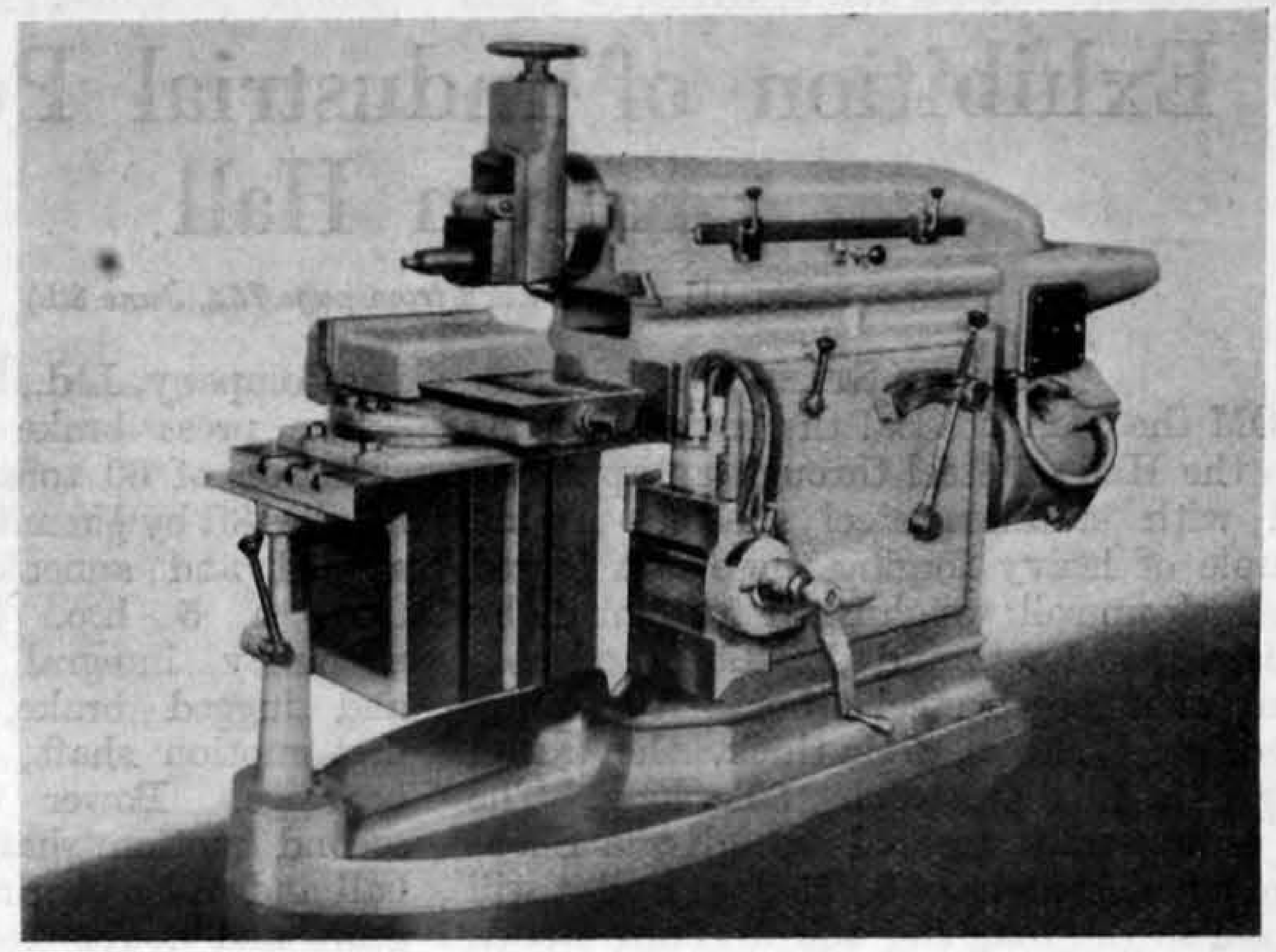
60-TON BRAKE PRESS

The profile cutting machine, supplied by the British Oxygen Company, Ltd., can work from a steel master template through a magnetic roller, a plywood master template by using hand control of the spindle head, a drawing by using hand control of the tracing head and a specially prepared drawing in association with an automatic electronic tracing head. For each of the above methods of working a separate and easily interchangeable driving head is supplied. The magnetic head consists of a mains-energised magnet bearing a roller which loads itself against the steel template. A milled spindle driven from a splined sleeve forms the spindle head, the milling driving the spindle along the profile. The tracing head bears a knurled tracking wheel and a spot of light projected on to the drawing indicates the position of the head, which is guided by a hand wheel. For using the fourth head a specially prepared drawing having ¼inch wide black lines on a white background is required. Guidance of the head is effected by a spot of light projected to fall so that the spot area is equally divided into black and white segments and deviation from this balance causes reaction in a photo-electric cell. The controlling medium is the reflected light received by the photo cell, which provides mechanical operation through circuits to control the steering motor. The photograph which we reproduce shows the general arrangement of the machine, which cuts a minimum radius of 1½in and a maximum thickness of 12in. When using the electronic head the cutting area is 36in by 24in, and this is extended to 44in by 26in when using a template or other means of reproduction.

Another tool, seen in our illustration, is the "Hydetsco" shaping machine, which is sturdily constructed and has a cast ram with large bearing surfaces. Vee-section ram slides have a full-length jib with adjustment for wear, and the guides are protected by a guard at the rear and felt wipers at the front. The heavy box-section swivelling table is supported on a large diameter trunnion and can be clamped in any position. There is a reversible hydraulic power feed for the horizontal traverse, while gears and a telescopic screw which is hand operated, control vertical movement of the cross rail, end thrust being taken on a ball race. Both feeds are fitted with micrometer dials. The tool head can swivel through 60 deg. on either side of zero; the toolbox also swivels and is provided with a tapered location for quick release and elimination of side thrust. A flange-mounted 5 h.p., 950 r.p.m. motor drives a variable delivery pump and a lever, at the pump, controls the ram speed, which can be varied from 0 to 110ft per minute. The ram has a stroke of 24in and the down feed of the tool head is 6in, while the longitudinal feed of the table is 22in, with 8½in vertical feed.



CROSS CARRIAGE FLAME CUTTING MACHINE



HYDRAULIC SHAPING MACHINE

Other particulars of the machine are:— Length of cross slide, 36in; table sizes, 24in by 14¼in top and 14in by 14½in side; and a net weight of 1 ton 17 cwt.

The lathe exhibited in the workshop is a 12in H.D. all-geared head centre lathe, giving a 24in swing over the bed and a 38in swing in the gap, and is a product of the Crowthorn Engineering Company, Ltd. The bed, which is 12ft 9in long, has inverted vee slides and admits 8ft between centres, while the hollow spindle admits 3⅝in diameter and is mounted on Timken taper roller bearings at the front end and parallel roller bearings at the rear. Power is supplied by a 10 h.p. motor through vee belts and a multi-disc friction clutch, and there is a motor-driven suds pump.

Overhead, on a gantry supplied by A. and J. Main and Co., Ltd., is a 5-ton, three-motor electric crane, manufactured by Herbert Morris, Ltd., having a span of 36ft 6in which is representative of the cranes produced by that firm. The driver has a comfortable cage arranged to give good visibility, and the bridge travel gears are enclosed, while pedestals with self-aligning ball bearings support the cross shaft. An electrically welded steel structure forms the crab frame, which carries the traversing and hoisting motors, gearbox and drum. The hoisting drum is of large diameter, driven through heat-treated nickel-chrome gearing by a liberally rated motor, and there is a hoisting rope equaliser pulley supported from a pivoted cross bar. The load is held by an electro-mechanical brake when the hoisting circuit is broken, and a self-resetting switch cuts off the current when the bottom block reaches a specified height. Normalised high-carbon steel hoisting gear spur wheels are mounted on shafts of nickel-chrome steel; the electric motors have flexible couplings. Among the tool room equipment is the "Talysurf" surface measuring instrument, manufactured by Taylor, Taylor and Hobson, Ltd., and illustrated herewith. The instrument measures the roughness of surfaces by traversing a sharply pointed stylus over the surface and electrically amplifying its movements, which are recorded graphically to give a cross section of the surface undulations or a number indicative of the degree of roughness. The pick-up can take either a rounded skid or a flat shoe for generating the datum, and the diamond stylus has a tip dimension of 0·0001in working under a pressure of 0·1 gramme. There is a movable gearbox, a simple stand and an amplifier, incorporating the power pack, which is designed to feed an average meter or recorder. The pen recorder provides a graph having rectilinear co-ordinates, the trace being made by electrical marking on Teledeltos paper. Magnifications normal to the surface extend in steps of 1000 to 50,000 times; those along the surface are 100 or 20 times.

(To be continued)

Joint Engineering Conference

No. II—(*Continued from page 763, June 8th*)

WE continue below our summaries of papers presented at the Joint Engineering Conference in London which comes to an end to-day.

Thursday, June 7th

PORTS AND HARBOURS

By L. Leighton, M.I.C.E., M.I.Mech.E., A.M.I.E.E.

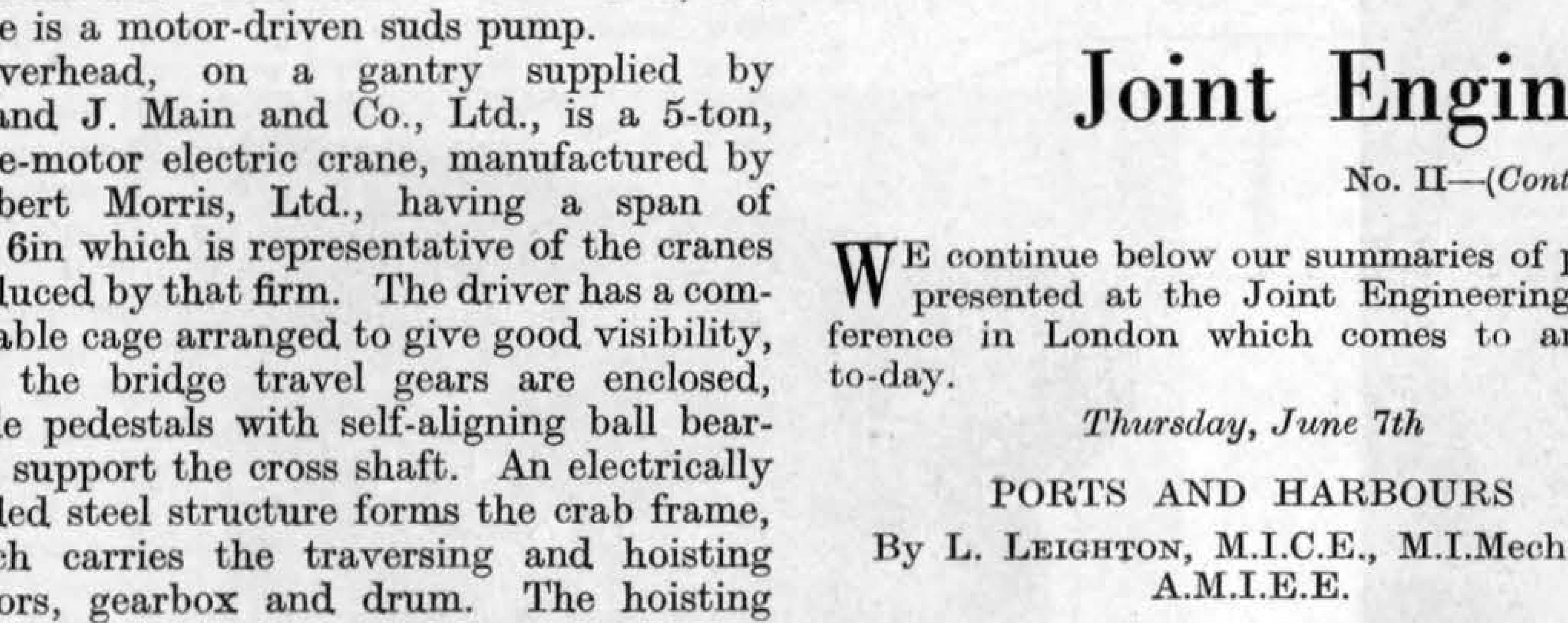
DRY DOCKS

By J. Guthrie Brown

The importance of harbour facilities to Great Britain is reflected by the fact that there are to-day in this country 330 ports, operating under statute, ranging from large passenger and cargo ports to small fishing harbours and harbours of refuge. Of these undertakings, 50 are now controlled by the British Transport Commission, 110 are administered by Harbour Boards, Commissions or Trusts, 70 are owned by municipal authorities, and 100 by companies or individuals. There are also the naval ports. In a large port system, dredgers may have to deal with a million tons of silt a year. Considering the matter on the bed of the seas which is agitated by storms and carried by the great tidal impulses, it seems that some dredging will always be necessary. Even with natural depths adequate for shipping, it is only necessary to study what happened to the ancient ports of the Mediterranean to appreciate the result when artificial means are not adopted to counteract the natural deposits, and there are examples in this country of what were once navigable waterways which are now of little, if any, value commercially.

Generally speaking, a port authority is fully occupied in providing berths and ensuring that the port system will operate efficiently without undertaking warehouse duties, with the one important exception of grain; during the five years 1934–38, some 180,000 tons of grain per week were imported into this country, where the largest silo has a storage capacity of 60,000 tons and a pneumatic plant able to discharge ships at the rate of 600 tons per hour. Engineers have contributed greatly to mechanical handling of bulk cargoes like grain, seeds, coal, ores, petroleum, molasses, latex and sugar.

There are thirty-two major dry docks in the world, ten of them within the British Commonwealth and so well distributed that they might be considered as capable of serving most of the world's main sea routes. Ten are situated around the seaboard of the United States; of the remaining docks, eight are in Europe and one in the Panama Canal Zone. Any forecast of dry docks of the future is linked to the gradual increase in the dimensions of the vessels now building or projected. General average increase in the size of commercial vessels, and particularly the increase in their beam in proportion to their length, continues. In considering the more distant future developments of dry docks, atomic power and the atomic bomb cannot be ignored.



"TALYSURF" SURFACE MEASURING MACHINE

The future impact of these momentous discoveries upon both naval and commercial vessels is a problem to which at present no definite answer can be given.

MECHANICAL PLANT FOR ELECTRICITY POWER STATIONS

By V. Alexander Pask, M.I.Mech.E., M.I.E.E.

In 1882, the Electric Lighting Act was passed, and in 1884 a very important technical advance was the invention of the steam turbine by Sir Charles Parsons, which led to the eclipse of the steam reciprocating engine for power generation on grounds of size and thermal efficiency. From 1905 onwards for twenty years the output of turbo-generators increased from 4000kW to 35,000kW at 1500 r.p.m. The setting up of the Electricity Commissioners in 1919 led to the co-ordination of generation and main transmission on a voluntary basis. During seven years from 1923 to 1929, some 3½ million kW of plant was installed, and by the beginning of the period from 1937 to 1950 the Central Electricity Board had carried out the main functions embodied in the Electricity (Supply) Act, 1926; in 1938 planned control of the output of 171 stations showed that only thirty were running for the whole year, fourteen of the most economical stations supplying 50 per cent of the units generated.

In 1884, Sir Charles Parsons took out his master patents for the steam turbines which also covered gas turbine developments. The first turbines were built by Clarke Chapman at their Gateshead works, and were small non-condensing machines; condensing turbines up to 5000kW output were later built at the Heaton works. Improved blade forms of aerofoil section were established by means of a small experimental turbine. The vertical Curtis turbine was developed in the U.S.A., and the Rateau impulse turbine on the Continent, where large gas engines were used for public power supply. The first diesel engine was built at Nuremburg in 1897. In 1895 there were many improvements in the design of Francis turbines and Pelton wheels, which led to world-wide water power developments.

In Great Britain, fifty-three new power stations have been designed for generating plant to be released in the period 1946–56; twenty-nine stations for the first five-year programme 1946–50 inclusive; twenty stations for the second five-year programme 1951–5 inclusive, and four for the first year of the third five-year programme. World power resources so far used comprise water, coal and oil, with its associated natural gas; the rates of extraction of coal, oil and natural gas during the past century have been so great as to cause anxiety regarding the future power position. In the near future, rapid expansion of water power resources and the more efficient use of coal, oil and natural gas resources are necessary.

Development and use of atomic energy may eventually redress the exhaustion of underground energy resources. Economic studies would appear to justify use of heat from atomic piles for base-load stations with resulting saving in national coal resources. Atomic piles in association with steam plant may become practicable in the near future.

ELECTRIC TRACTION AND SIGNALLING

By C. M. Cock, M.I.E.E., H. H. Dyer, M.I.E.E., and R. Dell, M.I.E.E.

The earliest credit for the conception of an electric railway is due to Thomas Davenport, of Brandon Vermont, U.S.A., who, in about 1835, made many models of electric railway cars which he operated by batteries. In 1842 a Scotsman named Davidson made a 7-ton, two-axle car for the Edinburgh–Glasgow Railway; each axle carried a wooden cylinder on which were fastened three iron bars parallel to the axle. Four electromagnets were arranged in pairs on each side of each cylinder, and a speed of 4 miles an hour was attained with a load of 6 tons. This was probably the first electric locomotive ever to run.

Electric traction first made its appearance in Great Britain in 1883, when the first quarter of a mile of Magnus Volk's railway at Brighton was opened to the public; in September of that year 8 miles of railway between Portrush and Giant's Causeway were electrified, power being supplied by a hydraulic plant, the first example of hydro-electric power used for railway traction. In 1890 the City and South London Tube Railway was opened and was extended to Clapham Common and Moorgate in 1900. British engineers have made outstanding contributions to railways abroad, the most notable works being the electrification of the suburban systems of Melbourne, Sydney, Cape Town, Bombay, Wellington, Buenos Aires, and main lines in India, South Africa, New Zealand and Brazil.

Long before colour-light signals were introduced on railways, electric power was used for operating points and signals. In 1900, the London and North-Western Railway brought into use electric power signalling at Crewe. Power signalling was introduced throughout the District Railway when that system was electrified in 1905, and the same method was employed for the tube railways. The principle of interlocking railway signals and points by electrical circuits, or relay interlocking, was first introduced by the automatic operation of a cross-over and its associated signals on the Mersey Railway in 1923.

Power signalling with its associated track circuiting makes possible the concentration at a central point of signalling controlled from a number of signalboxes. It thus enables signalboxes to be dispensed with and a consequential saving in operating costs to be made. Future development in this respect is largely dependent upon considerations of economy and manpower and the same applies to the extension of the block controls and the introduction of automatic warning control in locomotive cabs.

Friday, June 8th

PUBLIC HEALTH IN MUNICIPAL ENGINEERING

By H. J. B. Manzoni, C.B.E., M.I.C.E.

Civil engineering has a considerable bearing on the health of the people; highway design and construction, for example, whilst devoted mainly to providing convenient roads for all types of traffic, also aims at eliminating risk of accident and such a nuisance as dust, which may be a menace to public health.

The state of British towns and cities in the early years of last century was almost incredible to modern ideas. Often the people of London had no water to drink other than that from the sewer, which slowly trickled under their windows, bearing its quota of dead fish, dogs, cats and filth. Although cholera was rife, the people drew their water from the cesspool. The Public Health Act deals with the problems arising from solid as well as liquid waste, and the two most important subjects which concern the municipal engineer are the collection and disposal of refuse from buildings and street cleaning. Before World War II the quantity of refuse collected and disposed of every year by local authorities in England and Wales was estimated at 14 million tons, at a cost of about £11 million per annum.

Modern street-washing machines hold about 1000 gallons of water in a large tank, and they can be used both for washing streets by pressure and also for damping down refuse, so that it can be easily collected. When used for damping down, the water flows from the machine by gravity, and with one jet working it can cover 4 miles without refilling. If the sprinklers only are used, a similar distance can be covered, but when washing down with four jets under pressure, 1000 gallons of water are used per mile of travel. During a shift of eight hours, allowing for normal delays, a street washer can clean from 12 to 15 miles of road.

Mr. Manzoni refers briefly to the very interesting subject of district heating, pointing out that there is no technical difficulty about it, the problem being largely financial. He states that district heating is the cheapest form of heating for an estate of appreciable size where the whole of each building is heated; the cost, however, is greater than the cost of coal required for fires in only one or, at the most, two rooms of each house. This results in a higher weekly charge than is paid for the normal very meagre heating at present available. For very large estates, steam turbines and high-pressure boilers are necessary to generate electric current, the exhaust steam being used for heating water for the district heating scheme.

THE APPLICATION OF POWER TO AIRCRAFT

By F. M. Owner, C.B.E.

The first successful attempt to produce a power plant for a heavier-than-air craft was made in Great Britain by John Stringfellow just before the Great Exhibition of 1851, his steam-powered model aircraft having flown in 1848. Fifty years later Sir Hiram Maxim had succeeded in reducing the specific weight of a steam power plant from 50 lb per horsepower in Stringfellow's model to just below 10 lb; although Sir Hiram's machine lifted itself from the ground, it never achieved free controlled flight. When this was achieved in 1903 by the Wright Brothers, their power plant was considerably heavier per horsepower than that of Sir Hiram Maxim.

The fundamental principles of aerodynamics were originally laid down by Leonardo da Vinci, but not until Lanchester's work in the early days of the present century were they enunciated and codified in a classical and authoritative manner. A similar basis was laid down for engines by the famous research of Gibson and Heron at the Royal Aircraft Factory as early as 1915, and by 1920 these principles had been embodied in the first successful fixed radial engines, the Bristol "Jupiter" and the Armstrong Siddeley "Jaguar," these having ousted the rotary engine because its cooling system was indiscriminate and not controllable.

To-day, the propeller has a field of usefulness in which it cannot be challenged, because of its high propulsive efficiency. Recent advances in propeller design for high speeds have suggested that they can possibly be used at trans-sonic and even super-sonic speeds. The propeller is accepted as the best mode of propulsion for speeds up to 500 m.p.h. and altitudes up to at least 40,000ft, beyond which the turbo-jet engine has no competitor at present. The piston engine continues to be accepted as suitable for use for transport aircraft with speeds up to 300 m.p.h., and at altitudes up to 20,000ft. For very long duration, compounding is coming into use by the addition of an exhaust turbine driving either the crankshaft or the supercharger. Another specialised application is the helicopter power plant.

