THE
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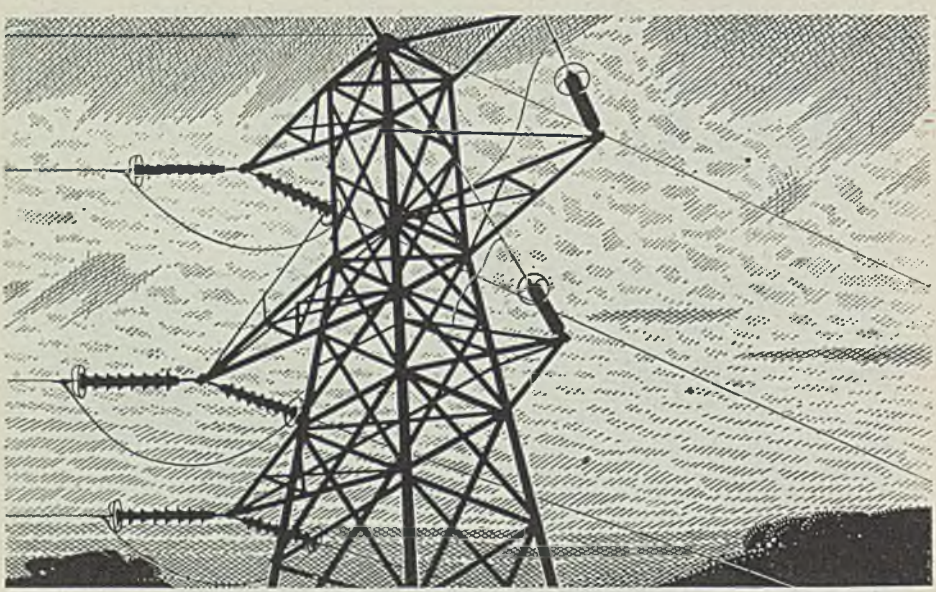

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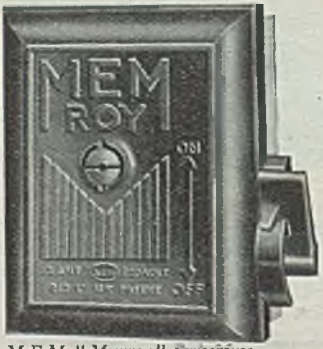

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CHIEF CONTENTS OF THIS ISSUE

Electricity Supply

THE Incorporated Association of Electric Power Companies, which embraces all the power companies, including their associated undertakings, has issued a challenging statement of the views of its members, and this makes out a strong case for free enterprise in the supply industry. After giving a word picture of the industry since 1900, it is pointed out that by 1910, 3 000 miles of transmission lines had been constructed by the companies, whereas, to-day, the figure is 48 000; that domestic consumers numbered 62 000 against the 2 000 000 to-day; and that by private enterprise, rural industries were for the first time enabled to enjoy electricity supply.

Credit for the further progress which rural electrification has made, is, with few exceptions, almost solely due to the power companies, for whereas in 1929 there were 3 700 miles of low voltage mains the mileage had increased to over 20 000 by 1938, making electricity supply available in 67 per cent. of the premises in rural areas.

Further development both in rural and urban districts was halted by the war, but the plans which the companies have made for the extension of generation and distribution, already involve a new capital expenditure of at least £100 000 000, including £50 000 000 on distribution alone. Spending at the rate of £10 000 000 a year, every undeveloped, or partially developed, area throughout the territories served by the companies is scheduled for further supplies, and so complete are the details of the schemes, that the companies await only the removal of war-time restrictions on labour and materials in order to go ahead.

Whatever may be thought on the subject of ownership, this clear-cut policy of the companies with respect to the future, stands out as an example of enterprise, not even attempted let alone approached by any other section of the supply industry, and is, to say the least, far more constructive than the pleas for nationalisation to which the last few years have given birth. While on this point, it must not be overlooked that many attempts have been made to bring discredit on the work of the companies by the argument that municipal supply is in many cases cheaper than company, but without entering too deeply into the subject it is obvious that whereas local authorities for the most part serve relatively densely populated areas, company consumers number, on an average, only 20 per mile of mains, due to the avoidance by the majority of municipalities of rural area risks and their attendant troubles. Even so, the average selling prices of power companies and of local authorities are reasonably comparable.

Those who advocate the nationalisation of the industry have not made known what is intended in the future; their policy has been one of possession

first; those who are opposed to nationalisation but advocate municipal-ownership are again without a constructive policy of the type set up by private enterprise.

