# A Seven-Day Journal

## Machinery Supplies to India

It is announced by the India Office that the Government of India has established in the United Kingdom, under the High Commissioner for India, a new organisation to assist in the sponsoring and supply to India of plant, machinery, equipment, and other goods. Mr. P. C. Chaudhuri, O.B.E., I.C.S., has been appointed in charge of the organisation, and offices were opened at 45 to 47, Mount Street, London, W.1, on Monday, November 5th. The organisation will be in a position, we learn, to give assistance and advice to exporters and others with interests in the Indian market. The new organisation will take over from the Economic and Overseas Department of the India Office, the work hitherto performed on behalf of the Government of India by that Department in connection with the supply of goods from this country to India. We are given to understand that the work of the new organisation will cover the registration, co-ordination, and processing of all import licences; sponsorship under the consumer goods scheme or under sponsorship arrangement; and the programming and progressing of requirements of machinery plant, equipment, and goods. These include, for instance :—Heavy electrical plant scheduled through the Central Technical Power Board, and all other power plant, including boilers, &c., machine tools, textile machinery and mill stores of all kinds, food machinery, including vegetable oil and ghee plants, cement, road-making, and tea machinery, chemical manufacturing plant, refrigerating machinery, agricultural and crawler tractors, coal-mining machinery and plant, wireless and telecommunication equipment, artificial fertiliser plants, irrigation schemes, and motor vehicles; also raw materials, such as steel, dyes, chemicals, and fertilisers. In addition, the organisation will represent the Government of India on the various committees at which India's requirements are planned.

## The Parsons Marine Steam Turbine Company, Ltd.

At the forty-eighth annual general meeting of the Parsons Marine Steam Turbine Company, Ltd., held at Newcastle-upon-Tyne last week, the chairman, the Hon. Geoffry L. Parsons, said that since the outbreak of war the works had been continuously employed to their full capacity on the construction of main propelling machinery for naval and mercantile ships, the construction of mechanical gearing and the cutting of teeth in gear wheels for other marine engineering companies, and for vessels built in the United States and Canada. Previous to the outbreak of war in 1939 the machine shops were extended, principally to allow of gear-cutting machines and pinion hobbing machines being installed in a shop in which the temperature could be controlled. The blade shop was brought up to date and the brass fitting shop and other departments reorganised. The interior of the test house was rearranged for the manufacture of welded steel gear cases to Admiralty requirements, and the original test plant was now housed in a new building specially erected for the purpose of experimental and research work. The company's jetty, which was erected in 1898, had been strengthened and lengthened, and the basin dredged to accommodate all kinds of ships for the installation of machinery. The sheer-legs had been replaced by a modern electric travelling crane of 30 tons capacity, while the works boiler equipment, installed in 1898, which consisted of two Babcock and Wilcox boilers, had been replaced by a new boiler from the same makers, fitted with special coal-handling equipment. Canteens had been built for the staff and workmen, and a suitable workshop and study were in course of preparation for the training of apprentices. The Parsons and Marine Engineering Turbine Research and Development Association had been formed, and a test station on land adjacent to Turbinia Works, belonging to the company, was being constructed and would be leased to the Research Association. It was intended to use this station for carrying out full-scale tests of high-pressure and high-temperature turbine installations up to the maximum power required for war vessels, as well as for undertaking a vigorous research policy in connection with research for improvements and development of steam and gas turbines, and transmission for marine propulsion.

## Fannich Hydro-Electric Scheme Confirmed

It is announced by the Scottish Office that all objections having been withdrawn to the North of Scotland Hydro-Electric Board's Constructional Scheme No. 3—the Fannich scheme, described in The Engineer of April 27th, 1945—the Secretary of State has therefore not found it necessary to hold an inquiry. The Secretary of State's Order confirming the scheme, along with the details of the scheme, have been laid before Parliament. If during forty days neither House of Parliament resolves that the Order be annulled, work may commence immediately at the end of the period. Constructional Scheme No. 3 covers part of project No. 71 of the Board's development scheme. With an estimated average annual output of 77 million units, it proposes to utilise Loch Fannich in Ross-shire as a reservoir. A power station, with an installed capacity of about 24,000 kW, at Grudie Bridge, in Strath Bran, will be fed by means of a tunnel and pipe line from Loch Fannich. The scheme, which has been designed to meet the growing demands of consumers in the northern part of the Board's area, is the first large-scale project for the district. It is within reach of the town of Inverness, and near the eastern parts of Ross and Cromarty, and the deep-water harbour of Cromarty Firth, from which there are good road and rail connections with the rest of the country. It is understood that the Board hopes to link the Fannich station and other stations in the North with the stations of the Tummel-Garry project and with Aberdeen, so as to form a "backbone" from which the development of the North of Scotland district can be built up. The scheme in its present form, as confirmed, has been amended to give effect to recommendations of the Fisheries Committee, and it also includes a clause which safeguards the flow of water to the Loch Luichart hydro-electric station of the Grampian Electric Supply Company. Plans of the buildings will be submitted to the Amenity Committee at a later stage, and that Committee has asked that the pipe line be concealed as far as possible, and that it should be consulted as to the disposal of the excavated material.

## An Oil-Electric Rail Traction Group

On Monday, November 5th, it was officially announced that a number of British engineering firms have agreed to pool their research and technical resources in order to present a united front in the world markets for oil-electric rail traction. The firms concerned are :—Associated Locomotive Equipment, Ltd., of London and Worcester; Petters, Ltd., of Loughborough and Worcester; Petters, Ltd., of Loughborough; Mirrlees, Bickerton and Day, Ltd., of Hazel Grove, Stockport; J. and H. McLaren, Ltd., of Leeds; Oil Engines (Coventry), Ltd.; Brush Electrical Engineering Company, Ltd., Loughborough; and other members of the Associated British Engineering, Ltd., group of companies. The efforts of all these separate undertakings in the field of rail traction are to be co-ordinated by Associated Locomotive Equipment, Ltd., under the direction of Mr. E. W. Marten, B.Sc., A.M. Inst. C.E., M.I. Loco. E., the managing director of that company. The group will produce a wide range of components used in the production of oil-electric trains, locomotives, and shunting locomotives. Main engines up to 1500 B.H.P. and over are available, as well as generators, motors, control equipment, and switchgear, all of which are produced by the firms in the new group. An export order has already been received for a high-speed luxury train, designed for a running speed of 100 m.p.h., and incorporating the latest features devised for safety and comfort at high speeds. It is expected that such trains will be of the multiple-unit type, with two, three, or four passenger coaches permanently coupled and complete with their own power equipment.

## Requisitioned Industrial Premises

Replying to a question in the House of Commons on the continued requisition of industrial premises by Government Departments on Monday, November 5th, Sir Stafford Cripps, the President of the Board of Trade, said that it was hoped that at the end of the year 35 million square feet of space would be actually vacated. It was aimed to vacate the whole of the rest of the premises—with possible small exceptions—by the end of 1946. The most urgent matter to-day, Sir Stafford went on to say, was to get the capacity which was required to re-employ our people when they were demobilised or left the munition industries. The Government was therefore prepared to take the most drastic measures and was already using airfields for placing goods out of doors, if necessary, and taking the risk of their deterioration. This matter was being dealt with by one department of the Board of Trade, and General Lindsell, who had had great administrative experience during the war, had been asked to take charge of this job. A network of regional controls had been set up in order to decentralise the work as far as possible. It was hoped to have the assistance of the regional boards and the National Advisory Committee on Production. With this new machinery, which had only been functioning a few weeks, he (Sir Stafford) thought that they would get a very considerable acceleration of the process. Every possible step was being taken to ensure that goods which might be sold to the public quickly were put on the market as soon as possible. The actual volume of such was, however, unfortunately, very small.

## Renfrew Foundries, Ltd.

It is announced that Colonel Devereux and his associates have combined with Rolls-Royce, Ltd., to form a new company, Renfrew Foundries, Ltd., to take over the light alloy foundry at Hillington, near Glasgow. This foundry, which formed a part of the Rolls-Royce factory at Hillington, built for the Ministry of Aircraft Production, supplied not only the Hillington factory, but other Rolls-Royce factories, and to the American company which has been making "Merlin" engines during the war. It is probably one of the most outstanding production undertakings of the war. It has given employment to over 4000 workers, a high proportion of which were women, most of whom had no previous experience of foundry work and had to be trained to operate ingenious machines, whose design alone made it possible to produce complicated castings without the moulder's acquired skill. These workers produced 31,440 tons of aluminium alloy castings, enough for nearly 80,000 high-performance aero-engines. In future the programme will include not only aero-engine castings, but aeroplane castings, and castings for ships, motor vehicles, and railway rolling stock, while domestic and building fixtures and articles will also be covered. The urgent needs of the export trade will not be forgotten. Renfrew Foundries, Ltd., having special facilities for scientific research and development, is prepared to advise on all questions concerned with the use of light alloy castings. It is satisfactory that those who have made such a magnificent contribution to the war will be maintained in employment under peacetime conditions.

# Engineering Developments in Asiatic Russia

By Professor C. A. MIDDLETON-SMITH, M.Sc., LL.D., M.I. Mech. E.

No. IX—*(Continued from* *page 339, November 2nd)*

### Western Siberia

Eastwards from Soviet Asia's mineral-bearing region in the Urals are the agricultural "Middle West" and the hidden arsenals, in a great area which we will call Western Siberia. It is divided into four territories, each said to be as large, or larger, than the largest of the U.S.A. States. It contains the now-famous Kuznetsk coal basin, with its mines and steel mills. The Trans-Siberian line serves it from east to west, the Ob and Yenesei river systems from south to north. In one of the territories more than £110 millions were spent on industrial development between 1928 and 1937.

The chief natural resources of Western Siberia are coal, iron, timber, metallic ores and water power. Mercury, molybdenum, zinc, and other metals from plants established within the Arctic Circle had made it possible by 1939 to double the output of these metals in the whole of the U.S.S.R. In the huge plant installed at Lorilsk copper and nickel are also refined. A railway, 90 miles long, was laid to carry the metal to a port on the Yenesei, whence it is shipped up or down the river.

The products in 1912, mostly from farms, were valued at about £8 millions, but in 1937 they were worth about £130 millions, mostly from industries. With industrial towns, the population in the Kuznetsk basin was 800,000, according to *Pravda*, May, 1939.

There are a number of other coal deposits which have been explored in Western Siberia. It is said that those discovered comprise nearly half of all the deposits known to exist in the whole of the U.S.S.R. G. B. Cressey stated (1942) that the Kuznetsk basin was producing 20 million tons of coal. A metallurgical "combinat" in the area was making pig iron and more than 2 million tons of steel per annum, about half the production of Japan. Manganese is obtained from deposits 400 miles distant, and some iron ore is obtained locally, but at first all of it, and now most of it, comes from Magnitogorsk 1500 miles distant, and Kuznetsk coal feeds the furnaces there. Every endeavour is being made so that Kuznetsk may obtain all raw materials for industry in nearer districts.

Stalin once reproved the Siberian workers for their indifference to the value of human life. He told them, "of all the world's capital, the most valuable capital is people." He has raised the standard of medical services all over Soviet Asia to a height comparable with those in urban and country districts in many parts of the U.S.A. Whereas formerly the peasants and workers were indifferent to cleanliness, now it is insisted upon. My own observation of the habits of Siberian peasants in 1913 made them seem to me repulsive. According to American observers, they and the industrial workers now realise the advantages of sanitation, health centres, and the many medical services provided for them.

### The Kazakh Republic

This great area, one-third as large as the U.S.A., includes much semi-desert land. It lies between the oasis countries of Central Asia and the huge forest steppe of Siberia.

The most important transformation of the area was decided upon during the war, as the result of the loss of the Ukraine in Europe. In November, 1941, a special scientific expedition, which had surveyed the lands and drawn up a plan for food production, completed its task. There were 3 million Kazakhs, about half the population of the Republic, before the great influx of evacuees from Europe. They were formerly nomad tribes, grazing cattle, and were in sharp contrast with the agriculturalists of Central Asia.

Nowadays the people in Kazakhstan are no longer nomads, although stock-raising is important. Great quantities of wheat and sugar beet are annually produced, and there has been a remarkable development of industries. In 1920 the value of the industrial production of Kazakhstan was 6 per cent. of the total; but in 1940 it was 60 per cent. of the total production of the area.

During the last twenty years 4000 miles of railways were built in Kazakhstan. Although no details of the lands selected for agricultural production have been published, it is fairly certain that they are near these railways.

When the German armies drove towards the Volga River in 1942, only 100 miles separated Kazakhstan from them. The Nazis must have hoped to use its railways for outflanking our troops in Syria, Iran, and Iraq, and then to go on to India to effect a juncture with the Japanese. They failed, but the Kazakhs were ready to fight.

An important deposit of petroleum has been discovered in the Ural-Emba oil basin, which is estimated to contain more than 1¼ billion tons, and is said to cover an area of 156,000 square miles. These oilfields are said to be as important as those in southern Texas, and they were (1942) producing the third largest tonnage in the Soviet Union. American drilling machinery was imported and from Emba a 434-mile pipe line carries crude oil to a modern refinery in the Urals.

The rich copper deposits of Kazakhstan are estimated at over 800 million tons, and copper refineries have been erected. In 1941 one of them refined more than 100,000 tons of copper.

Among the other minerals discovered are lead and zinc, the estimated deposits of the former being over 2½ million tons and of the latter over 4½ million tons.

### Karaganda Coal

The great coal deposits of Karaganda yielded an output in peacetime surpassed only by the Donbass mines in the Ukraine, and the Kuzbass mines in Siberia. They produced in 1920 35,000 tons, but in 1940 4½ million tons were produced by 15,000 workers. A city containing 150,000 people stands at Karaganda where there was once only a tiny poverty-striken village, and a new city was being built (1942) 8 miles away to house the overflow population.

On the Irtysh River there is a large power plant to serve the numerous new smelters and refineries for the non-ferrous metals obtained from mines in the Altai Mountains. It is said that much of the metals so obtained was shipped to the U.S.A. during the war.

In another area vast deposits of nickel, said to exceed those of New Caledonia, have been discovered, and one of the world's largest synthetic rubber plants has been erected.

The transformation of Kazakhstan includes agricultural development. In the 8000 collective farms, 25,000 tractors, 10,000 harvesters, and hundreds of cotton-pickers, built in Soviet factories, are at work. There are 330 tractor stations. When the Germans occupied the Ukraine, an additional 1 million acres were made to produce crops.

Two native plants yield rubber and over 2½ million acres are cultivated to ensure supply from this source. It is an extraordinary story of scientific research, successfully carried out, to produce a fairly high-quality rubber from a plant growing wild on the hills, the roots of which produced a milk-like liquid. In 1942 an expert in the U.S.A. informed the Government that this plant could be cultivated in his own country and would produce 600,000 long tons of rubber if 7 million seeds suitable for planting were utilised.

### The Central Asian Republics

The peoples of the numerous races in this area, formerly called Russian Turkestan, have completely changed their outlook and habits of life since they revolted against the Tsarist attempt at conscription in 1916 and their suppression by a terrible punitive campaign. Their contribution to the war against Germany was an outstanding feature of the struggle. Peoples who were either feudal or pre-feudal in organisation until about 1920, worked in factories, drove tractors—women and men—built towns, irrigation schemes, hydro-electric plants, and worked in mines. There probably was never a greater economic and cultural transformation in any area of the same size in so short a time as two decades in any part of the earth.

While we in Britain were anxiously awaiting news of the fighting at Stalingrad and around Moscow, the nomad peoples of Central Asia were erecting factories in the ancient cities of Bokhara, Tashkent, and Samarkand, settling on to the new collective farms, and learning to work machinery, while their children went to the new schools. Not only did they bring more land into production by irrigation, but they used new methods of cultivation and doubled the output per acre.

Yet Central Asia is a mosaic of peoples, religions, and languages. There are Moslems, Jews, Christians, Mongolians, Russians, Ukrainians, and Tartars. There are laws punishing "any advocacy of racial or national exclusiveness or hatred and contempt."

The U.S.A. has been called the melting pot of European nationalities; Central Asia is the melting pot of European and Asiatic nationalities. They live mostly in communities of the same race, but they are all intensely patriotic for the Soviet Union.

### Machinery and Income

Even that is not the most remarkable fact about these diverse peoples. What is extraordinary is their enthusiasm for machinery, irrigation, and applied scientific work of all types. To it they attribute the increased cash income of the farming families which in four years, was ten times its former value. In that time the wages of industrial workers doubled. Formerly, they hated and feared the Russians. Now they learn from them not only how to handle machinery and to construct rapidly canals, but to understand the principles of hygiene and to seek medical advice.

The most important of the four Central Asian Republics is Uzbekstan, with its 6½ million people on an area not quite as big as California. It supplies the U.S.S.R. with more than 60 per cent. of its cotton, with a yield recorded as high as 12,500 lb. per acre, although the average is only one-tenth that figure. Most of the 12½ million acres were irrigated (1942), but extensive work was then in hand, including the Northern Tashkent Canal, to irrigate 120,000 acres of uncultivated land.

In 1938 Germany, with twelve times the population of Uzbekstan, had fewer tractors and harvester combines at work. Although cotton is the most important agricultural product from a financial aspect, grain and sugar beet production was greatly increased to make up for the loss of food from the Ukraine. Without reducing the area devoted to cotton, the irrigation work and tractors enabled 1 million acres to be brought under cultivation for grain in 1942 and 170,000 new acres of sugar beet were planted.

Cities famous for their market-places and minarets are now industrial centres, with factories and spinning plants. In 1939 some 12,000 tons of silk cocoons were collected, made into finished silk articles, much of the product being used for parachutes. A great plant for agricultural machinery in Tashkent, costing some £18 millions, was able to manufacture tanks and guns.

#### Ancient Irrigation Schemes Reconstructed

Away to the west the Republic of Turkmenia borders the Caspian Sea, and since 1924 the inhabitants have waged war against the desert. Many of the derelict irrigation schemes were reconstructed, new canals built, more acreage brought into production. In 1938 there were 4000 tractors cultivating fields, which produced 116,000 tons of cotton. The Tashkepru dam was built and motor pumps replaced those worked by hand. The Oxus of the Greeks is now called the Amu-Darya, and there is a great scheme to use it for extensive irrigation.

Where camel caravans rested near wells in the desert there is a sulphur plant, and the first motor speedway built by the Soviets (it is 155 miles long) carries the products to the railway. "The carpets of Turkmenia are celebrated all over the world," according to a Russian geographical treatise. The 30,000 individual carpet-weavers are mostly replaced by factory workers.

In the mountainous areas of the other two Central Asian Republics, Tadjikistan and Kirghizia, there was constant border warfare, and no means of communication. To-day a railway joins Stalinbad, the capital of Tadjikidstan, with Tashkent; narrow-gauge railways run through the Vakhsh river valley, where a £6 millions irrigation scheme was recently completed. There are 4000 miles of roads, giving access to the gold, silver, and lead mines in the Pamir Mountains.

#### Strife in the Cradle of the Human Race

One oilfield produced 30,000 tons of petroleum in 1938; the output of another oilfield is not published. In 1939 the output of twenty-seven hydro-electric plants was in this Republic 30 million units. Nearly £5 millions were spent after 1938 on a textile mill, two cotton-ginning mills, a meat-packing plant, and hydro-electric power. More than 2 million head of cattle feed on the pastures of the valleys and on the crops of alfalfa—seven each year—which are grown.

Moslem pilgrims from all over the East considered the town of Osh, in Kirghizia, as second only to Mecca as a sacred centre. Many scientists are said to agree with the legend that this area was the cradle of the human race. It was from the dawn of history a centre of strife. Persian, Turk, and Chinese invaders ravaged the land, and the hordes of Tamerlane carried the Koran and the sword in their efforts to make the pagans followers of Mahomet. It is on the old trade route from Europe to China.

Then came the new industrial revolution. More than £14 millions were spent in four years up to 1942 to promote it. The area is called "the stokehole of Central Asia," producing 2 million tons of coal. Factories produce cotton goods—one has a capacity of 51 million yards a year. A woollen mill, with 11,000 spindles, a shoe factory, a great silk mill, and tanneries use up the raw materials provided by the district. Tractors and harvester combines are used on all the collective farms.

It is an astonishing fact that under adequate instruction by trained technicians, a backward, illiterate, and pastoral people have suddenly been able to become adepts in mechanised industry. It has happened in Central Asia.

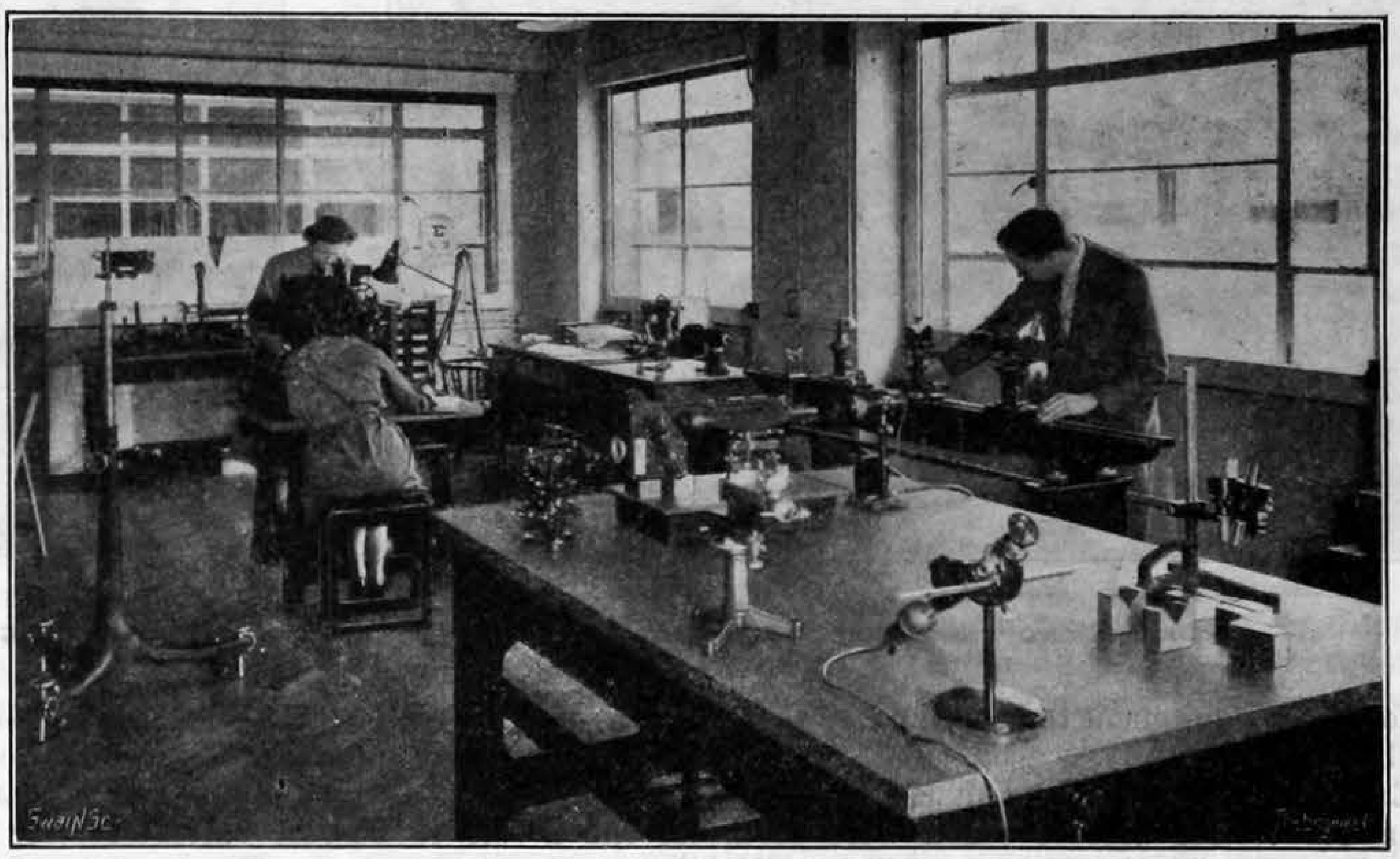
*(To be continued)*

# A.I.D. Test House, Harefield

No. II—(*Continued from page 344, November 2nd*)

#### Aircraft Equipment Division

Generally, this division is responsible for checking the accuracy of all types of aircraft instruments. An engraving overleaf shows the dashboard instrument laboratory. Mechanically operated indicators, controlled by 50-cycle tuning forks, establish standards for the stroboscopic testing of engine speed indicators and similar instruments, with accuracy of 0·1 per cent.



Optical Laboratory

As a general principle, every endeavour is made to ensure that all test apparatus can be referred back to "first principle" methods of measurement. For example, pressure gauges are standardised by deadweight methods. Time-recording apparatus is checked by a standard pendulum, which controls all the clocks in the building and also supplies variably timed impulses to such laboratories as require this service.

As a further example of this principle, the electrical standards laboratory, illustrated overleaf, is of interest. This room is temperature controlled to within 1 deg. Cent., and contains the reference electrical standards for the department and apparatus for measuring all the fundamental electrical properties, such as current, voltage, resistance, frequency, inductance, capacitance, power factor, dielectric constant, &c., to a high degree of accuracy. The frequency standard is one of the most accurate in the country.

An extension of the electrical standards room houses audio-frequency bridges and an interesting piece of apparatus designed and built in the Test House for measurement of very small inter-electrode capacities of valves. This room has soundproofed walls, floor, and ceiling.

All steelwork in the wing of the building in which these laboratories are situated was, during construction, completely bonded, and a 1in. mesh steel screen, also bonded to the steelwork, was embodied in the concrete floor. Special "earthing" arrangements, with two independent and remote earths, are provided, so as to avoid any interaction.

Much other equipment of interest in the aircraft equipment division can only be briefly mentioned. Laboratories are provided for photometry; mechanical tests of all types of aircraft cameras; tests of photographic plates, films, and paper; and tests on Radar equipment and radio apparatus.

Of special interest are the laboratory for the testing of instruments operated wholly or partially by means of gyroscopes, the optical laboratory and the bomb-sight laboratory. These three laboratories contain a comprehensive range of special equipment for testing the wide variety of instruments, such as bomb sights, drift sights, artificial horizons, auto-controls, &c., used in modern aircraft. Furthermore, another laboratory is equipped to test instruments under extremes of temperature, corresponding to tropical or high-altitude conditions.

Yet another laboratory in the aircraft equipment division contains equipment for high-voltage insulation tests, and voltages up to 100,000 are obtainable. In view of the high voltages, precautions have been taken in the installation of the equipment, including the earthing of all metal in the laboratory, the provision of cut-out switches on doors to prevent accidental entry to a live area, and the fitting of copper earth plates in the ceiling above the bus-bars to prevent static charges accumulating in any of the metal in the laboratory above.

METROLOGY DIVISION

This division checks and tests all types of gauges used by the staff. A small tool-room is equipped with machine tools, where gauges are repaired and modified, and where a small number of gauges most urgently required are made.

Each room in the division is laid out for the inspection of specific types of engineer's gauges and the whole is claimed to contain what is probably the most comprehensive collection of equipment to be found anywhere in this country.

Examples of the leading makes of apparatus for testing surface finish were seen, including the Taylor-Hobson "Talysurf" surface meter, which gives a graphical record of surface finish. Other laboratories contain equipment such as the "Interferometer," an instrument which measures the flatness of slip gauges to within one one hundred thousandth part of an inch. Many of the rooms have special lighting arrangements designed to eliminate parallax errors in reading scales and dials.

MAINTENANCE DIVISION

This division is, of course, responsible for the maintenance of all plant and for all minor repairs and alterations required in any of the buildings, in addition to the maintenance of the varied services, such as heating, lighting, power, gas, water, compressed air, and vacuum.

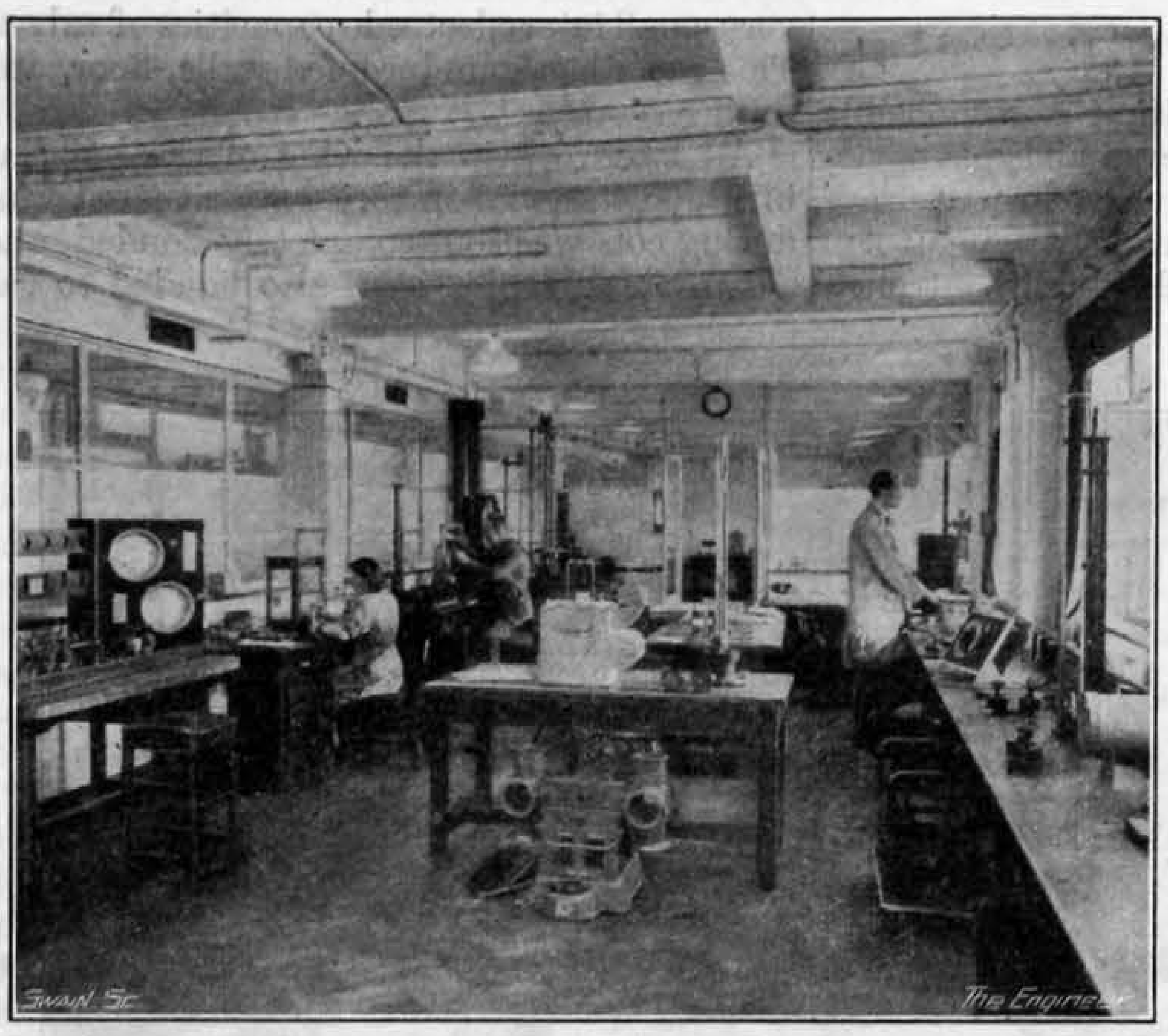
In addition to these functions, the maintenance division prepares all test samples, whether metallic, plastic, or of other material, and has therefore workshops equipped with all manner of tools. Its maintenance duties are not confined, however, to the abovementioned list, for it also has a separate section to deal with the maintenance of all the test equipment at the establishment and to manufacture or modify test apparatus.