The immediate successor to the piston engine is clearly the propeller turbine, or "turbo-prop," engine, which comes into its own at powers around and beyond the natural limit of the piston engine. It is lighter, and can show a competitive fuel consumption at high speeds and altitudes. In flexibility and part load consumption it is intermediate between the piston and turbo-jet engines. These features and the simplicity of aircraft conversion make the turbo-prop a natural successor to the piston engine for the faster modern aircraft, and it may be expected to power aircraft having speeds up to 500 m.p.h. at altitudes up to 40,000ft for a long time to come.

The author writes that it is sobering to reflect that his brief review covers a period of less than half a century, and that the rate of progress has so accelerated that a substantial proportion of the whole development has occurred in the last decade. Power units still discard much more energy than they convert to useful power and the cost of speed has been high. Speed is what the aircraft has to "sell," and, therefore, it is necessary to concentrate on improving efficiency without undue sacrifices in lightness; the most profitable field to explore may be the "no-man's land" between the aircraft and the engine designers.

Many years ago Fokker said that the difference between marine and aircraft design was that with aircraft the "spray" could not be seen, and to that may be added that nowadays much of the spray is very hot. Pending the advent of atomic power—for which it may be necessary to wait a long time—it may be well to remember that the world's vast sources of liquid fuel are neither inexhaustible nor replaceable, and some day it will be necessary to economise. The author hopes that Great Britain can continue to lead the way in the more efficient provision of aircraft power for whatever aircraft the future may have in store.

BRITISH ACHIEVEMENTS IN ELECTRICAL MEASURING INSTRUMENTS

By S. Whitehead, M.I.E.E.

The early workers in electrical science were handicapped by the pitiable inadequacy of the means of detecting electrical currents; the heating of a wire, a gaseous discharge, and even the twitching of a frog's leg were some of the methods used. Enormous advance became possible by Oersted's discovery in 1820 of the deflection of a compass needle by a conductor. In 1821 Faraday showed that Oersted's couple on the needle was counterbalanced by similar reaction on the conductor which, if free to move, was deflected by a fixed magnet.

The integrating meter is the most widely used single instrument and the best known to the general public. Integrating meters have generally been electro-chemical, thermal or electromagnetic, but all types are directly founded on the researches of Faraday. The induction motor lends itself to energy measurement and alternating current, since the current in a disc and the field acting upon it can be made proportional to current and/or voltage. The earliest induction meters were produced about 1888 and they are now the predominating type since alternating current supply is nearly universal.

Sir Ambrose Fleming invented the diode in 1904, the first thermionic valve, and Lee de Forest invented the triode in 1907. These inventions and their developments have had a profound effect on measurements and a thermionic valve will work with a low input energy and up to very high frequencies. The Moullin voltmeter of 1922 opened up new fields because it was suitable for frequencies where hitherto fragile and power-consuming instruments had been used.

The early history of electrical measurements is a history of physical science. Electrical instruments enabled many of the most important discoveries to be made, which, in turn, produced more and better instruments and so led to more discoveries. Then came the development of the electrical industry, which was founded on measurement and uses and relies upon accurate measurement more than any other comparable industry. To-day we see electrical instruments and measuring devices permeating all forms of scientific and industrial activity. It is, indeed, rare to find any measurement in which electricity cannot play some part. Modern civilisation thus depends upon electrical measurements, and the part played by Great Britain in this achievement should be a source of pride and encouragement to future effort.

TECHNICAL ADVANCES IN THE GAS INDUSTRY DURING ONE HUNDRED YEARS

By F. M. Birks, C.B.E., M.I.Mech.E.

The gas industry as a public service came into being with the formation of the Chartered Gas Light and Coke Company in 1812. In those days technical knowledge was meagre and old musket barrels were used for the early gas pipes, giving rise to the expression "barrel piping." As an indication of the scale of development in gas manufacture, the author shows a very fine drawing of the world's first gasworks—yet another pioneer British achievement—of which relics may still be seen in Westminster. This was unique throughout its history, having been used for making two types of gas, namely, gas of maximum candlepower obtained from cannel coal and used to supply the Houses of Parliament, the Royal Palaces, and the purlieus of Westminster, and gas of normal candlepower made from Newcastle coal. This, with similar supplies from two other works, was used to feed the remainder of the district served by the Chartered Gas Light and Coke Company, as it was called.

During the greater part of the nineteenth century, charging of gas retorts was manual, so that the retorts were limited to two or three tiers. This limitation in height of the retort setting, and consequently the restricted amount of gas per unit of ground space, did not affect most works which had ample area. At the St. Pancras works of the Imperial Company, however, demand for gas increased so rapidly in about 1860 that D. Methven, engineer of this station, was only able to meet his requirements with the limited site available by building settings of ten retorts in five tiers. The top two tiers of retorts were charged from a movable stage. During the two decades 1870–1890, direct firing of retort settings was superseded by producer gas firing with or without the addition of recuperators for preheating the secondary air by heat exchange from the waste gases.

The period 1900–10 saw the successful development of the Glover-West and the Woodall-Duckham systems of continuous vertical retorts. High gas output per unit of space and improved amenities owing to elimination of hot coke discharge and low fuel consumption have made continuous vertical retorts so popular that they are now responsible for about one-half of the gas output of the industry. The author shows a drawing of a modern installation of continuous vertical retorts with step-grate producers arranged at the end of the bench so that both sides of the setting can receive a direct supply of fuel gas.

At present the fuel consumption of continuous vertical retorts is only about one-sixth of the coke produced. This also yields about 1050 lb of waste heat steam per ton of fuel, which is sufficient to supply all the process and power requirements of the works. A ton of Durham coal yields 74 therms of gas, 20 therms of tar, and 165 therms of saleable coke, the total products for sale having 86 per cent of the thermal value of the coal.

The author points out that the gas industry differs from any other public utility as it has to market several different but interdependent fuels and chemical materials, and the manufacturing cost of its main product—gas—is markedly influenced by the revenue received from the other residuals of the carbonisation process. A rather delicate balance, therefore, exists in relating markets and prices to secure commercial stability, and the gross revenue account in the gas industry is more dependent upon fluctuations in both national and international prices than any of its sister services.

From the economic aspect the gas industry has a promising future, for even in the light of present knowledge it is able to convert thermal energy for cooking purposes at an overall capital cost of considerably less than half that required by any other system of distributed energy, and this advantage is likely to be maintained for a long time to come.

THE BRITISH TELEVISION SERVICE

By Sir Noel Ashbridge, M.I.C.E.

It was early recognised that it would be necessary to dissect an image before transmission, then transmit the component parts separately and finally re-assemble them at the receiving end. Notable early experiments were made by Ayrton and Perry, who sought to solve the technical problems by constructing mosaics of a large number of small selenium cells. In 1906 an arrangement of this character was patented in France by Ringnoux and Fournier, and a model using sixty-four selenium cells was successfully used to transmit simple patterns and letters. In 1908, Campbell Swinton, in a famous letter to *Nature*, outlined a proposed method of television strikingly similar to that now in use. Notable among the workers on mechanical methods of transmission was John Logie Baird, who by early 1926 gave public demonstrations of television over a closed circuit.

In the early 1930s the B.B.C. ordered equipment from both Baird Television, Ltd., and from the Marconi-E.M.I. Television Company, Ltd., and alternative transmissions of these systems took place for two hours a day over a period of three months until the beginning of 1937, when the Marconi-E.M.I. system was adopted for the regular public service on 405 lines. A number of important factors influenced the adoption of the electronic system, partly because the electronic camera seemed to offer the greatest scope for future development.

The selection of sites for television stations has demanded even more care than the selection of sound transmitter sites. The maximum number of stations that can be accommodated is limited so that each must be very carefully placed; propagation problems are much more serious and affect the overall coverage to a greater extent. Topography enters into the consideration in a much more decisive way.

From time to time proposals are made that stereoscopic transmission should be considered, but the objections to this are very serious. It would increase the channel space required for transmission, would considerably increase the cost of a receiver, and, owing to the extra complexity of production in the studio, would certainly affect the cost of transmission. All the reasons which have militated against the adoption of stereoscopic cinematography operate even more strongly against the possibility of stereoscopic television transmission. Colour transmission offers the most attractive large-scale development in television for the future. It is now possible to transmit a satisfying picture of adequate detail in colour within the same spectrum space as a picture of apparently similar detail in monochrome.

(To be continued)

Floodlighting Fire Tender

A mobile floodlighting fire service tender has recently been despatched overseas by Merryweather and Sons, Ltd.

The tender is of modern limousine design. In addition to the driving compartment with accommodation for driver and officer, there is also ample accommodation for a crew of six in the well-lighted rear compartment, which is fitted with cushioned seating.

The vehicle carries four 1000W floodlights, each with focusing control. Two lamps with their detachable light steel tripods are in each compartment and the accompanying cable drums are conveniently placed. Each drum carries 300ft of rubber cab-tyre cable allowing the lamps to be positioned advantageously.

The generating plant is situated immediately to the rear of the driving compartment, and comprises a 9kVA alternator (together with its exciter and an automatic voltage regulator) driven from the main engine through a power take-off mounted on top of the main gearbox. The supply of 230V a.c. is fed to an electrical switchboard and control panel comprising ammeter, voltmeter, switches and fuses. For maintenance, the alternator and control panel can be reached from the rear compartment. Alternatively, ten 300W floodlights can be plugged in if necessary in place of the four lamps provided.

The Merryweather-A.E.C. chassis has a six-cylinder petrol engine developing 175 h.p. The carburetter has "hot spot" induction, and dual ignition is provided. The power transmission unit is fitted with a single-plate clutch, four forward gears and one reverse.

History of the Science Museum.—On the occasion of the opening of a special exhibition depicting the past and future of the Science Museum at South Kensington, an illustrated booklet entitled "A Short History of the Science Museum," has been published by H.M. Stationery Office (price 1s.). The history, which has been prepared by Mr. F. Greenaway, M.A., shows how the establishment of the Museum was a sequel to the Great Exhibition of 1851, and records, very concisely, its development to the present day. The booklet does not attempt, of course, to give full details of the many collections now housed in the Museum, but it nevertheless presents, very effectively, a general idea of what has been achieved by the Museum since 1853 when the Treasury approved "the setting up of a Department of Science and Art as a section of the Board of Trade."

Turbine Steamship "Patricia"

By G. W. TRIPP, O.B.E., F.C.G.I., M.I.C.E.

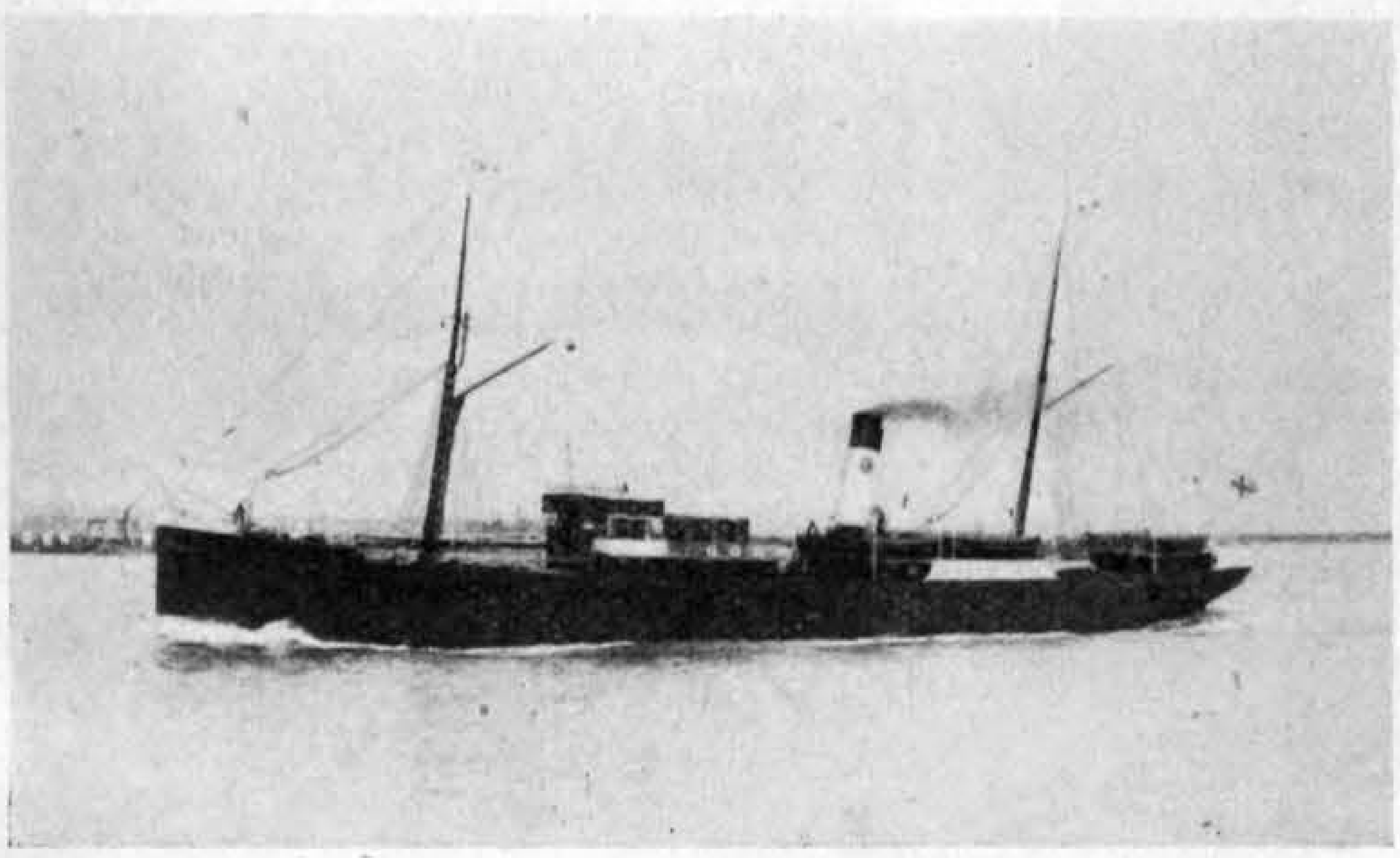
PARTICULAR interest attaches to the arrival in London of the new steamship "Patricia," intended to operate on the regular passenger and cargo service between Gothenburg and London, which, for many years, has been maintained by the Svenska-Lloyd Steamship Company; indeed, there have been regular sailings for three-quarters of a century. A reversal in policy seemed forecast by the building of the large motor vessel "Saga," which was launched in 1940, but not put into commission until 1946. She was the largest ship to be employed, having a tonnage of 6458 gross, and being exceptionally well equipped; accordingly, when it was announced that another ship was to be built and that she would be a steamer, the advocates of steam were jubilant. A comparison between the two vessels' performances will be very useful.

As an indication of the development in the ships that have been engaged on this route, it might be remarked that when the "Thorsten" was put into service in 1883, she was hailed as a fine vessel, though she would be considered modest by present-day standards. Her leading dimensions were: length, 262·2ft; breadth, 33·3ft; depth, 16·2ft; tonnage, 1634 gross. She was driven by compound engines with cylinders 30in and 62in diameter, with a stroke of 41in, and her speed was 13 knots. Steam was supplied at 180 lb per square inch by three single-ended boilers, with a grate area of 144 square feet, and a heating surface of 4620 square feet. Like most vessels of her day, she was propelled by a single screw.

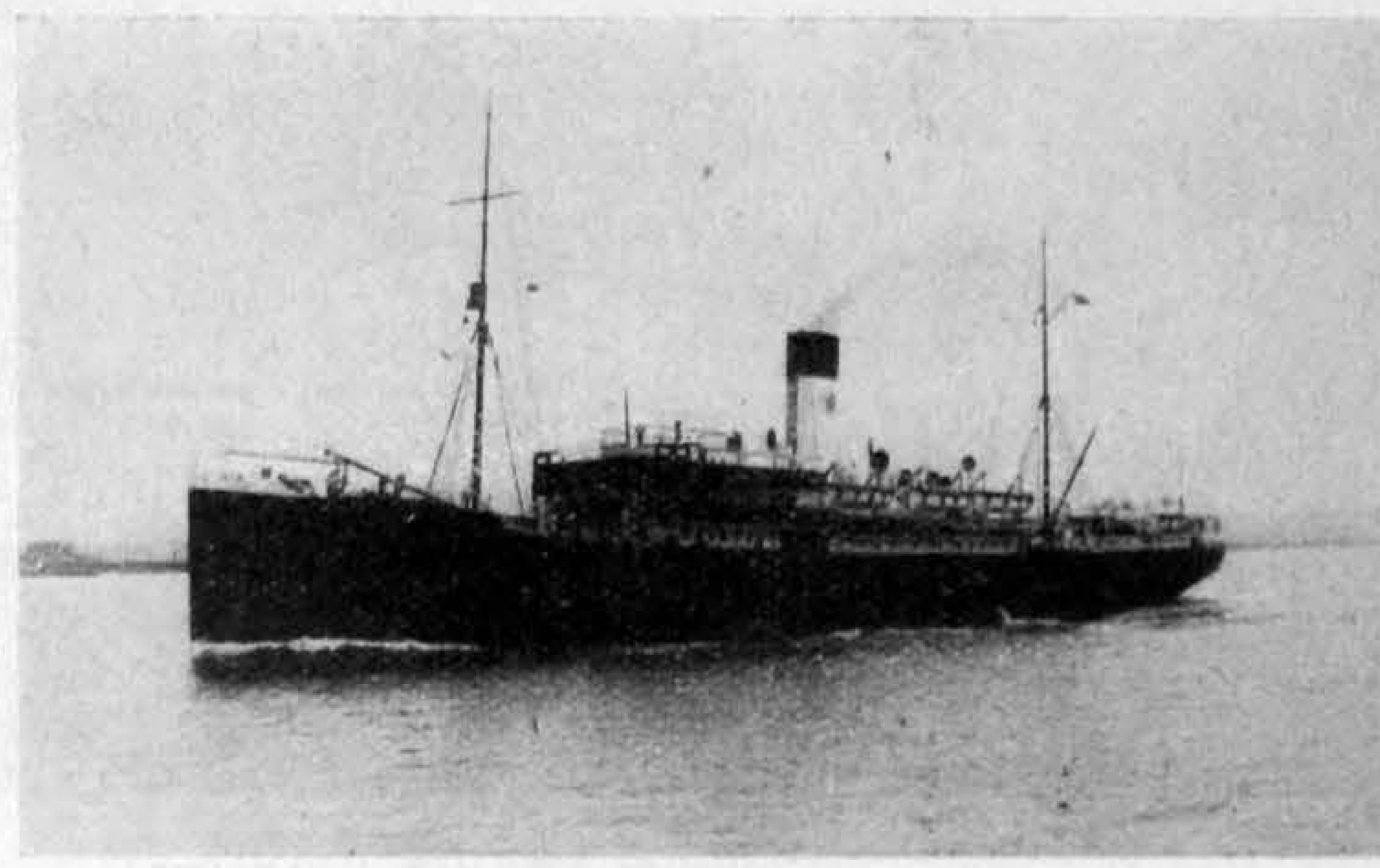
Some ten years or so later the first steamer to be driven by triple-expansion engines appeared, while a decade later an interesting ship was built at Trieste, and, after being used on various routes, was taken over by the Swedish-Lloyd Line and renamed "Patricia." She had the following dimensions:—Length, 344ft; breadth, 43ft; depth, 24·3ft; tonnage, 3285 gross. She was a twin-screw vessel with two sets of engines with cylinders $22\frac{7}{16}$in, 38in, and 62in diameter, with a stroke of 36in. Steam was supplied at 180 lb per square inch pressure by five single-ended boilers.

In 1929 a radical change took place when turbine propulsion was adopted and two sister ships, "Britannia" and "Suecia," were built for the company by Swan, Hunter and Wigham Richardson, Ltd., of Newcastle-upon-Tyne. They were larger than their predecessors, and noticeably smooth running, one of the characteristics of the geared turbine steamers. They have the following principal dimensions:—Length, 373·5ft; breadth, 50·1ft; depth, 28·6ft; tonnage, 4216 gross. The single screw is driven through single-reduction gear Parsons turbines, and steam is supplied at 220 lb per square inch pressure from four single-ended boilers, with grate area of 258 square feet, and heating surface of 11,788 square feet. The hull was strengthened specially for navigation in ice.

In the still larger Swedish-built "Saga," to which allusion has already been made, the adoption of oil engine drive was a radical departure. She is driven by four oil engines, which are four stroke-cycle, single-acting units, with thirty-two cylinders having a diameter of $19\frac{11}{16}$in and a stroke of $27\frac{9}{16}$in, provided with electro-magnetic slip coupling and single-reduction gearing. She has a length of 413·9ft, a breadth of 55·2ft, and a depth of 29·6ft.



THE 1883 "THORSTEN"



THE FIRST "PATRICIA"

In the "Patricia," the third of the name, we have a notable craft, the largest to be employed on the service as the following dimensions show:—Length overall, 454·3ft; length between perpendiculars, 415·6ft; breadth, 58ft; depth, moulded to "B" deck, 31·75ft; tonnage 7710 gross. She has accommodation for 408 passengers, thirty-two more than has the "Saga." She is fitted with modern navigation devices, including echo-sounder, wireless direction finder, gyro compass, radar and Decca navigator plant.

Above the boat deck is a spacious wheel house and chart room, under which there is a pleasant first-class lounge, which, on account of its elevation, gives passengers an unimpeded view ahead. Behind this lounge is an officers' radio and recreation room, the remainder of the boat deck being open and affording space for deck games. In the bows of the "A" deck are quarters for the crew, amidships there is a spacious and well-fitted first-class lounge with bar, also a first-class smoking room, library, private suites, and cabins de luxe, while further astern come the second-class lounge, smoking room and bar, and, finally, a third-class smoking room and bar. The forward part of the "B" deck is devoted to further accommodation for the crew, and amidships first-class cabins. Towards the stern there is a spacious first-class dining saloon, with a small private dining room adjoining it. The "C" deck is principally devoted to first and second-class cabins, but there are also quarters for the engineers, and an officers' mess. On the "D" deck towards the stern are the third-class cabins, and forward accommodation for the sixty-four "dormitory" or "group" class passengers. As the name implies, these passengers sleep in dormitories of six or eight berths, the occupants being allowed to use the third-class deck. Throughout the vessel the happy blend of Swedish and British taste is noticeable, the decoration of some of the rooms being to Swedish design, while others have been designed and furnished by a London firm.