Danger of Political Influence

THE industry has received a set-back during the war, from which it will take several years to recover; development and extensions have been brought to a standstill except where required for the war effort; and, we submit, to revolutionise the industry to-day, to disturb a framework upon which so much progress has already been built up, would do no more than delay the expansion which is anticipated; do no more than throw the industry into the political arena. The machinery of the supply industry of to-day may in the view of many be subject to criticism, for nothing is perfect in this imperfect world, but its record in the last forty years or so indicates that it has been both progressive and reliable; it has, furthermore, withstood the acid test of a war unprecedented in its fury, destruction and privation. We are all for improvement, but along the political road lies not freedom for development, but control—and co-operation with gas.

Victory Illuminations

ONE of the most cheering spectacles that could be staged for V-Day celebrations would be streets illuminated up to the pre-war standard, and the floodlighting of public buildings. The end of the war in Europe may come even sooner than is expected, and a supreme effort should be made by local authorities to make as bright a show as possible. Many have already reconditioned their street lamps and are ready to switch on, but others are not so far advanced in the work of restoration. The Edinburgh Streets and Lighting Committee has authorised the fullest possible illumination of the capital on Victory Day, and it is reported that the re-equipping of the lighting standards has made such progress that it is likely that full pre-war illumination will be possible. Some of the London boroughs are in an equally happy position, but it is doubtful if the metropolis could be uniformly lit in the immediate future. The urgent need for the early abolition of the war-time lighting restrictions is recognised by the Government, who are concerned mainly about the number of road deaths of which the dim-out is held to be a serious cause. The resumption of full street lighting, may in consequence, be allowed as soon as the danger of enemy piloted aircraft has been fully removed, and now is the time to prepare for it.

Northern Ireland Power Stations

THE circumstances which led up to the building of the Ballylumford power station, of which details are given elsewhere, lend special interest to the fact that simultaneously with the early stages of the work, the power station at Larne was also extended, and the additional plant put into operation nine months after construction commenced. Ballylumford itself was put into commission twenty months after the direction was given, and the station has about it several points worthy of attention. In the first place all switchgear within the station buildings is of the air-break type, and the main 33 kV gear, which is of the low oil content type, is located in an outdoor sub-station some distance away from the main building. The four 110 kV switches being installed at Finaghy sub-station are of the air-blast type and are believed to constitute the largest installation of its kind in the British Isles, for a working voltage in excess of 66 kV.

Example of Engineering Improvisation

BALLYLUMFORD has many features common to other war-time stations, such as a separate building for the control room, a separate relay room and so, all of which are made more prominent when it is realised that the only access to the site was a rather narrow road over which all building materials and plant had to be transported. Moreover, at the start of the work the site was without fresh water, electricity or gas. To cope with these difficulties, a temporary reservoir of about 100 000 gals. capacity was improvised to trap drainage of surface water and arrangements were made with the War Office for the use of an American mobile Diesel generating set to make available the necessary supply of electricity for contractors' plant.

War-Time Transport Problems

IT is interesting to recall that due to war conditions, the shipment of plant and materials from England and Scotland to Ireland became one of the major problems connected with construction at Ballylumford. As a result of enemy

action, the ports from which equipment was to be shipped were frequently closed to traffic at short notice, and it was often necessary to locate and to re-route plant which had already been despatched from manufacturers' works. Congestion at the docks also frequently resulted in delays, and it was necessary to visit them constantly—in England, Scotland and Ireland—to prevent items urgently required from becoming "buried" under other cargoes. A number of arrangements had also to be made for the transport of items of equipment which were particularly urgently required, and to convey the 72-ton power transformers and the 80-ton alternator stator from Belfast Docks to the station site it was necessary to send to Northern Ireland special road transport vehicles by arrangement with the Electricity Commissioners and the Central Board.

The Kelvin Lecture

THE subject chosen for the Kelvin Lecture of the I.E.E. is always of special interest, but that which will be dealt with this year by Sir EDWARD APPLETON, F.R.S., will command extra attention. Everyone has heard of radiolocation, everyone in this country has enjoyed a measure of protection under its beams, and on April 26 members of the I.E.E. are to be treated to an explanation of its scientific principles. Sir EDWARD APPLETON is already well known for his work in connection with the ionosphere and the behaviour of reflected waves, and for this reason his selection as the speaker for this year's Kelvin Lecture is particularly apt. The occasion will, too, see the presentation of the Faraday Medal to Dr. C. C. PATERSON and the Certificate of Honorary Membership of the I.E.E. to Mr. J. S. HIGHFIELD. In all a very promising evening.