The arrangements for the provision of electrical services are of considerable interest. All current is drawn from the 6600-volt grid. There is a complete sub-station situated in a small separate building, in which there are two 400-kW transformers and all necessary switchgear. Current may also be taken from two other sub-stations in the area, in the event of a breakdown in the Harefield sub-station.

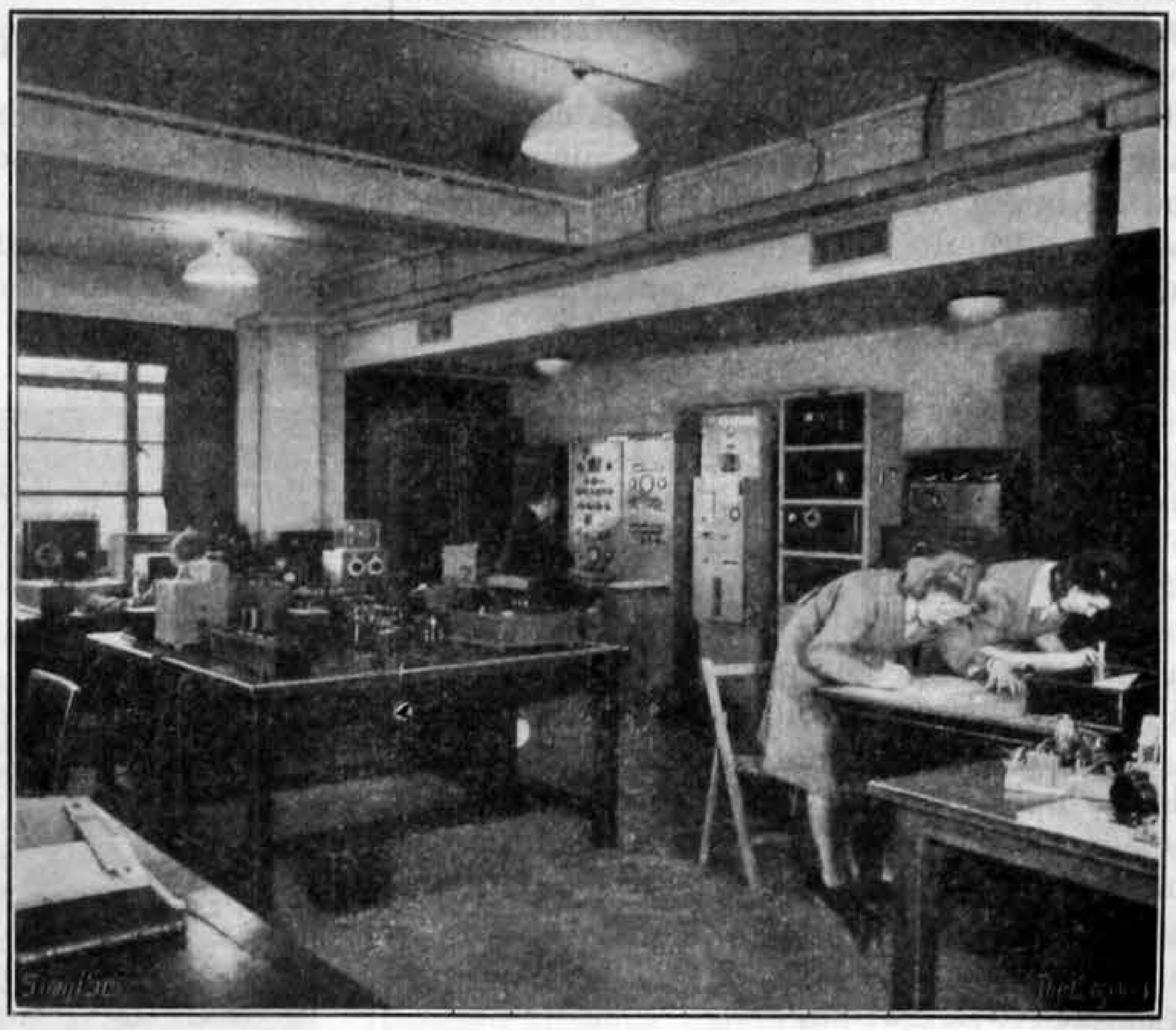
At Harefield the sub-station provides three-phase current at 415 volts to the generator hall, where it is converted as required for the various laboratories. The current available includes 210-volt D.C. mains; 110-volt D.C. mains; 2-volt to 60-volt, 500-ampere-hour battery; 260-volt, 100-ampere-hour battery; 10-volt to 1600-volt, 300-milliampere-hour battery; 230-volt, 300-cycle, motor-generator, for converting to higher voltages; and a motor-driven alternator for 50-cycle sine wave generation. There are also four motor generator sets providing voltages varying from 800 to 2200 D.C., which are remotely controlled from the laboratories where these supplies are required.

An interesting feature of the switchboard for the 2-volt to 60-volt battery service is the provision of a separate contact breaker for each cell of the battery. This serves a dual purpose. First, it allows individual cells to be charged independently of the others; secondly, where a test requiring a particularly heavy current is being carried out, the generators can be put into operation, thus converting the cells concerned into filters. By this arrangement the advantage of a positively controlled voltage is combined with an equally steady heavy amperage. This lay-out is unique, but we are informed that it is fully justified, since the chance of breakdown has been as far as possible eliminated, whilst maintenance has been simplified.

The 50-cycle alternator is remotely controlled and is used for supplying the 100,000-volt transformer in the insulation testing laboratory. It embodies an unusual method of voltage control, whereby the field of the exciting generator is controlled varying the voltage and current supplied to the alternator field. This has been found to give a finer and steadier output than could be obtained by the usual methods. Another point is that it is possible to take the alternator through zero, removing any residual magnetism, thus ensuring that on starting the voltage will not rise until the control is operated.



DASHBOARD INSTRUMENT LABORATORY



ELECTRICAL STANDARDS LABORATORY

# British and German Mine Design

*(By Our Naval Correspondent)*

No. I

WAR is a forcing house of scientific and engineering development. Yet in many cases such wartime developments have to be kept secret until the defeat of the enemy has robbed them of their immediate importance. That is not to say that they have lost their importance owing to the cessation of hostilities—and much less their interest. Once the veil of secrecy, so essential during the war, is lifted, there are few more fascinating studies than that of the evolution of mines and of the means of dealing with them.

It must be stressed that the war which has been brought to a victorious conclusion has seen a complete revolution in the technique of using the mine as a maritime weapon. It is as well to remember that the mine is unique among the weapons of war at sea, in that it is the only one which is not aimed at a ship. That is not to say that it is not aimed at a target. During this war it has been aimed at a target, and, what is more, it has often been specially designed for the attack on a specific target.

In the war of 1914–18 and previous wars since the invention of the mine, this weapon has been one of defence alone—although one might concede that its use in circumscribing the tactics of the enemy had a certain offensive character. Be that as it may, the sea mine was, in use if not in conception, a defensive weapon in the years before 1939.

This war has altered the fundamental characteristics of mine warfare. No longer do we think of mines as a protection for harbours and ship channels. These functions of the mine continue—as witness the great mine barrage laid to protect the inshore channel up the east coast of England, and the fields of varying depths laid to deny the

Straits of Dover to the U-boats. But the development of aircraft has given to the mine a completely new characteristic, which the submarine was already trying to confer upon it. Modern aircraft enable the mine to be laid in inshore enemy waters, in the estuaries and rivers, in the harbour entrances, and even in the secluded waters used for the trials of warships and the training of their crews. This has made the mine an offensive weapon of great importance, whereas it used to be almost entirely defensive. The Germans realised this, and they tried to make the mines even more offensive by dropping them from aircraft ahead of some of our convoys on their way to North Russian ports. By doing so, however, the most that they achieved was to dictate a tactical alteration of course, and that seemed to be the whole of the German objective, for no real use appeared to be made of this tactical manœuvre.

Throughout the war, in fact, the German use of the mine was tactically and strategically unsound. That is not to say that it did not cause us casualties and much food for thought. It did. But the necessary reticence regarding our own mining campaign and technical developments in this field of sea warfare has tended to give the impression that the Germans called the tune, and that we followed panting and occasionally, by lucky chance, producing a timely antidote to German ingenuity. Nothing could be further from the truth. We used secrecy to our great advantage, and, taking the mine warfare of the past six years as a whole, we were ahead of the Germans both in the production of mines fitted with "circuits" calculated to provide work and headaches for the German technicians, and in the rapid production of effective sweeping arrangements and antidotes to the new forms of mine produced by the enemy. Mine warfare has become a battle of wits between the technical staffs, but the battle, to be conducted with any prospect of success, must be waged by technical experts whose efforts are keyed to the practical problems of strategy, tactics, and seamanship. In fact, success in a modern mining campaign is not ensured solely by technical superiority, but by technical efficiency keyed to the requirements of the war at sea as a whole. The mines of to-day are highly technical, but mine warfare is an applied science rather than a science in itself. There must be a nice balance between the technical and the practical, and it would seem that the Germans erred in making the practical subordinate to the technical.

When all things are taken into account, our success in this type of warfare has been established from records of the German minesweeping efforts and the German organisation responsible for dealing with our mines. It has been ascertained that the German effort was between three and four times that employed by us—and yet this great force, amounting to between 40,000 and 50,000 officers, men, and technicians, failed so signally to overcome the problems which we set them that the whole of the German organisation broke down completely nearly six months before the German surrender.

It would probably be impossible to compute the degree of contribution of this fact to the final disintegration of the German State. One can but state that for six months before the surrender even the smallest classes of shipping in the Baltic were at a complete standstill, and there was hopeless chaos in the German coastal traffic.

The Germans, it must be remembered, required mine-free water only for such coastal traffic as the internal transport organisations could not handle; for traffic across the narrow seas between Denmark and North-Eastern Germany and Southern Norway, and for training grounds in the Baltic for the new U-boat crews. Great Britain, on the other hand, was forced to regard mine-free water off her East Coast and in the approaches to her harbours as an absolute necessity for survival. Moreover, the British waters suitable for attack by modern mines are far more accessible to minelaying aircraft, minelaying U-boats, and small surface minelayers than the German waters in which the mine could usefully be employed as a weapon.

### The Magnetic Mine

In the new, and offensive, use of the mine, therefore, the inherent advantage lay with Germany. This the German naval staff had determined to exploit. They had developed a magnetic mine with which they were very pleased, so much so that the German naval staff considered that it would meet their requirements for the whole war, and no official work on the development of other types of mine had been done. The German Navy had determined to use their magnetic mine as a weapon of accuracy, laying only a few at a time, and laying them in positions where there was a high probability of each one of them being effective in inflicting a shipping casualty. This the Germans proposed to do in three ways. They determined to lay the mines almost right up to the English coast by using surface vessels, both destroyers and small minelaying craft like E-boats. Mines were to be laid in channels inaccessible to surface craft by small minelaying U-boats. In harbours and enclosed waters the mines were to be laid by aircraft of the Seeluft—the German Fleet Air Arm—and special minelaying aircraft had been designed and produced for this task. The whole of these organisations were keyed to the plan of using only a few mines at a time; thus the aircraft were to lay the mines in groups of three only, and it was hoped that this could be done with great accuracy by their specially trained crews.

### British Magnetic Mines

The conception of the magnetic mine was by no means new. A type of magnetic mine had been developed by us during the war of 1914–18. It was then known as the "M Sinker." Between the two wars a certain amount of work was done on the development of magnetic mines and magnetic pistols for torpedoes, and this work was, of course, considerably speeded up with the realisation in 1935 of the urgent need for re-armament. Hand in hand with these developments went the investigations into the magnetic properties of ships which, as described in The Engineer of September 21st, formed the groundwork for the system of conferring a high degree of immunity upon ships by "degaussing" them.

As a result of all the work upon development, we produced a very satisfactory and robust form of magnetic mine, and it was practically ready when war broke out, although it was not available in quantity for some months.

The magnetism of a ship can be resolved into a horizontal and a vertical component. In the development of our magnetic mine we had worked on the principle of using the horizontal component of a ship's magnetism to actuate the firing mechanism. This component had been selected because it is the stronger of the two except immediately under and close to the bottom of a ship, and because it is, for the practical purposes of mine design, unaffected by the earth's magnetic field. The use of the horizontal component conferred other advantages. The sensitive element in our magnetic mines consists of a rod wound with a great many coils of wire and known as the C.R. rod, the initials standing for "coiled rod." This rod had to lie horizontal and, since our mines were long and torpedo shaped—because they were designed to be dropped from torpedo-carrying aircraft of the Fleet Air Arm—we were able to use a C.R. rod running through the charge and thus nearly as long as the mine itself. This was a great advantage, for the sensitivity of the mine depends upon the length of the C.R. rod.

The fact that these mines were robust was of great importance, for comparatively little was then known about shock and the absorption of shock, particularly as applied to the delicate instruments of the modern mine when it is dropped into the sea from an aircraft. Experiments showed that our mine could be dropped with a parachute only 5ft. in diameter. The early lack of precise knowledge in dealing with the shock of dropping the mine had an incidental, but very important, effect upon the future developments of our mines. In designing the mine considerable space was left in the chamber housing the actuating mechanism in case additional shock-absorbing packing should be found necessary. That refinement was not needed, and the extra space allowed us to fit developments to our existing mine without having the casing redesigned. Our magnetic mine was cylindrical in shape. The parachute was attached at one end and the other end was chamfered in order to turn the mine to the horizontal in the water so that it would not stick nose down in the sea bed.

### German Magnetic Mine

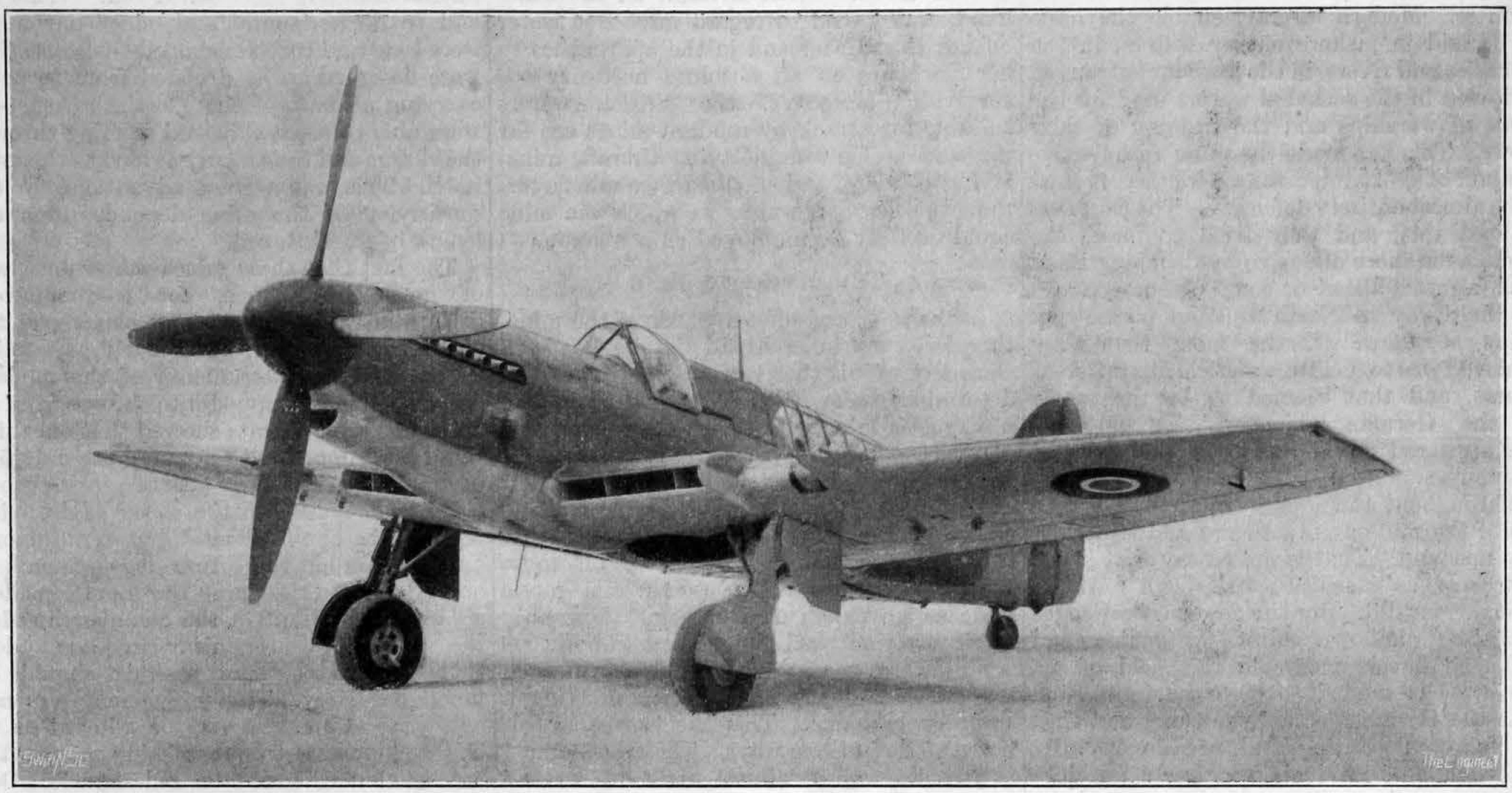
While the British designers were evolving our magnetic mine, the German designers were also busy. They started work about the year 1932. The fact that they were working on a magnetic mine design was known to us, but we did not know the principle they proposed to employ. Fortunately, we came into possession of the entire arrangement and mechanism of the mine almost immediately after it had been put into service by the enemy. As far as is known, the Germans laid the first of their magnetic mines on the night of November 21st, 1939. On the very next night two were dropped by German aircraft on the mud flats off Shoeburyness, where they were uncovered at low tide. Urgency overrode danger, and the mines were stripped down and examined. From this examination two things were immediately discovered, each of which had tremendous importance in the rapid evolution of our counter measures.

The first of these was the fact that the German mines were operated by the vertical and not by the horizontal component of a ship's magnetic field. The other was the degree of sensitivity of the mine. These items of knowledge played a great part in our "degaussing" arrangements and in the evolution of a "sweep" system.

As has been said, the German magnetic mines worked on the vertical component of the magnetism of a ship. In other words, the sensitive element of the German mine was a magnetic dip needle instead of a C.R. rod. The mechanical limitations were such that the dip needle had to be small—it was, in fact, a magnetic plate about 6in. in length and rather less than 1in. in width. It followed, therefore, that the electro-magnetic structure of the German mine was much less robust than that of our mine. This was a factor which had an important bearing upon the German minelaying technique.

A magnetic mine working on the dip needle principle and actuated by the vertical com-

# FAIREY "FIREFLY" MARK IV NAVAL FIGHTER



ponent of the magnetic field of a ship is at its most sensitive when a ship is passing directly over it in shallow water. The German magnetic mines, therefore, scored few "near misses." Use of the vertical component of the ship's magnetism, however, has certain important disadvantages. Whereas a mine working on the horizontal component of a ship's magnetism can be said to be operated by the magnetic field of the ship, a mine working on the vertical component must work on the difference between the vertical component of the magnetism of the ship and the vertical component of the earth's magnetic field, and the latter varies considerably with the latitude. The German mine, in fact, worked on the difference between the earth's "dip" and the ship's "dip." This was a characteristic which set the Germans a nice problem. It appears that in the first instance all their magnetic mines were issued from the factories with a latitude setting, which made them efficient for use in or near the Thames estuary. The difference in the "dip" of the earth's magnetic field is, however, such that mines with this setting were not suitable for laying, say, in the Firth of Forth. Moreover, the setting of the latitude in the German mines of those days was done in the factory and not in the mining depôt, and the mine mechanism was sealed on leaving the factory. The result was that mines suitable for laying in the Thames estuary could not be made suitable for laying in Scottish waters in the mining depôts, but had to be returned to the factories for alteration.

In the later designs the Germans incorporated a most ingenious latitude corrector which was automatic. This worked in the following way. When the mine had settled on the sea bed the "dip" needle rose on to its free pivot, which amounted to "arming" the mine and making it dangerous. As soon as the needle was on its pivot it, of course, took up an angle equivalent to the "dip" of the earth's magnetic field at the latitude at which the mine had been laid. In other words, the "dip" needle of the mine measured the earth's "dip" at the particular location of the mine. Once the "dip" needle of the mine had thus measured the earth's "dip," a clockwork mechanism took charge and wound the needle back to the horizontal, thus eliminating the effect of the latitude.

The mechanism of these German magnetic mines was far less robust than that of the British mines, and yet their sensitivity, in the earlier models, was much lower. There is no denying, however, that the German design was well suited to German industry and production. They were exceedingly well made and their production had obviously followed after the design period well before the rush of war, so that the skill and plant of instrument makers had been switched to the making of these units.

*(To be continued)*

## The Fairey "Firefly" Mk. IV

We illustrate herewith the latest version of the Fairey "Firefly" naval fighter and reconnaissance aircraft. This version has several outwardly distinguishing marks. The bulbous radiator beneath the engine has been replaced by radiators installed in the leading edge of the centre plane. Secondly, the wings are "clipped" instead of elliptical. Thirdly, directional stability has been improved by an increase in fin area. In addition, the Mark IV is equipped with a "Rotol" four-blade airscrew in place of the three-blade in the Mark I. The result of these changes gives the "Firefly" IV a top speed of 386 m.p.h. at 14,000ft. This is an increase of some 70 m.p.h. over the Mark I. A contributing factor is the high-speed gloss finish to the exterior in place of the matt finish. Smooth finish gives an extra 8 to 10 m.p.h. at top speed.

A Rolls-Royce "Griffon" 72 engine is fitted and gives 2300 H.P. at 14,000ft. The "Griffon" 74, incorporating the Rolls-Royce fuel injection pump, is to be used in later production versions. As with the Mark I, the "Firefly" IV carries four 20 mm. cannon guns. According to tactical requirements, however, it can carry, in addition, sixteen rockets, eight heavier rockets, bombs of various sizes up to 1000 lb., and long-range jettisonable tanks, which permit a maximum range of 1400 miles. The cruising speed is 220 m.p.h. for four hours, using standard fuel tanks.

The cooling of the engine is controlled by mechanically interconnected metal flaps in the exit ducts. By means of a thermostat the duct apertures are continuously adjusted to maintain a steady engine temperature. Cabin and gun heating is ducted from the forward side, with individual controls in each of the cockpits. Access to the radiators is gained by the removal of one large panel; when necessary, the whole unit may be lifted out by slackening the holding-down bolts and slinging at the two eyes provided. All piping and flap controls are accessible through the same opening.

A forward-facing engine air intake is formed integrally with the bottom portion of the engine cowl, and an ice guard is fitted a few inches from the entry. Air cleaning is achieved by closing a pneumatically operated flap which causes the air to be sucked through internal louvres in the under surface to obtain primary cleaning. Thereafter the air passes through a Vokes cleaner to complete the process. The cleaner is positioned so as to cause no obstruction in the air intake duct when it is out of circuit. The lowering of the chassis is arranged automatically to bring the filter system into operation.

The aircraft has a span of 41ft. 2in., a length of 37ft. 11in., a height of 14ft. 4in., and a weight of 13,200 lb.

The London and North-Eastern Railway announces that on November 19th the Press Relations office will be transferred from Hitchin to Dorset Square, London, N.W.1 (telephone, Paddington 1831).

"Springbok" Service.—The British Overseas Airways Corporation announces that the direct service from the United Kingdom to South Africa, will open to-morrow (Saturday, November 10th), and will be known as the "Springbok" service. It will be operated jointly with South African Airways with one service a week in each direction at first. On Saturday a "York" aircraft will leave Hurn airport, near Bournemouth, at 5 p.m. G.M.T. for Johannesburg, where it is due at 1.40 p.m. G.M.T. on Tuesday, November 13th. Another "York" will depart from Johannesburg for England at 3 a.m. G.M.T. on Saturday, reaching Hurn at 5 p.m. on Monday, November 12th.

# The Merchant Aircraft Carrier "Empire Macalpine"

It is now possible to give some account of the design and construction of that new type of ship, the merchant aircraft carrier, which played an important part in the Battle of the Atlantic. In the spring of 1942 packs of German U-boats were concentrating their activities over a broad belt of the Atlantic Ocean, and were taking serious toll of our shipping, carrying vital munitions and food. The effective policing of this vast area of sea could not at that time be effectively covered by shore-based aircraft, or surface auxiliary vessels from either side of the Atlantic, and Britain was then short of fleet aircraft carriers and anti-submarine naval vessels. Even before this time the Admiralty had anticipated the need for a double-purpose ship, combining facilities for the transport of foodstuffs from America and Canada with the duty of providing aircraft cover during the voyage out and home, and in conjunction with the Burntisland Shipbuilding Company, Ltd., it had arranged for a double-purpose type vessel of this kind to be designed and developed. Essential features of the new ship were that the characteristics of a fleet aircraft carrier should be combined with maximum cargo-carrying capacity, although no shipboard mechanical facilities could be provided for loading or discharging.

The general design, which was prepared by the Burntisland Shipbuilding Company, Ltd., in conjunction with the Merchant Shipbuilding Branch of the Admiralty, was agreed with scarcely a day's delay, and working plans with all relevent information were immediately prepared and passed on from Burntisland to other shipyards which had been commissioned to build ships of this special class. In fixing the official designation of this new type several points of interest were raised, since they were neither full merchant ships nor complete naval vessels. As they were to be employed as merchant aircraft carriers, the initials M.A.C. seemed appropriate, and they were subsequently referred to as "Mac" ships. The series of "Mac" names, "Empire Macalpine," "Empire MacKendrick," &c., followed.

### The First Ship

The keel of the first ship of the new class, the "Empire Macalpine," was laid at the Burntisland shipyard on August 11th, 1942, and the completed ship was delivered to the Admiralty on April 14th, 1943. During this period of only eight months many problems associated with the design were worked out. The armament, comprises four Oerlikon guns, two Bofors guns, and one 12-pounder gun, and a number of "Swordfish" aircraft can be housed in the hangar.

The principal dimensions of the merchant aircraft carrier are given in the following table:

*Hull Dimensions*

| | |
|---|---|
| Length overall ... | 448ft. |
| Breadth ... | 57ft. |
| Length of flight deck ... | 422ft. |
| Breadth of flight deck ... | 62ft. |
| Depth from keel to flight deck ... | 53ft. |
| Depth moulded to shelter deck ... | 37ft. 9in. |
| Depth moulded to second deck ... | 28ft. 9in. |
| Loaded draught in service ... | About 24ft. 6in. |
| Deadweight carrying capacity ... | 7930 tons |
| Cubic capacity ... | 379,000 cubic feet |
| Gross tonnage ... | 7950 tons |
| Net registered tonnage ... | 3250 tons |

*Propelling Machinery*

Type: Single-screw Doxford opposed-piston oil engine

| | |
|---|---|
| Number of cylinders ... | Four |
| Cylinder bore ... | 600 mm. |
| Combined stroke ... | 2320 mm. |
| Designed output ... | 3400 S.H.P. |
| Running speed ... | 114 r.p.m. |
| Service speed of ship ... | About 13 knots |

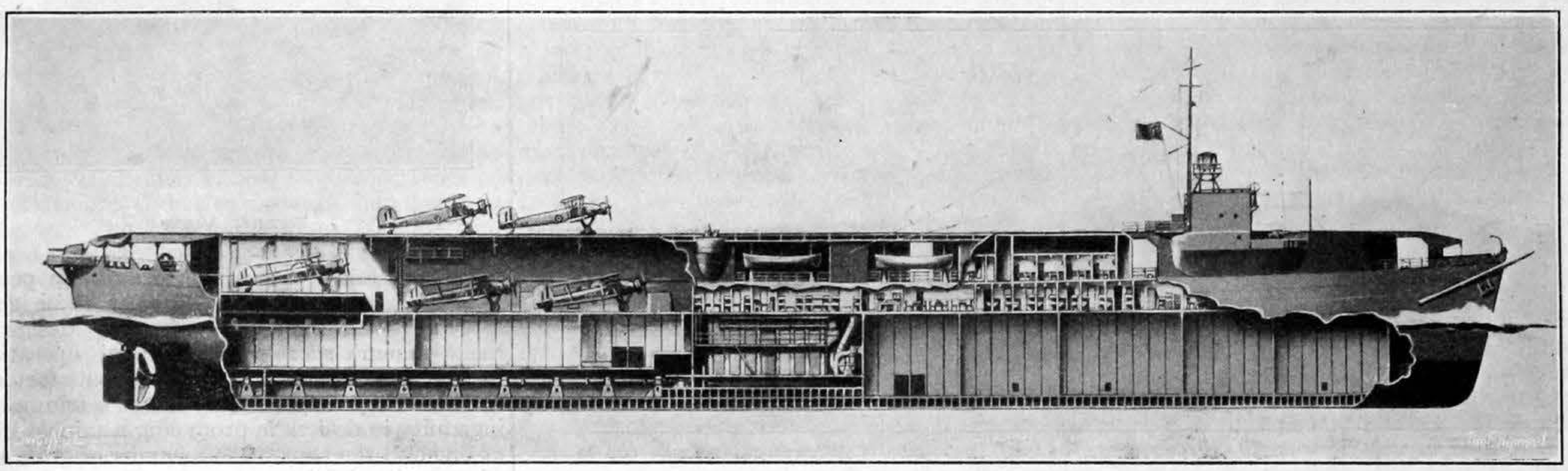
As will be seen from the accompanying sectional arrangement of the hull, cargo is carried in eight large holds, all of which are arranged below the second deck. Cargo, such as grain, is loaded through trunkways which extend to the flight deck and terminate in flush water-tight hatch covers. Arrangements for the discharge of the cargo by shore suction plants were made. The cellular double bottom, which extends fore and aft, carries water ballast, oil fuel, and fresh water in appropriate tanks. Water ballast is also carried in the fore and after peaks, and in deep tanks in way of the aftermost hold. Additional tanks are also fitted at the fore end of No. 8 hold, at the sides of the tunnel, and extend to the tunnel top. In these tanks a supply of fresh water for ship's use is carried. In way of the engine-room a further feed tank in the double bottom is provided, and three of the cargo holds, Nos. 2, 5, and 6, are adapted for use as deep tanks, when necessary.