The life-saving appliances consist of six Fleming hand-propelled lifeboats, and two motor lifeboats, all of which are in gravity davits, with electric boat winches. There are also seven "Simplex" buoyant appliances each capable of carrying twenty persons. An automatic sprinkler and fire alarm system is installed in all the accommodation, public rooms and storerooms, while there are CO_2 fire-extinguishing connections to the cargo holds, machinery space, &c., and a smoke-detection installation has been fitted to the cargo holds, cargo 'tween decks, and refrigerated cargo space.

TURBINE STEAMER "BRITANNIA"

The vessel is propelled by one set of Parsons turbines, installed by the builders, Swan, Hunter and Wigham Richardson, Ltd., of Newcastle upon Tyne. Incidentally, this company built the former turbine steamers of this line, and, before that, built steamers with reciprocating engines. The turbines comprise h.p., i.p. and l.p. stages, connected to the one propeller shaft through single-reduction gearing. This set is one of the largest yet built for a ship of this kind. The main condenser is a Weir regenerative unit, and is secured direct to the underside of the l.p. turbine casing. Steam is provided by two Babcock and Wilcox integral furnace water-tube boilers arranged to burn oil fuel with preheated, forced-draught air, at a working pressure of 450 lb per square inch at a temperature of 750 deg. Fah. For providing low-pressure saturated steam for the various ship's services, there are two Cochran vertical auxiliary boilers arranged for burning oil fuel with natural draught.

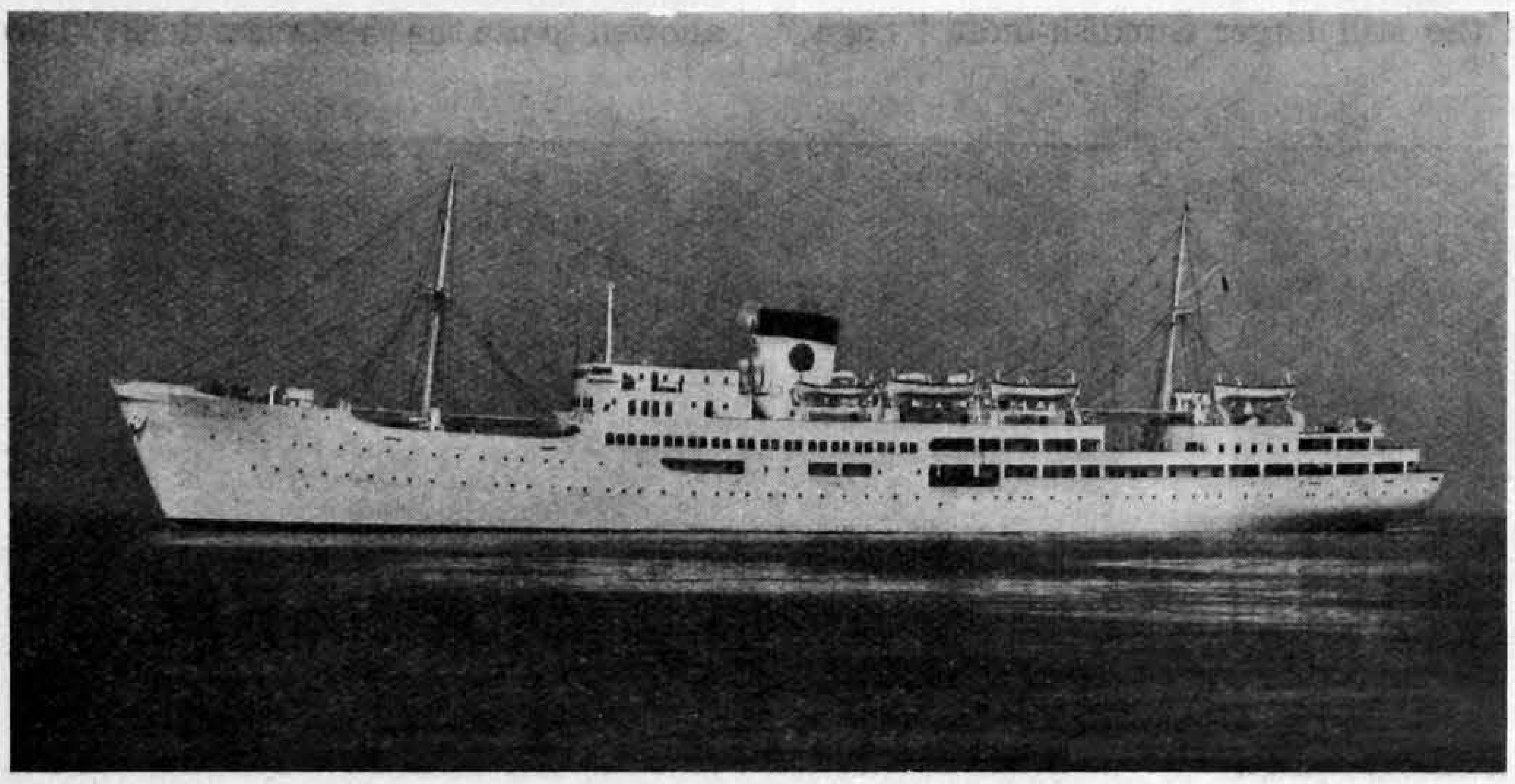
The auxiliary machinery, apart from the main feed pumps and the pumps for the auxiliary boilers, is electrically driven. There are two turbo-generators for providing electric power when at sea. In port, when the boilers are shut down, two diesel-driven generators are used.

Mechanical ventilation and heating are provided for all the accommodation, and there is special exhaust ventilation to lavatories, bathrooms, galleys, &c. Thermostatic control is incorporated in the ventilation system for all the public rooms; the first and second-class cabins are served by the "Thermoreg" system, which permits individual air temperature control by the passenger. Hot and cold fresh water and hot and cold sea water are arranged for all passenger accommodation, and there is a vapour bath in the first-class.

Cargo is carried in three holds, and three 'tween decks, No. 2 hold and 'tween decks being arranged for the conveyance of motor-cars; one 'tween deck is insulated for refrigerated cargo. The large hatches are fitted with steel covers, and are served by 3, 5 and 10-ton derricks with electric winches. The deadweight is about 2430 tons on a mean draught of 19ft, and the ship has a cargo capacity of about 105,300 bale cubic feet, which includes 5310 cubic feet net of refrigerated cargo space.

On a tour of the ship the impression gained was of spaciousness and comfort, so much so that one was inclined to question the need for so large a vessel. It should be recalled, however, that the highest pre-war number of passengers carried in 1938 was 28,515; in the first post-war year of 1946 a total of 25,795 was reached, and since then the number has risen without a break, year by year, until in 1950 no less than 59,517 passengers were carried. These figures suggest that there was ample justification for the building of "Patricia," a ship which happily has steered clear of any eccentricities in general outline and appearance.

"Patricia" was launched in November, 1950, did her trials on April 29, 1951, and made her first voyage from London to Gothenburg on May 28th.



TURBINE STEAMER "PATRICIA"

The British Plastics Exhibition and Convention

THE British Plastics Exhibition, which is being held at Olympia, London was opened on June 6th by Sir Hartley Shawcross, and will close to-morrow, June 16th. It is the first exhibition arranged to represent the entire British plastics industry, and its main object has been to promote a fuller appreciation of the many forms of plastic materials, their different properties and diverse applications. The Convention has been running concurrently with the Exhibition and is likewise organised jointly by the British Plastics Federation and *British Plastics*. There have been fifteen sessions, during which thirty-six papers were presented. The scope of these papers was such as to cover progress in the materials themselves developments of plant and fabrication techniques, and applications of plastics in the chemical and textile industries, in building, architecture, transport packaging, medicine, and surgery. The inaugural lecture entitled, "The Place of Plastics in Industry," was given by Sir Ben Lockspeiser, F.R.S.

The exhibits from ninety-seven firms cover the wide field of materials, manufacturing plant and equipment, and manufactured articles. Some eight firms are demonstrating injection and compression moulding machines ranging in capacity from 4 oz to 32 oz shots, extruders, calenders and radio frequency heaters, and several items are being shown for the first time. The largest multi-screw extrusion plant in this country is being demonstrated by R. H. Windsor, Ltd. It uses the twin-screw principle with meshing threads rotating in the same direction, and is able to extrude in two or more colours or with different resins by employing two extruders and combining their output in one die. This plant has a capacity of 200 lb. Also shown by this company for the first time is its 32 oz injection moulding machine, which incorporates a retractable injection unit. The Projectile and Engineering Company, Ltd., is demonstrating several of its "Pecco" injection moulding machines, which range from 2 oz to 32 oz capacity. Dowding and Doll, Ltd., is showing the new "Lester" machine (made under licence), which has an interesting fast double-toggle locking mechanism and a large central die adjustment screw, the locking pressure being 250,000 lb and the capacity 4 oz.

On the stand of T. H. and J. Daniels, Ltd., is a three-unit plant consisting of a 125-ton preforming press employing opposed vertical rams, a "Radyne" radio frequency heater and a 150-ton downstroke press.

Apart from its 1½in diameter and 4½in diameter screw extruders and other equipment, Francis Shaw and Co., Ltd., is showing its new four-bowl prototype calender, each 16in by 8in bowl being driven by an individual variable-speed motor. A zero clearance arrangement is fitted to the top roll to maintain correct nip-setting under all load conditions. Each roll adjusting screw is driven by its own motor.

The low thermal conductivity of phenolic and crenol moulding powders has led to the increased use of dielectric preheating equipment, and radio frequency heaters with outputs ranging from 500W to 3kW and capacities up to 2 lb per minute are displayed by The General Electric Co., Ltd., and Radio Heaters, Ltd.

The electroforming of moulds, mould cavities and dies is demonstrated on the stand of London and Scandinavian Metallurgical Company, Ltd. In this process the cavity is formed from a positive master made in such materials as Catalin or Perspex, and made conductive by a chemically deposited micro-silver plating. A nickel-cobalt alloy, 48 Rockwell C hardness, is then deposited on the master to a thickness of about ⅛in. The shell is finally backed electrolytically by another alloy similar in hardness to mild steel and the back of the shell precision ground. The master is then removed from the cavity, which is fitted into a steel bolster.

High-vacuum equipment suitable for various processes is shown on the stand of W. Edwards and Co., Ltd. A particularly interesting application is its use in the relatively new process of depositing thin metals, their salts and oxides, on bases, particularly of plastic materials. The process consists of volatilising the material in a chamber evacuated to 10^{-4}–10^{-5}mm Hg., the vapour subsequently condensing upon the surface to be coated.

An extensive range of moulded articles in thermo-plastic and thermo-setting materials is exhibited by thirty different manufacturers. The particular use of laminated and impregnated plastics for gear wheels and heavy bearings and other general engineering applications is illustrated on the stands of Tufnol, Ltd., and Ferodo, Ltd., amongst other firms who are associated with laminated plastics.

B.E.A. Power Station Thermal Efficiencies

THE British Electricity Authority has published a statement showing the twenty steam power stations under its control that had the highest overall thermal efficiencies for the calendar year 1950. Arranged in descending order of thermal efficiency, the stations are as follows:—

Station	Overall thermal efficiency, per cent
Battersea "B," London	29·31
Littlebrook "B," Dartford, Kent	27·99
Cliff Quay, Ipswich	27·25
Battersea "A" and "B" combined	26·73
Stuart Street (h.p.), Manchester	26·67
Fulham, London	26·51
Lynfi, South Wales	26·49
Hams Hall "B," near Birmingham	26·36
Kearsley (h.p.), Lancs	26·23
Meaford, near Stone, Staffs	26·02
Dunston "B," Newcastle upon Tyne	25·83
Barking "B," London	25·76
Battersea "A," London	25·74
Brimsdown "B" (h.p.), near Enfield	25·71
Earley, Reading	25·54
Brimsdown "A," near Enfield	25·34
Little Barford, near St. Neots, Hunts	25·29
Mexborough, Yorkshire	25·17
Kirkstall (h.p.), Yorkshire	25·11
Rotherham, Yorkshire	24·87
Ferrybridge (h.p.), Yorkshire	24·82

The list excludes the Staythorpe power station which was not commissioned until March, 1950. This station's thermal efficiency for nine months of 1950 was 25·15 per cent.

Instrumentation for the Study of Engine Fuel Requirements

THE SUNBURY ROAD TEST PANEL

By H. J. EATWELL, M.B.E., A.M.I.Mech.E., and H. J. HULF, Grad.I.E.E.

THE octane requirement of motor vehicles is a matter of importance to both the motor and the petroleum industries. It is important to the former because it sets a limit on the use which can be made of high compression ratios to an extent depending on details of design, and to the latter because it imposes a standard of fuel quality below which engine performance will suffer.

Until the beginning of the war in 1939 there was a steady increase of compression ratio in spark ignition engines, which was made possible by a corresponding increase in the anti-knock quality of the fuel available ; since 1945 there has been a continuation of the upward trend in the U.S. and the successful operation of an experimental engine of 12·5 : 1 compression ratio in 1947 indicates an attainable level.

The refinery expansion schemes in hand in the sterling area will eventually lead to the distribution of higher octane fuels in Europe generally, although there is an economic limit to an indefinite rise. It is therefore essential that full attention should be given to new engine designs to ensure that they can make the best use of their fuel in terms of both power output and economy.

Power output of an engine on the road is often limited by the onset of knock, and engines of similar efficiency but different design still have very dissimilar fuel anti-knock requirements.

The design of even the most advanced engines may be expected to improve steadily and, as it does, suitable fuels must be made available. The ideal is a co-ordinated development of both the engine and the fuel to avoid waste of octane numbers on the one hand and unsatisfactory performance on the other.

The problem of selecting fuels to suit engines, and the converse of determining how far an engine can be modified to make full use of a better fuel than it now requires, can be solved by the use of one of a number of road test methods. Two of the more widely used are the Modified Uniontown test and the Modified Borderline test.

The Modified Uniontown test is made by running the engine at each of a series of ignition settings until one is found on which the knock never rises above trace intensity at any speed during a full throttle acceleration.[1]

Using this method, it is possible to determine the octane requirements of the car in terms of standard reference fuels and to check whether any production type of fuel meets road requirements. The method may also be used to determine the road ratings of fuels and any change of requirements due to alterations in design.

The Modified Borderline test gives data which show the spark advance at any engine speed at which a reference fuel of known octane number gives only trace knock.[2] When a series of such curves is drawn and the ignition curve for maximum power plotted over them it is possible to determine the octane requirement of a car at all speeds. By extending the test to include marketed grades of petrol the road octane numbers of these can be measured, and the severity of the engine estimated in comparison with other possible designs which may use the fuel to better or worse advantage.

These test procedures need accurate means for indicating the spark advance of the engine whilst the car is on the road. The Borderline Test also requires an accurate engine speed indicator, and the results from both methods are of greater value if certain engine operating temperatures are measured, such as those of the water jacket, the inlet manifold hot spot, and the lubricating oil in the sump.

Various instruments and combinations of instruments have been tried in the U.S.A. For spark advance measurement a stroboscopic flashes, illuminating graduations on the flywheel or electronic spark advance indicators are widely used.[3] A self-contained electronic instrument panel has been designed and built at the research station of the Anglo-Iranian Oil Company, Ltd., at Sunbury-on-Thames for road tests of the type outlined. It provides for continuous observation of both spark advance and engine revolutions per minute on 4in dial Circscale meters and for the indication of engine operating temperatures at four selected points. In addition, manifold depression can be observed on a 2in dial gauge—a useful accessory for the study of part throttle knock.

The panel is illustrated in Fig. 1, and its size,

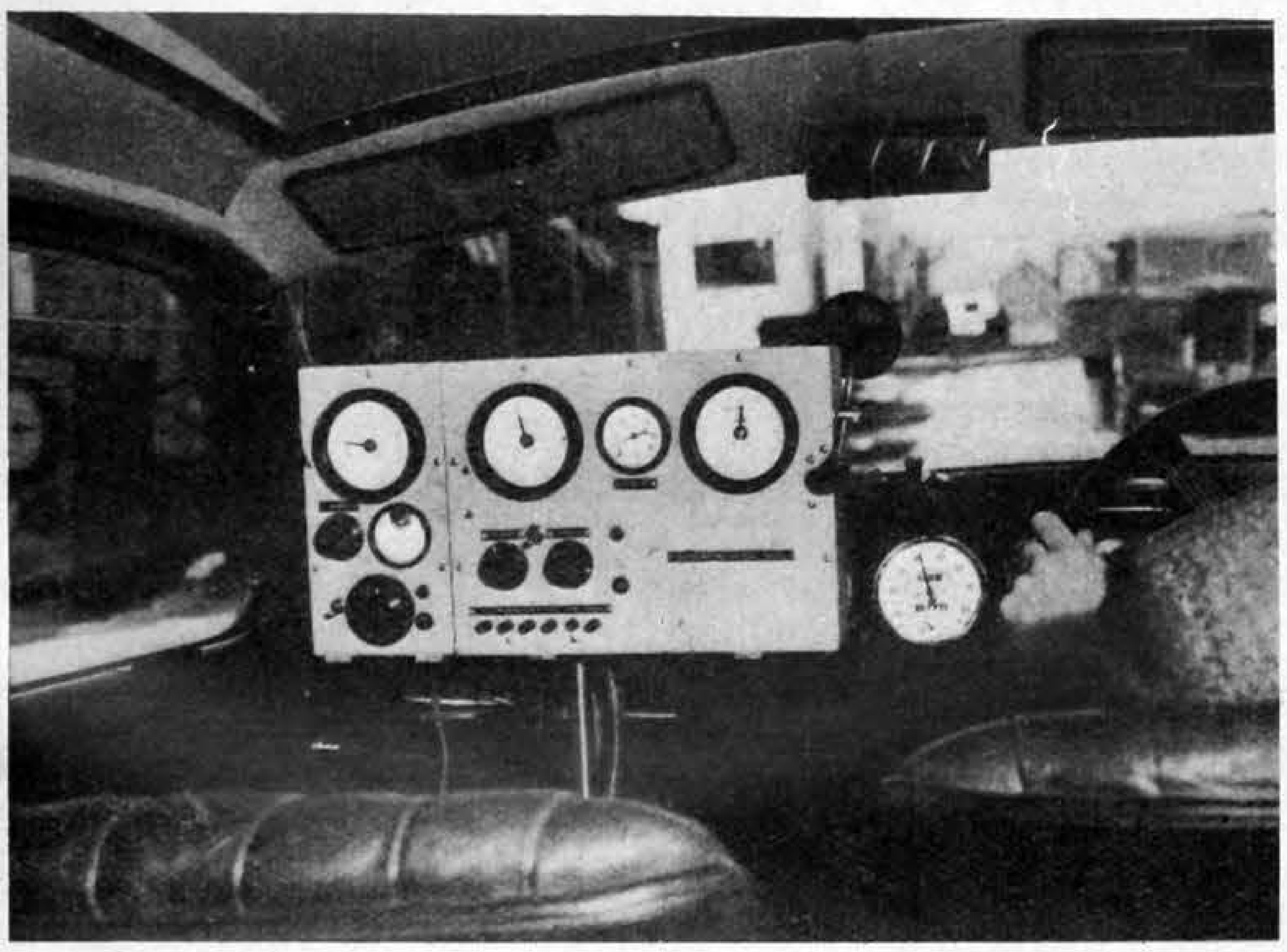
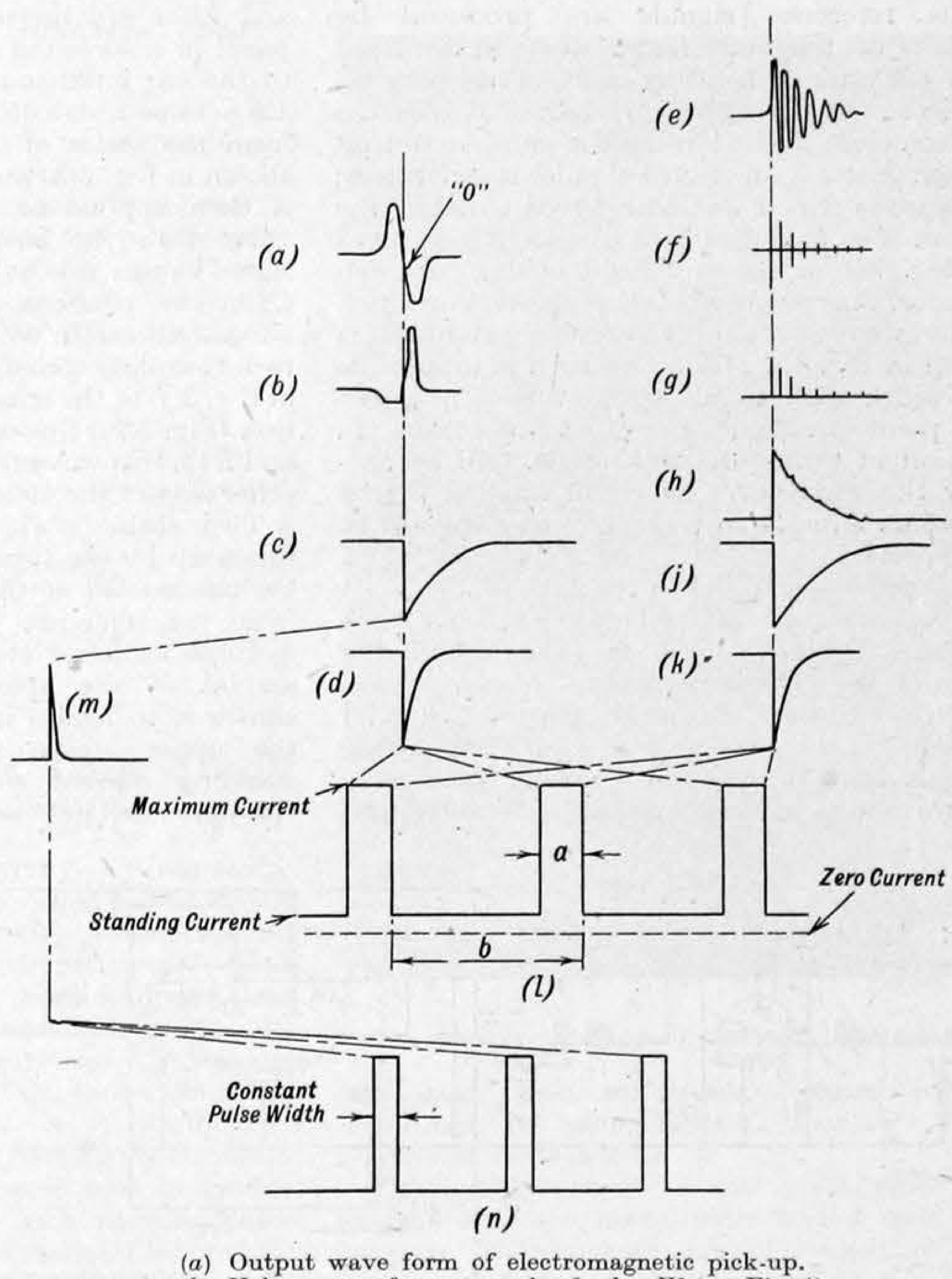


FIG. 1—ROAD TEST PANEL IN POSITION

FIG. 2—ELECTROMAGNETIC PICK-UP INSTALLATION



(*a*) Output wave form of electromagnetic pick-up.
(*b*) Voltage waveform at anode of valve *V*1 (see Fig. 4).
(*c*) Voltage waveform at anode of valve *V*2.
(*d*) Voltage waveform at grid of valve *V*3.
(*e*) Waveform of spark impulse.
(*f*) Waveform from ringing circuit showing individual high-frequency pulses.
(*g*) Detected waveform showing individual d.c. pulses.
(*h*) Voltage waveform at anode of valve *V*5.
(*j*) Voltage waveform at anode of valve *V*6.
(*k*) Voltage waveform at grid of valve *V*4.
(*l*) Valve *V*4 anode current waveform.
(*m*) Voltage waveform at cathode of valve *V*6.
(*n*) Valve *V*7 anode current waveform.