Industry and Tax Relief

THE Engineering Industries Association has sent a timely reminder to the Chancellor of the Exchequer, that though the provisions of the Income Tax Bill actuate to give relief in respect of expenditure incurred on buildings, plant, etc., on April 6, 1944, there is no immediate relief, and that the initial and annual allowances do not become available until an "appointed date." The position in which industry now finds itself, however, is that relief is required immediately in order to assist the provision of much needed funds for rehabilitation and post-war planning. Furthermore, relief is required at 100 per cent. by way of a charge against E.P.T. liability. The association has, in the form of a memorandum to the Chancellor, therefore advocated that the initial allowance should operate as at April 6, 1944, and that the annual allowances should date from the same day.

Need of Information on Conditions

IN the same memorandum, the association draws attention to a point raised many times in these columns, namely, that the lack of information available in connection with the form to be taken by post-war credits is having a serious effect upon industrialists who are anxious to prepare their programmes for peace-time production, and who are, too, being called upon by various Government departments to make efforts in maintaining full employment. The need for a more constructive policy on post-war conditions, both with respect to taxation and materials is becoming more apparent every day, for though industry is willing to play its part in rehabilitation, it can only do so when it is aware of its commitments, its limitations, and to what extent its initiative will be allowed to operate.

Electricity and the Farmer

AT a meeting of the Farmers' Club, on Monday next, Mr. H. W. GRIMMITT is to address members on the present and future aspects of electricity in agriculture, and in view of the interest which the N.F.U. has displayed in the subject, the meeting is likely to prove most instructive. Addresses of this type cannot be too frequent for so much has been said and written on the subject of electricity and agriculture by those who know more about agriculture than electricity, that many would-be electro-farmers, if not altogether misinformed are at least, a little confused as to what can and what cannot be done in present and future circumstances. The electrical industry, both supply and manufacturing, has indicated time and again how it can serve agriculture, but no matter how much further effort is put into such service it will never be the success that it might be without the complete co-operation of the farmer.

Ballylumford Power Station

An Exceptional War-Time Achievement

ONE of the outstanding achievements of the mid-war period, it is claimed, was the erection and equipment of the 60 MW station at Ballylumford, Co. Antrim. At the beginning of 1941, when enemy air attacks threatened every industrial district in Great Britain, Northern Ireland was mainly dependent for essential electricity supplies for its war industries on the single large power station at Belfast Harbour. This station was supplying over 80 per cent. of the total requirements of the province, and, in view of the risk of large-scale interruption of war-production, the Ministry of Commerce gave instructions for a new power station to be constructed outside Belfast.

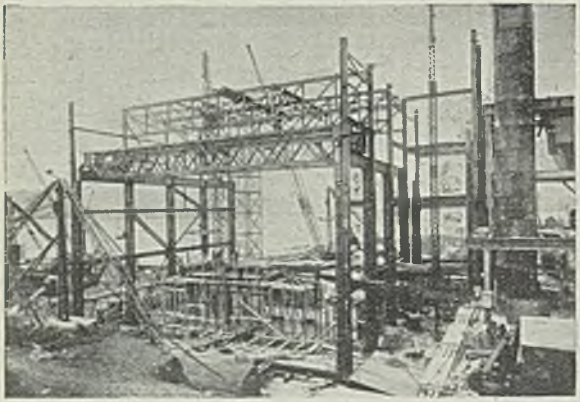
On the recommendation of their consulting engineers, Messrs. Kennedy and Donkin, the Ministry of Commerce agreed to an extension of the existing power station at Larne, utilising plant known to be available in England, to be ready for service during the next winter, and the construction of a new power station at Ballylumford on the tip of Islandmagee, opposite Larne Harbour.

The extension at Larne, comprising one second-hand 7 200 kW turbo-alternator and three new 40 000 lbs./hr. boilers, was completed and commissioned by the end of December, 1941, the time for construction being 9 months.

In view of the urgent need for the new station at Ballylumford to be commissioned in the shortest possible time the Ministry arranged with the Belfast Corporation for the transfer to that site of contracts for a 30 000 kW turbine and two 150 000 lbs./hr. boilers, which had been placed for an extension at Belfast Harbour.