The space between the upper and second decks is principally allocated for storage, which is vital in the operation of a ship of this special class. In this part of the ship provision is made for ship's stores, cold chambers, magazines, aviation petrol compartments, and lubricating oil tanks, aircraft stores, electrical spares, medical stores, linen and bedding compartments, and miscellaneous equipment. In these 'tween-deck spaces accommodation for ratings is provided and the gyro-compass is housed.

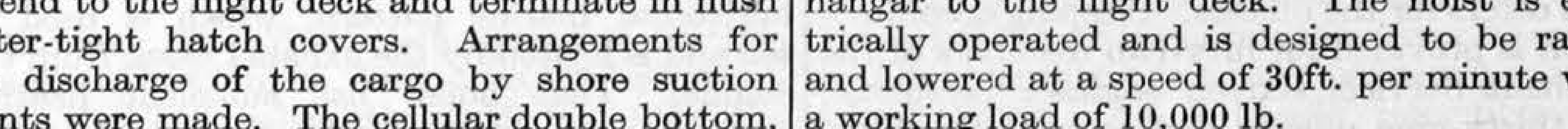
### Aircraft Accommodation

The aircraft hangar space is, as our engraving shows, at the after end of the vessel, and it extends from the second deck up to the flight deck. Ample space for aircraft with folded wings is provided, together with acommodation for the larger aircraft spares, such as wings, tail-planes, and other spare parts. The hangar hoist has a platform 42ft. by 20ft., which is used for transporting the aircraft from the hangar to the flight deck. The hoist is electrically operated and is designed to be raised and lowered at a speed of 30ft. per minute with a working load of 10,000 lb.

The flight deck, which has a length of 422ft. and a breadth of 62ft., is so arranged that there is a minimum freeboard of 28ft. 6in. at the fore



Sectional View of Merchant Aircraft Carrier "Empire Macalpine"




Merchant Aircraft Carrier "Empire Macalpine" end of the ship, above the water line, when the vessel is in service condition. No sheer is given to the flight deck; on the contrary, there is a drop of 2ft. 6in. at the ends. The deck has a perfectly flush surface and it is coated with a non-skid paint. As with fleet aircraft carriers, arrestor wires are arranged at intervals to assist in retarding the aircraft when landing, and forward there is a small steam jet, which acts as a wind direction indicator. Safety nets are fitted at the sides and after end of the flight deck, and as an emergency measure "Phomene" foam generators are provided at intervals to deal with a possible fire. At the after end of the deck there is a workshop, which is complete with all the tools and equipment necessary for the quick repair of aircraft. The wheel-house, which is constructed of non-magnetic steel and is encased in plastic armour, is placed on the starboard side of the flight deck. It is so designed that the ship may be conned either from inside or outside the wheel-house. At the after end of the house there is a signal mast. Throughout the ship there is an elaborate system of telephones and voice pipes, complete with call-up bells or lights, all of which are built to the Admiralty's latest requirements.

### Crew Accommodation

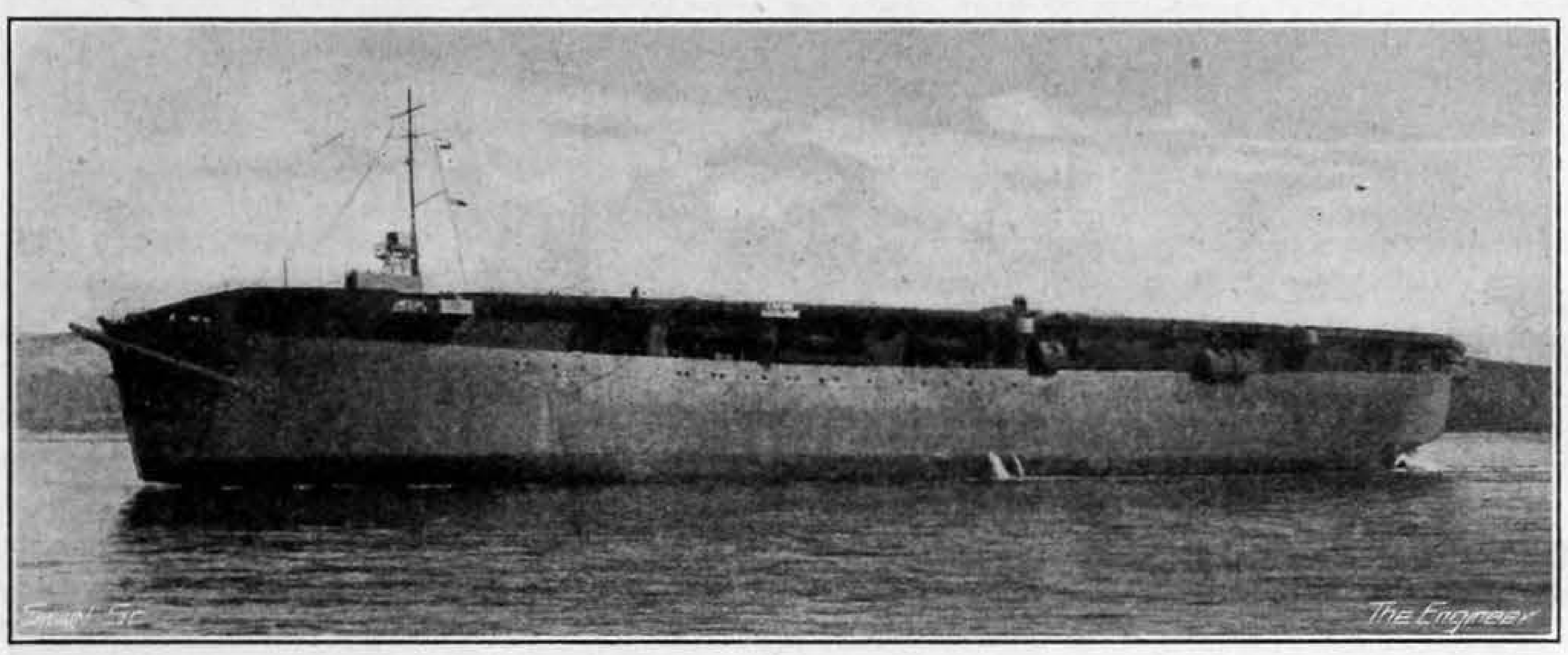
Good accommodation for a total personnel of officers and crew numbering 107 is arranged between the upper and flight decks. Throughout, a high standard of comfort has been adopted. An accompanying illustration shows the dining room, which is capable of seating twenty-six persons. A roomy and well-appointed wardroom caters for the officers. Sleeping accommodation is provided for fifty-two members of the Merchant Service, sixteen engineer personnel, and thirty-nine officers and men of the Fleet Air Arm. There are separate offices for the use of ship's officers, engineers, and air crew. The ship carries its own doctor, and there is a hospital and dispensary. Two chart rooms are used, one for the ship's officers and one for the air personnel. The wireless office is adjacent to the wireless operators' cabins, and in addition there is an emergency wireless office in the upper 'tween deck space. Navigating and safety equipment, suited to the operation of a ship of this class, includes a Radar installation.

### Deck and Propelling Machinery

The deck machinery comprises a steam-driven windlass, a hydraulic steering gear, and three steam winches, which are arranged on the upper deck for working the store derricks and the lifeboats. One of the winches which is fitted aft can also be used as a warping winch, while for handling the ship's stores there are four 3-ton derricks. Booms fitted on the ship's side between the upper and flight decks take the aerial and signal leads from the mast. Forward of the ship "Paravane" gear is fitted and, as previously indicated, fully equipped steel lifeboats, life rafts, and other buoyant gear are carried, as may be needed.

For the propulsion of these merchant aircraft carriers oil engine drive was selected. The engine is arranged amidships and consists of a Doxford four-cylinder, opposed-piston, oil engine, designed to develop 3400 S.H.P. at 114 r.p.m., corresponding to a service speed of about 13 knots. The engine cylinders are 600 mm. bore, with a combined stroke of 2320 mm. The auxiliary machinery is steam driven, the steam being generated in two boilers. One is a boiler of the composite horizontal marine pattern, which is used at sea and is heated by the exhaust gases from the engine. That boiler has sufficient heating surface to provide steam for the principal ship and engine-room auxiliaries required during an ocean voyage. Both boilers are conveniently arranged in the 'tweendeck space. The exhaust gases from the two boilers and the main engine are led through the side of the hull.

The type of ship we have described is classed 100 A1 at Lloyd's, and is constructed to the requirements of the Home Office and the Ministry of War Transport. Special requirements were formulated by the Admiralty with regard to the carriage and fitting of the aircraft, armament, wireless telegraph installation, and the fitting and stowage of depth charges, including all arrangements in connection with magazines and the carriage of aviation petrol. Finally it may be recorded that these ships lacked nothing in equipment or design to make them successes in naval operations in the war which has now so satisfactorily ended. They may be regarded as a triumph of ingenuity in design, in producing a ship which is at one and the same time a carrier of grain and of operational fighter aircraft. They reflect the very close co-operation which existed between the Naval Staff and the Department of Merchant Shipbuilding.




Merchant Aircraft Carrier "Empire Macalpine"


Stern View


Dining Saloon

# The Mechanical Engineering Industry of Clydeside: Its Origin and Development*

By C. A. OAKLEY, B.Sc., Ed.B., M.I.E.S.S.

In a previous paper†, in which the nature of mechanical ability was discussed, the author commented on the difficulty of defining mechanical ability except in tautological terms. Mechanical ability w s then said simply to be the ability to understand, to make and to use mechanical things. Although it would seem to be one of the acquisitions of man's more highly civilised days, many psychologists hold that its quality—whether in a particular individual it is high or low—is largely influenced by inherited characteristics. The part which social environment plays in shaping the ability is clearly recognisable, but even to-day it is often surprising to find that out of a simple-living community of peasants there may emerge, within a few years of its being introduced to agricultural and other machines, young men of quite exceptional engineering talent.

Although the "Scotch engineer" has become a well-known figure throughout the world—almost invariably he is a Clydeside engineer—the Scot has no traditional reputation for being adept at mechanics. His standing in Europe as a merchant, a soldier, a poet, and a philosopher has been considerable, but few in the past thought of him in association with industry,

* The Institution of Engineers and Shipbuilders in Scotland, October 23rd. Abstract.

† "Trans.," I.E.S., 1932-33, Vol. 76, page 561.

let alone with engineering industry. Yet in the seventeen-sixties one of the most important—perhaps the most important—inventions in the history of mechanical engineering was made in Glasgow, and within little more than half a century Clydeside had attained the position, which it still holds, of one of the leading centres of the engineering industry in the world. A review is made in this paper of some of its achievements, and reference is made to certain Clydeside engineers, whose contributions to the development of mechanical engineering have been particularly notable.

In the middle of the eighteenth century the only opportunity the Clydeside youth had of learning about mechanical things was by making models of them and by helping to repair them when they broke down. James Watt (1736–1819) was, however, fortunate. He had been a sickly child, ridiculed by the children of his neighbourhood because of his grave demeanour and lack of humour, and had received his earlier education at home. His father was a ship chandler and a great many pieces of nautical gear passed through his store for repair. Accordingly, young James Watt had plenty of opportunities for studying how mechanical things worked and for finding out how they were put together. Some branches of the mechanical craft were old even in those days. Mariners' compasses and other mathematical instruments were usually manufactured by clockmakers, and James Watt's first engineering interests lay in trying to get things to "go like clockwork." His mathematical talents, coupled with these other interests, led to mathematical instrument making being chosen for his career. There was no one in Glasgow with whom he could serve a satisfactory apprenticeship, so he was sent to London to learn the rudiments of the craft, but ill-health brought him back to Glasgow. The Incorporation of Hammermen refused him permission to work in the city, but luck was on his side, as the University asked him to repair a case of damaged astronomical instruments. He was provided with a room at the University and so was brought into close association with the staff and students of the Physics Department. He revelled in his new environment and, by using his opportunities to the full, became one of the first men ever to be really able both as a mechanic and as an applied scientist. In 1757 he was appointed mathematical instrument maker to the University and soon was known as a universal mechanical expert. He then went into partnership with John Craig and their engineering business did so well that fairly soon they had sixteen men on their staff. It was not until 1763 that James Watt first became interested in steam engines. At that time a model of the Newcomen fire-engine, belonging to the University, was out of order. As Watt himself says, he set about repairing it just as any other mechanician would have done, but he soon observed that the engine itself was most inefficiently conceived. In his precise way, he set out to discover how much heat really was being wasted, and came to the conclusion that three-quarters of the steam was not being used. There was clearly a fundamental weakness in the design and he decided to find out what it was. James Watt himself has told the story of how, while walking on Glasgow Green one Sunday afternoon, he realised in an intuitive flash that, as the cylinder itself had always to be kept hot, it was the last place in which to try to condense the steam. By providing a separate condenser, which could be kept cold, the waste of heat could be avoided.

Watt's steam engine was at first manufactured commercially at the Carron Works, Watt having gone into partnership with John Roebuck. The arrangement, although it lasted for almost ten years, was not a success. Roebuck was unable to produce the engine parts with the necessary degree of accuracy, wh le Watt constantly changed the design of the engine, so adding to Roebuck's difficulties. A visit to Matthew Boulton's Soho Works at Birmingham opened Watt's eyes to the possibilities of organising engineering production, and he wanted to transfer the manufacture of the steam engine to Birmingham. A coal-mining venture having made Roebuck bankrupt, the way was open and in 1773 Watt went south. There can be little doubt that thereafter his genius did much more to make the Midlands a great engineering centre than it did for his native Clydeside.

The common impression that once he had joined Boulton in partnership Watt was comparatively free to conduct his researches in the seclusion of his laboratory is very wrong. He had to work hard for a good many years, supervising the erection and repair of the engines, which were first used almost exclusively for pumping water from the Cornish copper and tin mines. For a time, too, he had to take charge of the company's office and counting-house—a job which he was ill-fitted by temperament to undertake. But he continued his investigations, and in 1784, while experimenting with the double-acting engine, made the most attractive of all his inventions, the action of rods jointed to form a parallelogram, giving parallel motion. In it, as perhaps in no other of his achievements, is exemplified his "sense of mechanical beauty." Watt was an artist as well as a scientist. By then his affairs were going well. He was becoming prosperous, and his company was able to employ skilled mechanics to take over from him many of his supervisory duties. Accordingly he was able to devote the last thirty years of his life to his inventions—and, like many others delicate in their youth he lived well into his eighties. They were of a much more varied character than is commonly realised. His patents and other interests covered a machine for copying letters, an adding machine, a smoke-consuming furnace, an oil lamp, a process for bleaching fabrics with chlorine, a linen-drying machine, the application of centrifugal governors to steam engines, some aspects of medical chemistry, an artificial alabaster, and a machine for copying sculpture. Above all, perhaps, he was the father of systematic engine testing. The ideas underlying several of his discoveries were not his own—one of his weaknesses was claiming, when shown a new device, or an improvement to an old device, that he had already thought of it—but he was as critical of the imperfections of machines invented by others as he was of his own, and he was, invariably seized with a desire to turn these machines into works of art.

A blot on Watt's record is undoubtedly that caused by his treatment of the second great mechanical genius hailing from the Glasgow district, William Murdoch or Murdock (1754–1839)—he changed the spelling of his name to suit the pronunciation of the English. He was the son of an Ayrshire millwright, who had been a gunner in the Royal Artillery at Woolwich, and it was from his father that he learned his craft.

Murdock, like Watt, left Clydeside for Birmingham, but, unlike Watt, who went on horseback, Murdock walked the whole way. He had hoped to see Watt and to ask him for employment, but, fortunately for him, he saw Boulton instead. Recently the opinion has been repeated in a Birmingham publication that Watt did not like Scottish workmen, regarding them as unreliable and argumentative. The fact remains, however, that Boulton received Murdock well and, according to an oft-told anecdote, was intrigued by a wooden top-hat which Murdock had made for himself, after constructing an "oval lathe" for the purpose. Murdock was sent almost at once to Cornwall to assist Watt and, subsequently, Boulton described him as the most active man he had ever seen and quite the best engine erector. The Cornishmen liked Murdock and even Watt's own biographers say that, when a Cornish mine-owner reported to Birmingham that an engine needed rep ir, he would usually ask that Murdock rather than Watt should come. Murdock's life is a really impressive history of a man's devotion to his employers. He had no ambitions, and he declined an offer from the Cornish mine owners of £1000 per year, preferring to remain with Boulton and Watt at 20s. per week. Boulton and Watt never made him a partner, although retaining him as their works manager and right-hand man. It should be recorded that, when the sons of Boulton and Watt succeeded their fathers, they redressed this wrong, but, by that time, Murdock was past his best and by 1830 he had gone into retirement.

Murdock's reputation to-day rests on his discovery of how to use coal gas as an illuminant. As early as 1792 he had been experimenting with the illuminating properties of various distilled gases. In that year he built a retort in his backyard at Redruth, Cornwall, and purified and stored the gas. There is some dispute about the actual date on which he can be said to have mastered the use of illuminants, however, for he was still experimenting with them in Birmingham in 1799. It is definitely recorded, however, that he lit part of the Boulton and Watt works with gas during the celebrations of the Peace of Amiens in 1802. It is in keeping with his character that he should have made nothing out of the invention, and that by 1809 gas lighting should have got into the hands of company promoters. It is difficult for us to-day, in spite of our recent experiences with the "black-out," to appreciate the significance of this invention. It changed the whole social life of the country. In the opinion of some authorities, the coming of what might be described as modern times dates from the first use of gas for lighting streets. The year in which this was done in Glasgow—one of the pioneering cities—was 1818.

Much of the work Murdock did to improve the design of steam engines has not been recorded, his inventions having been attributed to the company. It seems certain, however, that in 1781 he invented the gear for the sun and planet motion. Among his other inventions and interests were improved machine and foundry tools, an oscillating engine, a slide valve, paint for ships' bottoms, iron cement, stone pipes, compressed air as a source of power, and a steam gun.

Coal has been worked in Scotland since the twelfth century, but the Lanarkshire mines were of insignificant size until the growth of population and the industrialisation of Clydeside after 1760 created a substantial demand for coal. The native ironstone also was little used in the past, and the first two furnaces erected in Scotland—both about 1750—to utilise charcoal produced in the neighbouring woods, were located at Goalfield and Bonawe, in Argyllshire, the iron ore being brought by ship from Cumberland. Heavy industries had their real beginning in Scotland in 1760 when the Carron Company was founded. In the following decades several other ironworks were built in the West of Scotland, Glasgow's famous undertaking being the Clyde Works of James Dunlop, opened at Tollcross in 1786 and particularly associated in the public mind with the name of his son, Colin Dunlop. It was there that David Mushet (1772–1874) began the career which led to his becoming one of the country's greatest metallurgists. He is chiefly remembered in the West of Scotland for his discovery in 1801 that the so-called "wild coal" of Lanarkshire contained between 50 and 70 per cent. iron. Although almost forty years passed before this "black-band" ore was properly utilised, the rise of the heavy industries of Lanarkshire dates from his discovery.

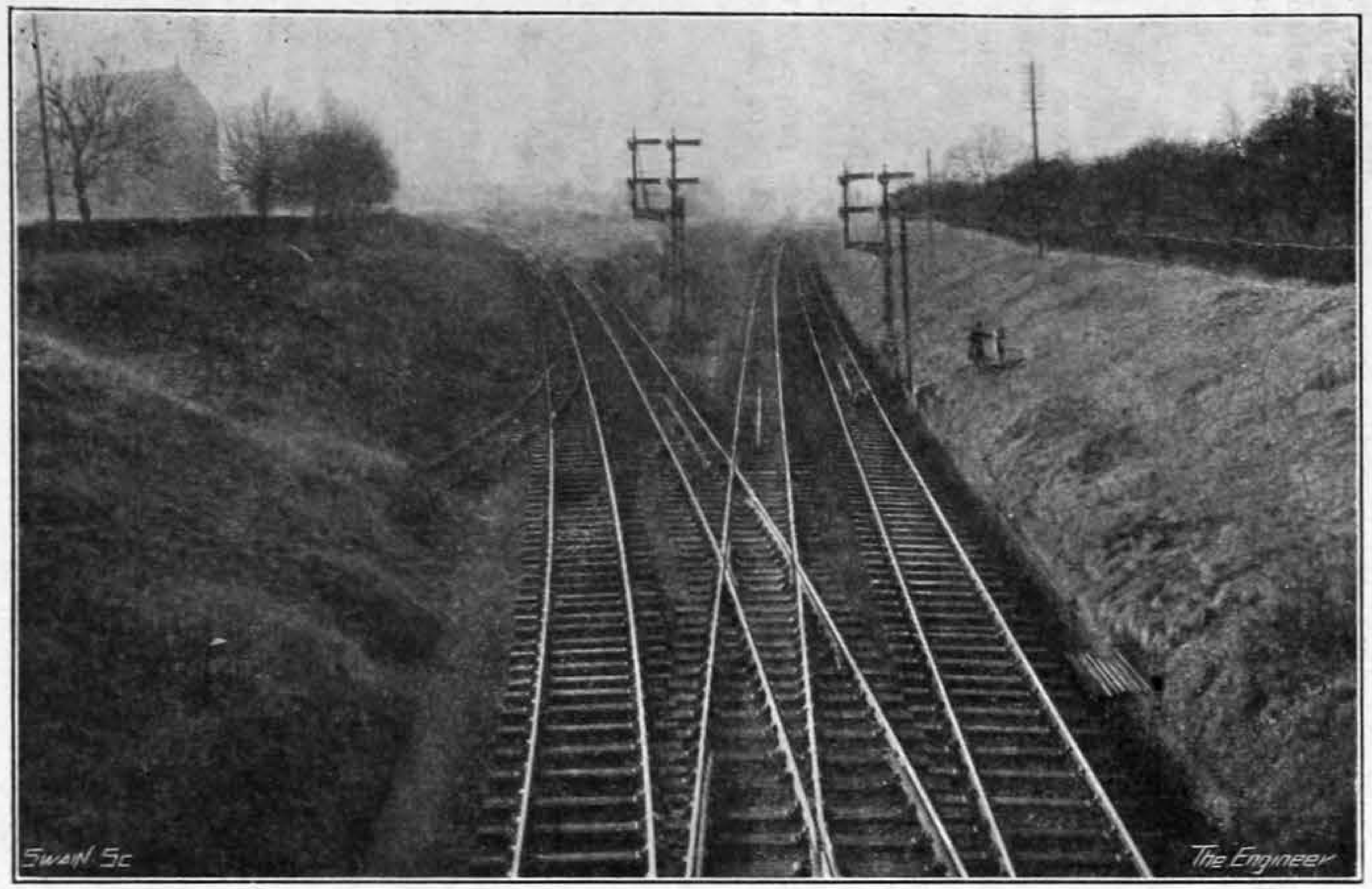
In the 'sixties it seemed that Clydeside was going to be the principal producer of pig iron in the British Isles, but by the end of the century it had slipped to s cond place and, the black-band seams being exhausted economically, it has declined further since.

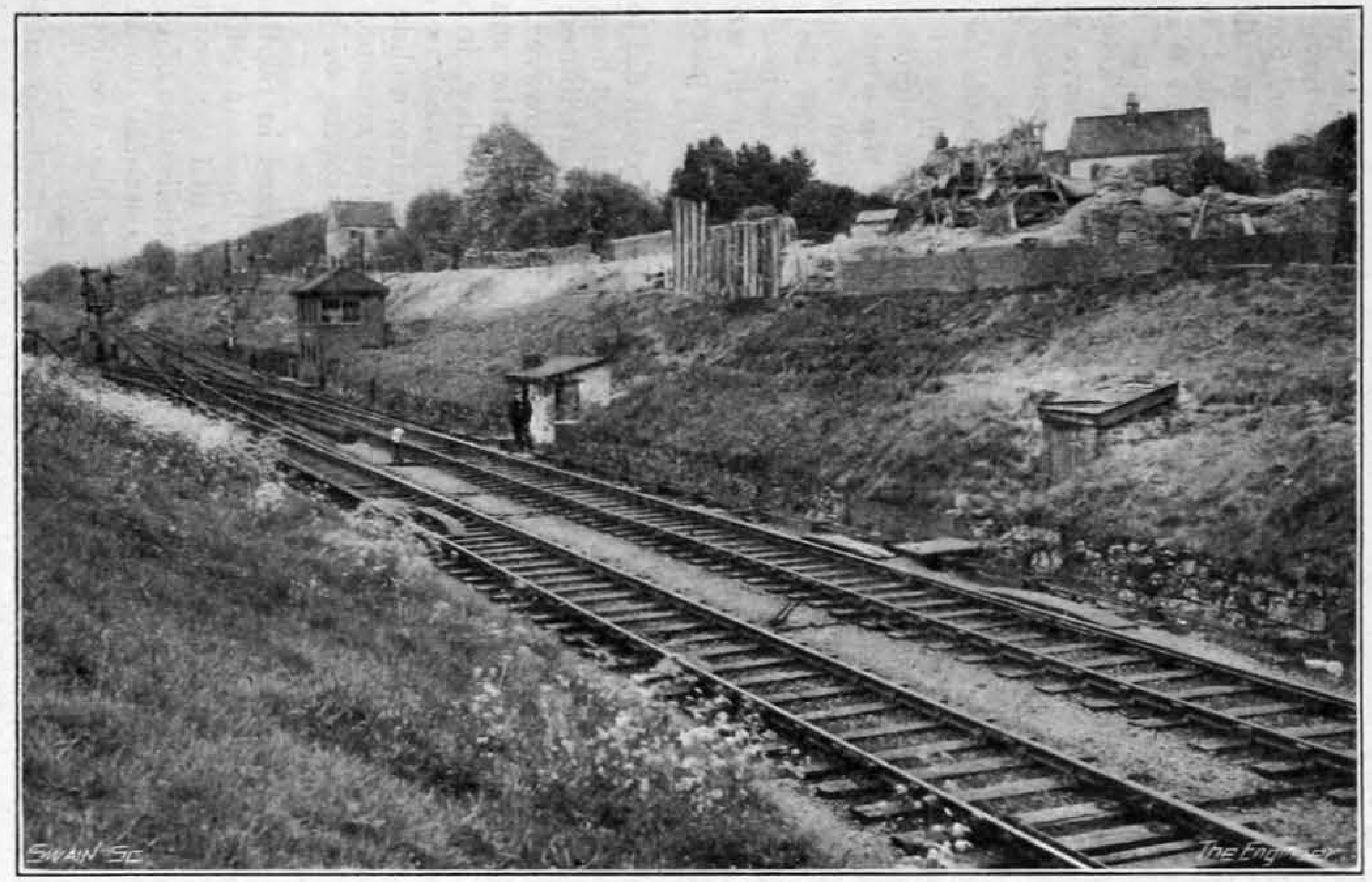
*(To be continued)*

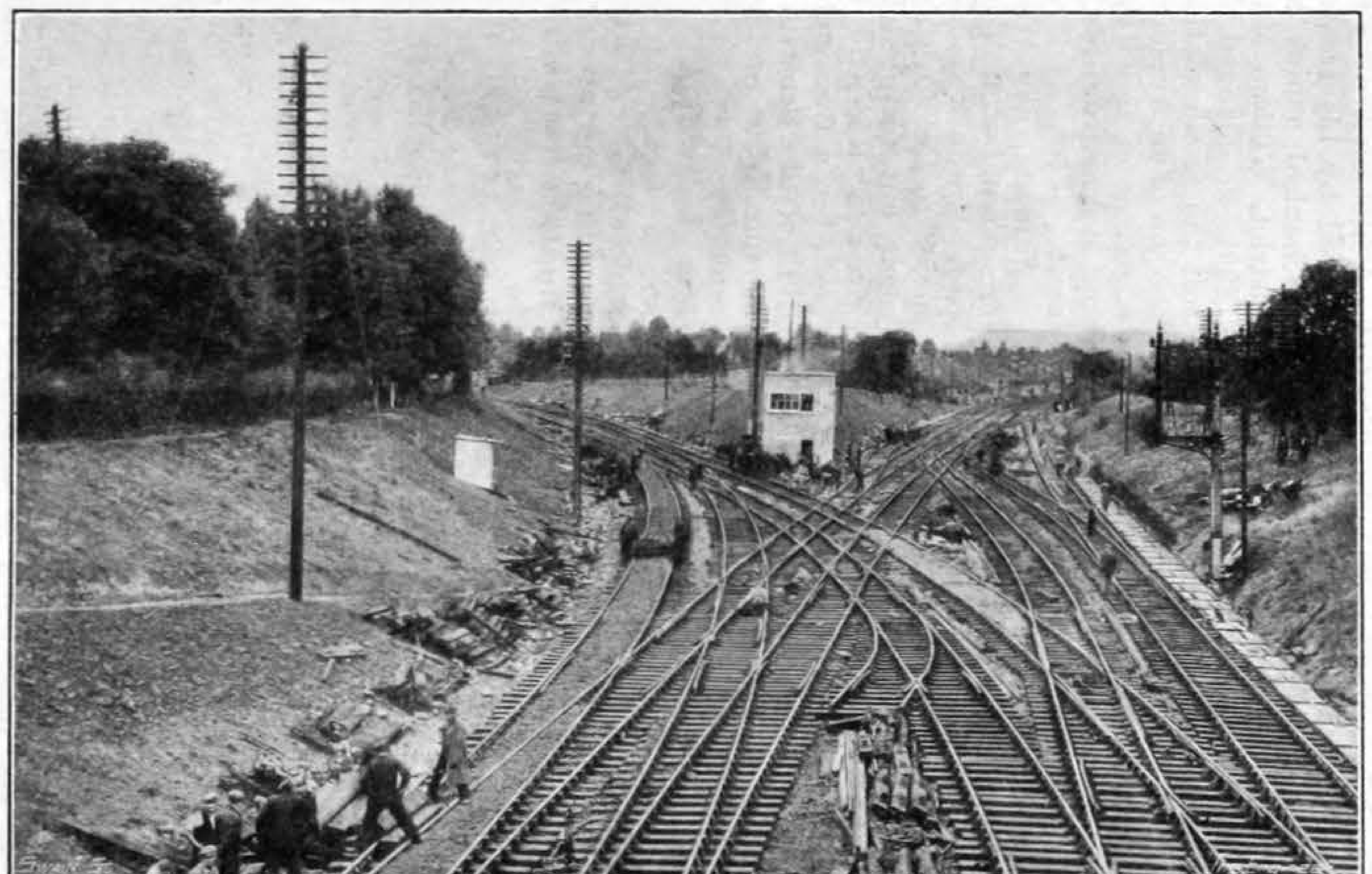
Plant and Equipment for India.—The Government of India has established in the United Kingdom under the High Commissioner for India, a new organisation to assist in the sponsoring and supply to India of plant, machinery, equipment, and other goods. Mr. P. C. Chaudhuri has been appointed in charge of the organisation and offices have been opened at 45 to 47, Mount Street, London, W.1. Advice and assistance in this connection will be readily available from the organisation to exporters and others interested in the Indian market. The new organisation will take over from the Economic and Overseas Department of the India Office work hitherto performed on behalf of the Government of India by that Department in connection with the supply of goods from this country to India.