FIG. 3—VOLTAGE WAVEFORMS THROUGHOUT INSTRUMENT

18in by 9½in by 4in, allows it to be used in any private car.

The following requirements were specified before development, and all have been met in the finished design :—

(*a*) It must be possible to fit the panel and associated equipment to a car with the minimum of adaptation, and there must be no interference with the normal operation of the engine.

(*b*) Temperature indication must be possible with thermo-couple compensating leads of any length, and it must not be necessary to balance the thermo-couple circuits to a given resistance value.

(*c*) A high standard of accuracy must be obtainable. A detailed description of the instrument follows.

Spark Advance Meter

This instrument indicates the average spark advance of the engine cylinders in crank angle degrees by measuring the interval between signals from fixed reference points in the engine cycle and the occurrence of each spark.

The reference signals are produced by pointers of magnetic material which are fixed to a convenient rotating part of the engine. An electromagnetic pick-up is mounted in a fixed position close to the path of the pointers so that as each passes it an electrical pulse is generated ; for reasons which will be referred to later, the system is so arranged that a pulse is generated 70 deg. before the top dead centre for each cylinder. A typical installation is shown in Fig. 2.

The wave form of the pulse produced is shown in Fig. 4. This alters both in amplitude and width with engine speed variations ; but the point marked *O* remains constant in position in terms of crank angle, and accordingly the wave form has been applied to the electronic circuits so that they can operate at this point.

The pulse is applied to the grid of valve *V*1 (Fig. 4) with the positive half of the wave form leading. Valve *V*1 amplifies and inverts the phase of the signal, producing the wave form shown in Fig. 3(*b*) at its anode; because valve *V*1 has zero grid bias the negative half of the anode pulse is limited by anode current saturation. The wave form in Fig. 3(*b*) is passed to the control grid of a gas tetrode valve *V*2. The initial positive portion of the pulse causes *V*2 to conduct, discharging *C*4, the condenser connected between the valve anode and earth. When the anode voltage reaches the extinguishing value for the valve, which then ceases to conduct, the condenser recharges to high-tension voltage, producing the voltage wave form shown in Fig. 3(*c*) at the anode of *V*2. This wave form is then differentiated (Fig. 3(*d*)) by components *C*5 and *R*9 and applied to trigger one side of an Eccles-Jordan electronic switch consisting of valves *V*3 and *V*4.

A pulse is obtained for operating the instrument each time a spark occurs by capacitance coupling the signal into the instrument input. The spark pick-up takes the form of a wire wound on a Tufnol-former which slides over the ignition cable, the wire coil forming one electrode of the coupling condenser and the core of the ignition cable acting as the other.

Each cycle of the relatively lightly damped spark pulse (Fig. 3(*e*)) causes a heavily damped high-frequency tuned circuit, consisting of the inductance *L*1 (Fig. 4) and the input lead capacitance, to oscillate, giving a series of highly damped pulses whose consecutive peak amplitudes are greatly attenuated (Fig. 3(*f*)). This series of pulses is passed through a half-wave rectifier and a three-stage screened high-frequency filter, made up of a germanium crystal diode *G*1, capacitors *C*11, 12 and 13, and resistors *R*26, 27, 28 and 29. The wave form available for applying to the grid of valve *V*5 is then in the form of a series of detected d.c. pulses (Fig. 3(*g*)).

In order to ensure that no radio frequency signals enter the main instrument panel, where they may cause spurious operation, the rectifier and filter are housed outside the instrument panel in a screened box which is always fixed to the car bulkhead under the bonnet. Valve *V*5 acts as a detector and amplifier producing from the series of d.c. pulses the wave form shown in Fig. 3(*h*) at its anode. This wave form is then applied to the grid of a gas tetrode valve *V*6 ; the initial portion of the positive signal causes this valve to conduct, discharging *C*16, the condenser connected between the anode and earth, which then, in turn, recharges to h.t. voltage producing the wave form shown in Fig. 3(*j*) at the anode of *V*6. After differentiation (Fig. 3(*k*)) through coupling components *C*9 and *R*15, this wave form is applied to trigger the other side of the electronic switch.

Two stable states of equilibrium may be taken up by the type of electronic switch used. On the arrival of the trigger pulse originating from the reference channel the anode of *V*4 assumes its lower stable voltage value and the arrival of the spark channel trigger pulse causes it to regain its upper stable value. At the upper stable voltage value the small standing current shown in Fig. 3(*l*) passes through the indicating meter in the anode circuit of *V*4. The cyclical repetition of reference and spark pulses when the engine is running causes a train of rectangular current pulses (Fig. 3(*l*)) to pass through the meter, whose mark-space ratio is directly proportional to the angular relation between the spark occurrence and the reference pick-up position. The meter movement and pointer take up a position equivalent to the mean value of the current pulse train which is directly proportional to the mark-space ratio.

Calibration and Range Switching

When the spark advance is at the same number of degrees before top dead centre as the occurrence of the reference pulse no current pulse is generated (i.e., $a=0$, Fig. 3(*l*)) ; at this condition, therefore, the mean current through the meter equals the standing current value. This value of standing current is thus equivalent to the number of degrees before T.D.C. at which the point *0* on the reference pulse occurs. This angle, as previously mentioned, had been made 70 deg.

The indicating meter is calibrated from 70 deg. of crank angle advance to 10 deg. of crank angle retard, which covers the range required for experimental purposes.

The peak value of the rectangular current pulses that occur at the anode of *V*4 equal in value the mean current that would pass for a mark-space ratio of one, i.e., referring to Fig. 3(*l*), when $a/b=1$. This means that on any engine the value of peak current is proportional to the number of crank angle degrees between consecutive firing cylinders. Therefore it is possible to calibrate the meter by making valve *V*4 continuously conduct its peak anode circuit current and adjusting the current through the indicating meter by means of a shunt to give full-scale deflection for any given number of crank angle degrees.

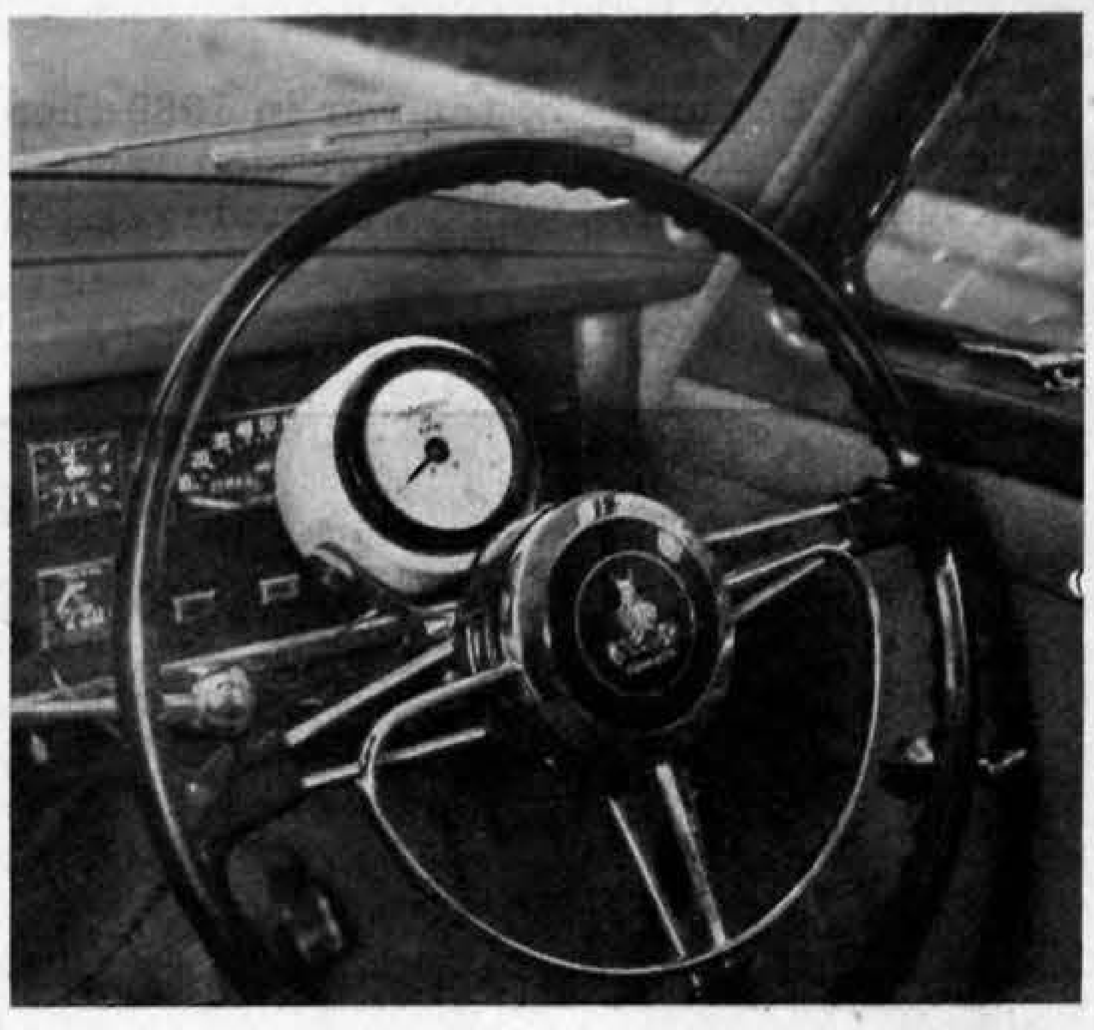


Fig. 5—Engine R.P.M. Indicator

This condition is brought about by means of switches *S*1*A* and *S*1*B*, which disconnect the spark channel from the electronic switch and place an appropriate shunt across the meter. With the engine running, the first trigger pulse received from the reference channel causes the voltage at valve *V*4 anode to assume its lower value of equilibrium, i.e., *V*4 passes peak circuit current in which state it remains, due to the cutting off of the spark channel trigger pulses.

The mean currents passed by *V*4 above the normal standing current for a given number of degrees of spark advance on a four, six or eight-cylinder engine respectively are in the ratio 2 : 3 : 4. In order, therefore, that the scale of the indicating meter shall be correct, regardless of the number of cylinders in the engine under test, the meter must be shunted by resistors of appropriate values. The shunts for the four, six and eight-cylinder engines are selected by switches *S*5*B*, *S*4*B* and *S*3*B* respectively, which are in the form of press buttons on the instrument front panel.

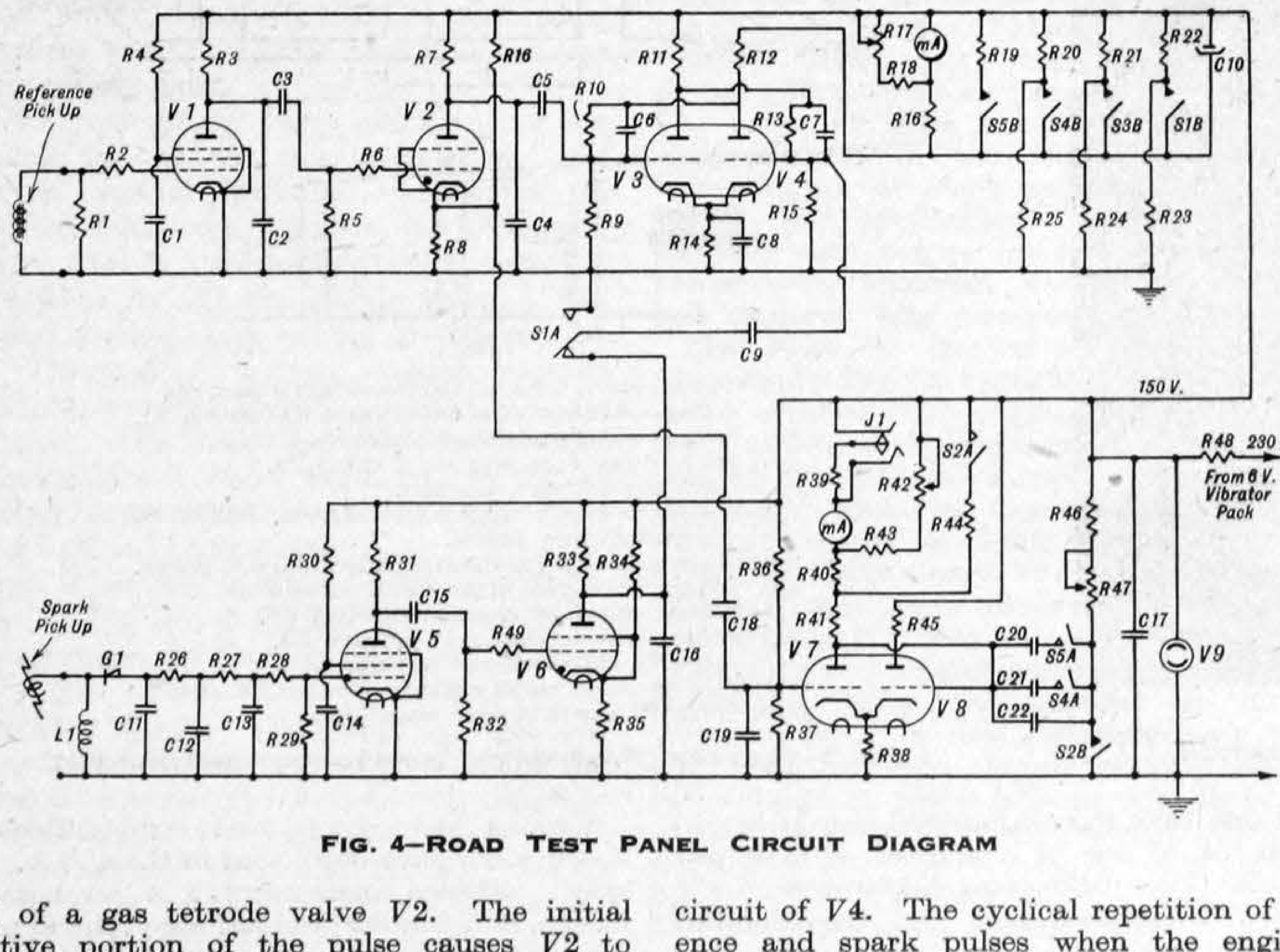


Fig. 4—Road Test Panel Circuit Diagram

Tachometer

At the same time as valve *V*2 develops at its anode the pulse shown in Fig. 13(*c*), a positive pulse of very short duration is produced at its cathode by the discharge current from *C*4 through the cathode resistance *R*8. This pulse is used for triggering a single-shot multi-vibrator circuit consisting of valves *V*7 and *V*8.

The single-shot multi-vibrator is in the form of an electronic switch, which generates a square wave form current pulse of constant width at the anode of *V*7 each time the grid of *V*7 receives a positive pulse. The width of the square pulse is constant and mainly dependent on the time constant of the circuit comprising the coupling condenser between the anode of

*V*7 and the grid of *V*8 and the grid resistor of *V*8.

The continued repetition of spark pulses cause a train of rectangular current pulses (Fig. 3*n*), whose mark-space ratio is directly proportional to engine speed, to pass through the indicating meter in the anode of *V*7. The meter movement is proportional to the mean current, and is therefore proportional to engine speed.

The instrument is calibrated by earthing the grid of valve *V*8 through switch *S*2*B*, which causes *V*7 to conduct continuously the peak value of current of the square wave forms, at the same time shunting the meter by means of resistor *R*44, which is switched in through *S*2*A*. Full-scale deflection of the meter is then corrected by adjusting potentiometer *R*42.

In order that the meter scale shall give correct readings when used on four, six or eight-cylinder engines, the pulse width for each range is adjusted to give the same mean current for meter full-scale reading when operated at the three frequencies corresponding to 4500 r.p.m. in each case. The condenser combinations *C*22, *C*22+*C*21 and *C*20+*C*22 give the three ranges, and are switched in by *S*5*A* and *S*4*A*.

A second meter for indicating engine revolutions can be inserted in series with the panel meter by plugging it into the panel jack *J*1, Fig. 4. This meter is provided to permit the driver to observe the engine speed, and it is so arranged that it can be fixed to a car steering column, as shown in Fig. 5.

POWER SUPPLIES

A 6V d.c. vibrator pack is used to supply the two instruments described above; it has an output of 230V d.c., which is arranged to give a stabilised supply of 150V d.c. by the use of a glow discharge tube *V*9. The valve heater supply is obtained directly from the 6V supply battery. The total current consumption is 5A.

TEMPERATURE INDICATING INSTRUMENT

A simplified circuit diagram is given in Fig. 6.

The sum of the E.M.F.s (*V*1) from the thermo-couple and the automatic cold junction is applied across resistor *R*1. An opposing E.M.F. (*V*2) produced from the power pack is also applied across this resistor, and its value is adjustable by means of the variable resistance *R*2. When *V*2 is adjusted to equal *V*1, current ceases to pass through the thermo-couple circuit, and galvanometer *G*, in series with the thermo-couple, is used to indicate this condition. The current through *R*1 from the variable voltage supply is then proportional to

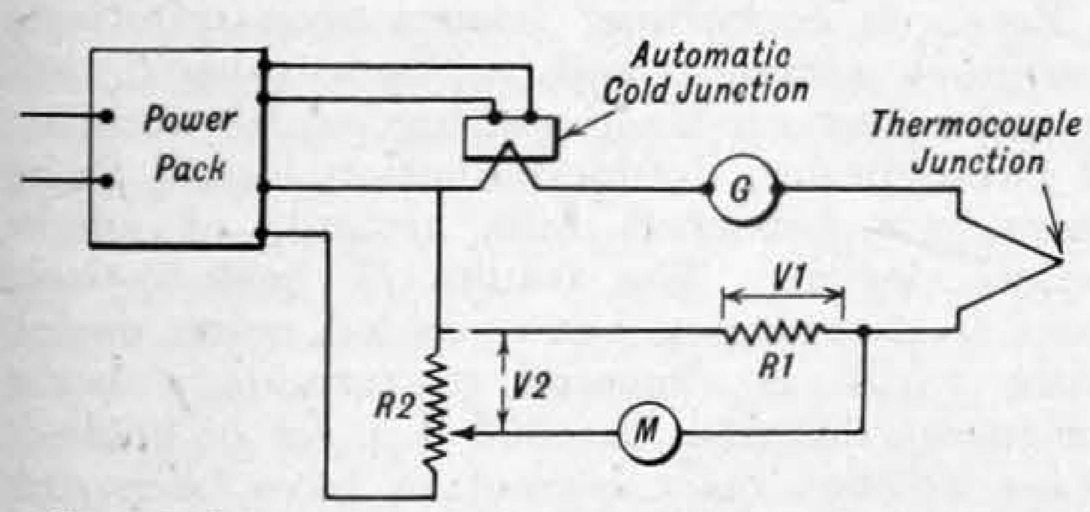


FIG. 6—TEMPERATURE INDICATING CIRCUIT

the E.M.F. produced by the thermo-couple circuit and is, therefore, directly related to the temperature. The meter *M*, calibrated in degrees Centigrade, is used to indicate this current and thus the temperature. As no current flows in the thermo-couple circuit at the point of balance, the resistance of the individual thermo-couple circuits (i.e., the length of compensating lead) has no effect on the temperature indicated.

The automatic cold junction E.M.F. is derived from a standard type of eureka-copper resistance bridge circuit (Fig. 7), in which the out-of-balance voltage is made to equal the E.M.F. developed by the thermo-couple materials used with this instrument (chromel and constantan) over the ambient temperature range against a cold junction at 0 deg. Cent.

The spark pick-up, as previously stated, slides over the main ignition cable between the ignition coil and the distributor. The lead from the pick-up connects to the "detector filter" box, which is fixed in any convenient position under the bonnet; the output lead to the panel is taken through the car bulkhead together with the input lead to the panel from the reference pick-up.

The equipment can be used for road test work requiring indication of engine ignition timing, speed and operating temperatures with a minimum of preparatory work for installation —a very important factor in all such experimental work. In addition to the uses already

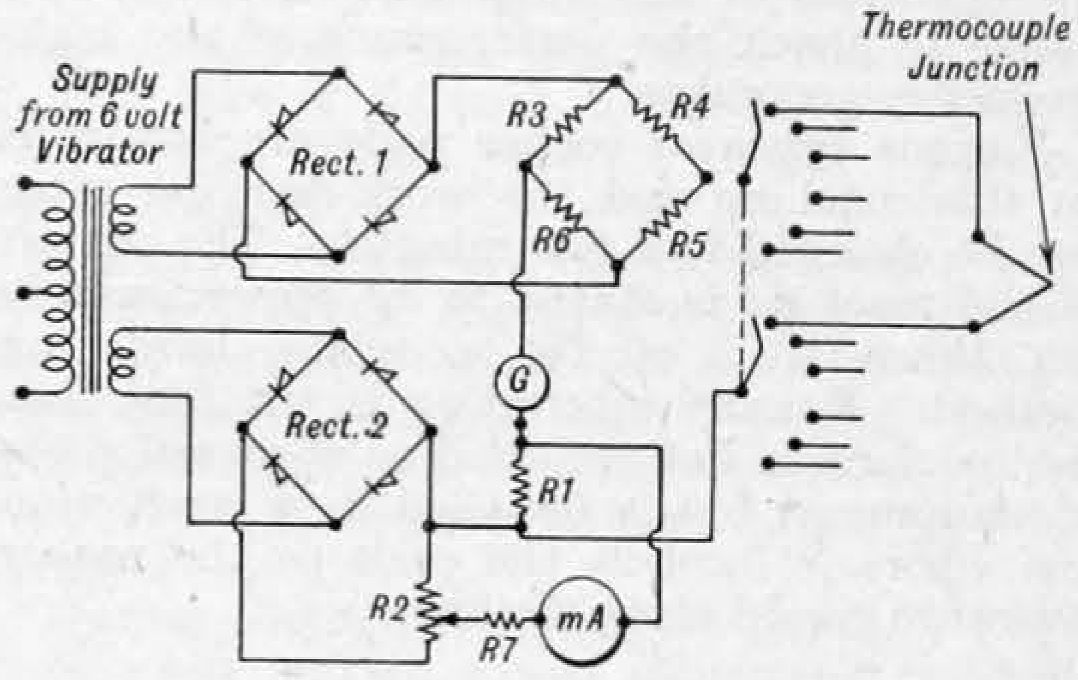


FIG. 7—AUTOMATIC COLD JUNCTION E.M.F. SOURCE

described, the response of automatic distributors to speed and throttle under road conditions can be readily measured.