Instructions to proceed with the work were given by the Ministry of Commerce on May 7, 1941, and the first sod was cut in July, 1941. The transmission system was completed in November, 1942, and the turbine was started up in December. The initial section of the station went into commercial operation in January, 1943, 18 months after the commencement of construction.

It was obvious in 1942 that further plant would be required in 1944-45 if adequate provision was to be made for the expected demand in that year, and it was decided that the additional plant capacity required should be provided as an extension at Ballylumford. Accordingly first one 150 000



In order to keep up to programme, it was necessary to check progress at frequent intervals. It was always realised that one of the limiting features would be the completion of the turbine room crane, without which it would be impossible to place the turbine condensers in position. This picture shows the turbine room crane partly erected on June 10, 1942, and it was used to locate the first half of the condenser in the turbine room on June 20, 1942

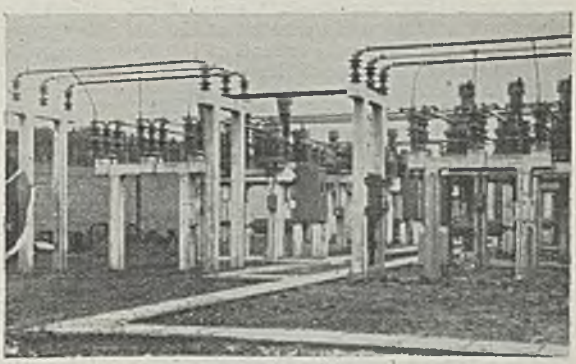
Turbine block with both halves of condenser in position at July 8, 1942

lbs./hr. boiler, and later two further 150 000 lbs./hr. boilers and a 31.5 MW turbo-alternator were placed on order. As calculations showed that it would not be desirable to perpetuate the low pressure conditions of the initial installation (220 lbs./sq. in. and 780° F.), all this new plant was designed for operating conditions of 600 lbs./sq. in. and 820° F. at the turbine stop valve. The first of the new boilers has been operating at low pressure since March, 1944. The remaining plant is due for commissioning very shortly.

All the switchgear within the station is the air-break type, and the main 33 kV switchgear is located in an outdoor sub-station some distance from the power station buildings. Oil within the station is thus limited to that essential for turbine governor gear and lubrication, and the risk of oil fires had been reduced to a minimum.

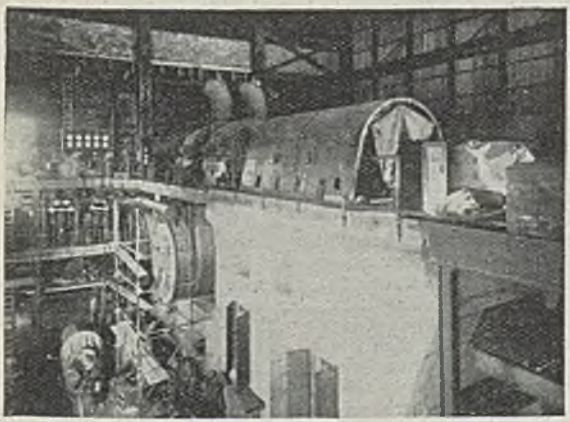
The main buildings are steel-framed with brick wall panels and reinforced concrete floors and roofs. The brick chimney is of 17 ft. internal diam. and stands 250 ft.

The coal supply is sea-borne, delivery being taken at a concrete jetty designed to berth, at any state of the tide, ships up to 2 000 tons capacity. Two five-ton travelling cranes of the portal type, with level luffing jibs and four-rope grabs, unload the colliers and discharge via two travelling feeder hoppers on to a belt conveyor having a capacity of 250 tons per hour and running the length of the sea leg of the jetty. From that conveyor the coal passes via duplicate rising conveyors, each having a capacity of 150 tons per hour, to a distributing tower at the north end of the boiler house. These conveyors, each of which incorporates a Blake-Dennison automatic belt weigher, are supported from the land leg of the jetty. A fixed feeder hopper is also provided at the heel of the jetty for receiving coal from the northern crane and delivering it on to the rising conveyors. From the distributing tower the coal can be delivered (a) direct to the boiler house bunkers which have a capacity of approximately 430 tons per pair of boilers, or (b) to the coal store situated to the east of the station, with a capacity of 22 000 tons, which can be increased to 38 000 tons.