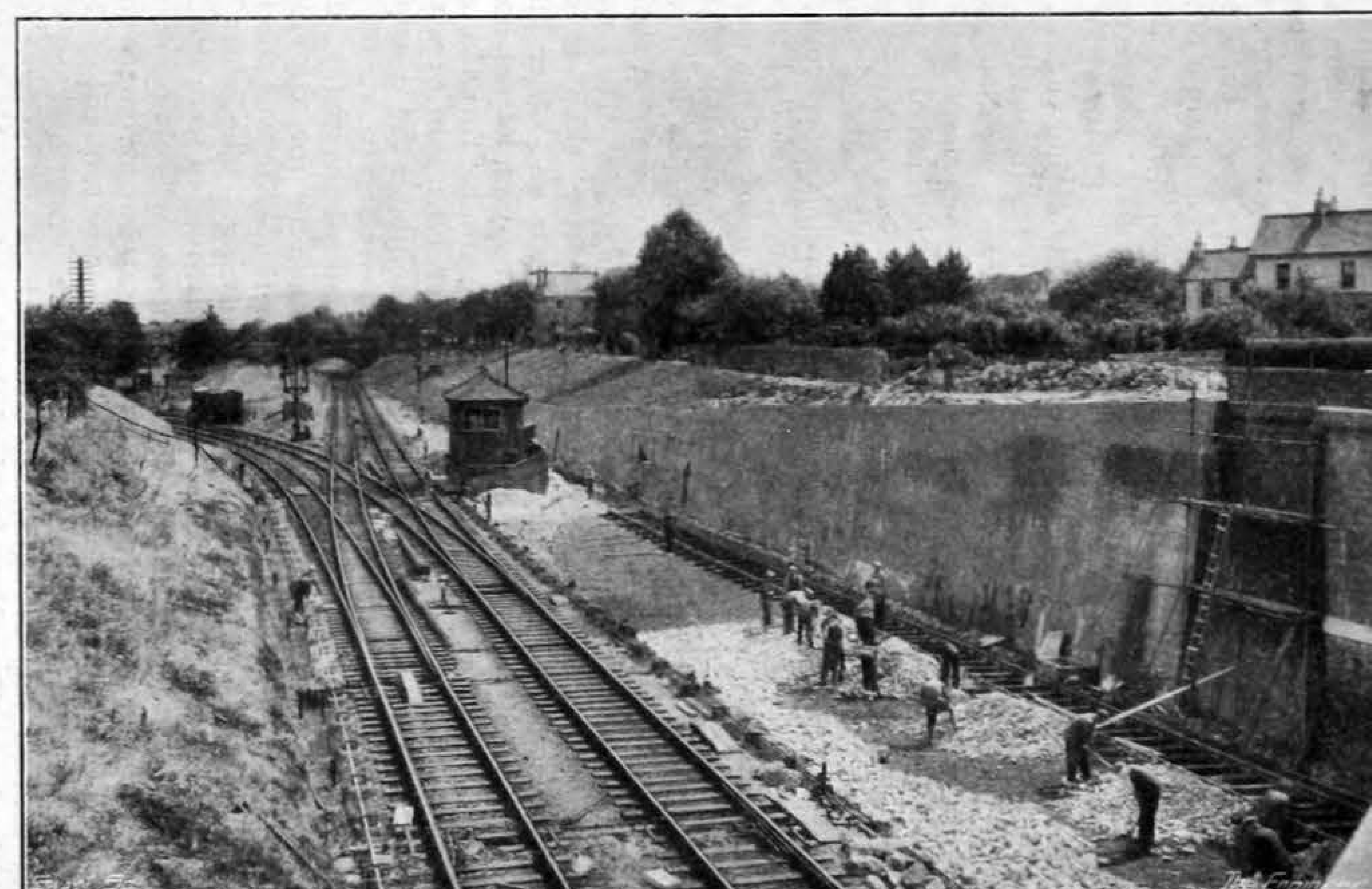
# TRACK WIDENING BETWEEN CHELTENHAM AND GLOUCESTER

(*For description see opposite page*)





VIEW FROM LANDSDOWN ROAD BRIDGE TOWARDS GLOUCESTER BEFORE AND AFTER WIDENING

VIEW FROM LANDSDOWN ROAD BRIDGE TOWARDS CHELTENHAM BEFORE AND DURING WIDENING

# L.M.S.—G.W.R. Cheltenham and Gloucester Track Widening

DURING the years 1941 and 1942 an approximately 6-mile length of track on the Cheltenham and Gloucester line was widened to take four lines of traffic instead of two. Though in normal times the work involved would hardly be regarded as being of outstanding interest to civil engineers, in point of fact, owing to the necessity of carrying out the work as an urgent wartime operation, many peculiar difficulties were met and overcome.

About 3 miles of the line is owned and maintained by the L.M.S., whilst the other half belongs to the G.W.R. Before the widening there was at each end a heavily worked junction where the lines of the two companies separate; between the junctions the whole of both companies' traffic was carried on the double track. As the route became of increasing importance during the war, the "bottle-neck" so caused became acute, and it was decided that work should be completed on a high priority.

Speed of completion was throughout the work the dominating factor, so much so that certain risks were run which would not otherwise have been entertained. The chief among them was the adoption of open-cut excavation in the construction of some of the overbridge abutments and retaining walls, instead of normal trench work. In the case of bridges, this method was only possible because, first, the existing bridges were of girder construction, and consequently no question of unbalanced thrust from arches arose; and, secondly, because permission had been granted to close the roads.

The history of the preparations for the work is of interest as an example of the difficulties caused by a joint scheme of this nature, where two railway companies are involved. In June, 1941, rough estimates of the cost had been provided, and in July of that year the work was authorised. At that time neither the G.W. engineer nor the L.M.S. engineer had plans sufficiently advanced to enable a normal contract to be let. As the G.W.R. were heavily involved in other work, the chief engineer of the L.M.S. undertook to let and supervise the contract for the whole of the work, each company being responsible for its own signalling and permanent way work, except that the plain road on the G.W. portion was to be laid in by the contractor. As the engineering data for the G.W. portion was naturally in the hands of the G.W. engineer, the drawing-office staffs of both companies had to produce at short notice drawings for a tender. The contract was let in September, 1941, to Sir Robert McAlpine and Sons, Ltd., and the further problem arose of keeping pace with the contractor's drawing requirements. However, by close co-operation, the work proceeded apace, and we understand that at no time did the contractor suffer delay from this cause. Similarly, the efforts of both estate departments speedily acquired the necessary land.

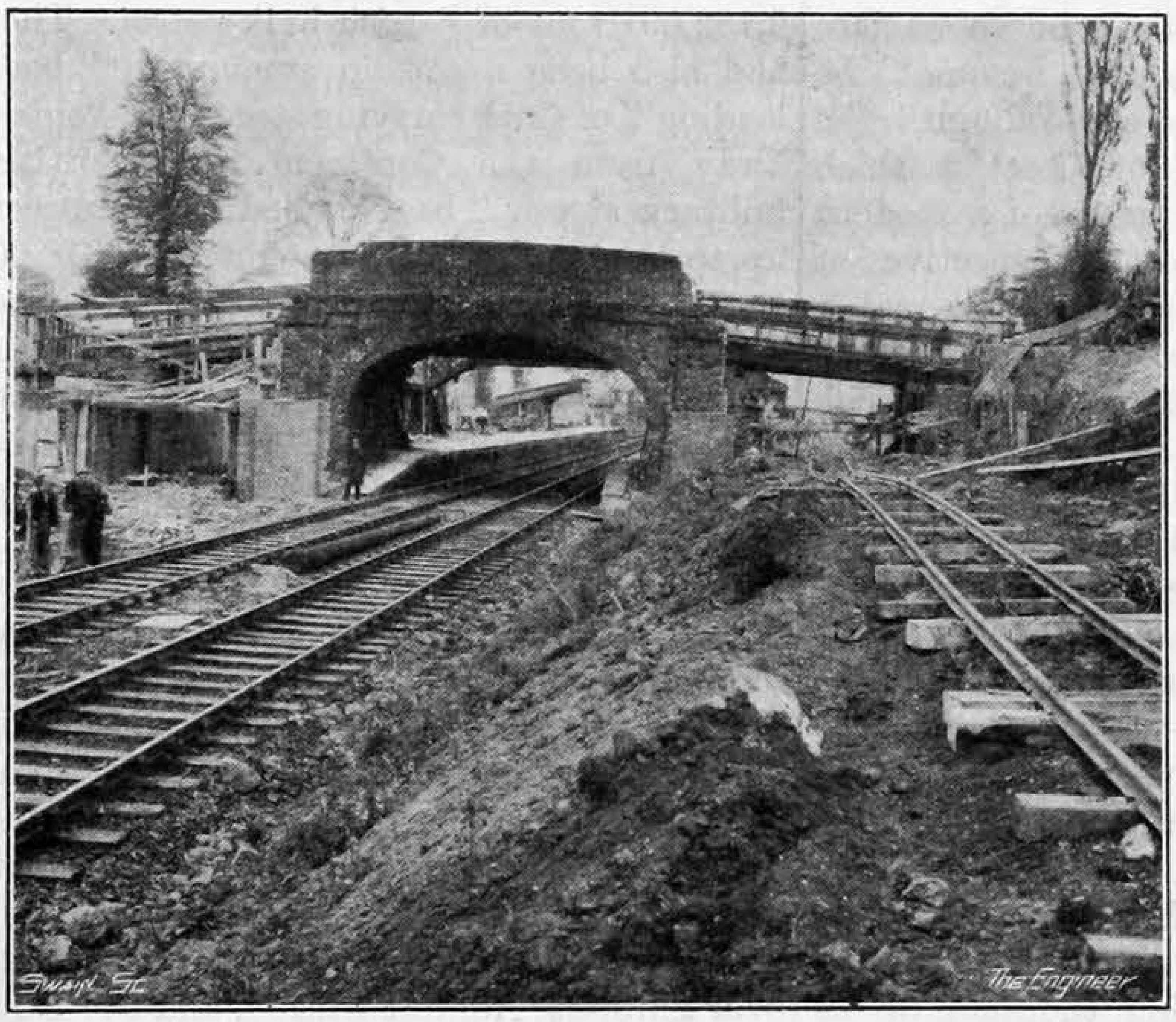
The Cheltenham and Gloucester line runs approximately east and west. The additional double track was constructed on the south side of the existing lines, except for a length of about half a mile towards the Cheltenham end, where the new lines were provided on the north side, necessitating a double "fold-over" from old to new lines. Between Cheltenham and Gloucester there was one other junction, about ¾ mile from the eastern end, and a passenger station — Churchdown — situated about the middle of the 6-mile stretch. All three junctions and the station were affected by the widening.

Accompanying illustrations show some of the work in progress. The plan was to proceed in stages in the direction from Gloucester to Cheltenham. The first mile of the widening, including the junction, was brought into use with a temporary junction from the two existing main lines at the Cheltenham end, necessitating a reversal of direction on one of the existing lines. The second stage was a continuation to Churchdown Station at the mid-point of the widening. The third embraced the Cheltenham and Banbury junction, and the fourth the remaining ¾ mile, including the complicated Cheltenham junction.

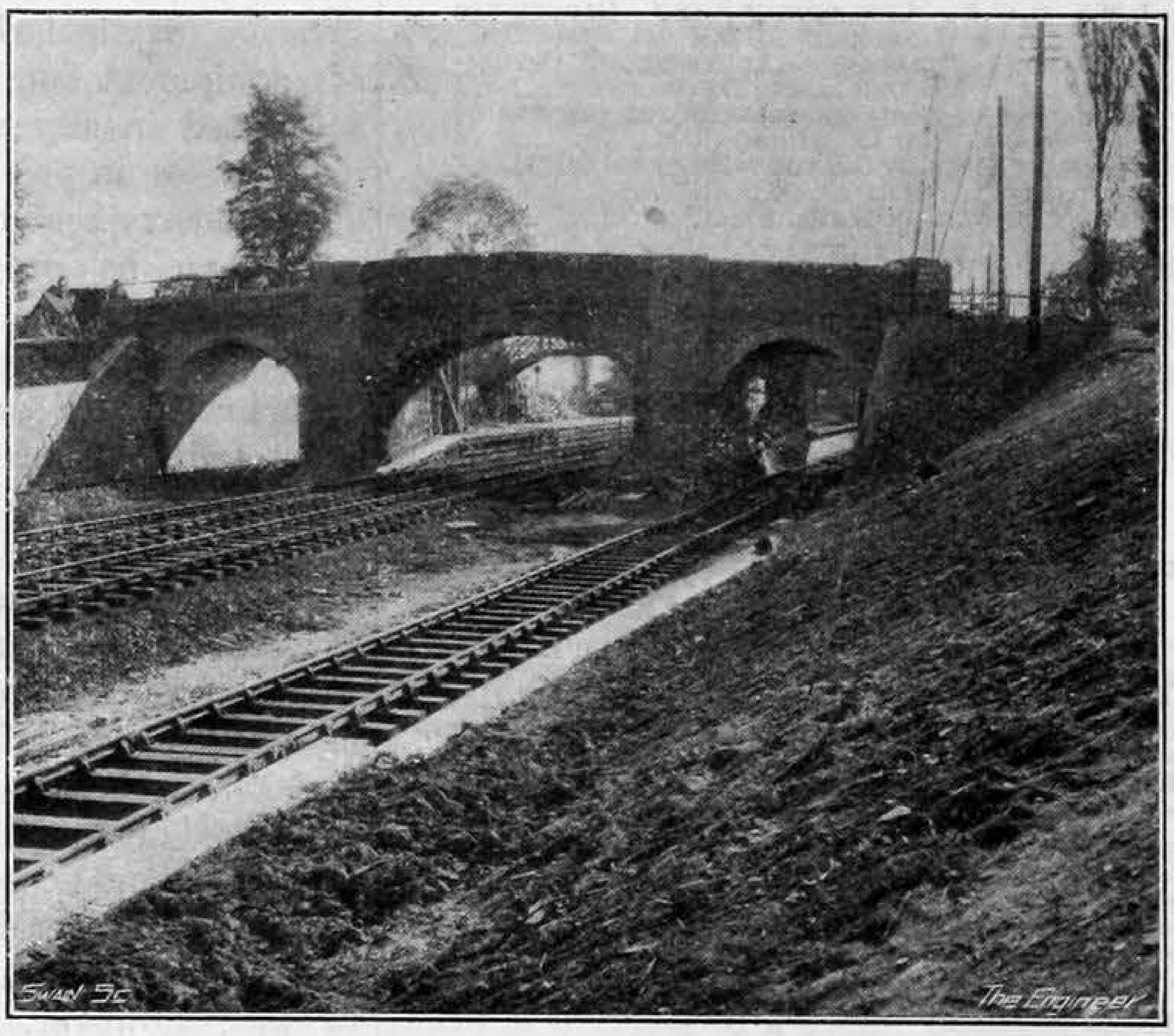
There was a considerable amount of earthwork in the contract. The longest cutting was 1 mile 48 chains, and the longest embankment 1 mile 24 chains. Another embankment, 58 chains in length, reached a maximum height of 40ft. Here considerable surface drainage had to be carried out before tipping could be begun, as slipping had occurred in the past due to the water-logged state of the ground. The excavation exceeded a quarter of a million yards, of which about 140,000 cubic yards was required for embankments, leaving a surplus of about 120,000 cubic yards to be tipped elsewhere.

Disposal of spoil was difficult and hauls of considerable length were unavoidable, due to the continuous lengths of cutting and bank. Because the traffic on the existing main lines was heavy, it was not possible to haul trainloads of surplus excavation on these lines, and therefore special arrangements had to be made. Part of the spoil was dumped in a triangular site between branch and main lines, but the bulk of the surplus of one cutting had to be tipped on adjacent land, which was specially acquired. Unfortunately, a public road ran across this site, and it was necessary to divert this road by building a new road for about ¼ mile.

A heavy telegraph line had to be diverted for the full 6 miles of widening. Five new signal boxes had to be built, the new ones at Gloucester and Cheltenham each containing more than a hundred levers. The contract work included the extension of seven underbridges, five new openings under existing overbridges, the extension of ten culverts varying from 2ft. to 8ft. wide, and long lengths of retaining wall on the eastern portion. Tracklaying comprised 11½ miles of plain road and 3¼ miles of points and crossings. At Cheltenham it was also necessary to lower a considerable length of the diverging Banbury line in order to maintain gradients suitable for the new position of the junction points.




CHURCHDOWN ROAD BRIDGE UNDER RECONSTRUCTION




CHURCHDOWN ROAD BRIDGE RECONSTRUCTED

The contractor started excavation on September 15th, 1941, laying an overhead road to deal with the excavation for the mile of embankment in the first stage. The work of constructing the three bridges, the culverts, and the signal box at Cheltenham was also put in hand. The completion of this box was important, as one of the new lines went through the site of the old box, and the old junction had to be connected with the new box in order to keep traffic going. This stage was duly completed in nine months.

In the meanwhile, work proceeded on the other stages. The second stage was brought into use in July, 1942; the third at the beginning of August; and the last at the end of August, well within the contractor's estimate of twelve months. Praise is due therefore to the contractor's and railway companies' staffs in progressing and completing the work to such a strict timetable, particularly in view of the many wartime difficulties encountered.

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SWEDISH RAILWAY ELECTRIFICATION.—On September 29th the electrification of the Northern Swedish railway line between Ostersund and Storlien, on the Norwegian border, was completed, and on that day the last section of 51 miles between Järpen and Storlien was put into operation. In all, 2889 miles, or nearly 40 per cent. of the total State Railway system in Sweden, comprising 7519 miles, are now electrified, 568 miles having been completed during the war.

# The Engineer

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## THE PORT OF ANTWERP

"After overrunning the Scheldt fortifications, the English would finally be in a position to land great masses of material in a large and completely protected harbour. With this material they might deliver a death-blow at the North German plateau and at Berlin." Those words are taken from a captured German order, and show that the German High Command was well aware that the opening and use of the port of Antwerp represented a vital step towards the victory of the United Nations over the German Reich. It was this realisation which led the Germans to hold so grimly to the banks of the Scheldt and to sow the 73 miles of river between the port and the open sea so thickly with mines of every known type. Of the battles fought to wrest control of the Scheldt from German hands, none will ever be more famous than the combined operation against the Island of Walcheren, the anniversary of which has just been celebrated. It was at Walcheren that the Royal Marines fulfilled their traditional *rôle* as "sea-soldiers," for they were transported by sea to fight a land battle, the object of which was the free use of a port.

Now, after almost exactly a year of service in the cause of the Allied armies, the port of Antwerp is being returned to Belgian administration. Antwerp has a big place in the history of warfare, but its record in the past year will surely stand out as unique. It may well be that historians of the future will find that the use of that port in its almost undamaged state must rank as the cornerstone of the Allied victory in Europe. Let the statistics of accomplishment speak for themselves. By VE Day there had been landed in the port of Antwerp 2,233,087 tons of British military stores and 2,946,659 tons of American military stores. There had also been landed enormous numbers of military vehicles—the British quota of these amounting to 54,089, while 1,298,741 tons of British bulk petrol had also been put ashore in the port. It is a truism that invasion, particularly in the modern warfare of equipment and material, cannot be accounted in any way successful until the invaders are in possession of a port at which all the heavy and bulky needs of a modern army can be put ashore irrespective of weather conditions. It was for that reason that the great prefabricated "Mulberry" harbour laid off Arromanches was of such supreme importance. It was for that reason that the Germans adopted the sound strategy of holding the ports until the last, and abandoning them only after they had done their utmost to make them incapable of use. That Antwerp was not so damaged was due to the lightning drive of the British armoured division, and also in some measure to the activities of the Belgian resistance movement. Arromanches had been designed only for ninety summer days, but it had continued to serve through foul weather as well as fair. It was, however, nearing the end of its usefulness, not because of any fault in the conception or execution of that great undertaking, but because of the shifting sands of the sea bed and the fact that the roads which had to carry the vast traffic from the "Mulberry" harbour were literally worn out. The whole responsibility therefore fell upon Antwerp, and this it discharged in the face of the worst that a determined and ingenious enemy could do. Having failed to hold the banks of the Scheldt and therefore prevent the opening of the port, the Germans subjected Antwerp to a prolonged and vicious attack by both V 1 flying-bombs and V 2 rockets. Nor is it any exaggeration to say that von Rundstedt's great offensive in the Ardennes had the closure of the port of Antwerp as its ultimate strategic object. The first "V weapon" fell on Antwerp on October 7th, 1944, and the last on March 30th, 1945. For the whole of those 175 days and nights the attack was sustained, a total of 2448 V 1 flying-bombs and 1261 V 2 rockets falling in the port and town. On the worst day—March 8th, 1945—120 of these missiles fell. The total number which descended upon Greater Antwerp during this period amounted to 18·7 per square mile, while 401 flying-bombs and 520 rockets fell within a 3-mile radius of "Navy House," from which the port and its activities were administered. That was an average of 21·2 flying-bombs or rockets per day. Naturally, the casualties and damage sustained under this weight of attack were heavy. A total of 4229 people were killed and 6993 were wounded, while 98,393 houses were destroyed or damaged. The worst "incident" ocurred on September 16th, when a V 2 rocket fell on the crowded Rex Cinema, killing 567 and wounding 291. The port of Antwerp, however, continued without cessation to minister to the needs of the victorious Allied armies, and despite the heavy damage in the town, the German attacks resulted in very little damage to the port or to the ships in the port. By September 30th of this year no fewer than 2876 ocean-going ships had arrived in the port since the opening of the Scheldt, while 2790 ocean-going ships had sailed from the port. In that time there had been landed in the port of Antwerp 3,172,087 tons of British military stores and 3,977,432 tons of American military stores. There had also been landed 70,097 British and 21,219 American military vehicles and 2,182,091 tons of British bulk petrol. There had also been a certain amount of "back-loading" of ships carrying stores and vehicles away from the Continent. The British military stores "back-loaded" at Antwerp up to September 30th amounted to 318,002 tons, while the equivalent figure of United States military stores was 349,955 tons. Nearly 5000 British military vehicles had also been "back-loaded." The fact that Antwerp has up to now been administered by British officers for the primary task of supplying the Allied armies has not altogether excluded civilian traffic, and rather more than 630,000 tons of civilian imports have been unloaded in the port. Moreover, although the main importance of Antwerp has been as a supply port, it has also performed valuable services in the realm of ship repairs and dry-docking on behalf of the British Ministry of War Transport, the United States War Shipping Administration, and the Royal Navy. A total of 78 ships have completed repairs and a further 15 ships have been dry-docked under the supervision of the British Ministry of War Transport, while 33 ships have completed repairs and one ship has been drydocked under the supervision of the United States War Shipping Administration; 12 vessels of the Royal Navy completed repairs during the month of September, and 13 vessels of the Royal Navy were dry-docked.

In view of such remarkable figures as these it can be asserted without hesitation that in the whole history of warfare no port has played a more important part in a wide-spread campaign than Antwerp. Deeply as we must deplore the pains and sacrifices imposed on a gallant Ally by the grim military necessity of retaking and holding at all costs her ancient port, and deeply as we must sympathise with all those who lost lives, limbs, property, and friends in those bitter 175 days and nights of constant attack from the enemy, yet we feel that the Belgians and the Dutch, who also suffered terribly in the operations for the reclamation of the port, will ever remember that through those sacrifices they wiped away the injuries and insults of the German tyrants. The part played by Antwerp in the conclusion of the Allied invasion was as important as that of the beaches at Arromanches in its opening. In returning Antwerp to the administration of the Belgian people, there is not one of the

Allies but will combine sympathy for her sufferings with homage for the part she took in the winning of final and complete victory.

### Recruitment and Training of Engineers

THE report of the Special Committee set up in April last year by the National Government "to consider the needs of higher technological education in England and Wales and the respective contributions to be made thereto by universities and technical colleges" was published at the beginning of this week. The Committee originally intended to submit successive reports on the requirements of different industries. Experience seems to have shown, however, that it would have taken many years to complete such a plan, and the Committee came to the conclusion that so wide a survey ought to be the task of a more permanent body. It therefore restricted its investigations to the study of only one broad field of industrial technology. That the field chosen happened to be mechanical, electrical, and civil engineering adds to the interest that engineers would in any case have felt in a report on technological education. The conclusion was reached that "the position of Great Britain as a leading industrial nation is being endangered by a failure to secure the fullest possible application of science to industry," and it is further considered that "the failure is partly due to deficiencies in education."

It is too early yet to comment at length upon this report. The education of engineers is in itself a subject provocative of widely divergent opinions. When so controversial a topic is further complicated by a desire to determine why the profession of engineering failed before the war to attract to itself a sufficient number of entrants of the high quality necessary to ensure the continuance of our technical predominance in the world, the mind tends to range facilely and indefinitely over so diffuse a field and find no resting place. Why was it that the outbreak of war found industry short of men of high technical and engineering ability? Subsequent events, the development of all kinds of technical weapons and tools of war to a degree and a standard unsurpassed by any other nation, proved that men of the desired quality were not really lacking amongst our population. Yet energetic measures had to be taken to enhance the immediate supply and ensure its continuance at least for the whole period of the war. Some glimpse of the reasons can be gleaned from the report under review. The matter seems to be bound up with the status and prestige of engineering jobs; perhaps also with the salaries attached, for engineering is notoriously less well paid than certain other professions; possibly, too, with the paucity of opportunities for advancement to high executive positions that it provides. Perhaps a certain snobbery intervenes also. Just as the status of the black-coated worker remains higher than that of the factory worker, despite the often lesser rewards for the labour involved, so do professions providing independent livelihoods and work unconnected with a factory enjoy a higher prestige than those requiring attendance each day within a factory's limits. Engineers may well ask why? The answer—unsatisfactory though it is—can be only that it is so. The point is made in the report under review, where a campaign is recommended to alter the views of public boarding schools and secondary schools upon the matter. It is made again in the Cambridge University Appointments Board report on University Education and Business, recently published, in which the superior status in the public mind of those who deal with organisation and finance *vis-à-vis* research workers and production engineers is emphasised. It is, however, difficult to see what can be done about it, unless the achievements of scientists and engineers in war have already brought about some change of heart.

Thus, though the problem how to attract to the engineering industries a due proportion of those with high attainments is recognised in the report under review to be to a considerable extent a human one, the only solid recommendations that can be made are almost wholly concerned with the limited field of the machinery of education. It is suggested that a strictly limited number of technical colleges shall be selected to provide a training broader than that given in Higher National Certificate courses, and comparable in standard, but not in content, with a university degree course, thus bringing this country into line with the Continent and America, where such technological colleges have existed for very many years. Proposals are also made for regional and national councils to co-ordinate technological studies and to advise the Minister for Education. These recommendations are of value, and the arguments in favour of them deserve close consideration, particularly by those who have not favoured such proposals in the past. But it is obvious that improved educational machinery alone cannot ensure an adequate supply of students of the desired high quality. It is the status of the jobs open to students in their subsequent working lives that will ultimately determine whether the best brains will be attracted to the profession. The problem is one that can only be fully solved by the co-operative endeavours of the Government, industry, educational establishments, and the major engineering institutions.

## Letters to the Editor

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

### WHOSE FAULT?

SIR,—I have followed with great interest the correspondence resulting from your leading article, "Whose Fault?" and I think the crux of the matter is bound up with the inferior status of the engineering profession in the eyes of the general public. The "right type of individual" might well be deterred from entering the profession by this fact alone, apart from the inadequate monetary prospects, when compared with, say, law, medicine, or architecture.

It is also generally recognised that there is no one established method of training for engineers as with other careers. On the one hand, a young man may enter a works as an apprentice, and by part-time attendance at a technical college take the Higher National Certificate, or, alternatively he may take a university course followed by a two years' pupilage at a works. The former is by no means the ideal method, in that he is essentially an employee of the firm, not a student, the part-time release being looked upon as a privilege rather than an integral part of his training. The time spent at college in a course of this nature is of necessity limited as is the scope of the education and character training received. Hence an individual pursuing this course has limited (I use the term comparatively) theoretical, but good practical training. Furthermore, it is not often that there is any definite line of demarcation between the potential professional engineer and the mechanic or craftsman. Can one imagine confusing an architect with a bricklayer?

Regarding the latter method, desirable as it may be, it still remains that there is no definite co-ordination of theoretical and practical training thus received. Far too often the university graduate proceeds directly to industry without practical training, ostensibly as a qualified man, thus being the absolute antithesis of the works apprentice. This state of affairs is most undesirable. Who, for instance, would condone a surgeon operating without first receiving thorough practical training, or conversely without adequate theoretical training?

The solution to this problem would appear to be in the segregation of the engineering student from the trade apprentice. This being achieved, the co-ordination of the former's education and training could then be controlled by the universities in co-operation with industry. Then, in fact, the engineering student would receive his works experience in much the same way that a medical student receives his hospital experience.

It is extremely unlikely that such a system would become generally accepted without the closing of the engineering profession by legislation, as, indeed, are the vocations referred to above. How this can be achieved I am not prepared to suggest, but would welcome readers comments.