One of these instrument panels has been in use for over a year in the study of motor spirit road anti-knock quality and has given very satisfactory service. Panels built to the design described are now available from Solartron Laboratory Instruments, Ltd., of Kingston-on-Thames.

The authors wish to express their thanks to the chairman of the Anglo-Iranian Oil Company, Ltd., for permission to publish this article.

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National Survey of Time Study Practice, 1950

THE first nation-wide survey of time study practice carried out by the Work Measurement Research Unit of the University of Birmingham was completed in November last year. This survey was planned and organised in close collaboration with the Joint Committee on Measurement of Productivity set up by the Institution of Production Engineers and the Institute of Cost and Works Accountants.

Including a preliminary meeting in Birmingham, seventeen meetings were held in twelve different centres. During each meeting films were shown depicting industrial and laboratory operations. Each engineer computed his normal times for all the operations, and studied and compared them with provisional values established by a control group of time study engineers. Opportunity was provided for discussion both of procedure and of the quality of individual studies. The total attendance was about 750.

At the meetings engineers were asked to record the rating values for both normal performance and standard (or incentive) performance. The full analysis of the survey, to ascertain the quality of time study rating, is being carried out. The results and interpretation of the calculations will not be available until later this year, when it is hoped to publish a further report.

In addition to the analysis of the 1950 survey results, the research unit is now engaged on the analysis of a comprehensive series of studies taken on the shop floor in the works of a number of co-operating firms. This new series has been designed to provide additional data which will be used to estimate the effect of a number of the variables occurring in time study practice, additional to those which can be assessed from the national survey results. A considerable number of operators, time study engineers (all of whom have already taken part in the national survey) and industrial executives are assisting the Research Unit in this new phase of the research project.

Multi-Motor Control Boards

OUR illustration shows a typical example of the multi-motor control board which is intended for heavy industrial use and has been introduced by Brookhirst Switchgear, Ltd., Chester. It is known as the type 948 "Unibord," and is built up as a unit embodying a number of standard assemblies, all of which are of the same width and are fully interchangeable. Basically, the control board consists of frameworks of bolted angle iron construction which accommodate standard busbar chambers of cast iron, and contactor starters housed in standard enclosures.

As shown in the illustration, the starter units are mounted above and below the centrally disposed busbar chamber units. Shallow connecting trunking is fitted between the busbar chambers and the starter cases, which are mounted immediately above or below them. All joints are made with flat rubber-bonded cork packing. Using the smallest size

"UNIBORD" MOTOR CONTROL EQUIPMENT

of starter cases, up to six starters can be connected to each busbar chamber (three above and three below).

The busbar chambers are in standard unit lengths and are fitted with bolted cast iron covers. The busbars are of tinned copper, air spaced and supported by insulating barriers in the ends of each chamber. Up to three bars may be used in parallel in each phase, giving a maximum rating of 1000A under normal ambient temperature conditions.

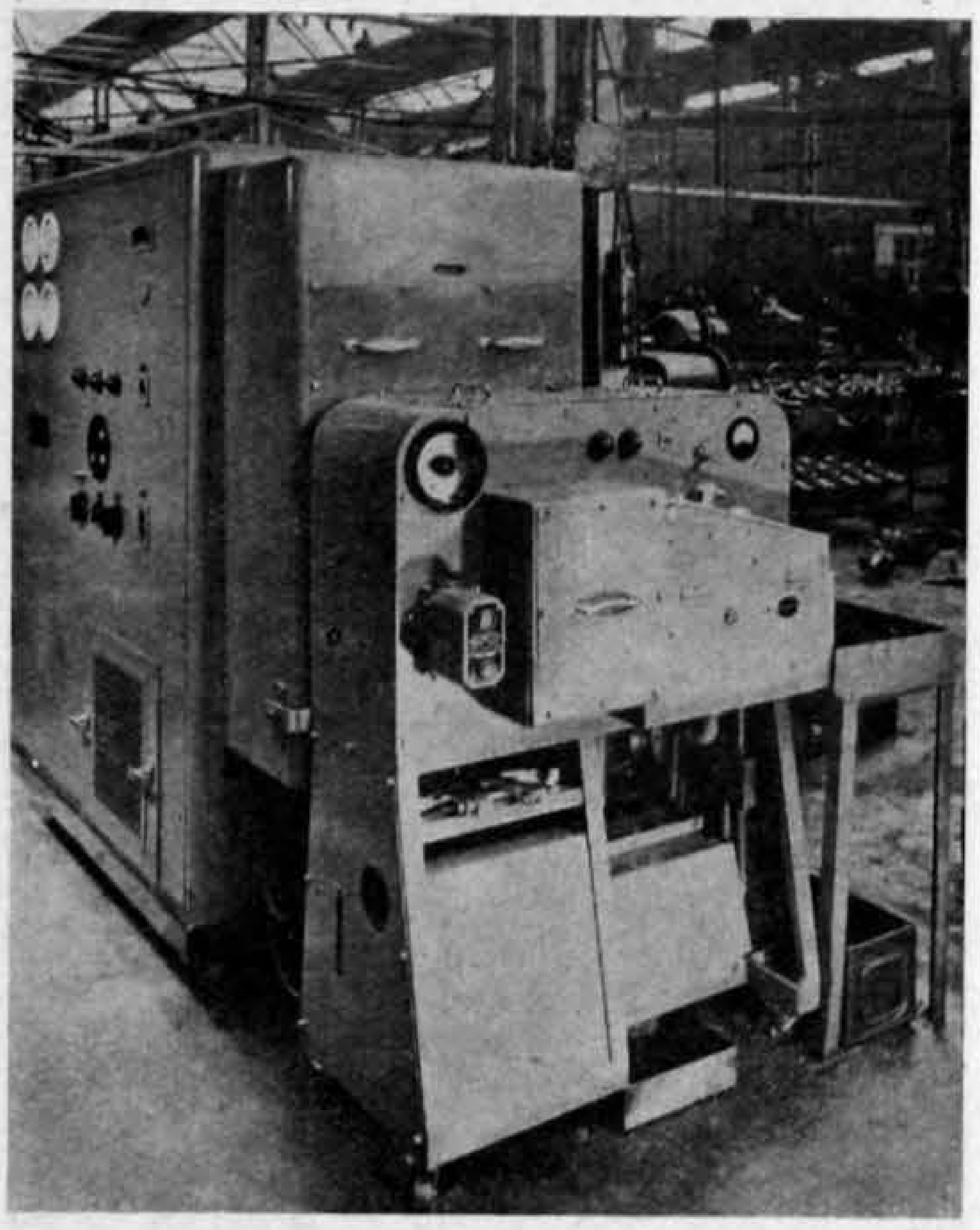
There are six sizes of starter cases, the width being the same throughout the range. The cases are of heavy gauge welded steel and the hinged doors are fitted with special wing-nut-headed fixing bolts. Normally, the door opening is limited to 90 deg. by a door stop which is, however, arranged as a quick-release catch to allow wide opening of the door when required.

The starter cases are designed to accommodate standard Brookhirst direct-on starting equipments for motors up to 200 h.p. at 400/440V. The starters incorporate contactors, thermal or solenoid-operated overload releases, high rupturing capacity main fuses and isolators, provision being made for local and remote two or three-wire control, for sequence interlocking and for the entry of all classes of paper or rubber-insulated cables. The isolators are mechanically interlocked with the case doors and electrically interlocked with the contactors so that the doors can be opened only when the switch is open, and the operation of current making and breaking can only be effected by the contactor. All live line terminals are completely shrouded. Ring-shaped handles are fitted to the isolators so that, when a starter case is mounted high up, the handle can be pole operated.

All frame units are interchangeable, being of uniform width (22⅜in between centres) to correspond with the dimensions of the busbar chambers and starter cases. To form a larger board adjacent frame units are coupled mechanically by simple all-thread ties. Main incoming and feeder switches and fuses, busbar couplers, and other distribution equipment can be included in "Unibord" motor control boards.

Automatic Rocker Pad Hardening Machine

The photographs reproduced herewith show two views of an automatic machine which has been built by the General Electric Company, Ltd., for hardening engine valve rocker pads in the Farington works of Leyland Motors, Ltd. The machine comprises a 5kW high-



AUTOMATIC ROCKER PAD HARDENING MACHINE

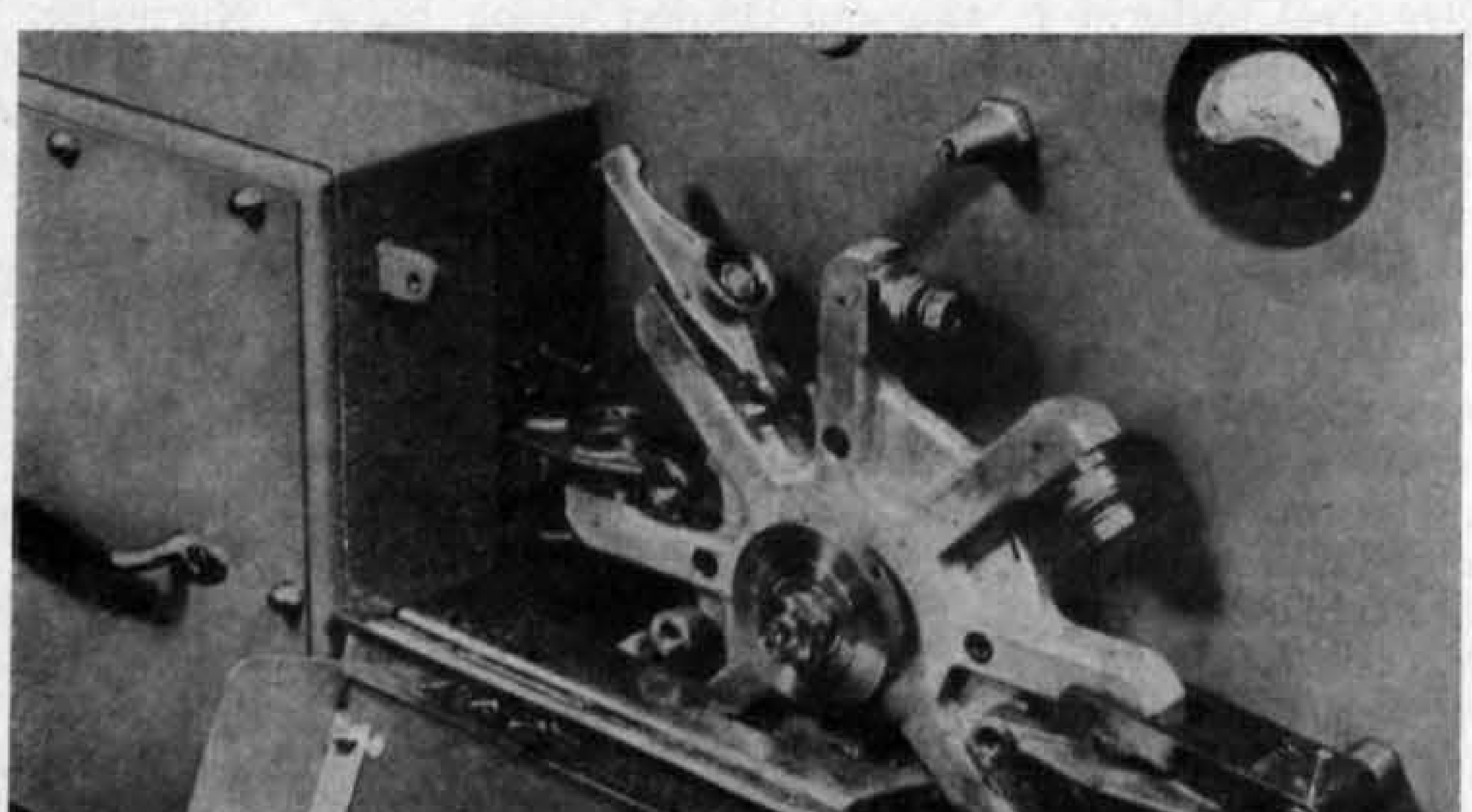
frequency induction heater, together with automatic handling equipment for the work.

The rocker levers are loaded manually on to the arms of an eight-position rotor which is indexed and carries each lever in turn to the heating inductor on the left of our second illustration. There the surface to be hardened is raised to the required temperature and is then immediately indexed to positions where oil quenching jets are directed on to it, after which the rocker is automatically ejected into a bin.

Indexing and unloading of the machine is performed pneumatically and safety devices are fitted to ensure the correct spacing of the rocker pads from the heating inductor and to prevent the application of high-frequency power unless the quenching jets are in operation. After being used, the quenching oil is passed through a heat exchanger, where it is cooled by means of a mains water supply and is then recirculated.

A process timer is fitted to the machine to enable the rotor which carries the rocker lever to be indexed at precise intervals. Signal lights are used to indicate various aspects of the operation of the equipment and there is a meter to check the performance of the high-frequency generator.

Various types of rocker pads are hardened on this machine and the work-carrying rotor can be changed in a few minutes. The output of the machine is stated to be approximately ten times that of the previous hardening method. Equally interesting is the fact that the machine is not regarded as a special piece of equipment, but is installed in a production line where it hardens the pads as the rocker levers are passed along the line.



EIGHT POSITION ROTOR AND HEATING INDUCTOR

Pametrada Progress Report for 1950

The progress report for the year 1950 of Pametrada, records a year of considerable activity in the testing and research into steam and gas turbines, and we summarise below the principal research and development items appearing in the report. The technical director, Dr. T. W. F. Brown, paid a visit to the United States and, besides inspecting turbine progress at a number of works, read a paper before the American Society of Mechanical Engineers. Three other papers were given during the year and seven provisional patents taken out. The expanding work is reflected in the size of the staff which now numbers 198, and includes a new group of engine testers and it is noted that the Research House extension is completed and that the new workshop is in operation.

The work of the design department continued to increase and the designs of more than two-thirds of the horsepower of geared turbine machinery completed by member firms were prepared by the Association. The ships concerned included liners, cargo liners, cross-channel steamers and large tankers. The cross-channel steamer "Brighton" is particularly noted as the machinery incorporated the Association's design of a single-cylinder turbine, in which all ahead and astern power is developed within a single casing. The most important development in turbine components is the method of manufacturing diaphragms and blading for impulse turbines by the assembly of separate blades and packers from rolled strip and brazed together in short groups. Tests have verified the predicted strength and stiffness and the diaphragm has been adopted for new machinery, for which steam conditions are 650 lb per square inch and 850 deg. Fah. Scuffing in reduction gearing is still under investigation and increased tip relief, although it improves conditions, is not regarded as a cure. Another interesting investigation, into the severity of the one-node torsional critical speed, involved the development of a new torsiograph, which can record vibrations at four separate points simultaneously. During the year particular attention has been focused upon the theoretical development of gearboxes capable of driving ahead or astern, in which either of the two annulus members may be stopped by hydraulic brakes. Such gears, when they reach the stage of installation, should result in considerable simplification of turbine construction.

The Research department has continued with the trials of destroyer machinery and the report on the "Daring I" was completed. "Daring II" trials were completed after 286 hours of running and the "Daring III" machinery, which is of all-impulse design, was erected during the year and trials are in progress. A number of research schemes have proceeded in association with the "Daring" trials. For condenser development heat transfer coefficients in condenser tubes have been further investigated and it is now possible to measure accurately the steam pressure drop. A new method, using the "Thermistor" device, measures the water temperature rise and in a range up to 120 deg. Fah. has an accuracy of plus or minus ¼ deg. Fah. Temperature distribution in turbine casings has been under review and also the relative expansion between rotor and casing, for which purpose a spark gap indicator has been designed. Some research continues to be carried out to reduce noise levels and this has been directed to the silencing of fan flats and to noise measurements on auxiliaries.

Faulty castings have held up high temperature steam turbine tests and turbine blade research has reached the experimental stage. Turbine diaphragm deflections and strains have been measured in a rig in which hydraulic pressure simulated steam loading and results have confirmed those obtained by calculation.

The 3500 s.h.p. marine gas turbine was put under power and a number of adjustments made to correct faults and to effect improvements, gland sleeves were modified, compressor surging investigated, distortion trials run and corner guide vanes fitted in the air-ducting. Late in the year the h.p. line reached the self-running state at 4300 r.p.m. with a h.p. turbine inlet temperature of 750 deg. Fah. but surging continued to take place at too large a mass flow. Several expedients to correct this have been tried and the present scheme is to reduce blade height and thus the flow area. Combustion chamber tests have been carried out and results recorded and the effect upon wall temperatures of a number of variables is to be studied. Centrifuging and the use of solvents have been tried as a solution of the ash problem and sprayer development has proceeded, including the design of an interchanging mechanism and the determination of the optimum shape of vortex chamber. More specific information is required for the design of compressors and for that purpose an experimental axial flow compressor is to be installed so that an analysis of flow conditions can be made at any stage in the machine.

Research concerning transmission questions continues actively and a back-to-back test is under way on Maag gearing, which consists of two-cylinder, double-reduction locked train gears, air hardened and ground, of single helical design. The results of back-to-back tests to destruction have yielded much useful data, which is expected to provide a basis for future designs. A 4000 h.p. set of hobbed gears without helix correction have been run to destruction and a similar set of gearing with helices corrected for torsion and bending have been loaded up to 325 per cent without failure.

Hydraulic reversing mechanisms have been tested by transmitting power from a steam turbine through an ahead fluid coupling to a dynamometer and results indicated that slip at full load should be less than 2 per cent, this figure being checked by calculating, from flow and temperature rise measurements, the heat absorbed by the oil. Following upon these tests, the astern converter type "A" was installed and initial trials showed that hydraulic losses were too high although mechanical performance was satisfactory. The causes were investigated and modifications effected, which improved the flow but further work is in progress. Astern converter type "B" is in course of manufacture.

Instruments required for the various investigations continue to be developed and improved. The torsio-axial pick-up for shafting, an electronic instrument, can measure the frequency and amplitude of torsional vibrations of turbine shafts, secondary shafts or units at selected points. The device was used successfully on the "Volsella" trials and a final model is being built. Work on strain gauge equipment for use at high temperatures has gone forward and a technique evolved for welding fine strain gauge wires and also devices for hot and cold calibration of the gauges. For the calibration of microphones for noise measurement a taper duct has been built for those dealing with the lower end of the frequency scale and a cabinet for the higher ranges. Among the other instruments noted in the report are torque meters, aphoto-elastic analyser and a wave analyser.

Synthetic Resins in the Foundry*

A SUB-COMMITTEE was appointed in March, 1949, to investigate the use and development of synthetic resins for (a) core binders, (b) moulding sands, and (c) other foundry applications concerned with the production of ferrous and non-ferrous castings. The terms of reference were interpreted to exclude impregnation. From the evidence available to the sub-committee, it was concluded that the report should be confined to the use of synthetic resins in the production of cores, since there appeared to be insufficient activity in other directions to justify their inclusion.

Information supplied from various sources showed that considerable interest had been displayed in the use of urea and phenolic resins as core binders. The result of much experimental work was revealed and a few—generally large—foundries reported satisfactory use on a production scale. Various criticisms were made due to the different characteristics of synthetic resins as compared with oil-bonded sand and, in a number of cases, experiments had been dropped in consequence. In cases where the right type of resin was used and the necessary modifications in practice were made, results were claimed to be equal to those given by oil-bonded cores and at lower cost.

The principal criticisms were of the sticky nature of the mixed sand and lack of flowability; nevertheless, by the addition of paraffin or other parting compounds, this defect could be offset, so much so that resin-bonded sands were in satisfactory use on core-blowing machines.

Summary of Findings

Both moisture content and milling time are somewhat critical in producing the required green properties, but, given a suitable mixture of resin, cereal—and possibly clay—and adequate technical control, the resin-bonded sand can be made to be practically indistinguishable from oil-bonded sand as regards "feel," bench life and working properties.

Baked strength depends a great deal on the moisture content present when baking; therefore, if cores are allowed to surface dry before baking, weak, friable cores result, but blacking or spraying of green cores just before baking improves the strength and hardness of the core surface. However, a fairly general complaint, from large users, of brittleness, with consequent loss of cores due to chipped edges or increased fettling costs, suggests that excessive hardness is undesirable, and the ideal resin has yet to be found. Baking at 150 deg. to 175 deg. Cent. for U.F. (urea-formaldehyde) and at 200 deg. to 250 deg. Cent. for P.F. (phenol-formaldehyde) is usual, and, as no time for oxidation is required, normal baking times can be halved.

Damping back presents no serious problem if adequate proportions of resin are used, when the baked cores have good moisture resistance under normal foundry conditions. Dimensional accuracy is usually satisfactory, although the results may depend in some degree on the mixture used and the precautions taken against sagging, particularly with medium to large cores. Rubbing of cores is not recommended, as the exposed surface tends to be friable.

P.F.-resin cores have a lower gas content than those bonded with oil; U.F.-resin cores yield a quantity of gas similar to oil-bonded cores, but at a high initial rate which may necessitate additional vents. Ease of knock-out and fettling is a characteristic feature of U.F.-resin cores, due to their complete disintegration and the reduced tendency to finning; P.F.-resin cores in these respects are not noticeably different from oil-bonded cores. Casting finish obtained when using resin-bonded cores is not inferior to that obtained when using oil-bonded cores under similar pouring conditions.