Generation at Ballylumford is at 33 kV, and the above photograph shows the main 33 kV switchgear, which is of a pneumatically-operated low oil content outdoor type

The first two boilers installed are rated at 150 000 lbs./hr. m.c.r., the steam conditions being 240 lbs./sq. in. and 800° F. at the stop valves. They are of Babcock and Wilcox CTM type, and incorporate Green's tri-tube economisers and twin regenerative air heaters by James Howden and Co. Ltd. They are stoker-fired with single style 28 B. and W. grates fitted with standard gear boxes driven by d.c. motors. The furnaces have Bailey water-cooled side and rear walls. Each boiler has duplicate f.d., i.d. and secondary air fans by Davidson and Co., Ltd., the forced and induced draught fans being driven by single speed a.c. motors through variable speed hydraulic couplings. The f.d. fans are mounted on the firing floor, as are the "Sirocco" grit collectors, and the secondary air fans and the i.d. fans are situated in the basement. Each unit is provided with a separate self-supporting steel



Interior of turbine room on November 9, 1942

chimney, 8 ft. 6 in. diam., 120 ft. high.

For the extensions, the steam conditions are 625 lbs./sq. in. and 835° F. The first has been in commercial service for twelve months, but working at a stop valve pressure of 240 lbs./sq. in. Two further boilers will be put into commission at 625 lbs./ sq. in. within the next few months. All three boilers for the higher pressure are of B. and W. " high-head " series type. Each of the three units is rated at 150 000 lbs./hr. m.c.r. with an overload of 180 000 lbs./hr. for three hours. They are fitted with multi-loop self-draining superheaters, steel tube flash-welded steaming economisers and twin regenerative air heaters, together with duplicate forced draught, induced draught and secondary air fans by Davidson. All three units are fitted with twin style 28 stokers driven through single speed gearboxes by variable speed. a.c. motors by Laurence Scott and Electromotors. The furnaces have Bailey water-cooled front and side walls. The design of the refractory rear wall is such that it can be converted to a water-cooled wall.

On all three h.p. boilers the f.d. fans are driven by variable speed a.c. motors and are mounted in an annexe at the rear of the unit, approximately level with the air heaters. The fans are driven by two-speed 3.3 kV motors through variable speed couplings. On two units these couplings are of the hydraulic type; for the third, B.T-H. eddy current couplings have been adopted. On the first of the extension units the secondary air fans are driven by single speed motors and the fans are fitted with inlet regulator control. On the two later units these fans are driven by two-speed motors. The i.d. fans for the first h.p. boiler are situated in the boiler house basement, and discharge into a self-supporting steel chimney. Those for the two later units are located on the firing floor and discharge into a brick flue in the boiler house basement, which leads to the brick chimney. On all three units the grit collecting plant is located on the firing floor and each equipment is fitted with its own independently driven booster fan.

Air Heaters

On the two original boilers and on the first extension unit the air heaters are contra-flow, and the cool end elements are mounted in removable trays to facilitate cleaning. On the two later boilers the air heaters are of the parallel-flow type with facilities for washing the elements without removal from the rotors whilst the boiler is steaming.

Individual central supervisory control is provided on all boilers, the desk and panel type control cubicles being mounted on the firing floor adjacent to their respective units.

On all units the sootblowers are electrically operated, automatic equipment of the B.T-H. manufacture being provided.

Ash handling is carried out by a series of conveyors which deliver to elevated reinforced concrete hoppers from which lorries can be loaded. The rear stoker hoppers discharge into belts, submerged in water, running parallel to the firing aisle in covered subways formed below the basement floor. These submerged conveyors discharge on to a belt conveyor of normal design, also in a covered subway, running at right angles to the firing aisle. That conveyor discharges on to an inclined conveyor running parallel to the firing aisle, but outside the boiler house, which terminates above and delivers into the reinforced concrete hoppers. Alternative settings allow the chute to be shut off from the hoppers and emergency ashing is carried out by opening the side doors and discharging the ash into tipping trucks running on 24 in. tracks laid flush in the basement.

A pneumatic conveyor plant is provided for grit handling.

The ash handling plant was provided by John Thompson (Wolverhampton), Ltd., and the grit handling plant by Davidson and Co., Ltd.

Turbo-Alternators

The turbine is a Metropolitan-Vickers two-cylinder impulse machine, driving, at 3 000 r.p.m., a 33 kV 37 500 kVA 0.8 p.f. alternator with main and pilot shaft exciters, the latter being combined in one frame. The turbine, which has 19 stages in the h.p. cylinder and 6 in each flow of the double-exhaust l.p. cylinder, is designed for an initial steam pressure of 220 lbs./sq. in. gauge, 780° F., and exhausts at a vacuum of 29.1 in. hg. at its economic rating of 24 000 kW (29.0 in. hg. at 30 000 kW M.C.R.), to twin condensers of the Metropolitan-Vickers central-flow type.