The following anecdote will illustrate my point regarding the general public's conception of an engineer. In a recent conversation I was asked if I knew of the managing director of a large works. I said that I did not, other than that he was an engineer, meaning, of course, an engineer as opposed to a purely business man. Whereupon the reply was, "Do you mean that he has worked his way up from the bottom?"

Finally, I would add that I have personal experience of the method of training criticised.

E. H. LEVER.

Greenford Park, November 2nd.

### THE LATE MR. GEORGE HUGHES

SIR,—In the obituary notice in this week's issue, you state that the late George Hughes "succeeded Mr. Aspinall as chief mechanical engineer of the Lancashire and Yorkshire Railway." May I remind you of the interim service in that capacity of Mr. H. A. Hoy? I agree with your "Dear George Hughes!"

G. B. WILLIAMSON.

Rochdale, November 3rd.

[MR. F. T. Neale, of Nottingham, writes to us to the same effect. Aspinall was appointed general manager of the L. & Y. in 1899. He had previously been chief mechanical engineer of that railway, and was succeeded in that office on his promotion to the managership by Hoy.—ED., THE E.]

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DIESEL-ELECTRIC LOCOMOTIVES FOR EGYPT.—The Egyptian State Railways have ordered from the English Electric Company a total of twenty-seven diesel-electric locomotives, twelve for general service, including express passenger duties, and fifteen for shunting. The general service locomotives will weigh 116 tons, and the engine will develop 1600 B.H.P. A maximum speed of 75 m.p.h. will be attained with an express passenger train. There will be six traction motors driving two three-axle bogies.

## The Council of Industrial Design

On Friday, November 2nd at a luncheon given by the Council of Industrial Design, the importance of the Exhibition of British Industrial Design, to be held next summer in London, was stressed by Sir Stafford Cripps, President of the Board of Trade. Sir Thomas Barlow, Chairman of the Council, presided. Introducing Sir Stafford Cripps, Sir Thomas Barlow said that in spite of all difficulties the Exhibition must be held in 1946. Lack of skilled craftsmen at present was a serious obstacle to industrial reconstruction. Sir Stafford Cripps thereupon proposed the toast of "British Industry: Success through Good Design." He stated that he was very anxious that a first-class exhibition be staged as early as possible, as we had a leeway to make up in the markets of the world. The Government would play its full part to enable and encourage industry to organise itself for its great tasks. At home and abroad good design was good business. Convenience in use—fitness for purpose—and attractiveness in line and colour were equally of importance in mass-produced articles as in individually made goods. From an economic point of view, it should be easier to get good designs for articles produced by the hundred thousand than by batches of ten. Sir Stafford pointed out that this was an immediate and not a long-term objective. As regards the forthcoming exhibition, he hoped that no manufacturer would hold back because his goods were not in quantity production. His Department would do everything possible to help firms in preparing for the exhibition, with materials and labour, even to the extent of sponsoring the release of skilled designers in the Forces in approved cases. He wished success to the Council and to the exhibition, which was to be renamed "Britain Can Make It."

## Concrete Pontoon Drawbridge

During the war period the pontoon bridge has had extensive development in American military and industrial work, and one such development is a drawbridge on a new road crossing a navigable channel in order to serve a war industry plant in California. The heavy traffic road, with four lanes of travel, crosses a channel 175ft. wide, but steel was practically unobtainable at the time, and the eventual decision was for a drawbridge of concrete pontoons. There are two pontoons, 135ft. long and 50ft. wide, 15ft. deep, divided by three longitudinal bulkheads and transverse bulkheads, some of the compartments being served by electric pumps to act as buoyancy tanks, increasing or decreasing the freeboard as required by a 12ft. tidal range. When in use, the two pontoons are locked together to form a single structure. The connections between the fixed approaches and the floating span consist of steel-frame ramps, having trunnion bearings at the shore ends, while the outer ends are fitted with wheels which ride on rails embedded in the concrete deck of the pontoon. The maximum gradient on these ramps, at low tide, is 1 in 6, and the length of ramp is about 80ft. When protective gates and signals are closed, the hydraulic locks are released, and each pontoon is drawn back under the ramp and approach by cables attached to the pontoon and operated by an electric winch. In this movement the wheels of the ramp ride along the deck of the pontoon, which is guided horizontally by wheels mounted on vertical shafts and riding against rails in concrete kerbs along the sides of the pontoon. There are two sets of these wheels, about 30ft. apart. The two winches are operated simultaneously by remote control from an operating tower. If waves or tides should shift the pontoon laterally a few inches out of line, the horizontal thrust is taken by fenders on the pontoon coming into contact with pile clusters or dolphins.

# Civil Defence in the London Region*

By Sir T. PEIRSON FRANK

No. I

It has been suggested that some account should be given of certain civil defence operations which have taken place in the London Region, and I have adopted that suggestion, for civil defence and civil engineering have many features in common. This decision has, in part, been influenced by the paucity of the information given regarding what might be termed "another underground warfare." It was carried on by the outdoor staffs of the local authorities and of the various public utility undertakings, working under the engineers to those bodies, and their assistants. Nor should one neglect to include the civil engineering contractors and their employees.

So far as Great Britain was concerned, the Greater London area seems, throughout the European campaign, to have remained within the bull's-eye of the enemy's target. Homes and offices might be destroyed or damaged by their thousands; but, grave as such injuries undoubtedly were, they could not be allowed to jeopardise the continuity of the life of the Metropolis. When a patient's main arteries, veins, nerves, and muscles are severed or seriously injured, then arises the question as to how long the patient can survive. A moment's reflection will reveal the main thoroughfares, railways, tubes, water mains, and sewers as the arteries and veins of each large urban community; the telecommunication systems certainly act like nerves; whilst electric cables and gas and hydraulic power mains can be classified in part or in whole under the community's muscular system.

### London Civil Defence Region

Great Britain was divided by the Minister of Home Security into twelve Civil Defence Regions, the London Region being approximately coincident with the Metropolitan Police area. It covered about 724 square miles, embraced the counties of London, Middlesex, with a small part of Hertfordshire, and portions of Surrey, Essex, and Kent, and had a normal population of nearly nine millions. This area was under the control of Regional Commissioners, and they had at a later period the assistance for several months of two Special Commissioners.

### Co-ordination of Repairs to Roads and Public Utility Services

At the request of the Metropolitan Borough Councils and of the outer County Authorities, the London County Council permitted me to act under the Regional Commissioners as Co-ordinating Officer for the repair of roads and public utility services. This was a part-time occupation, varying with the intensity of the aerial attacks.

The Region was divided into five groups (later four) in the County of London, and each of the four adjoining counties (or the portions thereof) formed separate groups. In the latter, as Group Engineer, I had the valuable assistance of the County Surveyors or their representatives, and within the county members of my L.C.C. staff acted in that capacity.

The services included the maintenance of roads and bridges, and the restoration of damage to sewers, water (including hydraulic power) and gas mains, electricity and telecommunication cables, and the Thames flood defences. Liaison officers were available at or through Regional Headquarters—but not at groups—for each of these undertakings, some continuously and others readily available at any time. Notification of any damage to these services was normally given by air raid wardens and was sent through the usual local authority controls. More detailed reports were supplied by the local authority's Engineer to the Group Engineer for transmission to R.H.Q.

The road repair services originally functioned without special financial aid from the Government. The scheme provided that a local authority requiring assistance for the repair of roads damaged by enemy action might obtain extra repair parties (that is, "mutual aid") from others, either within its group, through the Group Engineer, or, failing that, from other parts of the Region through R.H.Q. Extra plant and materials were obtainable through similar channels.

The civil engineering contractors were also mutually organised and in case an emergency should arise, each local authority was notified, early in August, 1939, of the names of the contractors allocated to them.

The actual road repairs, including any excavation and the filling, were the responsibility of the highway engineers, whilst the public utility undertakers had charge of the restoration of their pipes, mains, or cables. The order of priority of repairs was determined by the position and relative importance of the interrupted services. On the engineers to the local authorities also fell the task of removing *débris* from the highways; but after high-explosive bombing had become heavy and fairly continuous, a large number of men were employed under contractors and formed the Debris Clearance Organisation, which was under the direction of the Architect of the London County Council. This organisation, when not demolishing dangerous buildings or removing other *débris*, gave assistance to the local authorities' engineers in clearing highways.

### Protective Measures

*Main Drainage.*—Some indication of the type of protective steps taken by public utility services during 1939 and the earlier months of the war may be gleaned from a reference to those introduced by the London County Council in connection with some of its engineering services. At the thirteen main drainage stations the works included the provision of blast and splinter protection to door and window openings, blast walls to separate the various units of machinery, incendiary bomb protection, alternative fuel supplies for gas engines, reserve fuel storage for diesel engines, and supplementary cooling arrangements in case of failure of the water supply.

In view of the papers submitted to the Institution by Sir J. W. Bazalgette, Past-President, Inst. C.E.,† and by Messrs. J. E. Worth and W. Santo Crimp, MM. Inst. C.E.,‡ describing the plant originally installed—much of it in 1863–65—in the larger stations, it might be mentioned that since 1930 more

* Institution of Civil Engineers, November 6th. Presidential Address. Excerpts.

† "On the Main Drainage of London and the Interception of the Sewage from the River Thames." Min., "Proc.," Inst. Civil Engrs., Vol. XXIV (Session 1864–65), page 280.

‡ "The Main Drainage of London." *Ibid.*, Vol. CXXIX (Session 1896–97, Part III), page 49.

efficient plant has been erected in six of the largest stations and an additional storm-water pumping station constructed. The opportunity was taken to introduce alternative types of power and in all the capacity was increased by 15,580 H.P.—equivalent to a lifting capacity of about 4150 tons per minute.

Some tube Underground railway stations which had their lift shafts or escalators in close proximity to sewers carrying large volumes of sewage or storm water were the subjects of special survey. These involved (in 1936) the detailed examination of about 300 areas, and schemes of protective works were later put in hand, some by the London Passenger Transport Board and other major works by the London County Council on behalf of the Board. Perhaps this danger may be better appreciated if it is mentioned that an intercepting and a main sewer, if fractured during a severe storm, might have discharged 1500 tons of effluent per minute into an adjoining escalator tunnel. But as the 420 miles of main sewers vary in size, chiefly from 3ft. 3in. by 2ft. 4in. to 11ft. 6in. diameter, with occasional larger ones up to a 13ft. by 20ft. culvert—whilst about 35 miles are in embankment and many others not far below ground level—our protective measures had to vary. There are also fifty-eight crossings where sewers pass under canals, dock entrances, and waterways. These constituted grave danger points, for, if damaged, large volumes of water would enter the sewers and might overmaster the pumps and cause flooding.

After very careful consideration it was decided to construct at suitable points new connections between sewers, provide dam chases and penstocks in existing sewers, and use every facility for rapidly diverting, if necessary, the flow to undamaged sections of the system, or even to the rivers Thames and Lee. With Ministry of Health approval these measures were put in hand and, as subsequent events showed, they proved invaluable when, in spite of the number of serious incidents which occurred, reasonably efficient working of the system was maintained.

Obviously, portable pumps were a prime necessity, and some ranging from 6in. to 12in., with their power units, were obtained for the London County Council drainage area, whilst later we established a pool for the outer areas.

*Temporary Thames Bridges.*—Three bridges were erected between (1) Victoria Embankment and the County Hall car park (leading to Belvedere Road); (2) Grosvenor Road (Tate Gallery) and Albert Embankment; and (3) Chelsea Embankment (Flood Street) and Battersea Park. They are supported on timber piles protected by timber staging. The superstructure of the approach spans, generally 44ft. between centres of staging, consists of steel stringer joists supporting a timber deck. Each bridge has two main navigation openings spanned by 140ft. steel trusses. The width of the river varies from 724ft. to 857ft. A 20ft. carriageway and two 5ft. footpaths are provided and the structures are designed for Ministry of Transport standard loading. Most of the materials were purchased directly by the London County Council, the contractors supplying plant and labour. The total expenditure on the three bridges amounted to £132,000. A fourth Thames bridge of a somewhat similar type was erected at Staines by the County Engineers of Middlesex and Surrey.

*Thames Flood Prevention.*—About 20 square miles of the County of London lies below the level of the highest recorded tides and about 10 square miles is below the level of the ordinary spring tides. In recent years special steps had been taken to overcome the danger from flooding of these areas during heavy rainfall or exceptionally high tides. Such flood defences might be quite adequate in normal circumstances, but were incapable of withstanding the effect of well-directed high-explosive bombs. Four special depots, each manned by a nucleus staff on a twenty-four-hour per day basis, were therefore in operation by August, 1940, when raiding commenced. A tug and barges loaded with filled sandbags were available for carrying out emergency repairs.

A further danger to the low-lying boroughs in South London arose from the fact that the Blackwall and Rotherhithe tunnels emerge on the south bank below high-water level. To guard against the far-reaching effects from flooding which might occur if a tunnel were breached about high tide, flood gates, each weighing 22 tons, were installed near the south end of both tunnels, at a cost of approximately £12,000. These gates were manned only during alerts and when there was a possibility that a delayed-action bomb might explode and damage the tunnel during a non-alert period, with serious risk to the traffic in the tunnel. The London Passenger Transport Board had installed apparatus for detecting and locating unexploded bombs falling in the vicinity of their tunnels under the river, and arrangements were made for the Board to install similar apparatus near to the Blackwall and Rotherhithe tunnels, together with the necessary instruments at the Board's control centre, which was situated about 6 or 7 miles away.

One other protective measure might be referred to, namely, the erection of barriers in the L.C.C. pipe subways. Eight miles of these subways run under central thoroughfares and carry water, gas, and Post Office cables, &c. The object of the barriers was to reduce the extent of the damage in case gas mains were fractured and explosions occurred.


12-INCH RIDER WATER MAIN JOINING ENDS OF 24-INCH MAIN

## Effects of the War

*Water Service.*—It might be invidious to single out one service and state that it suffered more than any other, for unfortunately each had its period of appreciable anxiety; yet to the general public the interruption in the supply of wholesome drinking water might be regarded as most serious, and reference to its experiences shall take precedence. The blows to this service included damage to reservoirs, filter beds, and works on 192 occasions. The filter beds at one works sustained damage on three occasions during September, 1940, which seriously reduced the output and depleted the supply to portions of London. Yet these injuries in most cases did not seriously affect the supply. In the Region, 7702 mains were fractured, of which 942 were 12in. or more in diameter, the Metropolitan Water Board's portion of these being 6634 and 875 respectively.

Some of these fractures occurred in groups; for example, two 48in. mains and a 54in. main were severed by one bomb, but by continuous working an anxious situation was relatively quickly relieved. In a principal London thoroughfare one 36in. main, four 30in. mains, and one 18in. main were broken and resulted in short supplies over a large area. In an important main road in the outskirts of London one incident fractured one 42in., one 36in., two 30in., one 15in., and two 12in. mains. The water authorities had arranged for emergency supplies and in the two last-mentioned cases a water wagon supply was given in parts of the areas.

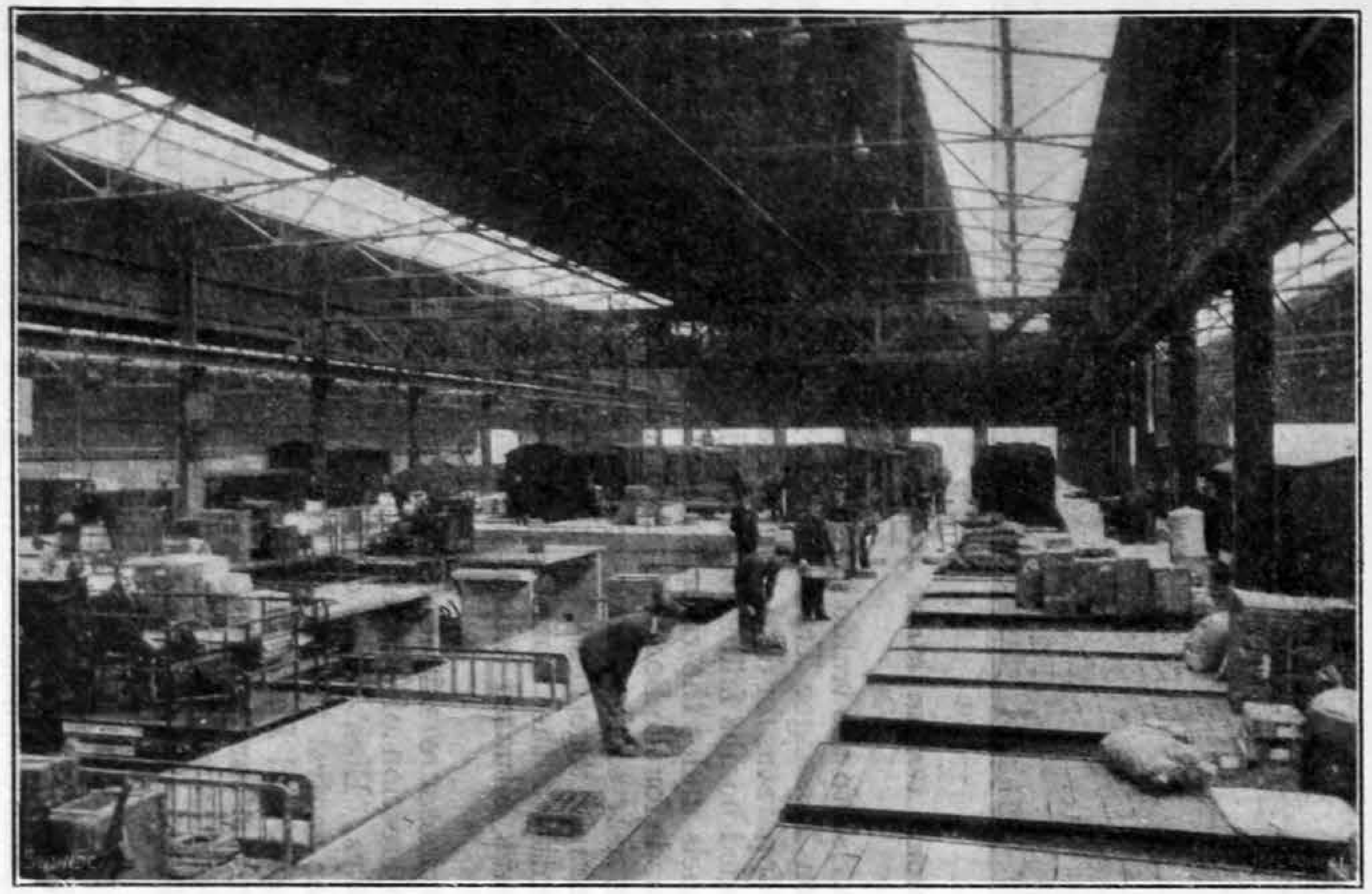
The foregoing are examples of the injuries experienced by only one of the services; and when it is realised that a number of other important services were almost invariably involved and that the road traffic was dislocated, some explanation is forthcoming for the duration of some of the repairs.

*Gas Service.*—Gas is distributed through a system much resembling that used by water authorities; the mains of the latter are generally laid slightly deeper, so that it is not surprising to find that the gas undertakers had to cope with the greater number of repairs. The total of fractured gas mains was 11,902, of which 831 were more than 12in. in diameter; 50 per cent. of the incidents occurred on the Gas Light and Coke Company's system and they had the responsibility of repairing 63 per cent. of the large mains. With so many mains out of commission, it can correctly be assumed that a very much larger number of service pipes were also broken.

All the large London gasworks suffered damage at one time or another, the greatest difficulty being caused by the loss of holder capacity. By the first heavy raids (September 7th–8th, 1940) one company had four

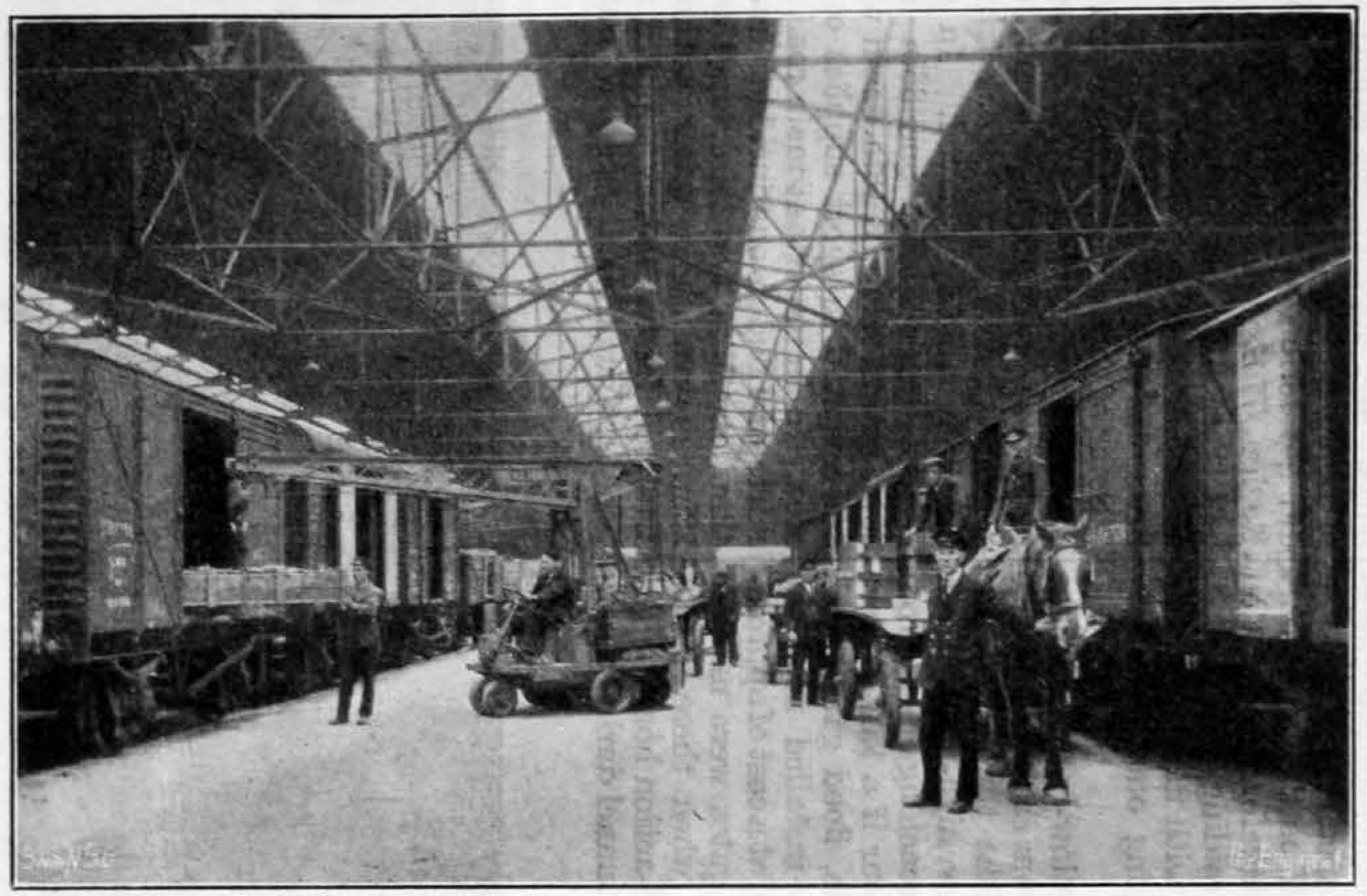
# LAWLEY STREET GOODS STATION, BIRMINGHAM

*(For description see opposite page)*

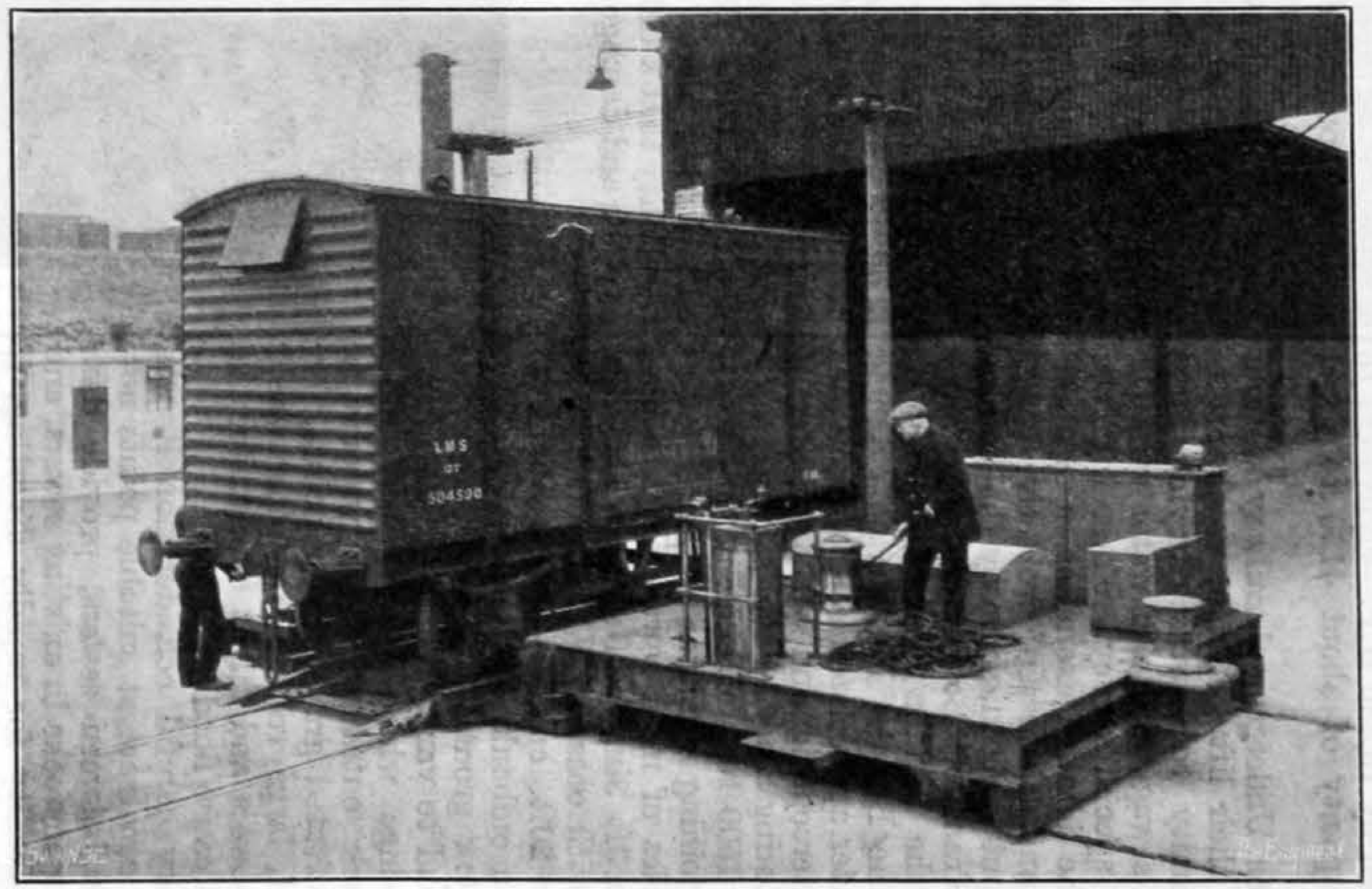


"RECEIVED" SECTION SHOWING CONVEYOR AND "FLATS"

"RECEIVED" SECTION SHOWING TRAVERSERS AND "FLATS"



LOADING WAGONS FROM "FORWARDED" CARTROAD



WAGON TRAVERSER AT WORK

plants put out of action and had their 48in. mains broken in nine places. During the same raids another gasworks suffered such extensive damage that practically the whole of one eastern metropolitan borough was without supplies. This state of affairs led to the speedy establishment by the London County Council of the Londoners' Meals Service—the forerunner of the British Restaurants. The service was under the direction of the Chief Officer, Public Control.

One incident gave particular trouble. A flying bomb hit a tar distillery plant in South London and ½ million gallons of tar was ignited. The tar, still blazing, flowed into and for about 200 yards along an adjoining highway. The highway was covered to a depth of 18in. in some parts, and entrances to premises were out of use for several days. The tar entered street gullies and manholes and flowed considerable distances along neighbouring sewers. The removal of the tar—which tended to solidify on cooling—from a weighbridge and from the road surface was a difficult operation, but by no means so difficult or so lengthy as was the clearance of the sewers.

Great credit must be given to the Gas Light and Coke Company for its operations on the night of the great City fire at the end of December, 1940, for during the earlier part of that raid the whole of the gas supply to the City was cut off by operating control valves on its boundaries.

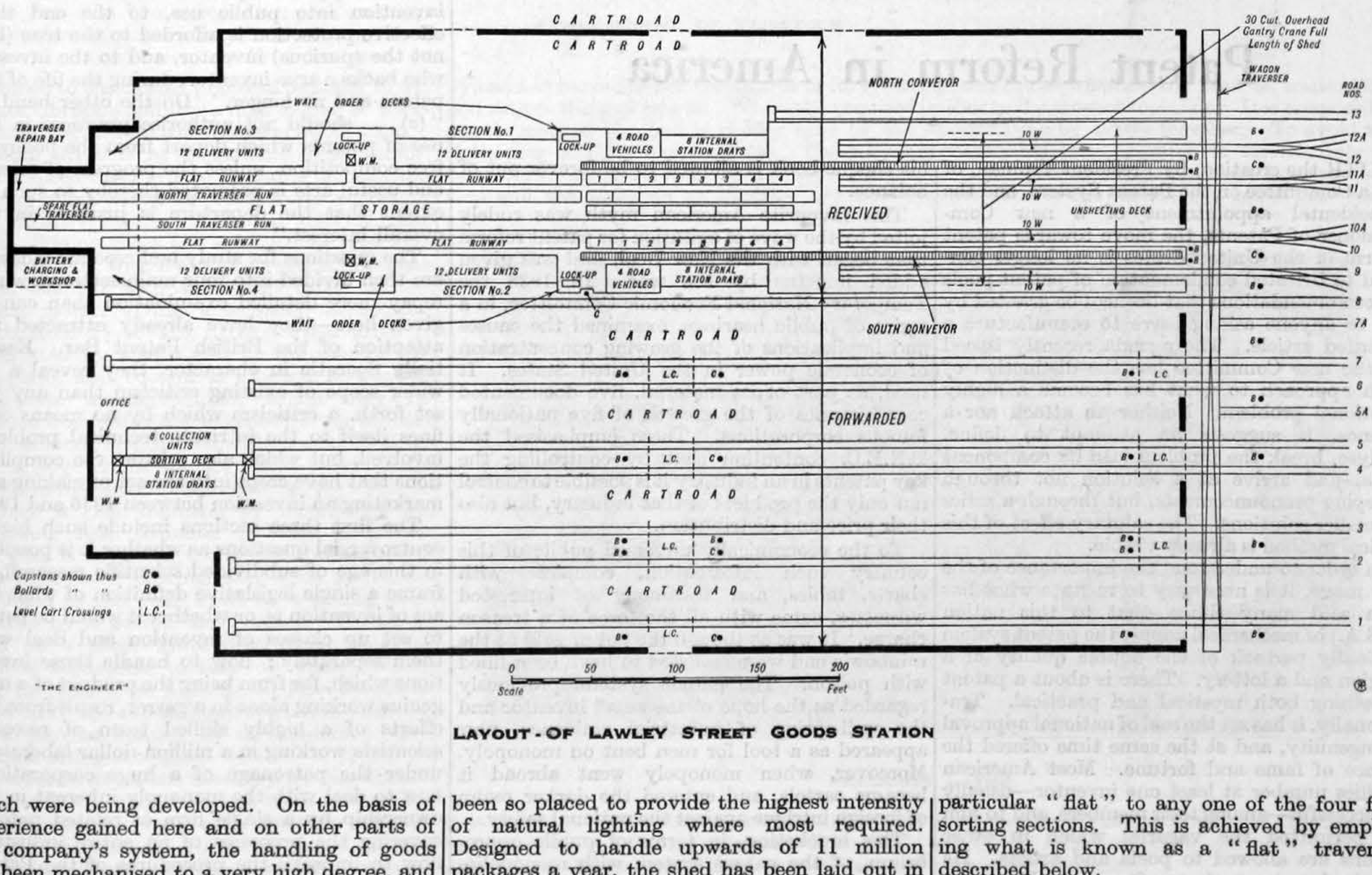
Occasionally the repairs confronting the gas and water authorities were so great that mutual assistance was obtained through the Regional Commissioners from other parts of the country. On the other hand, a few of the London repair parties were able to reciprocate by helping their provincial colleagues in heavily bombed areas.