Synthetic resins are home produced; they are also in ample supply; the cost of mixed sand is generally about the same as that of comparable oil-bonded sand; savings accrue due to reduction in baking costs and, in the case of U.F. resins, fettling costs may be reduced.

During casting, neither U.F. nor P.F. resins evolve the irritant fumes associated with oil-bonded cores, but the fumes from U.F. resin are disagreeable. The question of harmful fumes and the incidence of dermatitis have been considered very carefully by the committee. Whilst it is realised that the risk of dermatitis is not negligible, the information available indicates that there is no reason to restrict the use of synthetic resins in foundries, as in the experience of users the number of cases of dermatitis appears to be no greater than with oil-bonded sands.

Conclusion

The interest amongst founders in synthetic resins for core binding has now reached the stage where several foundries can show that advantages are real. On the other hand, some foundries have rejected synthetic resins on the score of odour and/or production difficulties. Methods that are accepted for oil-sand must not necessarily be carried on with a change-over to resin sand, and the new binder must be treated with respect and methods adapted to suit its characteristics.

The sub-committee are well aware of the keen interest shown and the extensive development work carried out by members of the British Plastics Federation during the past few years, and they wish to endorse that organisation's recommendation that foundries make full use of the technical services of the resin suppliers to obtain the best results from any particular type of resin. As to implementing the recommendations of the "Garrett" Report, the sub-committee is of the opinion that P.F. resin approaches the ideal of a practical and fumeless core binder. Nevertheless, the economic attractions of U.F. resin and the fact that fumes from the cereal portion of the mixture are inevitable, whichever resin is used, emphasise that good ventilation, together with the use of minimum percentage binder and thoroughly baked cores are the most practical means of improving conditions in foundries.

* Summary of a report submitted for discussion at the forty-eighth annual conference of the Institute of British Foundrymen, at Newcastle upon Tyne. June 12 to 15, 1951.

American Engineering News

(From our American Correspondent)

An Electronic Counter for Paper Currency

A fully automatic electronic machine for counting worn-out paper money has been designed and developed by H. M. Joseph and Carroll Stansbury, of the National Bureau of Standards. Sponsored by the U.S. Department of the Treasury, the "N.B.S. Electronic Currency Counter" will replace the present hand-counting system at an estimated saving of about 250,000 dollars a year to the Department. A total of twenty-five currency counters will soon be placed in service by the Treasury's redeemed currency unit, which has the responsibility of accounting for the unfit notes removed from circulation by Federal Reserve Banks throughout the United States. The replacement of the worn-out bank notes by new ones involves the redemption of some 8 tons of currency daily. Although new paper money has been machine counted for many years, mechanical handling of worn-out notes has, until now, been a difficult operation. Money returned to the Treasury is in the form of packets of 100 notes cut longitudinally into half-notes. The bulk of the returned money consists of 1 dollar bills, which constitute about 80 per cent of all the U.S. currency received for redemption. The bills are limp, wrinkled and difficult to handle; occasionally torn notes are taped together.

The electronic currency counter is designed to count packets of 100 notes and to reject automatically those with more or less than 100. It is an electro-mechanical device, and consists essentially of a trough to receive the packets of money, a mechanism for inserting and grasping each packet in a spindle, a friction band and air jet that separates the notes in regular intervals, and a binary counting circuit actuated by pulses from a photo-electric system. In this method, the cut packet of half-notes is clamped in and wrapped around a spindle to obtain the necessary separation between the ends of the sheets. The free ends of the sheets are then released as they rotate on the spindle, and a jet of air fans each sheet out into the light beam of a photo-electric cell. The regular interruption of the photo-electric beam by each sheet causes current variations in the circuit, which, in turn, are applied to an electronic counter. Experimental use of the light beam method in counting several thousand packets showed erroneous overcounts in less than 1 per cent of the packets counted. These results are well within the limitations set by the Treasury Department. In applying the technique to the worn half-notes, certain critical design requirements had to be observed. The light beam had to have an appreciable cross section (approximately ¼in by ¼in) to avoid false operation by stray fragments of paper and had to be placed at such an angle as to be reliably interrupted only by single sheets. To avoid turbulence and whipping of the sheets, the air jet had to be placed tangentially and as close to the contour surface as practicable.

For reasons of flexibility, a separate, completely self-contained cabinet, mounted on castors, is used for each counting head. Automatic feeding and removal of the packets to and from the counting head, an input magazine which can be replenished periodically with packets to be counted, and "correct" and "reject" outlet chutes, through which counted packets emerge, are provided. For ease of maintenance, the counter is composed of readily replaceable sub-assemblies which are completely interchangeable with duplicates.

The input magazine is an inclined trough. At the beginning of each counting cycle, a feeder mechanism pushes the packets from the trough, one at a time and endwise, into the opening between the spindle jaws. When a packet reaches this position, an electric limit switch is actuated, which causes the spindle jaws to clamp and rotate. The packet thus rolls around the spindle and is counted by the light beam method. The jaws then release and the packet is cleared from the counting head by an additional revolution of the spindle. The released packet falls on a sheet metal sorter vane, which has previously been tilted to either the correct or the reject position by an electromagnet responding to the count. A "turntable assembly" mounted on the top of the cabinet includes the counting head with its friction band and optical assembly. The spindle jaws, together with an electromagnet that operates them, are carried in a rotating element of the turntable assembly. The optical assembly includes a lamp, a condensing lens and two small adjustable mirrors for deflecting the light beam across the path of the sheet ends as they are blown out from the end of the friction band by the air jet. The free end of the friction band is pressed against the rolled-up sheets by a compression spring and piston mechanism. The stationary table surface of the turntable assembly is inclined at the same angle as the feeder trough, so that, at the end of its counting cycle, each packet of half-notes slides forward off the inclined table on to the sorting vane. The tilt of the vane, positioned by the electromagnet, causes the packet to slide to the "correct" or "reject" output chute.

Mechanical details of the pusher that holds the end of the friction band against the contour of the rolled-up sheets proved rather critical. It was found that a knife-edged bearing offered the best solution to the problem of releasing only individual sheets. Another critical design feature was the position of the air-jet nozzle relative to the end of the friction band. Its opening was placed as close as possible to the contour of the surface, and set to produce an airstream tangential in direction. This proved to be the only arrangement that would give the proper swinging motion to the individual ends of the half-notes as they passed the light beam. In the event of a packet of half-notes tangling around the spindle, a limit switch adjacent to the turntable is actuated and stops the automatic feed until the machine is cleared by hand. Other limit switches stop the machine after it runs out of packets and interlock the motion of the turntable with that of the feeder mechanism. The sorter vane mechanism is mounted on the upper of two chassis located in the cabinet below the turntable assembly. These chassis support the magnetic relays and the electronic components. A small rotary air compressor with integral motor drive is mounted on the bottom deck of the cabinet.

The electronic counting mechanism is mainly conventional. A cathode follower applies the photo-cell impulses to a trigger circuit for conversion to sharp, uniform amplitude pulses. These pulses are, in turn, applied to a binary electronic counter. The full counting capacity of this eight-stage counter is 256, whereas the desired count for a correct packet is 102 (100 half-notes, plus the wrapper sheet on each side). In ordinary production use by the Treasury, the actual numerical count resulting for each packet is not of interest, but for maintenance purposes the count is indicated by a series of neon lights situated just below the output chutes. The machine is "fail-safe" in the sense that a very large percentage of possible failures in the equipment are such as to cause all packets to be rejected. This would be quickly noticed by attendants and result in the particular machine being taken out of service. The less likely failure, in which all packets are accepted, would have the same result.

The most important factor in the counting effectiveness of the machine is the condition of the money to be counted. Thus, causes of erroneous low count include the extensibility of half-notes due to wrinkles; folded corners, which interfere with individual release of the sheets; folded or short sheets, and adherence of adjacent sheets due to taping of half-notes with gummy tape, cancellation punching with dull dies, or other causes. Causes of erroneous high count include interruption of the light beam by loose fragments of paper, and random disturbances in the air which whip the ends of the sheets through the light beam more than once. A study of optimum spindle speeds was made to determine the effect of varying speeds on the accuracy of count. The relative advantages of low operating speeds as compared with the use of a greater number of machines to do a specific job were also considered. Tentatively, the spindle speed adopted is 15 r.p.m., but this is subject to a possible upward revision on the basis of anticipated large-scale tests that will accompany early production operation.

The Gunnison-Arkansas Transmountain Water Diversion Project

The U.S. Secretary of the Interior has approved the Gunnison-Arkansas project, in which the Bureau of Reclamation proposes to tunnel under one of the highest peaks of the Rocky Mountains to divert an annual 69,200 acre-feet of water from the western to the eastern slope of the Continental Divide. The project will furnish about 467,000,000kWh to help meet the critical need for power in the project service area. It will supply about 185,000 acre-feet of supplemental irrigation water annually for approximately 322,000 acres of land in the Arkansas Valley, and make available about 15,000 acre-feet of water to supplement the municipal supply in ten communities in the State of Colorado. The plan for the diversion of water from the Colorado River to the Arkansas River catchment includes a system of about 50 miles of canals and tunnels in the western slope of the Continental Divide for the collection of water from Hunter Creek and Frying Pan River, tributaries of the Roaring Fork River. Furthermore, it involves the construction of the Aspen reservoir with a useful storage capacity of 28,000 acre-feet on the Roaring Fork River and the construction of the Frying Pan—Arkansas tunnel, about 6 miles in length at a height of 10,000ft through the Continental Divide, for diverting water collected on the western slope to the eastern slope. When completed, the tunnel will be the highest ever constructed by the Bureau of Reclamation. The major items in the eastern slope project will include three earthfill dams, 50 miles of power canal, three diversion dams, over 10 miles of diversion canals, seven hydro-electric power stations and switching stations, three small forebays and two afterbays, nine substations, about 400 miles of transmission lines, and a municipal water supply system. The project, estimated on the basis of October, 1949 prices to cost 147,440,000 dollars, would be completed in ten years under the proposed work schedule. About 25 per cent of that cost would be for structures on the western slope and the transmountain tunnel. Altogether, the plan contemplates the expenditure of 64,334,000 dollars for dams and reservoirs, 30,499,000 dollars for diversion canals and conduits, 34,021,000 dollars for power installations, 18,050,000 dollars for the municipal supply system, and 536,000 dollars on operation and maintenance costs during construction. All but about 18,000,000 dollars of the total cost would be returned to the Government within fifty years from power revenues and payments by irrigation, municipal and industrial water users.

The amount of irrigation water now available for the 322,000 acres of irrigated land in the project area varies considerably from year to year, but is seldom adequate for maximum crop production. Irrigation water shortages as high as 78 per cent of crop requirements have occurred and, moreover, in some instances long reservoir feeder canals have lost 50 per cent of their capacity because of sedimentation. The power facilities of the programme have been designed for integration with those of the Bureau's Colorado—Big Thompson project and with local utilities to serve a combined power market area. The seven power stations would have a total installed capacity of 104,800kW. The quantity of municipal water available on the eastern slope is barely adequate at present, and with anticipated population increases additional municipal water supplies will be needed, particularly by the towns of Pueblo and Colorado Springs. Colorado Springs, it is estimated, will require approximately 5231 acre-feet of additional municipal water by the year 2000. The Roaring Fork diversion plan contemplates providing a portion of that supply—a total of 4000 acre-feet of project water has been allotted to Colorado Springs. Under the project, 2700 acre-feet of water would be pumped into the city system annually from Middle Beaver Creek and replaced by 3200 acre-feet of project water; the remaining 800 acre-feet of project water would be reserved for replacement of future diversions. The municipal water would be lifted approximately 140ft into the existing Colorado Springs municipal supply system beginning with reservoirs on the south slope of Pikes Peak. The pumped water, regulated with the present supply, would generate energy in the two municipally-owned hydro-electric power plants of the Colorado River Springs system. The estimated additional water requirements for Pueblo by the year 2000 will be about 4547 acre-feet, and much of that supplementary supply and a better quality present supply is needed immediately. The additional water would consist of 2000 acre-feet from the existing Wurtz Ditch transmountain diversion and 3000 acre-feet from the potential Frying Pan—Arkansas diversion.

French Engineering News

(From our French Correspondent)

A programme to provide French West Africa with hydro-electric power is being investigated. Until now all electricity has been supplied by thermal power stations, but the barrage of a 30MW hydro-electric project is under construction near Brazzaville, and a 40MW scheme is in progress at Edea. The installed capacity of the Dakar plant is also being increased from 9MW to 20MW. A 10MW hydro-electric project is to be constructed on one of the tributaries of the Niger, and a 3MW power station near Abidjan.

* * *

France has regained second place among the world's shipbuilders, immediately after Great Britain. At the end of March, French vessels under construction totalled 485,888 tons, 28,475 tons more than the last quarter.

* * *

In spite of the reductions in the credits allowed for work under the Monnet Plan, the rate of execution of this work will not decrease very much in 1951. The Commissariat had asked for 466 milliard francs, compared with 383 milliard francs envisaged by the budget, of which 80 milliards will be raised by guaranteed loans; 441 milliard francs was granted in 1950.

* * *

Production is expected to increase in the South Madagascan coal basins as a result of two projects of the Charbonnages de Sakoa. The first concerns extraction of coal needed for the island and its immediate neighbours, and includes extension of mining equipment, construction of a loading station at Soalara, and delivery of coal by sea. This work will require an outlay of 350 million francs. The second project is for commercial exploitation of coal seams on a large scale. In the first stage it would handle 300,000 tons, increasing progressively to 600,000 tons.

* * *

The Union Technique de l'Electricité has recently adopted new specifications for lead accumulator batteries for starting internal combustion engines. The new specification has the following main characteristics:—The dimensional capacity, designated by the symbol P, is obtained as soon as the battery comes into use, or, at the latest, at the third discharging; the nominal capacity, designated by the symbol C, is indicated by the manufacturer and must be obtained at the twenty-fifth discharge, in the course of endurance tests. The two capacities, P and C, are expressed in ampere-hours. Starting performance is defined by discharges at 3P amperes, at temperatures of 25 deg., 0 deg. and −15 deg. Cent. Endurance is defined by the number of successive charges and discharges the battery can take without the capacity being lowered under 0·8P. The Union Technique de l'Automobile et de Cycle proposes to introduce two categories of batteries with the same starting performance, but different endurances (175 or 250 cycles).

* * *

The 850-ton coaster, "Haut-Brion," ordered by the Mercant Navy Ministry, has been launched at Le Havre. It has the following characteristics:—Overall length, 63·52m; width, 9·30m; draught, 4·05m; displacement fully loaded, 1557 tons. The vessel has three holds with a total capacity of 1256 cubic metres. The 750 h.p. two-gear diesel motor turns at 180 r.p.m.

* * *

It is now considered that French constructional plant manufacturers have completely recovered from the unfavourable conditions caused by the war. Plant now being produced is claimed to be of the most modern design, and in some cases ahead of that of other countries. The examples given of constructional plant include a very large concrete batching and mixing plant, a large grab, cranes, and road maintenance material. The industry has also produced large diameter boring tools and concrete vibrating equipment of advanced design. The production of the industry can now cover all the needs of the French Union, and a substantial proportion is also exported.

Industrial and Labour Notes

Iron and Steel Production

The British Iron and Steel Federation has announced this week that the output of steel ingots and castings during May—which included the Whitsun holiday—averaged 305,100 tons a week and was thus at an annual rate of 15,864,000 tons. Over the first five months of this year, steel production has been at an annual rate of 16,361,000 tons. Pig-iron output in May averaged 182,400 tons weekly, showing an annual production rate of 9,482,000 tons, compared with a rate of 9,280,000 tons in April.

The May figures for steel, the Federation says, show the effect of the difficulty during the winter period over the import of iron ore and the result of an exceptionally low import of scrap. Only 26,000 tons of scrap were imported in May this year, compared with 196,000 tons in May last year. The immediate prospects for imported scrap are somewhat better, however, and in June and July it is hoped that about 40,000 tons a month will be received. But the improvement in the raw material position for steel making depends on maintaining fully the good start to the scrap drive and on the expansion of pig iron output. So far this year pig iron production has averaged 182,000 tons a week. In the remaining months of the year it is expected to increase to at least 190,000 tons a week and then to continue to rise in 1952.

This increased pig iron production is based partly on the expectation of better arrivals of imported ore. Arrivals of imported ore in the first four months of this year were 560,000 tons a month. In May they rose to 660,000 tons and this month it is hoped that they will total about 760,000 tons. Consumption of home ore last year was 12,750,000 tons and this year it is running at 14,500,000 tons. Coke supplies have increased with the coming into operation of new ovens at Margam and by the end of the year additional coke should be forthcoming as a result of developments in South Wales and at Scunthorpe. Next year, the Federation points out, there will be capacity available for the production of about 10,500,000 tons of pig iron, compared with the 9,500,000 tons being produced this year. But it will involve increases in both home and imported ore supplies. Every effort is being made to ensure that the necessary material is available.

Non-Ferrous Metals Licensing

The Ministry of Supply has announced that the licensing system for unwrought copper, lead and zinc is to be extended from July 2nd to include licensing of scrap and residues of those metals. Provision for this is made in the Copper, Lead and Zinc Distribution Order, 1951, which was published last week. Under the Order a licence will be necessary to acquire, treat, use and consume copper, lead, lead alloys and zinc, and any scrap from those metals and their alloys. Those likely to be affected by the Order are asked to apply immediately for a licence to the Directorate of Non-Ferrous Metals, Ministry of Supply, 20, Albert Street, Rugby.

The Ministry says that before a licence can be issued, a return of stocks on December 31, 1949, December 31, 1950, and March 31, 1951, will be required, and certain records and returns will have to be kept and rendered thereafter. A licence will not be needed to acquire scrap or residues up to 13 tons in all over a period of thirteen weeks provided the metal is only cleaned, crushed or sorted. But a licence will be necessary to use any quantity, however small, for melting, remelting, making secondary ingots or any other purpose.

Industry in London and S.E. Region

At a recent meeting of the London and South-Eastern Regional Board for Industry it was stated that there were few instances of short-time working or labour redundancy through shortage of raw materials. Any workers becoming redundant were being quickly absorbed in other employment, although it was reported that raw material shortages continued to cause great concern to industrialists throughout the region, particularly because of the effect on export sales.

A report made to the meeting by the Ministry of Labour said that throughout the last quarter the employment position had remained good, and that the rearmament programme had resulted in a steady increase in the number of demands for skilled engineering workers. It was pointed out, however, that there was no immediate hope of meeting those demands unless the suggested reduction in the supply of raw materials for less important production materialised. The report also stated that the number of women volunteering for part-time work exceeded the demand in most parts of the region. Many women were available for work at irregular hours, and several firms were experimenting with evening shifts.

Another matter considered by the Board related to the distribution of industry throughout the region. It was stated that "a steady, but firm, resistance to moving out of Greater London was being encountered," particularly from those firms whose main sources of supply or delivery were in the Metropolis. These firms claimed that, as the Government was calling for stabilisation of prices, any move away from London would put them at a serious disadvantage because of increasing freight rates.

Railway Efficiency

When the wages dispute was settled by the Railway Executive and the three railway unions last February, it was agreed that special measures should be taken with a view to increasing efficiency and improving productivity in the railway industry. A special joint committee of the Executive and the unions was set up to examine methods, and last week a statement was issued about its deliberations so far.

The statement says that, as a result of the committee's discussions to date, it has been agreed that the practice of employing callers-up, to call footplate staff and guards for rostered turns of duty, should be discontinued not later than July 30th. Everything possible, it was added, would be done to prevent hardship for staff displaced as a result of the decision. The statement indicated also that an understanding about lodging turns had been reached, which would lead to a reduction in the wastage of manpower and result in greater efficiency and improved transits. The statement declared, however, that the subject of lodging turns was a complicated problem which could not be quickly resolved in its entirety.

Index of Industrial Production

The index of industrial production in the United Kingdom, which is prepared by the Central Statistical Office, has been provisionally estimated for March as 142 for all industries (1946=100). This compares with 150 for February and 144 for March, 1950. The March figure this year, of course, was affected by the Easter holiday. For the manufacturing industries alone the index for March has been put provisionally at 148, compared with 156 for February and 145 for January.

On the basis of information so far received, it is suggested that the index, for all industries, for April, 1951, will be 150–151. This forward estimate for April indicates that in the first four months of this year output was at a rate about 5 per cent higher than in the corresponding period of 1950.

Work Measurement in Industry

The report of the Nuffield Foundation for the year ended March 31, 1951, which has just been published, contains, among other matters, some account of the activities of the group set up to investigate methods of work measurement used by industry in this country. The report says that a committee of physiologists, psychologists, statisticians and experts in management, under the chairmanship of Professor Sir Frederic Bartlett, University of Cambridge, planned an experiment to test the consistency of stop-watch time study.

The project was designed to test and compare the findings of a group of thirty experienced time-study practitioners, from different industrial firms, when set to assess the same operation. The results of this experiment proved indisputably that, working under laboratory conditions with variables as far as possible reduced and controlled, the final time-values set by the group of time-study practitioners, assessing the same operation, revealed a high degree of inconsistency, and that the locus of inconsistency lay not in the basic times set for each operation, but in the assessment of the working performance of the operator, and in the differing "allowances" made by each observer for fatigue, personal needs of the operator, company policy and other factors.

The Conservation of Scarce Materials

The Anglo-American Council on Productivity has organised a special mission, which has left this country for the U.S.A. this week, to study matters concerned with the conservation of scarce materials. Sir Graham Cunningham is leading the mission, which will visit engineering and allied industries in America with a view to making suggestions as to how British industry can improve its industrial housekeeping and use scarce materials in the strictest possible way.

It is stated that the mission will concern itself primarily with the immediate short-term problem, but it hopes also to examine any long-term steps, involving basic changes in design, which are now being planned. It, therefore, proposes to investigate such matters as scarce materials substitution, emergency specifications and standards, short-term alterations in design, factory reorganisation to ensure economy, and possibilities of increasing co-operation between materials supplier and user.

Raw Materials Prospects

The current issue of *Bulletin for Industry*, a monthly review prepared by the information division of the Treasury, examines the production prospects for several of the raw materials now in short supply. In the non-ferrous metals field, it says, lead and zinc stand out among the main metals as the ones for which the prospect is most disturbing. New discoveries of important deposits have become progressively fewer in recent years, although it is suggested that more expensive prospecting methods may discover lead-zinc deposits. It is, at any rate, possible, the *Bulletin* continues, that by the end of this century lead and zinc will no longer be industrial metals. The production charts for the past twenty-five years indicate that consumption of lead is tending to fall slightly, and consumption of zinc to rise quite quickly, especially with the introduction of zinc-base alloy die casting.