The second turbo-alternator is also a Metropolitan-Vickers 3 000 r.p.m. two-cylinder impulse set with double exhaust, but differs from the first machine, not only in being designed for the higher steam conditions of 600 lbs./sq. in. gauge, 820° F., but also in that the most efficient rating of the turbine is at m.c.r. and that a 1 500 kW 3.3 kV house alternator is incorporated. The main alternator is wound for 33 kV as before, but the design power factor has been brought into line with the average system power factor of 0.95 so that the kVA rating of the new machine is 31 579 at 30 000 kW. To take advantage of the higher steam conditions, 23 stages are provided in the h.p. cylinder, the l.p. cylinder staging being as before. The twin condensers are also of Metropolitan-Vickers' manufacture and are designed to maintain a vacuum of 29.0 in. hg. at the turbine exhaust at m.c.r. of 31 500 kW when feed

heating. The combined surface of the two condensers is 27 000 sq. ft., and 24 000 gal. per min. of circulating water at 55° F. are required at m.c.r. The comparable figures for No. 1 set are 28 000 sq. ft. and 27 500 gal. per min.

The control of all auxiliary motors is grouped on a unit switchboard located opposite the exciter end of the machine.

Semi-automatic fire protection for the turbine oil system is provided on the Mulsifyre system. Completely automatic protection of the 3 300/400 V auxiliary transformers and the station oil storage system is also provided from the same plant.

Three tapping points are available on No. 1 turbine, but only two are at present in use to give two-stage bled steam feed heating to 190° F. at normal economic rating of 24 000 kW.

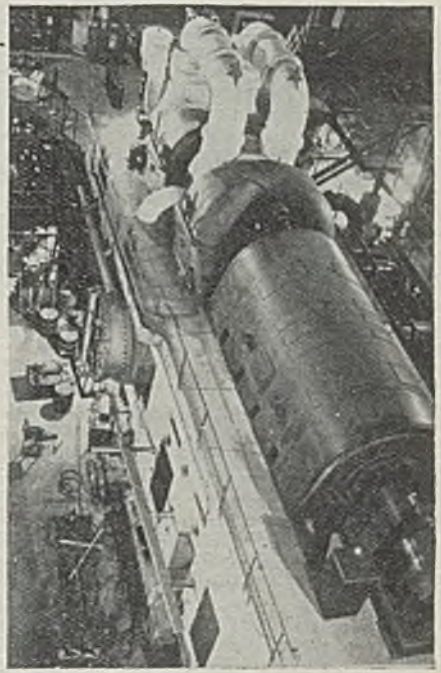
Two 360 000 lbs./hr. feed pumps—one electric and one steam — which had been ordered with No. 1 and 2 boilers, were originally provided, but this combination has latterly been strengthened by the addition of a 150 000 lbs./hr. motor driven pump for use on light loads and for " topping up " the boilers when No. 1 set is shut down. The electric pumps are driven by 1 500 r.p.m. 400 V squirrel cage motors, the remaining pump being driven by a steam turbine, arranged to start automatically on a serious fall in the feed line pressure.

A salt water evaporator was ordered from Mirrlees Watson Co., Ltd., to ensure a supply of make-up water in the event of delay in finding fresh water. Adequate supplies of fresh water were, in fact, obtained shortly after the station went into commission and are being used. The evaporator is a triple effect plant, with a maximum rating of 20 000 lbs./hr. of gained distillate. Feed water treatment is at present achieved by supplying caustic soda and sodium sulphite continuously, and sodium phosphate intermittently as required, by gravity to the feed pump suction, but a pump is now being installed to deliver the phosphate directly to the boiler drums.

Five-stage feed heating raises the condensate from No. 2 set to 340° F. at m.c.r. The three final heaters are on the discharge side of the boiler feed pumps and are provided with an automatic by-pass operated by excessive water level in any of the heater shells. Three 300 000 lbs./hr. Mather and Platt feed pumps have been installed, two of the pumps being driven by 500 H.P. 3.3 kV, 3 000 r.p.m. motors, direct-on started from the 3.3 kV auxiliary switchboard. The third pump is driven by a 3 000 r.p.m. steam turbine, with automatic starting in the event of the failure of either of the motor pumps. A bled steam evaporator, arranged to operate on sea water if necessary, is incorporated in the feed-system of the new set.