*Telecommunication Services*.—In peacetime the country is vitally dependent on the telecommunication system; in wartime its maintenance becomes of paramount importance. Let us see what extra duties the enemy threw on those officials of the General Post Office responsible for this service. About 1695 main cables (trunk, junction, and exchange) were damaged and as many as 1500 trunk and toll circuits, 25,000 junction circuits between exchanges, and 26,000 subscribers' lines were completely out of action at one time.

*(To be continued)*

# Lawley Street Goods Shed, Birmingham

THE official opening of the new Lawley Street goods shed of the London, Midland and Scottish Railway Company at Birmingham was briefly recorded in our issue of November 2nd. Following the destruction of the former main goods shed and warehouse on this site in 1937, advantage was taken in the temporary accommodation to test new ideas of goods shed lay-out which were being developed. On the basis of experience gained here and on other parts of the company's system, the handling of goods has been mechanised to a very high degree, and this shed is probably the most advanced of its kind yet built. It roughly forms a rectangle about 650ft. long by 350ft. wide, its central main span being 151ft., and there are only three rows of columns within the whole of the shed. The roof consists essentially of trusses at 25ft. centres, carrying purlins at approximately 6ft. 6in. centres, to which protected metal roof covering is fixed, except where glazing is provided to give good natural lighting. Roof glazing is equal to 30 per cent. of the floor area, and has been so placed to provide the highest intensity of natural lighting where most required. Designed to handle upwards of 11 million packages a year, the shed has been laid out in two sections, one primarily for miscellaneous traffic to be forwarded from Birmingham, and the other for incoming miscellaneous traffic.




LAYOUT OF LAWLEY STREET GOODS STATION

As may be seen from the diagram, the "Forwarded" section of the shed contains eight wagon roads, and on these 203 rail vans or wagons can be set. Between the wagon roads are paved roadways, on which the carman who collects the goods from Birmingham traders may take his vehicle directly alongside appropriate wagons for the loading of the goods. For sorting very varied loads a small deck is provided immediately inside the west end of the shed, and on this the goods are re-sorted on to pneumatic-tyred drays prior to being taken to the wagons for loading.

The miscellaneous traffic received by wagon, which has to be sorted and assembled into cartage loads for delivery in the Birmingham area, is dealt with in the "Received" portion of the shed, and it is here that mechanisation has been adopted to a very high degree. Forty loaded wagons can be set under cover on four wagon tracks arranged in two pairs, each with a conveyor running along the deck between them. Parcels are unloaded from the wagons and placed—label uppermost—on the conveyors, fi st from one line of wagons, and then, whilst they are being withdrawn and replaced, from those on the opposite side of the conveyor. This practice of discharging from alternate sides of the conveyor deck avoids the staff having to wait for work. Each of the sidings is served by a separate loaded-wagon road, and an empty wagon-throwout road outside the shed. The consignments out of any wagon may be for delivery in the area or may require reforwarding by rail. At the sorting end of each of the two conveyors the traffic is sorted on one side of the conveyor into four main divisions for delivery in the Birmingham area, and on the other side into four main divisions for traffic requiring to be reforwarded by rail. For Birmingham the traffic is sorted on to what are termed "flats" for subsequent sub-division in each case to twelve delivery vehicles, covering the forty-eight delivery rounds into which the Birmingham area is divided. Each "flat" carries on average 25 cwt. of goods, and as the traffic from either of the two conveyors may be for any part of Birmingham, arrangements are necessary to convey any particular "flat" to any one of the four final sorting sections. This is achieved by employing what is known as a "flat" traverser, described below.

The traffic for further rail transit from Birmingham is sorted on to pneumatic-tyred drays on the outside of the conveyors, opposite to the "flats." Each dray is hauled by electric tractor, forming an articulated unit with the dray, to the west end of the "Forwarded" wagon roads. Here, horses ready harnessed with patent light tubular shafts, are attached to the drays by an automatic coupling arrangement, for the vehicles to be hauled alongside the wagons where the traffic is loaded for dispatch.

Part of the company's normal practice is to run freight trains of important goods at passenger train speeds, and for this purpose an adequate number of freight vans or wagons fitted with brakes operable from the engine, are required. A portable plant has been provided for testing the vacuum brakes on these vehicles, and this plant can be moved to any part of the shed to make the requisite tests.

The capstans for positioning the wagons in the shed each have a 15 H.P. electric motor, and are designed to pull 1 ton at a speed of 150ft. per minute. Each of the moving deck conveyors is 360ft. long and 3ft. wide, and formed of hard wood slats attached to steel chains driven at a speed of 40ft. per minute. The driving unit in each case is below deck level at the delivery terminal of each conveyor. A 15 H.P. electric motor drives the chains through a fluid coupling and gearing. Should a package be inadvertently left on either conveyor until it reaches the end terminal, it would strike a vertical plate and stop the conveyor.

The "flats" on to which the traffic for town delivery is sorted are actually open-sided flat platforms, 14ft. by 6ft. 6in., mounted on flanged wheels running on a 3ft. gauge track, their tops being level with the conveyor deck beyond the wagon lines. Loaded "flats" are transported as complete units to appropriate cart-loading bays by a traverser. Three of these machines are provided, two being always in use, while one is stabled at the west end of the shed in reserve. The traversers are designed to travel at 500ft. per minute along their tracks, They incorporate a cross traverse carriage, which can be projected under the "flat" to be moved, and an elevating mechanism which raises it clear of its supports. The loaded cross carriage can then be retracted into the centre position for travelling. The traverser is driven by a 20 H.P. electric motor through a variable-speed hydraulic gear. It has a hand wheel controlling travel. When rotated, this wheel gives motion in that direction, while rotation in the opposite direction from the neutral position reverses the travel. The speed of travelling is proportional to the amount the control wheel is rotated, three-quarters of a turn in either direction giving the full range. Cross traverse motion is effected by hydraulic power obtained from an independent unit driven by the travel motion-motor. Movement of a control lever in the direction in which movement of the carriage is desired admits pressure into the appropriate one of two hydraulic cylinders. Elevation of the carriage is effected by an independent 3 H.P. electric motor and hydraulic unit on the cross traverse carriage, and this is pedal-operated by the driver. A series of island piers between the two traverser lines permits the transference of "flats" between the two decks. At the cart-loading bays the "flats" may be moved along between the appropriate town delivery vehicles by movement of a lever at one end of the "flat." Movement of the lever in one direction brings a shoe into contact with the upper surface of a moving creeper-chain conveyor; movement in the opposite direction applies a brake. The chain conveyors comprise a number of flat shoes on a steel chain, travelling at 100ft. a minute. Each conveyor is about 278ft. long. Heavy goods in the received section are handled by a 30-cwt. overhead travelling crane, having a span of just over 81ft. with a runway 625ft. long.

To facilitate the setting of individual wagons at the shed, the 20-ton capacity self-propelled wagon traverser, shown in the illustration, is provided on a track, 343ft. long, right across the east end of the shed. It travels at a speed of 350ft. per minute, and is powered by a 30 H.P. electric motor supplied from overhead collector wires. Control is effected from either one of two positions, so that an unobstructed view of the track ahead is obtained. As the traverser operates entirely in the open, special consideration has been given to the enclosure for the electrical equipment, which is housed in a weatherproof cabinet situated on the driving platform.

# Patent Reform in America*

WITH the creation, by President Truman, of a Committee on the Patent System, and the coincidental appointment of a new Commissioner of Patents, the move towards patent reform in the United States is no longer confined to irritated condemnation of patent pools or recommendations that licences be granted by fiat to anyone asking leave to manufacture a patented article. The agenda recently issued by the new Committee has the distinction of fresh approach to what has become a highly emotional problem. Neither an attack nor a defence, it suggests an attempt to define, analyse, break the problem into its component parts, and arrive at a solution not through sweeping pronouncements, but through a series of smaller solutions. The salutary effect of this clinical method is already visible.

In order to understand the importance of the new move, it is necessary to re-state what has been said many times—that to this nation (U.S.A.) of mechanical adepts the patent system originally partook of the double quality of a religion and a lottery. There is about a patent something both mystical and practical. Traditionally, it has set the seal of national approval on ingenuity, and at the same time offered the chance of fame and fortune. Most American families number at least one inventor—usually unsuccessful—among their members, and to him are permitted the vagaries which in other nations are allowed to poets and artists. He may be late to meals as often as he likes; he is not expected to be able to support his family; his cheque-book is allowed to be forever out of balance.

This favourite American myth was rudely jolted by the wave of agitation for patent reform that began with the New Deal, and was given added impetus by the war. In 1938 the Temporary National Economic Committee, in a series of public hearings, examined the causes and implications of the growing concentration of economic power in the United States. It used, as part of its material, five documented case histories of the growth of five nationally famous corporations. These emphasised the T.N.E.C. contention that by controlling the key patents in an industry it is possible to control not only the products of that industry, but also their price and distribution.

To the economically unversed public of this country such information, complete with charts, tables, and testimony of interested witnesses, came with all the force of a treason charge. It was as though the pot of gold at the rainbow's end were revealed to have been filled with poison. The patent system, previously regarded as the hope of the small inventor and the well-spring of industrial eminence, now appeared as a tool for men bent on monopoly. Moreover, when monopoly went abroad it became cartels, and entered the darker realm of foreign intrigue against the national safety.

This bracketing, in terms of public opprobrium, of the patent system with monopolies and cartels was reinforced when it was shown, three months after the United States entered the war, that the exchange of patents under a series of cross-licensing agreements between the Standard Oil Company of New Jersey and I.G. Farbenindustrie of Germany had been dissolved only when the European war made their maintenance untenable. Public alarm was not soothed by the charge of the then Attorney-General that the bargain between Standard Oil and I.G. Farben had kept from the United States full knowledge of the process for making artificial rubber. That the charge was later proven to be hardly accurate was beside the point. At that moment the United States, riding on thin tyres, with the natural rubber supply in the hands of Japanese armies, needed a whipping boy. Monopolies, cartels, and the patent system took the blows.

The prestige lost by the patent system in these two encounters has never been recovered. Nor has the system been helped by the growing tendency of the Supreme Court to decide patent cases against the holders of patents rather than for them. To this ideological disfavour there was most recently added the practical clamour of manufacturers, inventors, and patent attorneys, who found the traditional processes of the Patent Office, slow enough at any time, intolerable in a war period which brought the Office added burdens. By the summer of 1945 a back-log of twelve months' untouched work had accumulated.

The new attempts to survey and improve the hundred-and-ten-year-old American patent system must be understood against this background of sentimental attachment and practical difficulty. The present Committee was appointed last April, in the same month in which the British Committee appointed by the Board of Trade to look into desirable changes in the British Patents and Designs Acts submitted its first interim report.

Set up in stormy weather, the new agenda for study announces that its sole purpose is "to frame the questions relating to the patent system which have thus far been suggested for consideration." The procedure is to be one of study and recommendation in respect to three major objectives which embody the Committee's idea of what a proper patent system ought and ought not to do. It should, to the greatest possible extent, "(*a*) . . . afford an accessible and comprehensive public register of science as applied to useful arts . . . ; (*b*) . . . open the door of opportunity for the introduction of invention into public use, to the end that effective protection is afforded to the true (but not the spurious) inventor, and to the investor who backs a true inventor, during the life of the patent and no longer." On the other hand, it "(*c*) . . . should not authorise practices in the use of patents which depart from the policy of free competition, unless the progress of science and useful arts is promoted thereby to such an extent that the departure is justified in the overall interest."

The questions for study and recommendation are then divided into four main sections, which repay more detailed examination than can be given here—they have already attracted the attention of the British Patent Bar. Essentially Socratic in character, they reveal a far wider scope of existing criticism than any yet set forth, a criticism which by no means confines itself to the intricate technical problems involved, but which also mirrors the complications that have crept into the act of making and marketing an invention between 1936 and 1945.

The first three sections include such highly controversial questions as whether it is possible, in this age of subdivided scientific research, to frame a single legislative definition of what the act of invention is, or whether it would be better to set up classes of invention and deal with them separately; how to handle those inventions which, far from being the product of a mad genius working alone in a garret, result from the efforts of a highly skilled team of research scientists working in a million-dollar laboratory under the patronage of a huge corporation; how to deal with the monopoly inherent in the ownership by a single firm of related patents covering the processes of an entire industry; how to improve the procedures of the Patent Office.

The fourth section touches not only questions of local import, but asks "Should limitations in

* From *The Economist*, October 6th, 1945.

the national interest be imposed on patents granted to nationals of foreign countries?" Alarming as the subordinate suggestions may seem (and they have been made more so by inflammatory headlines in the daily Press), it should be emphasised that they constitute a small part of the agenda, and that they grow directly out of such conditions as were revealed by the Standard Oil-I.G. Farben agreements.

The Committee responsible for the agenda and the studies now going forward under it represents diverse elements interested in patent affairs. Its chairman is William H. Davis, a patent lawyer of high repute, who, like Sir Stafford Cripps, is now devoting the major part of his time to public affairs, as Director of Economic Stabilisation. The members include the Attorney-General, the head of the office of Scientific Research and Development, and representatives of business.

# A Large Precision Lathe

THE accompanying illustrations show a large new high-precision lathe, recently completed by J. Jameson, Ltd., of Ewell, which has been designed to swing up to 4ft. 4in. diameter between 14ft. 2in. centres and up to 8ft. diameter in the 4ft. 8in. maximum gap opening of the bed. It is intended primarily for heavy toolroom work, and is of particularly rigid construction, all parts having been designed and machined to the closest practicable limits to eliminate vibration and give a high degree of working accuracyover its wide range of application.

Initial drive is by a variable-speed motor, with a speed ratio of 3 to 1, and is transmitted through short vee belts to a worm reduction gear directly driving the main selector gear shaft. Sliding gears are arranged to give four spindle speeds, with 3 to 1 progression, this gear range, coupled with the speed range of the driving motor, giving a selection of spindle speeds from 1½ to 120 r.p.m. Final drive is transmitted by a bull gear at the rear of the face plate, and control is effected through a multi-plate driving clutch, which may be operated from either the headstock or the saddle. The headstock spindle is a carbon steel forging, with a large chuck flange. It is mounted in two white-metalled bronze bearings, the forward of which is 12in. diameter by 20in. long, the rear being 10in. diameter by 13in. long. A back gear is keyed on the spindle immediately behind the front bearing, and when needed it is coupled to the main shaft by a sliding gear operated by a geared hand wheel. Thrust is taken on a plain white-metal-faced bearing, which is adjustable to take up wear. When using the face plate a hardened steel spigot is bolted on to the chuck flange for use in location and to prevent damage by an accidental blow when mounting the plate.

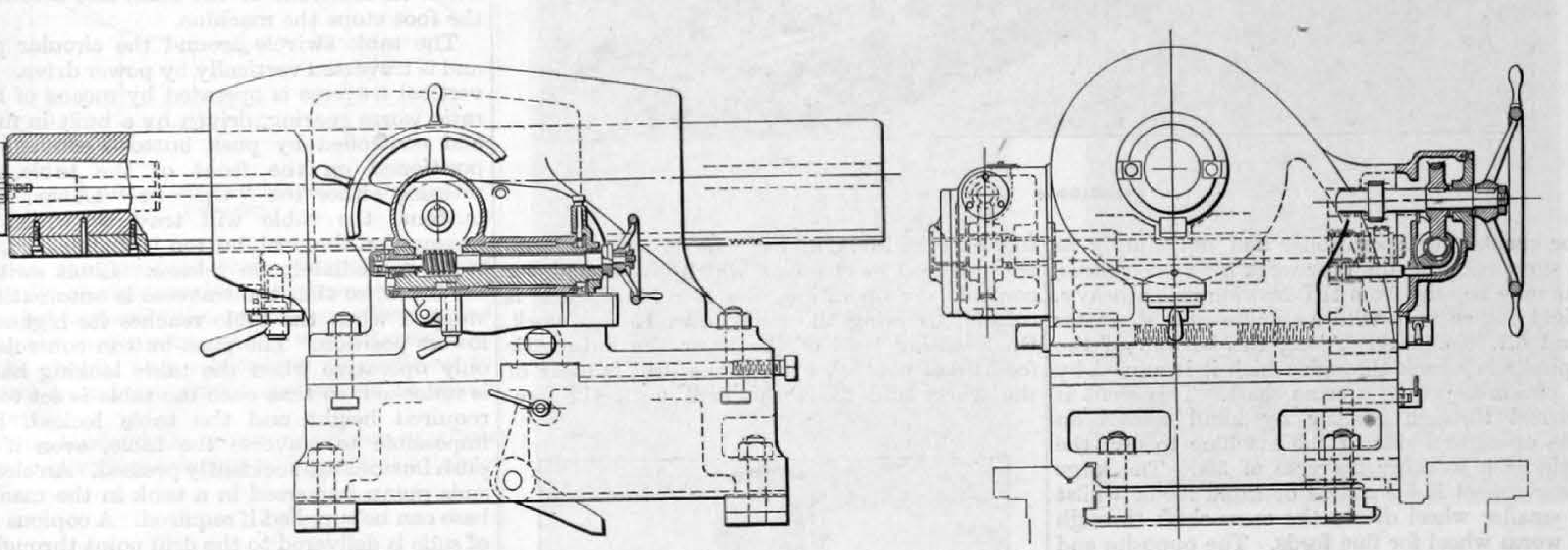
In order to avoid the necessity for large bearing holes in the main castings, most of the ball and roller bearings have been fitted on recesses turned in the shafts. All of the plain bearings are lubricated under pressure by an oil pump, and cascade lubrication has been adopted for the gears and ball and roller bearings.

A feature of the machine is that its working capacity may be increased by widening the gap to take large-diameter work up to 4ft. 8in. long. This has been done by building the machine with a rigid base, along which may be moved an upper sliding bed, 14ft. long, carrying the saddle and tailstock. The two outer ways of the base are slotted to take guide blocks and locking bolts of the sliding bed. A racking screw in the base of the sliding bed is turned by hand to move the bed backwards or forwards and adjust the gap length. When the required gap is reached the bed is rigidly held by the tightening of eight locking bolts. The sliding bed has two ways, the front one having a narrow step and the rear one an inverted vee guide. It is provided with a steel rack in front for the traverse of the saddle and tailstock. The saddle slides along the two main flat ways, whilst the tailstock is carried on the lower step of the front way and in the inverted vee of the rear way.

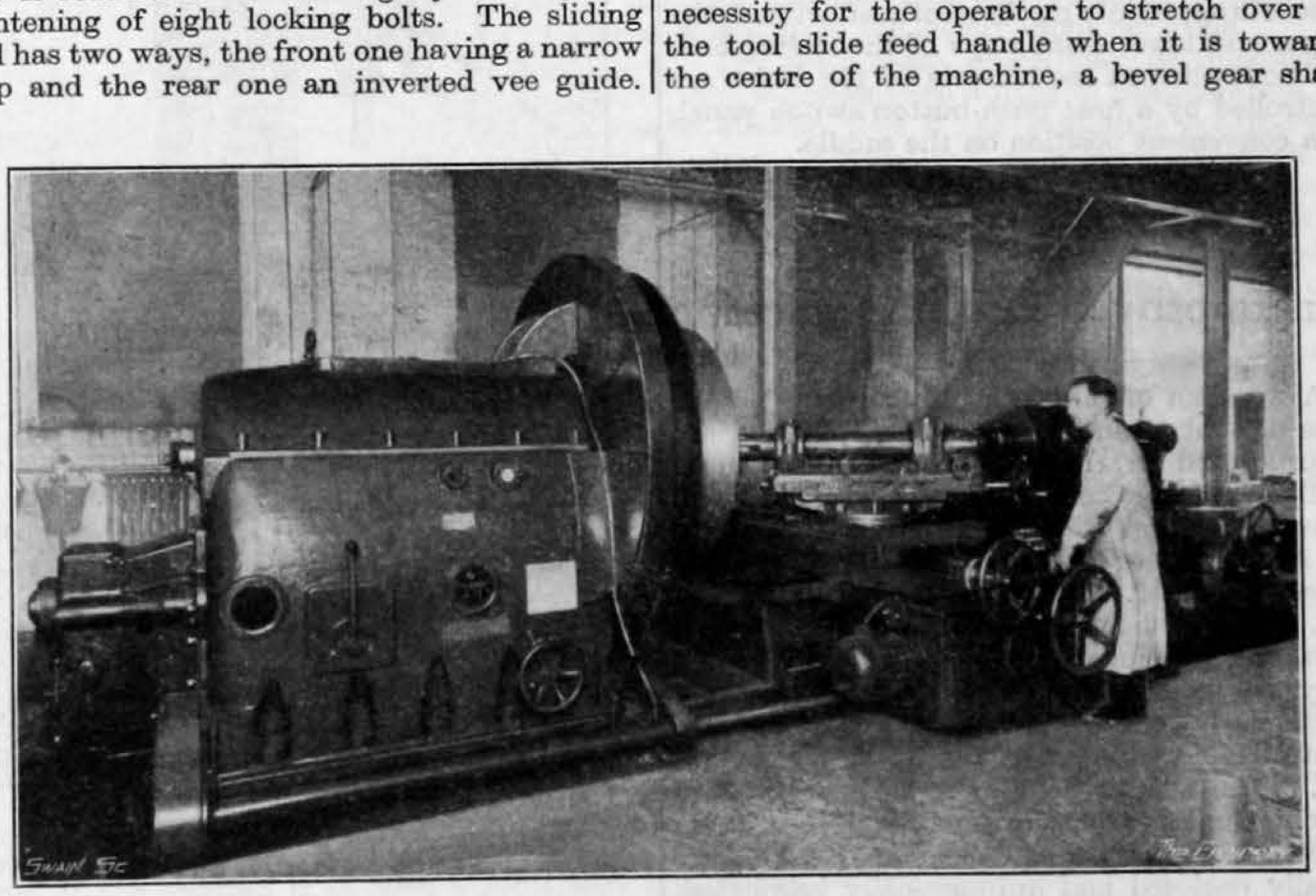
The saddle, cross slide and tool slide are power driven through a twelve-speed gear-box on the saddle apron, and feeds are cam-selected by the movement of a single hand wheel. In order to save the operator's time during setting and returning the tool between cuts, an independent rapid power traverse unit is used. This unit comprises a 3½ H.P. motor coupled to the gear train through a multi-plate clutch and operated by a "dead-man's" type handle, when rapid saddle or cross-slide movement is required. A method which has been adopted for selecting the direction of power feed to the saddle and cross slide is also worthy of particular note. This selection is done by a ball handle on the saddle, which is moved on the "joy-stick" principle. It is neutral in its upright position, but on being moved backwards, forwards, right, or left, automatically meshes selector gears to drive the saddle or the cross slide. On the handle being moved right or left the saddle-operating gears are meshed, and backwards and forwards movement links up the cross-slide gears.

Power drive to the tool slide is effected through a pair of bevel gears on a vertical shaft which connect the cross slide power shaft to the tool slide lead screw. A selector between the cross slide lead screw and power shaft is used to determine whether the feed is transmitted either to the cross or tool slide. It is not possible to feed both by power together. To avoid the necessity for the operator to stretch over to the tool slide feed handle when it is towards the centre of the machine, a bevel gear shaft in a swan-neck extension may be fitted to the end of the slide lead screw and permit its convenient manipulation.

Tools are fixed in a 6in. diameter steel bar gripped in trunnions which are integral with the tool slide casting. The rigidity and length



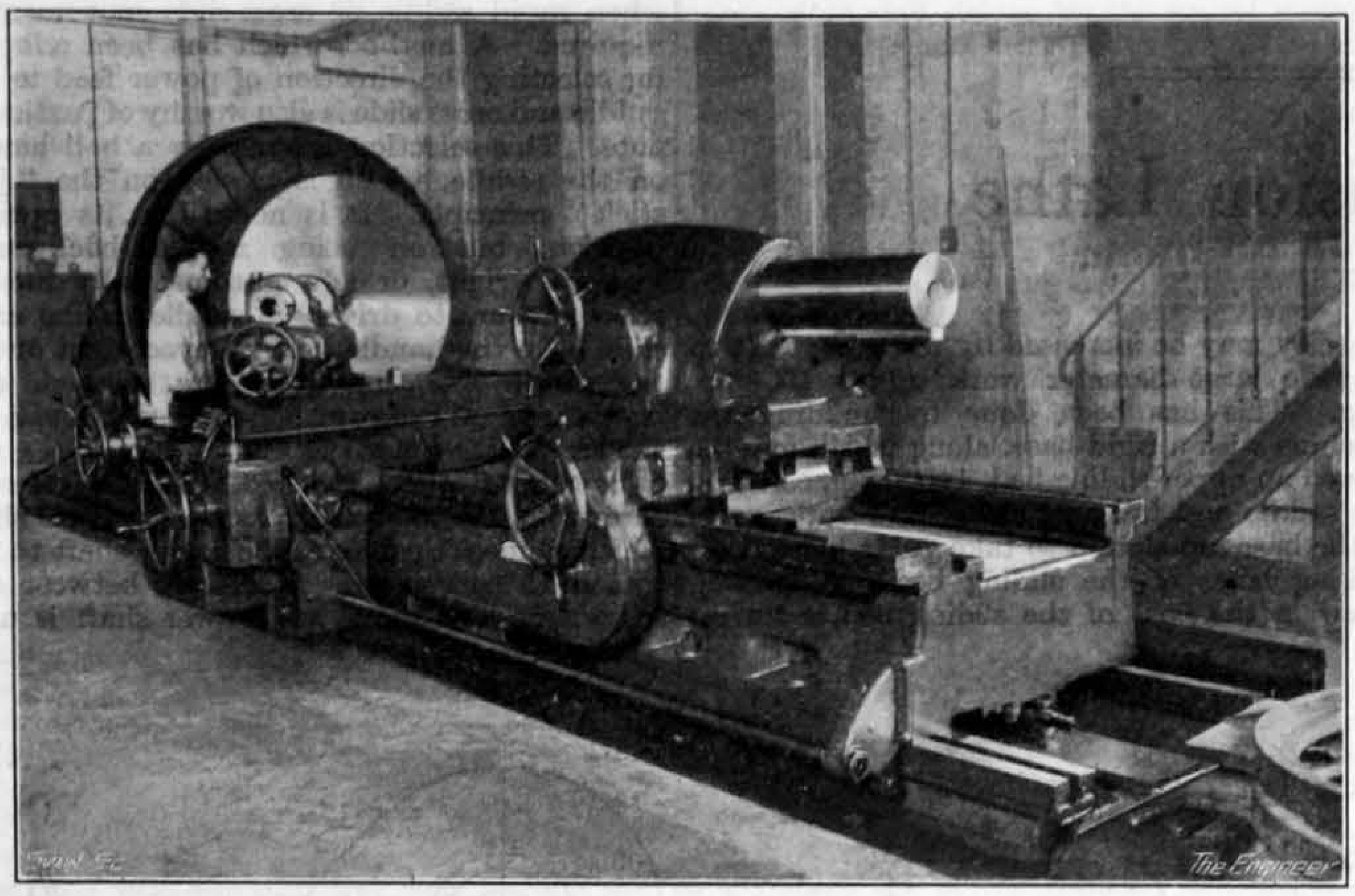
ARRANGEMENT OF TAILSTOCK



PRECISION LATHE

of the bar are such that deep recesses may be machined accurately without difficulty. When required, tool bars with racks in their bases, meshing with a wheel-operated pinion, may be used to permit easy tool-bar overhang adjustment to be made during setting or between operations.

The tailstock is designed as a working feature for machining operations, and not simply as a supporting medium for work between centres. As may be seen from the drawing it is a heavy, rigid box casting, with a spindle 10in. diameter and 6ft. 6in. long. Along the bottom of the spindle is a rack through which it is moved by a pinion keyed to a cross shaft. This shaft is turned through gearing by hand wheels on the operator's side of the machine to give the spindle a working traverse of 3ft. The large hand wheel is for coarse or rapid feeds, whilst a smaller wheel drives the cross shaft through a worm wheel for fine feeds. The opposite end of the cross shaft is coupled through a gear-box to a three-speed 1 H.P. motor, the use of which supplements hand feed when the tailstock is being used for deep drilling and boring. In order to prevent backing-off of the tailstock, when working under heavy lateral loads, a pawl in its base is dropped into ratchet teeth set between the upper and lower front ways of the sliding bed. All power-driven movements of the lathe are controlled by a neat push-button switch panel, in a convenient position on the saddle.