The long-term outlook for other metals is considered to be better. Known copper resources stand at forty years' consumption, and there is no anxiety about bauxite. Indeed, the *Bulletin* notes, aluminium is the non-ferrous metal likely to show the most rapid expansion, and plans for increased capacity in Canada, America and elsewhere will put world production up by 15 per cent by the end of this year. The limiting factor in aluminium production is the supply of cheap electric power. Iron ore reserves, of course, are plentiful enough, although a great deal of development is necessary to keep pace with demand. With the exhaustion of war scrap and the expansion of steel making capacity, world demand for iron ore is rising very quickly.

Notes and Memoranda

Rail and Road

TURBINE LOCOMOTIVE "No. 46202."—The former L.M.S. locomotive, "No. 46202," built in 1935 and which was experimentally fitted with a Lysholm-Smith Ljungstrom turbine, is to be converted to the normal reciprocating type of engine. The locomotive, which was described in THE ENGINEER of July 5, 1935, has now run nearly 440,000 miles since construction and it is considered that sufficient knowledge of the capabilities of this type of propulsion on the railways has been obtained over the years the locomotive has been in service. A serious failure affecting the transmission took place last year and, in view of the cost which would be incurred in repairing this damage and affecting other replacements, it is now felt that it would be economically sound to take the opportunity of converting the locomotive to an orthodox 4-6-2 design.

LIVERPOOL (LIME STREET) STATION.—The London Midland Region of British Railways states that a new concourse is to be built at Lime Street Station, Liverpool, complete with concealed lighting, a glass-fronted booking office, an up-to-date refreshment room and shopping facilities. The new face of the concourse will be finished in blue-grey tiles. The present structures on the existing concourse will be removed, the three present booking offices concentrated in a central office, the inquiry and reservation office will be entirely remodelled and the heating and lighting of the station modernised. The alterations have been planned to give more convenient access and better circulation in the concourse. New standard direction signs will be erected to give instant guidance to the passenger and a new departure indicator opposite the booking office will give "at-a-glance" details of trains.

LONDON TRANSPORT'S GARAGE PROGRAMME.—London Transport announces that the first stage of a comprehensive programme for the building of additional garages and the reconstruction, extension or modernisation of certain existing premises is now well in hand. It provides for the construction and equipment of seven new garages, four in the central area and three in the country area, and the reconstruction and re-equipment where necessary of nine existing central bus garages. The additional covered accommodation to be provided under this part of the programme will ultimately be of the order of 1000 buses. In preparing the scheme it was necessary to consider the overall requirements of the bus and coach fleet as a whole and, in the main, these determined the sites for the new buildings, as well as the selection of garages for reconstruction, although availability of land and similar practical considerations were naturally taken into account.

Air and Water

HUNDREDTH LIFEBOAT.—J. Samuel White and Co., Ltd., has completed a 52ft by 13ft 6in Watson cabin lifeboat, which is the hundredth lifeboat delivered by the firm to the Royal National Lifeboat Institution, and destined for the Aberdeen station. The vessel has a double diagonal mahogany hull laid on oak timbers and is equipped with 255 air cases. In service condition the displacement is 28·5 tons and the safe carrying capacity in fine weather is 145 persons, the figure being reduced to 100 in rough weather. The curve of stability shows that the maximum righting lever occurs at 40 deg. of heel and that the range is 100 deg. A pair of 60 b.h.p. diesel engines, running at 1200 r.p.m., drive outward turning propellers, through reduction gear, at 600 r.p.m., to give the boat a speed of 9 knots and sufficient fuel is carried to allow a range of 216 miles at full speed, or a cruising range of 376 miles.

MIDGET GAS TURBINE CRAFT.—The Navy now has a second gas turbine craft which is a dockyard harbour launch, 51ft long, in which a pocket-size power unit of about 100 h.p. has been installed. Built by the Rover Company, Ltd., the unit for the launch is similar to the engine fitted in the gas turbine car and to those used for experimental trials in the Rover Company's launch "Torquil." The unit, together with gearbox, weighs 600 lb, and replaces a diesel engine of similar power weighing 2½ tons, but this weight saving is partly offset by the need to carry more fuel as the turbine, at present, uses four times more fuel than the diesel. Operating from H.M.S. "Hornet," the launch has been successfully tested in Portsmouth harbour and will be put into routine service, and data acquired concerning gas turbine maintenance will be at the lower end of the power range.

Miscellanea

THE OPERATION OF GAS PRODUCER PLANTS.—The Combustion Engineering Association, in collaboration with the British Coal Utilisation Research Association, is arranging a conference on "Engineering Aspects of the Operation of Gas Producer Plants," to be held at the Palace Hotel, Buxton, on Tuesday and Wednesday, July 10th and 11th.

HANOVER TECHNICAL FAIR.—In the article dealing with the exhibits at the Hanover Technical Fair, which appeared in our issue of June 1st, last, we referred to a milling machine made by Köllmann Maschinenbau G.m.b.H. We omitted to mention in the description that the Selson Machine Tool Company, Ltd., is the sole agent for Köllmann machines in this country.

GLASGOW UNIVERSITY ENGINEERING SOCIETY.—In connection with the fifth centenary celebrations of Glasgow University, the University Engineering Society is holding a reunion luncheon in the Union on Saturday, June 23rd, at 12.30 p.m. for 1 p.m. Professor A. M. Robb, Dean of the Faculty, will preside and it is hoped that the principal guest will be Professor J. H. Keenan, of the Massachusetts Institute of Technology.

CARBON BLACK FACTORY EXPANSION.—The directors of Cabot Carbon, Ltd., announce that plans are in hand for the expansion of the new carbon black plant at Ellesmere Port. These plans involve erection of a new unit, which should result in a total annual capacity of 40 million lb, doubling present production. The new unit will produce primarily high-abrasion furnace grades of carbon blacks, best suited to the full reinforcement of rubber and certain other qualities. Liquid hydrocarbons, such as petroleum refinery residues, will be the raw material. Contractors for the new extensions will be the Lummus Company, of London, and construction will probably require at least a year, depending on availability of steel and other equipment.

THE ENGINEERS' GUILD.—The Metropolitan Branch of the Engineers' Guild held its first dinner and dance at the Café Royal, London, on Friday, May 18th, Mr. C. W. N. McGowan, M.I.C.E., M.I.Mech.E., being in the chair. The toast of "The Metropolitan Branch" was proposed by Mr. H. F. Buxton, M.I.Mech.E., chief engineer to the South-Eastern Gas Board, who referred to one of the aims of the Guild as being to obtain representation of the engineering profession at the highest levels of planning, control and direction. He stated that the Metropolitan Branch, the largest and most active of all branches, was doing its utmost to further that aim. In acknowledging the toast, the chairman proposed "The Visitors," to which response was made by Mr. G. Mackenzie Junner.

AN OIL COMMITTEE.—At the request of the Ministry of Fuel and Power, the three main British oil companies operating in the international oil trade, the Shell Petroleum Company, Ltd., the Anglo-Iranian Oil Company, Ltd., and Trinidad Leaseholds, Ltd., have formed a committee to advise H.M. Government on oil supply problems, with particular reference to defence. It is called the Oil Supply Advisory Committee and its members are Sir William Fraser (chairman), Sir George Legh-Jones and Mr. S. Vos. The Committee has no Government representatives and its secretariat will be composed of oil companies' staffs. The secretary of the committee is Mr. J. P. Berkin, of the Shell Petroluem Company, Ltd. The Ministry of Fuel and Power says that the setting-up of this committee is not related to the situation in Persia, the request for its composition having been sent to the companies some time ago.

CONCRETE BLOCK-MAKING MACHINES.—An investigation by the Ministry of Works into the manufacture in this country of concrete blocks has recently been published by H.M. Stationery Office, in the series of National Building Studies (Special Report No. 17. Price 1s.). In the course of the investigation twenty-eight firms were visited in England and Scotland—twenty-two engaged in making concrete blocks and six manufacturers of machines used in these processes. The report thus gives descriptions, comparative figures and critical evaluations of performance for the various concrete block-making methods in use. The investigation did not include any study of the quality of blocks produced. The machines examined ranged from the simple box-mould and tamper, costing as little as £5, with an average daily output of 350 blocks, to a fully automatic machine costing £14,000 and capable of an output of 7500 blocks a day.

Personal and Business

F. J. EDWARDS, Ltd., announces the opening of a new warehouse at James Street, Birmingham, 3.

DR. W. A. TUPLIN, M.I.Mech.E., has been appointed Professor of Applied Mechanics in the University of Sheffield.

MR. R. H. CAIN, V.C., has been appointed general manager of the Shell Company of West Africa, Ltd., with headquarters in Lagos.

MR. JOHN AYRES, M.I.E.E., works director (Loughborough) of the Brush Electrical Engineering Company, Ltd., has been appointed general manager of Petters, Ltd., Staines.

THE LUMLEY-SAVILLE ORGANISATION, Stratford-on-Avon, states that Mr. Graydon Poore has resigned his position and no longer has any connection with its associated companies.

DR. D. B. FOSTER, M.I.Mech.E., has joined Mullard, Ltd., as chief engineer of the equipment division. He has also been appointed executive director of Mullard Equipment, Ltd.

THE BELMOS COMPANY, Ltd., Bellshill, Lanarkshire, announces the appointment of Mr. J. E. Pegg, A.M.I.E.E., as its representative in Yorkshire, Nottinghamshire and Derbyshire.

LONDON TRANSPORT states that Mr. E. P. Lumley, A.M.I.E.E., has been appointed divisional depot engineer in the running division of the chief mechanical engineer's (railways) department.

WOLF ELECTRIC TOOLS, Ltd., has opened a branch service depot for Scotland at 1-3, Strathcona Street, Anniesland, Glasgow, W.3. The depot is under the supervision of Mr. A. R. Graydon.

THE ROCKWELL MACHINE TOOL COMPANY, Ltd., Welsh Harp, Edgware Road, N.W.2, has been appointed sole agent for the D. H. Prutton Machinery Company, Cleveland, Ohio, makers of high-speed planetary thread rolling machines.

MR. L. V. TURNER, M.I.E.E., has been appointed a part-time member of the South-Western Electricity Board, in place of the late Mr. Frank Forrest, M.I.C.E., M.I.Mech.E. Mr. Turner has recently retired from the position of manager of the Taunton sub-area.

DR. R. GENDERS, M.B.E., D.Met., F.R.I.C., F.I.M., has become associated as Consultant Metallurgist with Messrs. Sandberg, of 40, Grosvenor Gardens, S.W.1, in connection with the reopened analytical laboratory and newly-opened test house of that firm.

Launches and Trial Trips

TANK KING, motor tanker; built by Harland and Wolff, Ltd., for Sigurd Herlofson and Co., Oslo; length between perpendiculars 580ft, breadth moulded 76ft, depth moulded 42ft 6in, deadweight 24,000 tons; Harland-Burmeister and Wain two-cycle, eccentric, opposed-piston oil engine, seven cylinders, 750mm diameter by 2000mm combined stroke, 110 r.p.m., two single-ended, multi-tubular boilers. Launch, May 22nd.

KNUT KNUTSEN, motor tanker; built by the Furness Shipbuilding Company, Ltd., for Knut Knutsen, O.A.S., Norway; length between perpendiculars 560ft, breath moulded 80ft, depth moulded 42ft 3in, deadweight 24,800 tons on 32ft 3¼in; North-Eastern Marine-Doxford, single-acting, two-stroke oil engine, six cylinders 670mm diameter by 2320mm combined stroke, 6800 b.h.p. at 116 r.p.m., two Scotch boilers. Launch, May 22nd.

SYDENHAM, motor collier; built by the Burntisland Shipbuilding Company, Ltd., for the South-Eastern Gas Board; length between perpendiculars 265ft 10in, breadth 39ft 6in, depth moulded 18ft 6in, deadweight 2825 tons, draught 17ft 1in; British Polar diesel engine, eight cylinders 340mm diameter by 570mm stroke, 1150 b.h.p. Launch, June 4th.

Contracts

SIMON-CARVES, Ltd., Cheadle Heath, Stockport, has signed a contract with the Great Lakes Carbon Corporation of New York for the building of a battery of forty coke ovens at St. Louis, Missouri. It is believed to be the first coke oven contract ever obtained in the United States by a British firm. The contract includes oven machinery and extensions to an existing by-product plant. Apart from certain local building materials, such as common bricks and cement, all materials and equipment will be of British origin. Work has already begun on site and is expected to be finished in about a year's time.

British Patent Specifications

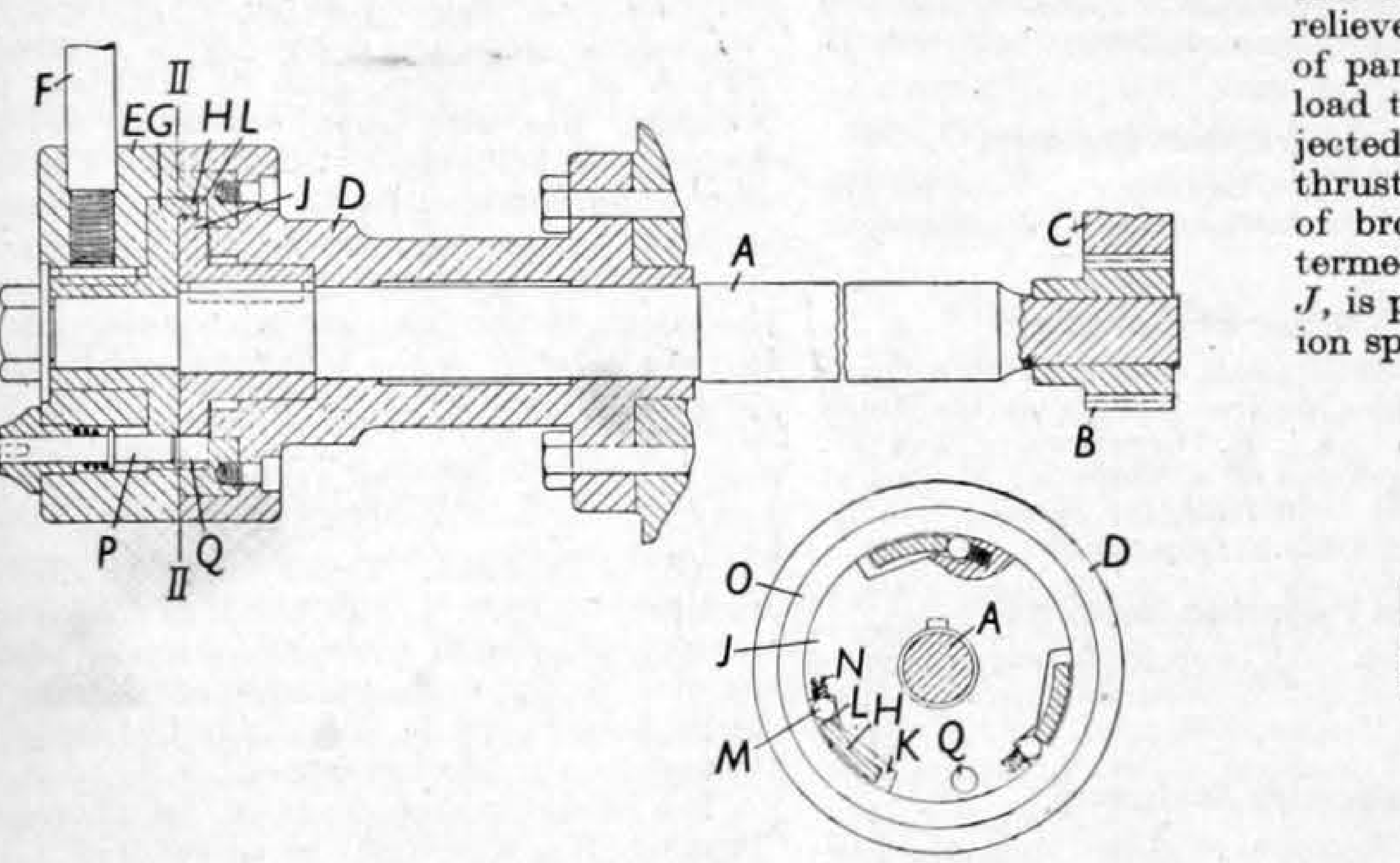
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 2s. each.

LATHES

652,547. August 25, 1948.—LATHES, H. W. Ward and Co., Ltd., of Dale Road, Selly Oak, Birmingham, 29; and George Conway Hooson, of the company's address.

This invention relates to lathes, and particularly capstan lathes, of the kind in which a slide, and particularly the slide carrying the capstan head, is movable through the medium of a manually operable rack and pinion. The invention comprises the combination with the rack and pinion mechanism of a unidirectional clutch adapted to prevent return movement of the slide by a force other than that exerted by the operative. The accompanying drawings show a sectional side elevation and a cross section on the line *II—II*. The spindle *A*, which actuates the pinion *B* engaging a rack *C* on a slide, is carried by a bearing *D*, against the outer face of which abuts a boss *E* forming part of the operating handle *F*. The boss *E* is freely rotatable on the slide and is adapted to serve as, or has incorporated with it, one part of a locking device in the form of a unidirectional clutch. As shown, this part consists of an annular member *G*, from one side of which extend any convenient number of segmental projections *H*. The complementary part *J* is located in a recess in the adjacent end face of the bearing *D* and is secured to the spindle. Part *J* has formed in its periphery three gaps *K*, adapted to receive the projections *H*. At one end each gap is formed with an inclined surface *L*. In and adjacent to the end of each gap is a roller *M*, which is urged away from that end by a spring *N*. The roller co-operates with the internal periphery of the recess in the bearing, or of a ring *O* secured in the recess. To put the locking device out of action there is, on the part *E*, a spring-loaded slidable bolt *P* adapted to engage at its inner end a hole *Q* in the part *J* for securing together the parts *E* and *J*.—*April* 25, 1951.

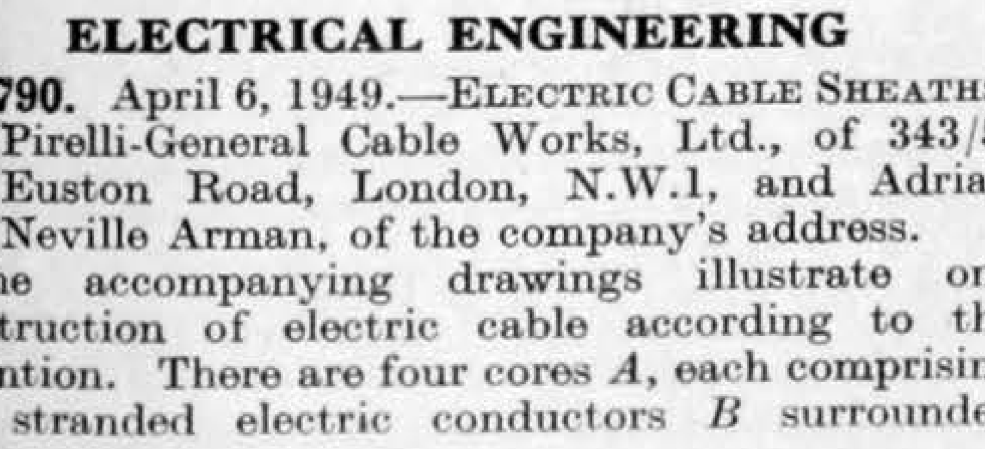


No. 652,547

ELECTRICAL ENGINEERING

652,790. April 6, 1949.—ELECTRIC CABLE SHEATHS, Pirelli-General Cable Works, Ltd., of 343/5, Euston Road, London, N.W.1, and Adrian Neville Arman, of the company's address.

The accompanying drawings illustrate one construction of electric cable according to the invention. There are four cores *A*, each comprising the stranded electric conductors *B* surrounded with dielectric material *C*; the cores are enclosed in a welded aluminium sheath *D*, around which is a covering of plastic material *E*, such as polyethylene or polyvinyl chloride. The aluminium sheath shown in the drawings was made by folding a strip of aluminium around the cores and then welding together the edges of the strip by a cold pressure welding operation so as to form a longitudinal seam *F*. An alternative method for the formation and application of an aluminium sheath to an electric cable is to wind an aluminium strip helically around the core or cores of the cable, the edges being then welded together to form the hermetically sealed sheath.—*May* 2, 1951.

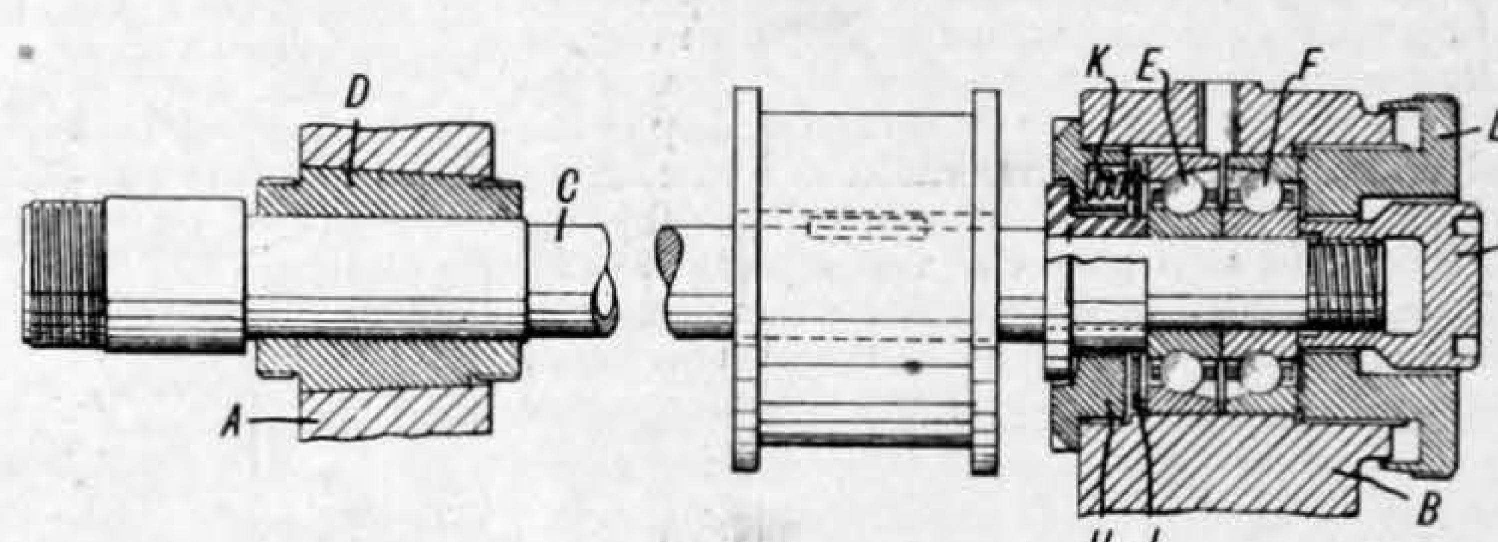


No. 652,790

MACHINE TOOLS

652,902. June 21, 1948.—BALL BEARING, Usines Tornos, Fabrique de Machines Moutier S.A.