Plant for re-circulating a portion of the boiler water is to be installed.

Circulating water is obtained from Larne Lough through the intake works which incorporate two Brackett band screens, each having a capacity of 1 600 000 gal. per hr. The number of screens can, if necessary, be increased to five, and a similar screen is also installed in an emergency intake. The



No. 1 turbo-alternator

circulating water pumps are under the main engine room crane in the turbine room, in pits in the basement, and are all of Drysdale manufacture. Two pumps are provided per set, those for No. 1 set being vertical spindle centrifugals driven by 435 r.p.m. 150 H.P. 400 V Metropolitan-Vickers' motors, with rotor resistance starting. The pumps for No. 2 set are of the vertical spindle axial flow type, with 960 r.p.m. 130 H.P. 3.3 kV direct-on started motors, also by Metropolitan-Vickers.

The main 33 kV switchgear, of the outdoor type, is laid out on the mesh principle, which avoids the necessity for complicated busbar protective equipment, since each section of busbars is within the zone of protection for each alternator or transformer. The switchgear is pneumatically operated and the circuit-breakers have a

small oil content, the breaking capacity being 750 MVA.

The protective equipment for the windings of the main 30 MW alternators consists of Merz-Price circulating current equipment with negative phase sequence equipment as back-up. Each alternator is earthed through a separate 25 ohm resistance and a Metrosil surge diverter is provided for each alternator circuit. The connections between the alternators and the 33 kV outdoor switchgear are made by cable, but in the case of the main step-up transformers and house transformers which are situated adjacent to the switchgear the connections are made by short tubular conductors. The protective equipment on both the main and house transformers consists of overcurrent and earth fault equipment.

Four 37.5 MVA transformers, are used to inter-connect the 33 kV main switchgear at Ballylumford with the 110 kV system.

The station auxiliary services are fed from the main 33 kV bus-bars through two 3 MVA, 33/3.3 kV step-down transformers. A separate and independent source of supply is provided by a 1 500 kW 3.3 kV auxiliary alternator which is coupled to the shaft of turbo alternator No. 2. The 3.3 kV switchgear is accommodated in an annexe to the turbine room, and is of the air-break draw-out type having a breaking capacity of 75 MVA. The larger auxiliary motors associated with the high pressure plant, such as circulating water pumps, boiler feed pumps and induced draught fans, are fed direct from the 3.3 kV switchboard. The remaining auxiliary plant is fed from 400 V unit boards, one of which is associated with each main item of plant.

Auxiliaries in Duplicate Groups

A feature of the station is the layout of auxiliary supplies. Each 400 V unit board is divided into two halves, which are coupled together by a section switch that is normally open. The auxiliaries associated with each main item of plant are divided into two duplicate groups, one group being supplied from one half of the the appropriate 400 V unit board and the other group from the other half. The incoming supply to each half of the unit boards is separated, one being derived from the station transformers and the other from the auxiliary alternator. It is thus possible to avoid a total shutdown of generating plant through the loss of auxiliary plant, and to make it unlikely that the whole output of the station would be threatened in the event of a failure of one source of auxiliary supply. The section switches in the unit boards can be closed if one of the incoming supply switches is open and the two groups of auxiliaries can thus be fed from the same source of supply in an emergency.

A 250 kW Diesel alternator has been provided to start-up the one set in an emergency.

The control room forms a building separated from the power station and is equipped with air conditioning plant and fluorescent lighting.

Power is transmitted to Belfast over a 110 kV double circuit transmission line, approximately 28 miles in length, the connection to the 33 kV systems of the Belfast Corporation and the Electricity Board for Northern Ireland being made respectively at Donegall and Rosebank sub-stations.

New Form of Pilot Earthwire

Over a short section of the line round Belfast a new form of embedded pilot earthwire has been used to provide means of interconnecting the Finaghy, Rosebank and Donegall sub-stations for protective gear and communication purposes.

A central 110 kV switching station is now under construction at Finaghy on the outskirts of Belfast, into which the various 110 kV lines will be connected. This station will be equipped with 110 kV air-blast switchgear of the outdoor type.

Two 30 MVA 110/33 kV transformers have been provided at the Donegall substation, and these are connected to the Belfast duplicate 33 kV cable ring main by metalclad indoor switchgear having a rupturing capacity of 500 MVA. This substation comprises one link between Ballylumford and the Harbour power station, Belfast.