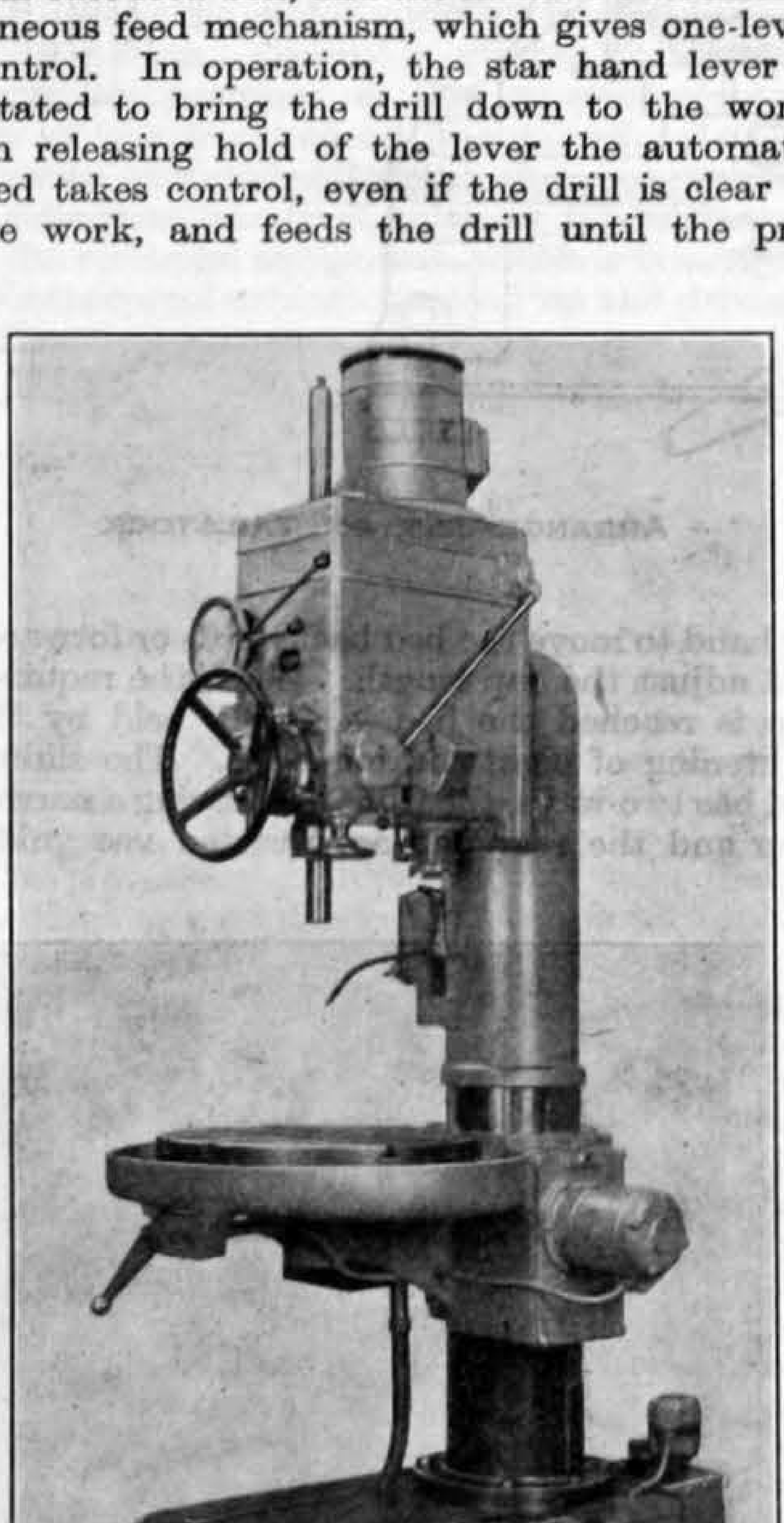


PRECISION LATHE

## An Improved Drilling Machine

A NUMBER of interesting features to permit ease of control and simplicity in operation are incorporated in the new 30in. round-column drilling machine, shown in the accompanying illustration, and which is now being made by A. A. Jones and Shipman, Ltd., of East Park Road, Leicester. It is capable of drilling up to 2in. diameter holes in mild steel, 2¼in. in cast iron, and tapping up to 1¼in. Whitworth. As may be seen, the lines of the machine are particularly clean, and all its controls are centralised within easy reach of the operator. The spindle is directly driven through machine-cut gearing by a vertically mounted electric motor. All the gears and shafts are totally enclosed and automatically lubricated, a pressure gauge being fitted to show that oil is being delivered during working. The gear-box provides eighteen spindle speeds, which are clearly indicated by a speed disc on the front of the machine. We are informed that three alternative ranges of spindle speeds can be supplied by the makers. The spindle is bored No. 4 Morse taper, with an extra cotter slot for holding a boring bar. It is of high-tensile steel with six driving splines, cut from the solid and mounted in a quill carrying an alloy steel feed rack, the end thrust being taken on combined journal and thrust bearings. It is counterbalanced by a weight enclosed within the machine column.

Automatic feed to the spindle is through a four-rate feed-box, and the maker's own instantaneous feed mechanism, which gives one-lever control. In operation, the star hand lever is rotated to bring the drill down to the work. On releasing hold of the lever the automatic feed takes control, even if the drill is clear of the work, and feeds the drill until the predetermined depth is reached, when the automatic feed trips out and enables the drill to be returned to its starting position clear of the work. If it is desired to cease drilling at any point of the automatic feed traverse before the required depth has been reached, all that is necessary is to rotate the hand lever in the reverse direction, and the automatic feed is disconnected, enabling the drill to be lifted clear of the work. The depth stop consists of a dial, which rotates with the cross axle; it is adjustable for the depth of hole to be drilled, and operative for both hand and automatic feed. The maximum stroke is obtained in several revolutions of the feed lever, and the depth stop is operative for the full stroke of 12in. without resetting. An additional stop disconnects the automatic feed at a predetermined point prior to the full depth of hole being reached, so that blind holes can be finished with accuracy by hand. This stop can be set so that the feed is tripped either 1/32in., 1/16in., ⅛in., or 3/16in. before the full depth is reached. Where a tolerance greater than 0·015in. is permissible, the ordinary automatic feed trip is sufficient, and the additional stop need not be utilised.



DRILLING MACHINE

An ammeter built into the head to show the current consumed serves to show whether the most economical penetration rate is being used, and to indicate when the drill requires regrinding. Start, stop, and reverse to the motor on A.C. three-phase equipment is controlled by a sensitive switch on the head, operating through a star-delta reversing contactor gear, which incorporates overload and no-volt protection. This switch may be used in tapping operations.

A stop switch for use in an emergency is fitted on the front of the base, and a touch of the foot stops the machine.

The table swivels around the circular pillar and is traversed vertically by power drive. The vertical traverse is operated by means of high-ratio worm gearing, driven by a built-in motor and controlled by push buttons conveniently positioned on the front of the table. By pressing either the "Up" or "Down" push buttons, the table will traverse whilst the pressure on the push button is maintained, and stops immediately on release. Limit switches are fitted, so that the traverse is automatically stopped when the table reaches its highest or lowest position. The push-button controls are only operative when the table locking handle is unlocked, so that once the table is set to the required height and the table locked, it is impossible to traverse the table, even if the push buttons are accidently pressed. An electric suds pump immersed in a tank in the machine base can be supplied if required. A copious flow of suds is delivered to the drill point through an adjustable piping system, and returned to the tank from the table trough by a telescopic pipe.

## British Standards Institution

*All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 3d. post free, unless otherwise stated.*

### HIGH-SILICON IRON CASTINGS

No. STA/25. With reference to the summary of the contents of this specification which appeared in our issue of October 5th, we are asked by the Metallurgy Division of the National Physical Laboratory to make it clear that the price of 6d. given at the end of the paragraph refers to the cost of the specification and not to that of the standard analytical samples obtainable from the Laboratory. These samples, in fact, cost 10s. 6d. each.

## Catalogues

W. H. A. ROBERTSON AND Co., Ltd., Bedford.—Illustrated catalogue of four-high rolling mills.

A. P. NEWALL AND Co., Ltd., Possilpark, Glasgow, N.—Illustrated brochure entitled "Newall Branded Bolts."

QUASI-ARC COMPANY, Ltd., Bilston, Staffs.—Technical circular No. T.C. 594, dealing with "Vortic" electrodes.

RUBBER BONDERS, Ltd., Dunstable, Beds.—Folder of notes on the subject of bonding to rubber, and entitled "A 'Flexible' Commentary."

MITCHELL CONSTRUCTION COMPANY, 1, Bedford Square, W.C.1.—Illustrated booklet giving particulars of civil engineering and building contracts carried out by the firm.

# The Mechanism of Tool Vibration in the Cutting of Steel*

By Professor R. N. ARNOLD, D.Sc., Ph.D., M.S., M.I. Mech. E.†

(*Continued from page 356, November 2nd*)

*Forces Acting on Tool and Possibility of Self-Induced Vibration.*—The forces existing between a tool and the metal which it is cutting may be very complicated, especially if the tool is itself in vibration. Under steady non-vibratory conditions it is usual to consider the force on the tool as composed of three component forces mutually at right angles. Of these the vertical force has normally the greatest magnitude, and being the major cause of the vertical deflection of the shank, may reasonably be assumed to control to a large extent any vibration which occurs.

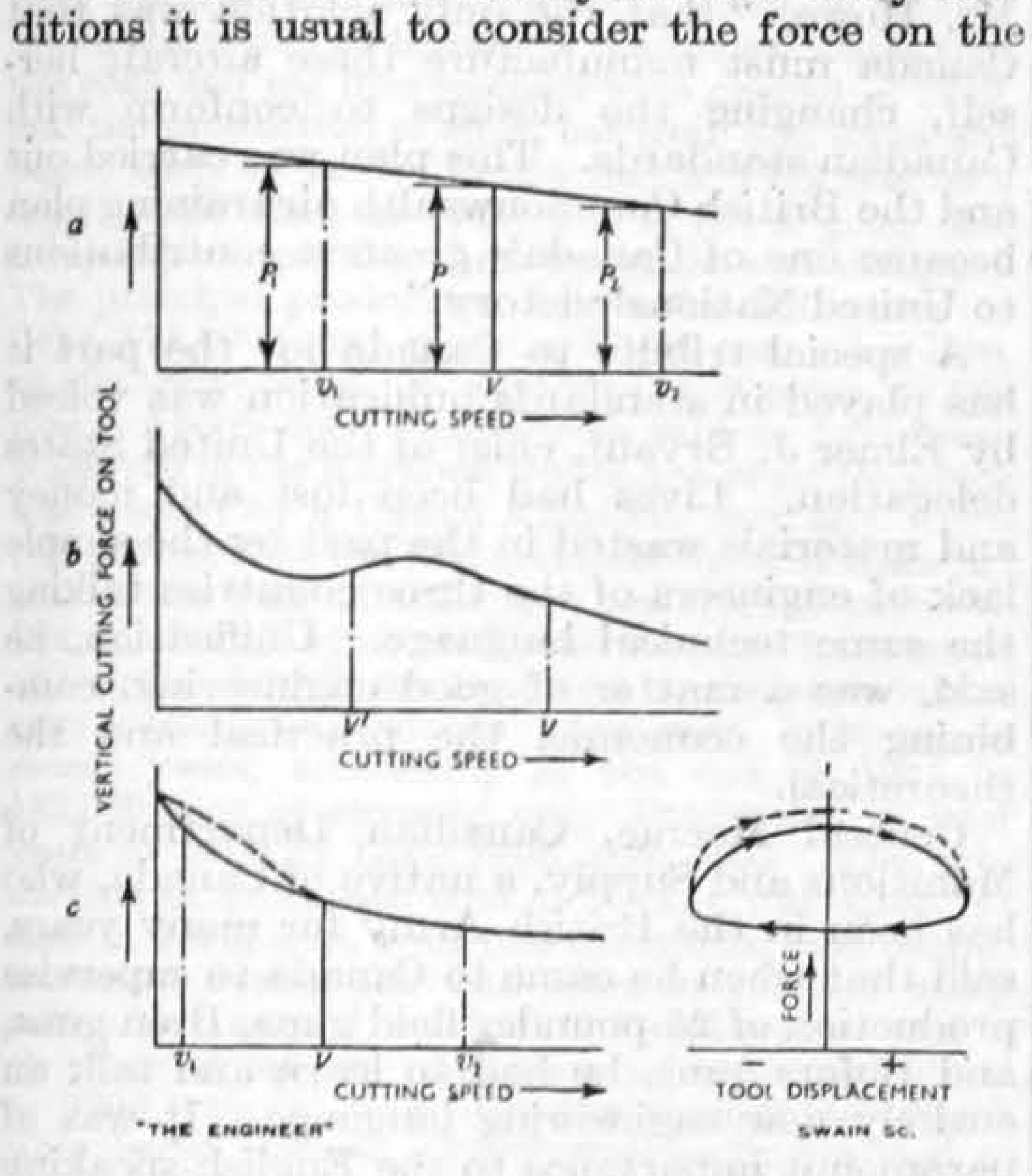



**Fig. 7**—*Explanatory Diagrams of Cause of Self-Induced Vibration*

To understand the vibratory influences which may be introduced during cutting it is legitimate to assume the tool set in motion with a free vibration of small amplitude, and study the changes which occur in the vertical force during any one cycle. This is obviously admissible, for the cutting force on a tool can never in practice be exactly constant, and any small fluctuations can start a free vibration; the crucial test is whether this vibration, once started, shall increase or decrease in amplitude.

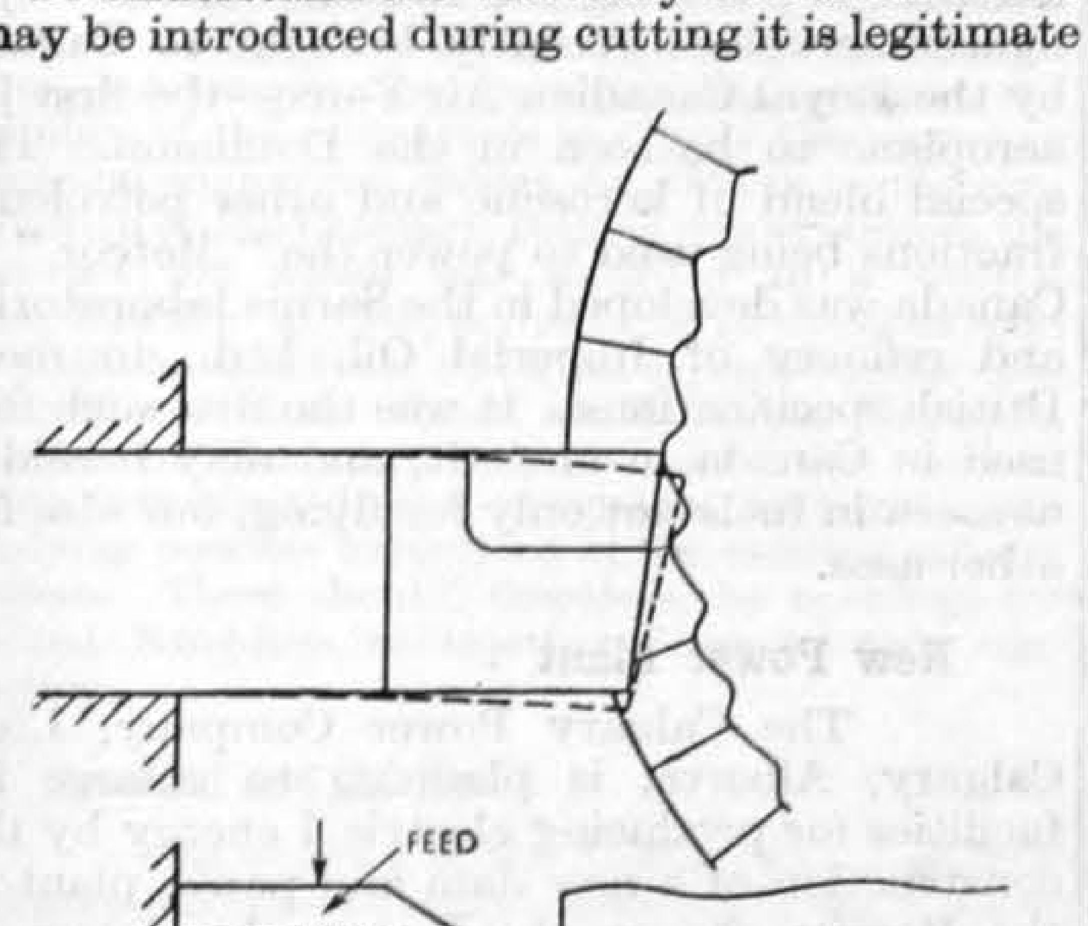



**Fig. 8**—*Explanatory Diagram Showing Reason for Existence of Forced Vibration*

* Institution of Mechanical Engineers. Cutting Tools Research: Report of Sub-Committee on Carbide Tools. October 26th, 1945. Abridged.

† Professor of Engineering, University College of Swansea; formerly of research department, Metropolitan-Vickers Electrical Company, Ltd., Manchester.

Examination shows that there are at least four distinct effects introduced by initiating vibration. Thus the vertical force on the tool may vary due to:

(i) Variable depth of cut produced by the movement of the tool point.

(ii) Variable top rake resulting from the change of slope.

(iii) Variable speed of tool relative to work.

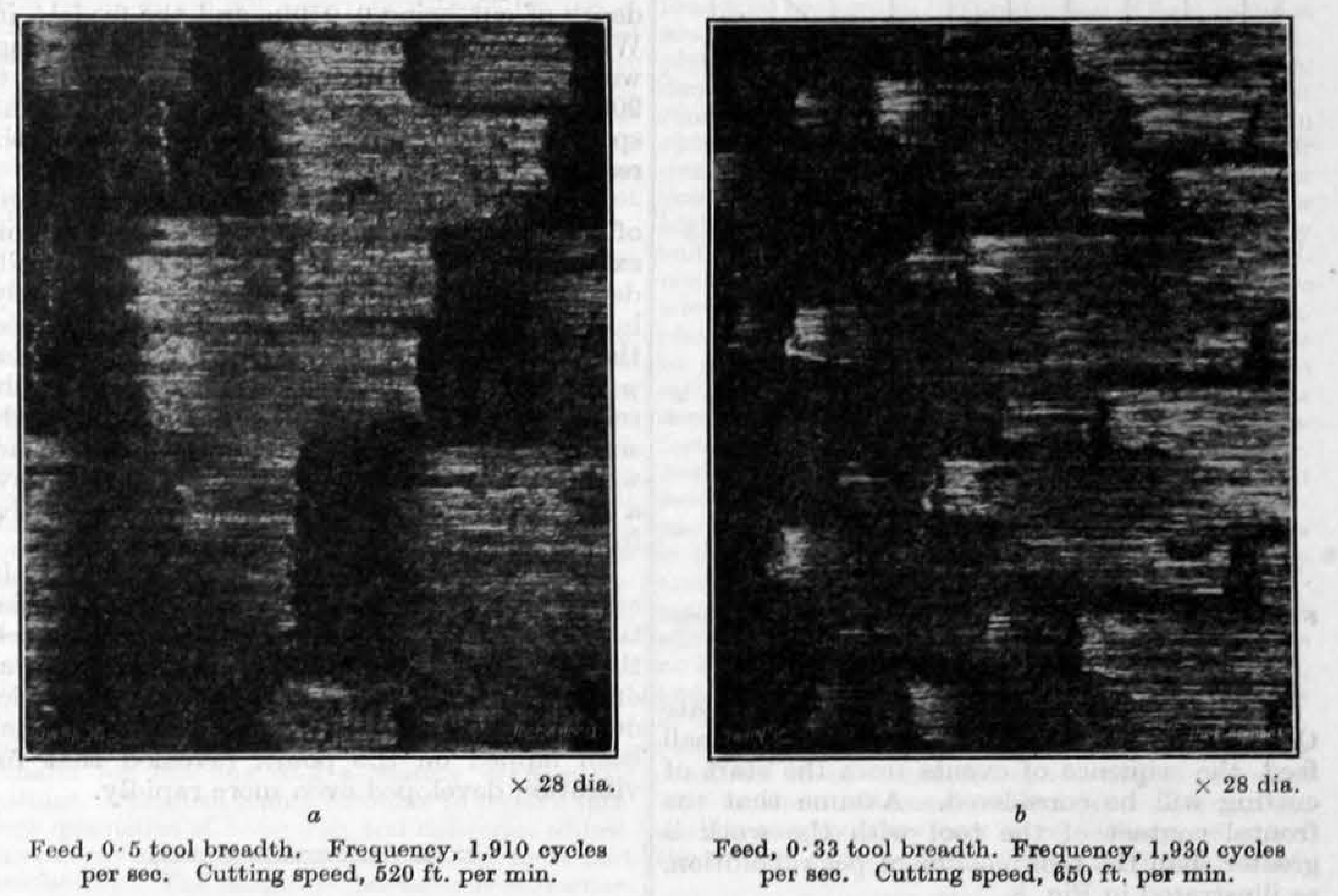
(iv) Influence of cutting action of flat at tool point.

Of these, (i) and (ii) increase with deflection, and it can be shown mathematically that they mainly affect the elastic stiffness, and therefore the frequency of the vibration. Experiment shows that their influence is small and may be neglected. Factors (iii) and (iv) are of paramount importance; but while it is possible to gain experimental knowledge of (iii), no corresponding measurement has been found possible for (iv).

Consider first the effect of speed variation during each cycle. The relation of cutting force to cutting speed will depend on the physical properties of the material being machined, and to a lesser extent on the shape of the tool. In Fig. 7*a* a straight line relation of negative gradient has been assumed to represent the relation between force and cutting speed. Suppose the speed of the work is V and that, due to tool vibration, the actual cutting speed varies between the limits $v_1$ and $v_2$. Condition $v_1$ will exist when the tool is in mid-position and moving downward, for then the relative velocity will be a minimum. Similarly $v_2$ will occur at mid-position when moving upward. This scheme of operations reveals that when moving downward an additional downward force of $(P_1-P)$ acts on the tool and when moving upward an additional upward force of $(P-P_2)$. In each case, therefore, the excess force is in the direction of motion of the tool, a condition which, in the absence of damping, will initiate self-induced vibration. In such cases energy is fed into the vibrating system by the variable force created and controlled by the vibration.

The above consideration reveals that a negative characteristic in the force-speed relation introduces dynamical instability which results in vibration. By a similar argument it may be shown that a positive characteristic results in dynamical stability. Complications arise, however, if the relation is of such a form that it possesses both positive and negative gradients. In such cases the resulting tool motion would be difficult to predict; but so long as a negative gradient exists in the vicinity of the mean cutting speed, some vibration will be induced and will build up until the positive and negative influences are neutralised. It does not follow, however, that this will occur whenever a positive gradient is encountered; for example, the shape of the curve of Fig. 7*b* is no deterrent to vibration when the speed of the work is V. At speed V′ the vibration could not start on its own initiative, but a slight impact might be enough to give it an amplitude at which the self-induced influences would predominate.

The way in which tool wear may modify the force relation during vibrati n is not clear, and apart from the fact that tool wear does increase the severity of vibration, no experimental measurement of its mechanism appears applicable. What is known, however, is that the flat is in contact with the work during the half-cycle in which the tool is moving downwards. It is reasonable, therefore, to assume that the vertical force on the tool is increased during this period, a condition which would result in an increase of energy to the system. The area of the right-hand diagram of Fig. 7*c* represents the energy input to the system per cycle when the cutting speed varies between $v_1$ and $v_2$. The dotted curve shows a hypothetical increase of force to correspond to the above argument, and it will be seen from the new area of the space-force diagram that this would contribute considerably to the energy input per cycle.



× 28 dia. *a* — Feed, 0·5 tool breadth. Frequency, 1,910 cycles per sec. Cutting speed, 520 ft. per min.

× 28 dia. *b* — Feed, 0·33 tool breadth. Frequency, 1,930 cycles per sec. Cutting speed, 650 ft. per min.

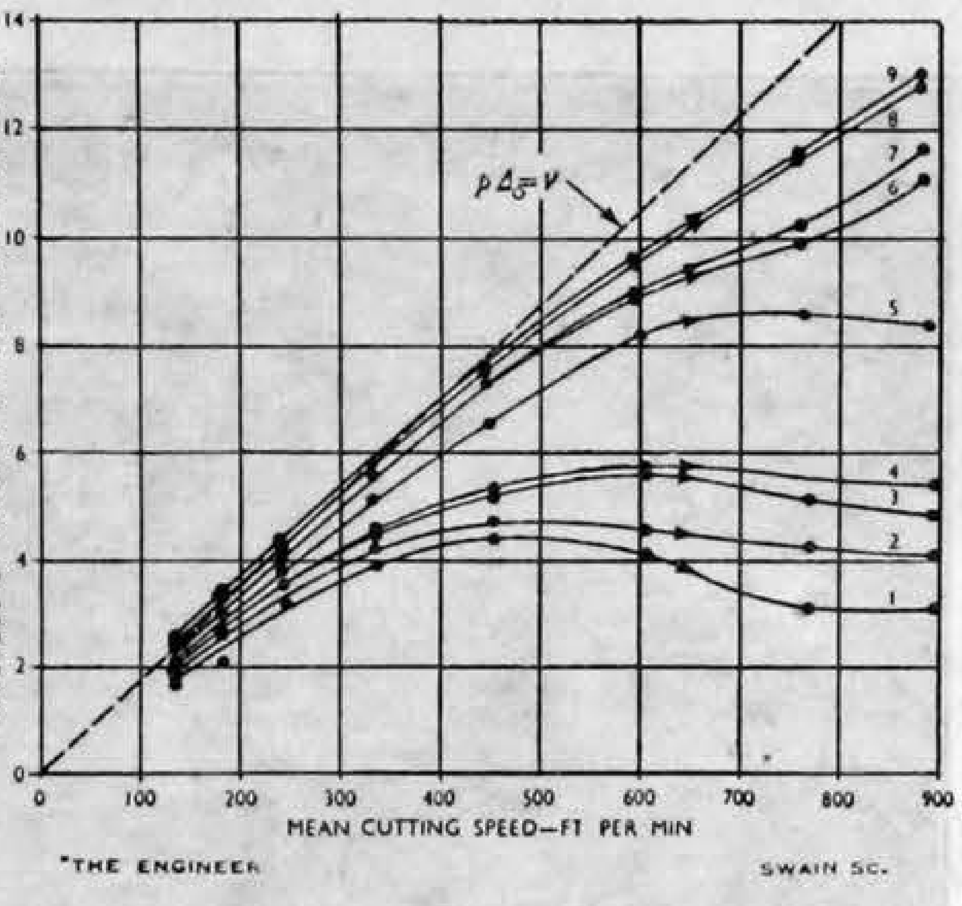
**Fig. 9**—*Surfaces showing Phasing due to Forced Vibration*

The restrictions which may be imposed on such vibrations are worthy of consideration. It is obvious that if the amplitude continues to increase a point will be reached at which the vibratory speed of the tool at its mid-position is exactly equal to the speed of the work. When this condition is reached a cutting speed of zero will occur instantaneously during each cycle, and any further increase in amplitude will result in the cutting speed becoming negative.

This appears, at first sight, to set a natural limit to the vibration, but further consideration indicates that this is not necessarily the case. It may be deduced from Fig. 7*a* that if the amplitude reaches the condition at which the instantaneous cutting speed becomes zero, energy is being constantly fed into the system. Unless other damping influences are present to neutralise this energy the amplitude must still continue to increase. However, on a negative cutting speed being attained, the frictional force at the tool point reverses direction and thereby absorbs a large amount of energy. It may be concluded, therefore, that with a negative gradient for the force-speed relation the amplitude of vibration may reach or even surpass the condition $V=2\pi f \Delta_0$, where V denotes the velocity of the work, $f$ the frequency of tool vibration, and $\Delta_0$ the amplitude of vibration at the tool point. The damping characteristics of the tool shank may, however, have a determining influence on whether such an amplitude is attained.

### Investigations with Cutting Interference

*Introduction.*—The investigations previously described were all conducted with feeds greater than the length of contact of the tool. It is obvious that, apart from the machining of screw threads, such feeds are of little practical importance, and cases with feeds less than the tool breadth will now be considered. Under such conditions forced vibration supplements the self-induced vibration. The distinction between these two vibratory influences should be clearly appreciated. With self-induction the vibration exists in virtue of the forces derived from its own motion. When the system is brought to rest, no periodic forces exist, though a minute disturbance will set the system again in motion. Forced vibration results essentially from an external periodic force, which is quite independent of the system on which it acts. The amplitude attained depends on the magnitude and frequency of this force and the inherent damping; but if the frequency is close to the natural frequency of the system, a large vibration may result from a relatively small force.




Frequency, 1820 cycles per second.
Depth of cut, 0·010in.; feed, $^1/_{80}$in.

**FIG. 10**—*Amplitude-Speed Characteristics for Progressive Wear at Tool Point*

*Cause of Forced Vibration.*—To appreciate the cause of forced vibration when using a small feed, the sequence of events from the start of cutting will be considered. Assume that the frontal contact of the tool with the work is greater than the tool movement per revolution, as illustrated in Fig. 8.

When cutting commences, self-induced vibration is rapidly initiated during the first revolution. During subsequent revolutions, however, the force acting on the tool is the result of two actions (i) that of shearing the new material at A (Fig. 8), (ii) that of cutting through a portion of metal B of undulating profile produced during the previous revolution. The first of these sustains the self-induced vibration, while the second produces a periodic force on the tool. Furthermore, since the profile cut during the previous revolution has a wave frequency close to the natural frequency of the tool, the periodic impulses will (assuming a constant machine speed) approximate to the resonant frequency, thereby exerting a powerful influence.

An anomaly may be observed here, in that the force producing the vibration is dependent on the vibration which existed at a previous time. The pedant might claim that this is in effect a self-induced vibration, but mathematically it has all the characteristics of a forced vibration.

*Phasing of Vibration.*—When forced vibration exists, a certain time relationship exists between the movement of the system and the force by which it is sustained. For instance, if the force be harmonic and its frequency exactly equal to the undamped frequency of the system (a condition of resonance), it is found that the motion lags precisely a quarter of a period (or 90 deg.) behind the force. This means that when the force is maximum downward, the system is at its mid-position and moving downward. The phase relation depends also on frequency and damping, but this need not be considered here.

It is not surprising that when a tool is subjected to forced vibration in the manner described, it tends to produce a wave which bears a definite phase relation to the previous contour. In spite of the fact that the surface wave length may not bear the correct relation to the circumferential length, it is found that perfect phasing will, in general, be rapidly attained, any discontinuity occurring at the end of the first revolution being rapidly eliminated.