The object of the invention is a bearing structure, in particular for the rotating spindle of a headstock, provided with a ball bearing capable of taking the axial thrust of the spindle. In the accompanying drawing the movable headstock comprises a front standard *A* and a rear standard *B* forming the bearing housings which carry the spindle *C* and a driving pulley. The bearing in the front standard has a bushing *D*, while the bearing mounted in the rear standard is of the adjustable axial-thrust type. This bearing comprises a double ball bearing *E* and *F* clamped against a shoulder of the spindle by a nut *G* screwed on the threaded end of the spindle. To relieve the thrust bearing of part or all of the axial load to which it is subjected, an auxiliary thrust ring *H* (preferably of bronze) with an intermediate pressure ring *J*, is provided. Compression springs *K* preload the ball bearing. Into the rear or outer end of the standard *B* is screwed a micrometer regulating ring screw *L* which engages only the outer race of the ball bearing *F*. By a small movement of the ring screw the thrust of the spindle is shared between the ball bearing and the auxiliary ring. It is thus possible to divide the axial load of the spindle in the desired proportion between the ball bearing and the auxiliary thrust ring.—*May* 2, 1951.

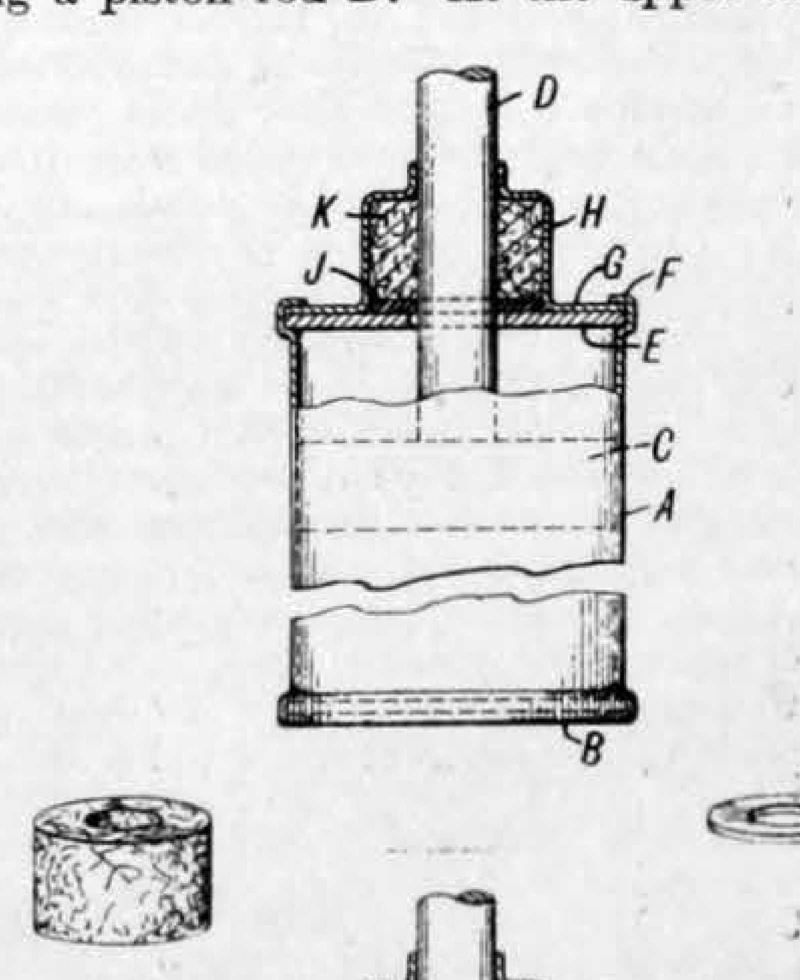


No. 652,902

MISCELLANEOUS

653,203. September 7, 1948.—STUFFING-BOX FOR PISTON AND CYLINDER ASSEMBLIES, Richard George Christopher Jenkins, of 1, Quality Court, 49, Chancery Lane, London, (communicated by *John Banta Parsons, of* 1210, *River Road, Maumee, Ohio, U.S.A.*).

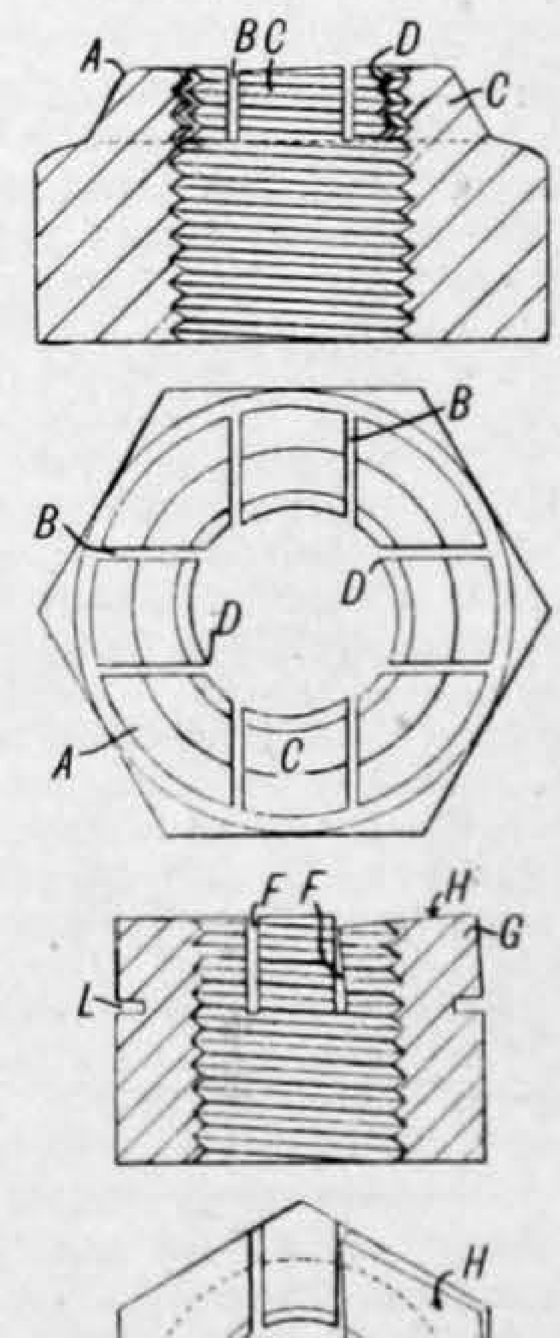
As the drawing shows, the invention comprises a metallic cylinder *A*, which is closed at its lower end by a cap *B* and within the cylinder is a piston *C* having a piston rod *D*. At the upper end of the cylinder is a metallic disc *E*, the end portion of the cylinder being crimped over at *F*, to hold the disc in place. The disc has a central aperture through which the piston rod passes, and bearing against the upper side of the disc is a flange *G* of an annular cup *H*, the upper end of which is reduced to embrace the piston rod. The crimped-over end also engages the edge of the flange *G* to hold it securely in place. Bearing against the upper side of the metallic disc is a washer *J* of rubber or other suitable resilient and flexible material. The aperture in the washer fits and has a wiping action along the rod during its reciprocation. Filling the remainder of the cup is an annulus *K* of felt or similar material, which is compressed to engage the piston rod and exert a yielding pressure against the upper side of the rubber washer. Preferably the annulus is impregnated with a lubricant to facilitate the reciprocatory movement of the piston rod. With this arrangement it is claimed that air or moisture from the outside is prevented from entering the cylinder and any air or moisture within the cylinder is expelled during the reciprocation of the piston. In this manner, rusting of the inside of the cylinder is prevented and its life and usefulness accordingly enhanced.—*May* 9, 1951.



No. 653,203

652,796. May 19, 1948.—SELF-LOCKING NUTS, Thomas Bruno Rule, of 1, Ash Walk, Alkrington, Middleton, Lancaster.

This invention deals with self-locking nuts of the kind wherein portions of the screw thread at one end of the nut are separated from the remainder of the main turns by slots and grip the male screw thread on to which the nut is screwed. Referring to the drawings, the top view shows a nut having an end *A* reduced in external diameter. This end has two pairs of cross slots *B* cut parallel with the axis of the nut, one pair at right angles to the other. Each pair of slots leaves between the slots two tongues *C* diametrically opposite each other and connected by their bases or roots to the remainder of the nut. There are therefore four tongues, each of which carries portions of the screw thread turns. Each tongue is distorted by twisting or bending. The distortion causes the edge *D* to slope or bend into the area to be occupied by the male screw thread from the root



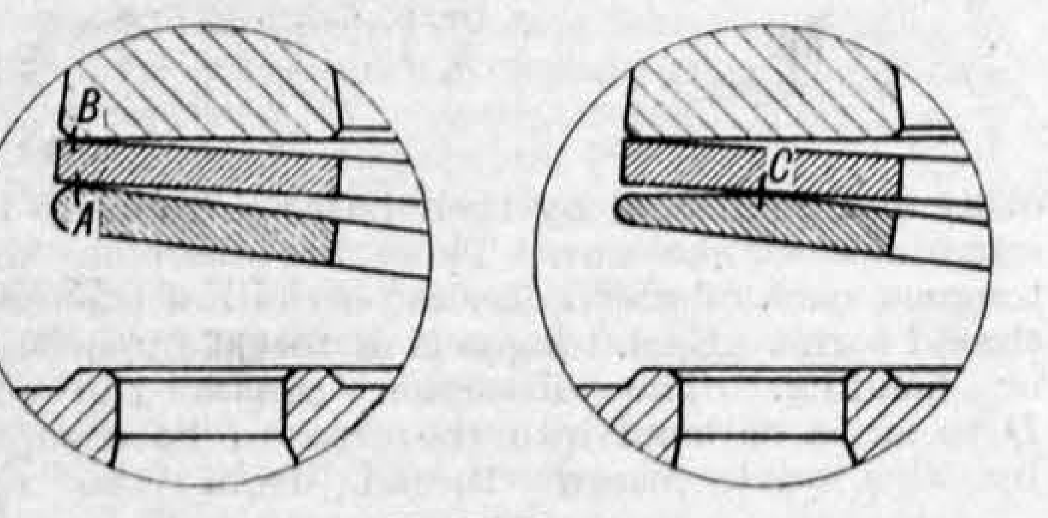
No. 652,796

to the end of the tongue. When the nut is screwed on to a male thread, the tongues *D* and undistorted screw thread portions *E* come into engagement after the nut has already been screwed partly into engagement. Rotation of the nut in the reverse or unscrewing direction is resisted by the considerable pressure of the stressed parts of the tongues. In the construction shown in the lower views the nut has a pair of diametrical slots F cut parallel with the nut axis in one unreduced end and lateral forces are applied to the parts G of the nut which are adjacent, but not between the pair of slots. The forces are applied only to the parts near the end faces H and are offset from the nut axis so that the trailing portion J of each part is bent inwardly, but the screw thread portions in the leading end K of the said part are left undisplaced and phased, whilst the screw thread portions extending from the leading end are dephased and displaced inwards to an extent which increases progressively. An external annular slot L or other external slots or grooves may be provided in the nut to facilitate the desired distortion and enable the distorted portions more readily to be flexed against the resiliency of the material into their undistorted positions by the male screw thread when the nut is screwed on to the male screw thread.—*May* 2, 1951.

VALVES

653,749. February 26, 1948.—AUTOMATIC PLATE VALVES, Martina Hoerbiger, of 34, Kroisberggasse, Vienna-Maver, Austria, and Robert Hans Hoerbiger, of 10, Jesuitensteig, Vienna-Maver, Austria, trading in partnership as Hoerbiger and Co.

The object of the invention is to reduce the stresses set up in the valve plates of automatic plate valves. In the drawings the left-hand view is a diagrammatic representation of an automatic plate valve of known design, the valve stroke being drawn somewhat enlarged and the valve plate being shown at its maximum tilt. Even if its edge is rounded off, the tilting valve plate makes contact at a point A close to the edge of the damper or buffer plate and that plate makes contact with the stop member at point B at no material distance from the edges of the plates. The right-hand view shows the same portion of a valve according to the invention at a maximum tilt, which, for the sake of clarity, is slightly exaggerated. In this case the valve plate has its upper marginal portion bevelled or chamfered, the chamfer angle being equal to, or slightly larger than, the angle of tilt. The width of the chamfer varies



No. 653,749

with the size of the valve and should be made, for discs, about one-eighth to one-twelfth of the diameter of the disc and, for rings, about half the width of the ring. The same effect may be achieved if the lower marginal portion of the damper plate or, in the absence of such a plate, of the stop member, is chamfered to a similar degree, and in the specification examples are shown. If the valve components are provided with the chamfer, then the impact will not occur in the vicinity of the edge of the plate, but at a point C on the marginal portion formed by the chamfer and it will be advantageous to radius the marginal portion slightly in order to make the point contact as near as possible a surface contact. The stresses set up at point C are much less injurious than those which usually occur at the edge of the plate, so that by the provision of the chamfer the following is achieved :—(1) The life of the valve plates is considerably increased, or, alternatively, (2) in the place of the special alloy steels used heretofore it is possible to employ ordinary unalloyed structural steels for the valve plates without thereby decreasing their life.—*May* 23, 1951.

A LARGE MAGNETIC PULLEY.—We learn that Rapid Magnetting Machine Co., Ltd., of Lombard Street, Birmingham, 12, recently completed manufacture of what is claimed to be the world's largest diameter electromagnetic pulley. The equipment is to be installed in the Belgian Congo as the terminal head pulley of a main conveyor system running at ½-mile centres and travelling at 256ft per minute, handling 700 to 800 tons of tin ore per hour. The pulley weighs 12 tons, and will extract "tramp iron" in the form of picks, shovels, cutter teeth and short lengths of mine railway line, from the ore prior to crushing; it is mounted on two main and two auxiliary roller bearing plummer blocks, the shaft being 16ft long by 8½in diameter. A total weight of more than 3000 lb of asbestos-insulated copper wire was used for the magnet winding, which has a continuous duty rating of 6·25kW at 220V.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of Supervising Electrical Engineers

Mon., June 18th.—CENTRAL LONDON BRANCH : St. Ermin's Hotel, London, S.W.1, Short Topical Discussion.

Mon., June 25th.—BOURNEMOUTH BRANCH : Grand Hotel, Firvale Road, Bournemouth, Lecturettes by members, 8.15 p.m.

Incorporated Plant Engineers

Mon., June 18th.—DUNDEE BRANCH : Works visit to B.X. Plastics, King's Cross Road, Dundee, 7.30 p.m.

Thurs., June 21st.—LIVERPOOL BRANCH : Radiant House, Bold Street, Liverpool, "Feed Water Treatment," 7 p.m.

Institute of Petroleum

Thurs., June 21st.—Royal Institution, Albemarle Street, London, W.1, "Competitive and Co-operative Research in the American Petroleum Industry," Robert E. Wilson, 4.30 p.m.

Institute of Road Transport Engineers

Wed., June 20th.—LONDON BRANCH : Visit to the works of Zenith Carburetter Company, Ltd., Stanmore, Middlesex, 2 p.m.

Institution of Mining and Metallurgy

Thurs., June 21st.—Geological Society, Burlington House, W.1, "Sinking of Irwin Shaft at the Roan Antelope Copper Mine," R. Cornthwaite and F. Juretic, and "Some Notes on a Simplified Method of Laying Out Diamond Drill Holes for Stoping," E. K. McDermott and P. A. Wilken, 5 p.m.

Institution of Production Engineers

Tues., June 19th.—WOLVERHAMPTON GRADUATE SECTION : Technical College, Wolverhampton, "Industrial Economics," C. Tragen, 7.30 p.m.

Joint Engineering Conference

To-day, June 15th.—Meetings at Institution of Civil Engineers, Great George Street, Westminster, S.W.1 ; Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W.1 ; and Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. For details of arrangements see THE ENGINEER, May 18th, page 662.

Women's Engineering Society

Thurs., June 21st.—35, Grosvenor Place, London, S.W.1, Annual General Meeting, 7 p.m.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 24, Victoria Street, London, S.W.1.

BINDER DISTRIBUTORS FOR ROAD SURFACE DRESSING

No. 1707 : 1951. This new British Standard applies to the following types of binder distributors : (*a*) Binder tanks and spraying equipment for hand spraying, with manually or mechanically operated pressure systems ; (*b*) mobile tank-spraying units, provided with a series of nozzles fixed to a transverse header holding binder under pressure ; (*c*) mobile tank units, provided either with gravity outflow pipes or a pump feed, combined with revolving or oscillating brushes to distribute the binder ; (*d*) mobile tank units provided with a combination of gravity or pump-fed simple nozzles, and a series of blades revolving on a horizontal shaft.

The standard specifies the essential requirements for the distributors and lays down a requirement for uniformity of transverse distribution of binder. It deals with capacities of tanks and requirements for distribution of binder and deals with lagging, road wheels and brakes, speed control, measurement of volume and temperature of binder, and equipment for hand spraying. Methods of test are also included. Price 2s. 6d.

PRECISION HEXAGON BOLTS, SCREWS, NUTS (B.S.W. AND B.S.F. THREADS) AND PLAIN WASHERS

No. 1083 : 1951. This edition of B.S. 1083 confirms as a regular British Standard the war emergency standard which was issued in 1942 at the request of the Ministry of Supply in place of B.S. 191 and B.S. 193. At the end of the war, the question of the most suitable post-war British Standard for bright bolts and nuts was discussed, and after consultation with a wide field of user interests, it was agreed that B.S. 1083 should be reissued. In preparing the new edition the opportunity has been taken to introduce certain amendments. The basic dimensions remain unchanged and the amendments are concerned principally with a clarification of certain of the former requirements and the inclusion of additional requirements to improve the general quality of the bolts and nuts. The term "precision bolts" is now used to designate the type of bolts, together with the corresponding screws and nuts, which are manufactured to prescribed mechanical properties and to tolerances required for use in engineering work where a good standard of dimensional accuracy and performance is required. The standard relates to ferrous and non-ferrous bolts, screws and nuts, and to split cotter pins and washers for use with them, and in the case of steel refers to the appropriate qualities in various grades up to 85 tons tensile, as specified in B.S. 970, and gives the detailed dimensions for bolts, screws, nuts, lock nuts, castle nuts, split pins and washers for all regular nominal sizes from ¼in to 2in. Stock sizes of steel bolts and screws and a code of Part Numbers are given in the appendices. Price 4s., post free.

MATERIALS FOR DAMP-PROOF COURSES

No. 743 : 1951. The revision of this British Standard extends its scope by including references to mastic asphalt damp-proof courses. Part 2, which is a classification of bitumen damp-proof courses, has also been extended to include two types with an asbestos fibre base. The specification gives details of lead, copper, bitumen, mastic asphalt, slates and bricks for use as damp-proof courses and information concerning mortar for the bedding of the various materials. An appendix gives guidance in the selection and laying of damp-proof courses. Price 2s. 6d.

BRAZING

No. 1723 : 1951. This standard, which is supplementary to B.S. 1724, "Bronze Welding by Gas," now in course of preparation, has been prepared as part of the programme of welding standards authorised by the Welding Industry Standards Committee of the Institution.

The standard is confined to those aspects of brazing for which it is considered advisable to specify definite requirements, although general recommendations regarding the features of one or more methods of brazing are given where it is thought that guidance will be helpful. In view of the vast range of joints and connections for which brazing is used this treatment of the subject has been considered the most appropriate.

The brazing processes covered are blow-pipe (torch), furnace, electric induction, electric resistance, dip and salt bath. A general section specifies requirements for joint design, general preparation, flux removal, inspection and testing procedure. Each process is dealt with in a separate section in terms of a description of the processes and the permissible filler metals for the various parent metals. Price 3s.

Catalogues

F. J. EDWARDS, Ltd., 359–361, Euston Road, London, N.W.1.—Brochure giving a brief outline of the history and policy of the firm.

FISCHER BEARINGS COMPANY, Ltd., Upper Villiers Street, Wolverhampton.—Service catalogue, "Passenger Cars and Motor Cycles."

BRITISH JEFFREY-DIAMOND, Ltd., Stennard Works, Wakefield, Yorks.—Folder describing the "25 S" scraper chain conveyor.

THE AEROGRAPH COMPANY, Ltd., Lower Sydenham, London, S.E.26.—Leaflet illustrating and describing the type "NSA" air brush.

THE BELMOS COMPANY, Ltd., Bellshill, Lanarkshire.—Leaflets dealing with pillar type industrial starters and distribution switchboards.

EXORS. OF JAMES MILLS, Ltd., Bredbury Steel Works, Woodley, Near Stockport, Cheshire.—Catalogue entitled "Bright Steel Sections."

DAVID BROWN AND SONS (HUDDERSFIELD), Ltd., Park Gear Works, Huddersfield.—Leaflet illustrating gear type flexible couplings.

HOLMAN BROTHERS, Ltd., Camborne, Cornwall.—Catalogue Section K 10, "Rotogrinds" ; Section K 12, "Tube Expander Motors."

THE STANDARD AND POCHIN BROTHERS, Ltd., Evington Valley Road, Leicester.—Publication No. 169, covering the range of Multivane pulley-mounted centrifugal fans.

KESTNER EVAPORATOR AND ENGINEERING COMPANY, Ltd., 5, Grosvenor Gardens, Westminster, London, S.W.1.—Leaflet describing Kestner autoclaves and reaction vessels.

W. E. SYKES, Ltd., Staines, Middlesex.—Catalogues dealing with horizontal gear generating machines, models "1A," "3C" and "5E," and machines and tools for gear production.

THE INCANDESCENT HEAT COMPANY, Ltd., Cornwall Road, Smethwick, Birmingham.—Leaflet V.12 A, illustrating and describing a method of heating bars, tubes, sections, light strip, &c.