This type of cutting leads to the production of many fascinating surface patterns, two of which are shown magnified in Fig. 9. Reproductions *a* and *b* show respectively the appearance of the surface cut with feeds approximately two-thirds and one-third the breadth of the tool. In the latter case complication arises due to the fact that the tool interferes with the contours of two previous revolutions.

*Amplitude as Affected by Attitude and Shape of Tool.*—The investigations so far described have all been conducted with a tool shape chosen for scientific convenience rather than practical utility. The development of vibration under more practical conditions was studied by using a tool of the form shown in Fig. 2*c*, *ante*. After careful lapping, it was subjected to test, the depth of cut being 0·010in. and the feed $^1/_{80}$in. When slight vibration became evident readings were taken at cutting speeds from 135ft. to 900ft. per minute in ascending order. This speed range was covered nine times, and the results were plotted, as shown in Fig. 10.

It will be seen that during the initial stages of wear (curves 1 to 4) the amplitude, far from exhibiting a straight-line characteristic, actually decreases at the higher speeds. Ultimately, however, the amplitude rises and approaches the dotted line representing the speed criterion $p\ \Delta_o = V$. It is considered that these results reflect the effect of the flat on the tool point, the size of which is greater in relation to the surface wave length as speed is reduced. This may have a considerable effect on the self-inductive influence.

From the practical standpoint, however, the results show that after a few minutes' cutting time, the vibration builds up to approximately the same magnitude as that obtained from all other tests. Furthermore, experiments carried out with the same tool after a small radius had been lapped on the point, revealed that full vibration developed even more rapidly.

## Canadian Engineering Notes

### Engineering Standards

A statement that "a solid basis of agreement" had been reached was issued following final committee meetings of a conference held at Ottawa during the latter part of September and the first week of October on unification of engineering standards among representatives of Britain, the United States, and Canada.

The conference, the third sponsored by the Combined Production and Resources Board of the three countries, was attended by a distinguished group of British, American, and Canadian engineers, the British delegation being headed by Mr. S. J. Harley, of the Machine Tool Control, Ministry of Supply.

The major achievement, in the opinion of all three delegation heads, was the proposed basic standard for a simple screw thread suitable for use of all countries using the inch system of measurement. The adoption of new standards approved by the conference depends on their voluntary acceptance by industry in the three countries through their respective standards associations. Some representatives expressed the opinion that what they termed the "A.B.C." (American, British, Canadian) standards would be approved by the three national bodies.

Of particular interest to professional engineers and technical societies was a gathering at one stage of the conference, presided over by Reconstruction Minister C. D. Howe, Canadian representative on the Combined Production Board, who introduced a number of speakers. He recalled that he was the oldest surviving member of the C.P.R.B., and said that he himself was particularly keenly aware of the need for unification of standards. That need came with greatest force to Canadian authorities shortly after the inception of the British Commonwealth air training plan. Originally it had been decided that the aircraft to be used in the training of Dominion and United Kingdom airmen should be built in Great Britain. But the fact that different engineering standards existed between Canada and the United Kingdom would not permit of the manufacture of aircraft parts for the British-built machines in Canada. "We came to the conclusion," said Mr. Howe, "that the only solution was that Canada must manufacture these aircraft herself, changing the designs to conform with Canadian standards. This plan was carried out and the British Commonwealth air training plan became one of Canada's greatest contributions to United Nations' victory."

A special tribute to Canada for the part it has played in standards unification was voiced by Elmer J. Bryant, chief of the United States delegation. Lives had been lost and money and materials wasted in the past by the simple lack of engineers of the three countries talking the same technical language. Unification, he said, was a matter of good engineering, combining the economic, the practical and the theoretical.

General Macrae, Canadian Department of Munitions and Supply, a native of Canada, who has been in the British Army for many years, said that when he came to Canada to supervise production of 25-pounder field guns, Bren guns, and Bofors guns, he had to learn and talk an entirely new engineering language. It was of paramount importance to the English-speaking peoples, he said, that agreement be found in technological definitions and tolerances.

The conference included technical discussions on screw threads, pipe threads, limits and fits, drawing practice, and metrology with a view to obtaining common standards for the three countries.

### Turbo Fuel for Aeroplanes

A new turbo fuel consisting largely of kerosene is powering the British "Meteor" jet fighter aeroplane recently brought to Canada by the Royal Canadian Air Force—the first jet aeroplane to be seen in the Dominion. The special blend of kerosene and other petroleum fractions being used to power the "Meteor" in Canada was developed in the Sarnia laboratories and refinery of Imperial Oil, Ltd., to meet British specifications. It was the first such fuel used in Canada in aircraft, and may herald a new era in fuels not only for flying, but also for other uses.

### New Power Plant

The Calgary Power Company, Ltd., Calgary, Alberta, is planning to enlarge its facilities for producing electrical energy by the construction of a new dam and power plant at the Barrier site on the Kananaskis River, in the Bow River forest reserve. The dam will permit 1100 cubic feet of water per second to be diverted through the structure to the powerhouse immediately below the dam, where the water will be returned to the Kananaskis River. The installed capacity will be 13,500 H.P. in one unit and the reservoir will flood approximately 673 acres in the Kananaskis River valley above the dam site, to provide some 17,000 acre-feet of active storage.

### Engineer Honoured

Sir William Stanier was made an honorary member of the American Society of Mechanical Engineers during a visit to Ottawa recently. The function was under the joint auspices of that society and the Engineering Institute of Canada, and was attended by British, American, and Canadian engineers attending the conference on unification of engineering standards then in session. Reconstruction Minister Howe, honorary member of both bodies, presented Sir William for the honour with the citation:—"For outstanding engineering contributions to locomotive design, for far-seeing leadership in engineering research, and for distinguished scientific service in World War II."

# Markets, Notes and News

**The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer**

### Turkey's Industries

The Department of Overseas Trade has recently issued a Review of Commercial Conditions in Turkey, which contains, amongst other matters, some information relating to the industrial wartime development of that country. Dealing specifically with the iron and steel industry, which is centred round the works at Karabuk, the review states that the coke and pig iron sections were opened in 1939, and the production of steel, bar iron, and pipes was begun early in 1941. Production in 1942 was on a larger scale than in 1941, but it fell a good deal behind the output for which the works were designed. The principal production figures for 1942 were :—Coke, 178,000 tons ; pig iron, 67,000 tons ; bar iron, 66,000 tons ; steel, 50,000 tons ; and pipes, 49,000 tons. About 4000 people were said to have been employed in the Karabuk works, the plant for which was erected by a United Kingdom company. It is pointed out that the iron and steelworks at Karabuk obtain the bulk of their iron ore from deposits at Divrik, though some ore is also supplied from mines at Gurek. Divrik ore is mined on the surface and very considerable stocks have been built up in recent years, amounting at the end of 1941 to 182,000 tons of screened ore. Production in later years is said to have been restricted. The production of unwashed coal in Turkey was 3,165,741 tons in 1943, and, with one exception, coal output increased during the war years in spite of many difficulties caused by lack of equipment and a shortage of labour. Copper production amounted to 9200 tons in 1943 from the three mines which were being worked. Further deposits are said to have been discovered, but it is not known if they are yet being exploited. Chrome ore production in Turkey has declined steadily since before the war, and actual exports of chrome ore during 1942 did not exceed 117,000 tons. In surveying the possibilities of Turkey as a post-war market for United Kingdom exports, the review says that opportunity should occur for the supply of capital goods in connection with various public utility schemes which have already been begun or which have been planned. Among these are paper, cellulose, chlorine, and cement factories, which have been under construction for some time. Contracts for these factories were all awarded in the first instance to German firms, but progress has been held up owing to the inability of the contractors to supply the necessary electrical equipment, cables, &c. Work on the construction of the Catalagzi electric power station, the contract for which was awarded to a United Kingdom firm in 1940, is due to be resumed as soon as possible, and other electrical schemes under consideration include those at Kutahya, Caglayik, Adalia, and Zammak. Port construction work is being investigated, and competent authorities are studying possible extensions of the existing railway system. There should, therefore, be openings for United Kingdom contracting firms in this connection.

### Scotland and the North

The activity of the Scottish iron and steel industry has been steadily increasing in the last few weeks, and a good rate of employment is now being maintained in most departments. There are several indications of the extent of peacetime requirements of iron and steel consumers at home, especially of the shipbuilding, locomotive, and other heavy engineering industries. Export business is still governed by official restrictions, but its present volume is making a useful contribution to producers' order books. The tonnages released for export, however, are a good deal below the amounts inquired for from overseas sources. Shipping facilities are restricted, and this, naturally, is one of the factors affecting the extent of overseas business which can be handled. Nevertheless, the active export demand is a matter of first importance at the moment. In the steel trade, business in plates is much more satisfactory than it was a few months ago. The demand for heavy descriptions from the shipyards has not yet developed a great deal, but the call for medium plates is more insistent and delivery dates tend to lengthen. The continued pressure for sheets is, of course, the most prominent feature of the steel industry, and the active condition of the sheet mills seems likely to be continued for some time to come. The keenest demand is for light-gauge black sheets, and some makers are now not able to promise delivery before the second period of next year. Galvanised sheets are in brisk request, but deliveries of these must of necessity be restricted until the labour situation in the galvanising departments is easier. Re-rollers have a fair number of orders in hand, business on export account helping to strengthen the position. The overseas demand for small bars and sections, and also hoops and reinforcing rods, is active, though home business is not more than moderate. There is little, if any, change in the semis supply position, and the re-rollers are anxious to see some improvement. Pig iron production is maintained at as good a rate as is possible under present conditions, and the needs of users of foundry and steelmaking grades are being satisfactorily met. The Lancashire iron and steel trades are fairly well employed, and with the consuming industries making some progress in the transition to peacetime conditions market activity is moderately good. The foundries are receiving an increasing amount of business, but they are still experiencing difficulty in obtaining sufficient labour. There is pressure for improved deliveries of pig iron as stocks of all grades are very small. Business in finished iron continues to be good, with the exception of Nos. 3 and 4 quality bars, offers of which are at present very limited. Steel plates of most descriptions are well taken up, there being a particularly good demand from locomotive builders and boilermakers. Heavy joists and other structural material are not a very prominent feature at present, but there is a fair business in light structural material. Apart from the smaller diameters, there is an active demand for mild steel bars. Blooms, billets, and other semis are in regular request. The North-West Coast steelworks are busy. The hematite pig iron trade also continues at a fair rate, though the demand has abated somewhat in recent weeks.

### The North-East Coast and Yorkshire

The increasing activity to be seen in the North-East Coast iron and steelworks reflects the progress that is being made in the change-over to peacetime operations in the engineering and allied industries. Producers of iron and steel now have a considerable volume of orders in hand, and are thereby assured of a good rate of employment during the coming months. The demand both from home and overseas continues to expand, and production figures may be expected to show improvement, although shortages of labour and fuel inevitably place some restraint upon current operations. Pig iron production is maintained at a rate which just about covers present needs. The light castings foundries, in particular, are pressing for bigger allocations in view of the strengthening demand for building and a variety of domestic castings. The steel plants continue to receive sufficient quantities of basic iron and deliveries of low-phosphorus and refined irons are for the most part satisfactory. The output of hematite is still somewhat limited, but this grade is more freely allocated now that the urgent demands imposed by wartime conditions have passed. In the last two or three months the activity of the shipbuilding yards has been increased by the placing of orders for new merchant shipping, and this is bringing about an improved demand for the necessary material. Specifications for steel plates are now more numerous, and the mills are much better employed. Structural material, such as heavy joists, is also attracting more attention. Re-rollers of bars, strip, and light sections now have a great deal of work in hand, but their anxiety over supplies of semis has not lessened. They are continually pressing for bigger deliveries of billets, and all available defective material that can be utilised is readily taken up. The demand for sheet bars is also very keen in view of the big commitments of the sheet mills. All sheet makers are working at a high rate of production, but even so it is difficult for them to keep pace with their delivery obligations, and inquiries about new business are coming forward continually. The Yorkshire steel trade is, generally well employed, although problems associated with labour transference continue to cause concern. In many departments there is a lack of skilled labour which retards development of business. Basic steel producers are quite well employed, and a moderate amount of business is reaching makers of acid-carbon steel. Supplies of raw materials to both these sections of the trade are satisfactorily maintained. Railway material of various kinds is in good demand and works engaged in the production of shipbuilding requisites are also well occupied. In the Sheffield area the demand for stainless steel continues to increase, but the output of polished sheets is still hindered considerably by the shortage of operatives for the polishing plants.

### The Midlands and South Wales

Conditions in the Midlands iron and steel industry are generally active, although the shortage of labour in some departments is slowing down the rate of expansion. There is a good deal of business in hand, however, and the demand continues to grow. The steelworks are fairly busy, and continue to make progress in the changeover to production of a civilian nature. The demand for plates is now showing an improvement and the mills are more fully occupied than they were a few months ago. Locomotive builders and boilermakers are making bigger requests for plates, but the needs of the shipbuilders, whilst increasing, are still moderate. Re-rollers of small bars, strip and light sections do not lack orders, and with a growing volume of business continue to press for bigger supplies of billets. The brisk demand for sheets shows no sign of abating, and all makers are maintaining a high rate of production in the effort to keep up with their commitments. Big tonnages of sheet bars are therefore passing regularly into consumption. Other products which are in constant demand are arches, props, and bars required for colliery maintenance, and permanent way equipment of all kinds, big tonnages of which are being taken up for railway reconstruction schemes. The foundries engaged in the production of light castings are anxious to obtain bigger supplies of high-phosphorus pig iron, in view of the increasing demand that is now reaching them. The light foundries, however, find considerable difficulty in obtaining sufficient labour, and, consequently, their output is limited. Improvement in their labour position will, however, lead to further pressure for high-phosphorus iron as the present make is barely sufficient to cover requirements. General engineering and jobbing foundries are receiving more work, but their present supplies of low and medium-phosphorus and refined irons appear to be adequate to their needs. The finished iron industry is moderately well employed. There is a regular demand for best and Crown quality bars, and satisfactory bookings for bars of Nos. 3 and 4 quality. Activity is increasing in the South Wales iron and steel market, and the transition to peacetime employment appears to be proceeding smoothly. Business in finished steel continues to improve. Both heavy and light plates are in growing demand, and makers of sheets are now so heavily booked that additional business is difficult to place. There is no abatement in the demand for semi-finished steel, and although production of billets and sheet bars is considerably higher than it was, it is still difficult to satisfy consumers' needs. A steady business continues to be transacted in the tinplate market. The volume of recent orders has shown some decline as producers now have little to offer for the present period. Export business is still limited.

### Iron and Steel Scrap

There is a fairly active business in iron and steel scrap in most areas. The demand continues to be concentrated principally on heavy, good-class material, and although in some cases there is more interest being shown in the lighter, inferior grades stocks of this kind of material are considerable. With increasing production at the steelworks, bigger deliveries of heavy, mild steel scrap are sought after, and in the last week or two there has been an improvement in the demand for this material cut to foundry sizes. Bundled steel scrap and hydraulically compressed steel shearings have lately become less plentiful, and consequently all available quantities are being disposed of easily. Supplies of good heavy and chipped mild steel turnings have also declined, and steelworks are anxious to acquire as good quantities as possible. Business in mixed wrought iron and steel scrap for the basic steel furnaces is an active feature, the demand for good-quality heavy material being regularly maintained. Current transactions in light material do not amount to very much. The market for good heavy cast iron scrap continues to be brisk, and in many instances merchants are being pressed for bigger deliveries. Trade in light cast iron scrap is not outstanding, as the quantities available for disposal are relatively small. There is a scarcity of good cast iron machinery scrap in cupola sizes, and some consumers are showing a readiness to take bigger quantities of lower grades of this description to help out their supplies. There is a brisk request for short heavy steel scrap suitable for foundry use.

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"The Battle of Steel."—A well-illustrated booklet, recording the achievements of the British iron and steel industry during the war years, has been prepared by the British Iron and Steel Federation. The booklet has now been issued under the title "The Battle of Steel." It is to be distributed abroad.

# Notes and Memoranda

## Miscellanea

COLLEGE OF AERONAUTICS.—The Board of Governors of the College of Aeronautics has appointed as Principal of the College, Mr. E. F. Relf, C.B.E., F.R.S., F.R.Ae.S. Mr. Relf has been serving since 1925 as Superintendent of the Aerodynamics Division of the National Physical Laboratory, Teddington.

THE LATE SIR GLYNN WEST.—We regret to have to record the death on Tuesday, November 6th, in London, of Sir Glynn West, at the age of sixty-eight. He was educated at Sedbergh School, and became well known as an administrator and industrialist. During the last war he served as Deputy Director-General of Munitions Supply, Controller of Shell Manufacture, and Director-General of Shell and Gun Manufacture. He was a member of the Munitions Council, and after the war was the chairman of Sir W. G. Armstrong-Whitworth, Ltd., and later chairman of Armstrong-Siddeley Motors, until his retirement in 1926. He was also a director of McMichael Radio, Ltd., and other companies.

REBUILT L.N.E.R. "PACIFIC" ENGINE.—As a result of a misunderstanding on our part, the two locomotives illustrated on page 313 of our issue of October 19th were wrongly described. The upper view—"Great Northern" "No. 4470"—is not one of the original engine built in 1922, but of that engine as rebuilt in 1945. The lower view—engine "No. 4496"—has no connection with the upper one. It illustrates a class "A 4" locomotive, which was originally called the "Golden Shuttle," and was recently renamed the "Dwight D. Eisenhower" and repainted in the peacetime livery of garter blue. In the opening sentence the words "and renamed 'Dwight D. Eisenhower'" should accordingly be omitted.

## Personal and Business

MR. N. KER LINDSAY has been appointed the first director of the British Non-Ferrous Metals Federation.

MR. A. H. CROUCHER has been appointed chief engineer of Nichols Compressors, Ltd., Oakcroft Road, Tolworth, Surrey.

LIEUT.-COLONEL K. G. MAXWELL has resumed his duties as publicity manager of the Metropolitan-Vickers Electrical Company, Ltd.

SPECIALLOID, Ltd., has opened a service depot at 32, Linen Hall Street, Belfast, in charge of Mr. F. W. Callaway, district engineer.

MR. C. B. M. DALE has been appointed chairman of the Gas Turbine Panel of the British Internal Combustion Research Association.

MR. E. J. BATCHELOR, director of sales of the Darwin group, and Mr. H. C. Yaffe, general manager of production, Darwins, Ltd., have been appointed to the board of Andrews Toledo, Ltd.

DAVID BROWN AND SONS (HUDDERSFIELD), Ltd., have removed their London office to Haymont House, 3, Panton Street, Haymarket, S.W.1 (telephone, Whitehall 5061; telegrams, Dabrogears, Phone, London).

MR. ARTHUR GROUNDS has become secretary of the Coal Industry Joint Fuel Efficiency Committee in place of Mr. F. A. H. Elliot, who has resigned on account of his increasing commitments as director of the Combustion Appliance Makers' Association

E. H. JONES (MACHINE TOOLS), Ltd., announces that Mr. Sidney Player has joined the board. Mr C. E. Rockwell has resigned his position as director and general manager, and has been succeeded by Mr. E. J. M. Jones. Mr. E. H. Jones has joined the board of the Newall group of companies.

THE COPPER DEVELOPMENT ASSOCIATION has acquired premises at Kendals Hall, Radlett, Herts, to which all urgent communications and applications for literature should be addressed. The Association will continue to maintain its registered address at Grand Buildings, Trafalgar Square, W.C.2.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., announces that Mr. H. Jack has been appointed chief electrical engineer; Mr. A. A. Pollock, chief mechanical engineer; Mr. G. S. C. Lucas, assistant chief electrical engineer; and Mr. K. R. Hopkirk, assistant chief mechanical engineer. These arrangements do not affect the turbine engineering department, of which Mr. R. H. Collingham remains chief engineer.

WILLIAM WHITEHOUSE AND CO. (ATLAS FORGE), Ltd., Netherton, Dudley, is the name of a new company which has been formed to manufacture and market hand tools and steel forgings, chiefly for the building and engineering industries and allied trades. Modern plant is at present being installed, and plans have been made to use new methods both in forging and finishing the tools. The directors are W. H. Whitehouse, H. Bates, and C. A. Roper.

# 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.*

### Chartered Surveyors' Institution

*Monday, Nov. 12th.*—12, Great George Street, Westminster, S.W.1. Presidential Address, E. B. Gillett. 2.30 p.m.

### Institute of British Foundrymen

*Saturday, Nov. 10th.*—SCOTTISH BRANCH: Royal Technical College, Great George Street, Glasgow. "The German Steel Foundry Industry," B. Gray. 3 p.m.—W. RIDING SECTION: Technical College, Bradford. "Steel Foundry Sand Practices," R. Foster and H. Stoker. 6.30 p.m.—LINCOLN SECTION: Technical College, Lincoln. "Consistency and the Cupola," C. A. Payne. 2.45 p.m.

*Saturday, Nov. 17th.*—E. MIDLANDS SECTION: Technical College, Leicester. "A New Method of Investigating the Behaviour of Charge Materials in an Ironfoundry Cupola and Some Results Obtained," N. E. Rambush and G. B. Taylor. 6 p.m.—WALES AND MONMOUTH BRANCH: Glanmoor Foundry, Llanelly. "Gating and Feeding of Steel Castings," S. T. Jazwinski, E. D. Wells, and L. Finch. 2.30 p.m.

### Institute of Economic Engineering

*Sunday, Nov. 11th.*—Waldorf Hotel, Aldwych, W.C.2. "Standard System for Time Recording, Progressing, and Costing," V. Carr. 2.30 p.m.

### Institute of Marine Engineers

*Tuesday, Nov. 13th.*—85, Minories, E.C.3. "Stainless Steels for Turbine Blading," A. Allsop. 5.30 p.m.

### Institute of Transport

*Monday, Nov. 12th.*—Inst. of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. "Modern Methods of Handling Goods at Railway Stations," T. W. Royle. 5.30 p.m.

### Institute of Welding

*To-day, November 9th.*—BIRMINGHAM BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham. "Review of the Application and Development of Oxygen Cutting," R. Dore. 6.30 p.m.

*Wednesday, Nov. 14th.*—W. SCOTLAND BRANCH: Inst. of Engineers and Shipbuilders in Scotland, 39, Elmbank Crescent, Glasgow. "The Use of Welding and Riveting in Shipbuilding," G. Roberts and J. F. Morton. 6.30 p.m.—N. LONDON BRANCH: Technical College, Queensway, Enfield. "Welded Construction and the Drawing-Office," H. V. Hill. 8 p.m.

### Institution of Automobile Engineers

*Tuesday, Nov. 13th.*—COVENTRY BRANCH: The Geisha Café, Hertford Street. "Some Factors Influencing Design for Export," R. A. Stavert. 7 p.m.—LUTON BRANCH: George Hotel, Luton. "Air Conditioning, Heating, and Ventilating of Vehicles," K. B. Hopfinger. 7.15 p.m.

*Wednesday, Nov. 14th.*—LEEDS SECTION: The University, Leeds. "The Automobile and the Community—A Study in Action and Reaction," F. G. Woollard. 6.50 p.m.

*Thursday, Nov. 15th.*—DERBY SECTION: School of Arts, Green Lane, Derby. "The Automobile and the Community—A Study of Action and Reaction," F. G. Woollard. 7 p.m.

*Monday, Nov. 19th.*—GLASGOW BRANCH: 39, Elmbank Crescent, Glasgow. "A Brief Review of the Wartime Development of Military Road Vehicles, 1939–45," H. W. Fulton. 7.30 p.m.

### Institution of Chemical Engineers

*Tuesday, Nov. 13th.*—Royal Institution, 21, Albemarle Street, W.1. "Large-Scale Gas Distribution and Usage in Steelworks," E. Hemingway Jones. 5.30 p.m.

*Saturday, Nov. 17th.*—N.W. BRANCH: College of Technology, Manchester. "Heat-Resisting Steels," L. F. Keeley. 3 p.m.

### Institution of Civil Engineers

*Tuesday, Nov. 13th.*—ROAD SECTION: Great George Street, Westminster, S.W.1. "Highway Planning, with Special Reference to Traffic Capacities," Rowland Nicholas. 5.30 p.m.

### Institution of Electrical Engineers

*Monday, Nov. 12th.*—N.W. CENTRE: Neville Hall, Westgate Road, Newcastle-on-Tyne. "Practical Aspects of Telephone Interference Arising from Power Systems," P. B. Frost and E. F. M. Gould. 6.15 p.m.

*Wednesday, Nov. 14th.*—EDINBURGH BRANCH: Heriot Watt College, Edinburgh. "Operational Control of Electricity Supply Systems," W. Kidd and E. M. S. McWhirter. 6 p.m.—TRANSMISSION SECTION: Savoy Place, Victoria Embankment, W.C.2. "Recent Progress in the Design of the High-Voltage Overhead Lines of the British Grid System," W. J. Nicholls. 5.30 p.m.

*Thursday, Nov. 15th.*—Savoy Place, Victoria Embankment, W.C.2. "High-Voltage Research at the National Physical Laboratory," R. Davis. 5.30 p.m.

### Institution of Mechanical Engineers

*To-day, Nov. 9th.*—Storey's Gate, Westminster, S.W.1. "Elementary Principles of Plant Organisation and Maintenance for Civil Engineering Contractors," H. O. Parrack. 5.30 p.m.

*Saturday, Nov. 10th.*—N.E. GRADUATES: Gateshead Gas Company, Grainger Street, Newcastle-on-Tyne. "The Steam Locomotive," R. H. Nicolson. 2.30 p.m.

*Friday, Nov. 16th.*—Storey's Gate, Westminster, S.W.1. "The Scientist in Wartime," Sir Edward V. Appleton. 5.30 p.m.

*Saturday, Nov. 17th.*—N.W. GRADUATES: Engineers' Club, Albert Square, Manchester. "Some Aspects of Arc-Welded Design," W. Nuttall and J. E. Cross. 2.30 p.m.

*Monday, Nov. 19th.*—MIDLAND GRADUATES: James Watt Memorial Institute, Great Charles Street, Birmingham. "Differential Power Transmission Systems," B. Bramall. 6.45 p.m.

### Institution of Mining and Metallurgy

*Thursday, Nov. 15th.*—Geological Society, Burlington House, W.1. "Tunnelling in Gibraltar During the 1939–45 War," W. H. Wilson; and "Notes on the Development of the Blyvooruitzicht Gold Mining Company, Ltd., South Africa," A. Savile Davis. 5.30 p.m.

### Institution of Production Engineers

*Friday, Nov. 16th.*—MANCHESTER SECTION: Mechanics' Institute, Crewe. "Use of Disabled Personnel in Industry," A. G. Doughty. 7.15 p.m.—WESTERN SECTION: Grand Hotel, Broad Street, Bristol. "Infra-Red Lamp Heat for Paint Drying," R. E. Rowland. 8.45 p.m.—COVENTRY SECTION: Technical College, Coventry. "Control in an Automatic Foundry," W. Barnes. 6.45 p.m.

*Saturday, Nov. 17th.*—NOTTINGHAM SECTION: City Gas Showrooms, Lower Parliament Street, Nottingham. "Time Factor in Industry," E. W. Hancock. 2.30 p.m.

*Monday, Nov. 19th.*—COVENTRY GRADUATES: Gas Showrooms, Rugby. "Fine Measurement," J. H. Hobbs. 7 p.m.—DERBY SUB-SECTION: School of Art, Green Lane, Derby. "Machine Tools," L. S. Dalapene. 6.30 p.m.—HALIFAX SECTION: Technical College, Huddersfield. "Engineering Drawing in Relation to Production and Inspection," C. A. Gladman. 7 p.m.

### Iron and Steel Institute

*Saturday, Nov. 10th.*—Royal Technical College, Great George Street, Glasgow. "The German Steel Foundry Industry," Basil Gray. 3 p.m.

### Junior Institution of Engineers

*To-day, Nov. 9th.*—39, Victoria Street, S.W.1. "Quality Steel Making," A. Roebuck. 6.30 p.m.—SHEFFIELD SECTION: Metallurgical Club, West Street, Sheffield. Film on "Wheels Behind the Wheels." 7 p.m.

*Friday, Nov. 16th.*—39, Victoria Street, Westminster, S.W.1. "A Pillar of Cloud," John Duguid. 6.30 p.m.

### Keighley Association of Engineers

*Friday, Nov. 16th.*—Devonshire Buildings, Devonshire Street, Keighley. "Industrial Automatic Control," F. Blezzard. 7.30 p.m.

### Manchester Geological and Mining Society

*Tuesday, Nov. 13th.*—Queen's Chambers, 5, John Dalton Street, Manchester. "Recent Researches on Explosions in Mines: A Review of Some Results from U.S.A., France, Belgium, and Britain," H. F. Coward. 2.45 p.m.

### North-East Coast Institution of Engineers and Shipbuilders

*Friday, Nov. 16th.*—Mining Institute, Newcastle-on-Tyne. "All-Welded Oil Tanker 'Phœnix.'" W. A. Stewart. 6 p.m.

### Royal Aeronautical Society

*Thursday, Nov. 15th.*—Inst. of Mechanical Engineers, Storey's Gate, Westminster, S.W.1. First British Empire Lecture: "Australian and Empire Air Transport," W. Hudson Fysh. 6.30 p.m.

### Royal Institution of Great Britain

*To-day, Nov. 9th.*—21, Albemarle Street, London, W.1. "The Contribution of Science to Agriculture in War," W. K. Slater. 5.15 p.m.

*Tuesday, Nov. 13th.*—21, Albemarle Street, London, W.1. "After the Discovery of X-Rays," A. Muller. 7 p.m.

*Friday, Nov. 16th.*—21, Albemarle Street, W.1. "The Dispersal of Fog on Airfields," A. O. Rankine. 5.15 p.m.

### Royal Society of Arts

*Wednesday, Nov. 14th.*—John Adam Street, Adelphi, W.C.2. "Operation Pluto," A. C. Hartley. 1.45 p.m.

### Sheffield Metallurgical Association

*Tuesday, Nov. 13th.*—Metallurgical Club, West Street, Sheffield. "Technical and Economic Problems in the Heavy Iron and Steel Industry," R. A. Hacking. 7 p.m.

### Sheffield Society of Engineers and Metallurgists

*Monday, Nov. 19th.*—Royal Victoria Station Hotel, Sheffield. "Aero-Engines, 1915–45: Some Personal Impressions," G. P. Bullman. 6.15 p.m.

### West of Scotland Iron and Steel Institute

*To-day, Nov. 9th.*—39, Elmbank Crescent, Glasgow. "The Making of Manganese Steel Castings by Continuous Process," C. J. Dadswell. 6.30 p.m.