The consulting engineers responsible for the design, planning and construction of the station and associated transmission system were Messrs. Kennedy and Donkin, assisted by Messrs. C. S. Allott and Son, consulting civil engineers, and Mr. A. Bryett, architect. In addition to those already mentioned, the contractors included: McLaughlin and Harvey, Ltd., civil engineering works; Harland and Wolff, Ltd., structural steelwork; P. C. Richardson and Co. (Middlesbrough), Ltd., brick chimney; Bailey Meters and Controls, Ltd., boiler control panels; Mechans Ltd., atmospheric exhaust piping; Newalls Insulation Co., Ltd., lagging; F. W. Brackett and Co., Ltd., circulating water screens; Gwynnes Pumps, Ltd., Stanton Ironworks Co., Ltd., cleaning water pumps and piping; A. Reyrolle and Co., Ltd., 33 kV main switchgear; British Thomson-Houston Co., Ltd., 3.3 kV and 400 V auxiliary switchgear; Brookhirst Switchgear, Ltd., Contactor Switchgear, Ltd., motor control gear; W. T. Henleys Telegraph Works Co., Ltd., 33 kV and low voltage cables; Sturtevant Engineering Co., Ltd., control room air conditioning plant; British Electric Transformer Co., Ltd., Bonar, Long and Co., Ltd., auxiliary transformers; Herbert Morris, Ltd., engine room crane; Ransomes and Rapier, Ltd., mobile crane; Troughton and Young, Ltd., lighting and wiring; Hackbridge Electric Construction Co., Ltd., and Ferranti, Ltd., 33/110 kV transformers; J. L. Eve Construction Co., Ltd., 110 kV steel tower line; Switchgear and Equipment, Ltd., 110 kV isolating switches; Allen West and Co., Ltd., 33 kV isolating switches at Rosebank; Edison Swan Electric Co., Ltd., batteries; Automatic Telephone and Electric Co., Ltd., internal telephone system.

From Cookers to Bombers

English Electric Co. to Make Peace-time Aircraft

THE English Electric Co., Ltd., who have produced at their Preston works alone over 3 000 bombers during the war—an average of one and a half a day in the peak period—are to make the design and construction of aircraft a regular branch of their business in peace-time. This was announced by Sir George H. Nelson, chairman and managing director of the company, at a luncheon to the Press last week on the occasion of a visit to the Preston works, arranged in co-operation with the Ministry of Aircraft Production.

In a brief tour of the works, where, before the war, the products ranged from electric irons to electric locomotives, the visitors were given a comprehensive view of the processes from which finally emerges the Halifax bomber, capable of carrying a bomb load of an aggregate weight of 12 000 lbs., or one bomb of 8 000 lbs.

The complete story of its electrical equipment and the electronic devices that ensure accurate navigation and bombing, even when the target is obscured by cloud has yet to be told. Some details of the instruments have already been published; others remain a secret for the time being. The visit was concerned mainly with the manufacture and assembly of the metal and plastic components of the structure of the aircraft, and it was not possible in the time available to examine the electrical installation, which is put in as assembly proceeds. There are miles of wire and a number of small motors, while the pilot, navigator, the wireless operator, the bomb aimer, and the engineer are provided with separate panels of indicators and controls.

View of plastics section, showing the forming of bomber nose, canopies, etc.

Tool room at English Electric Co.'s Preston works

On their arrival at the works the visitors were welcomed by Sir George Nelson and introduced to the guides who were to conduct them through the various departments and explain their functions. After a glimpse of the employment, drawing and accounts offices, the party came to the progress department from where the manufacture of the component parts is controlled. At the peak of the activities of the works this department was dealing with 30 000 requisitions week by week, and a million and a half of component parts were going into one store alone.

In the tool room skilled tool-makers operating a large number of machines driven by individual electric motors, were producing all the tools and jigs required for making and assembling components. In the details department all sorts of shapes and sizes of metal parts were being turned out from one of the latest rubber presses capable of exerting a pressure of 8 000 tons.

Another process of considerable interest was that of the electrical heat treatment of certain metal parts, but the greatest attraction was the plastics department, where the perspex nose, canopies, and so on, are moulded and processed. The party saw a large sheet of perspex being heated on a thick, thermostatically-controlled electric hot-plate, the elements of which are similar in operation to those on a domestic cooker hot-plate, and so arranged that the heating is perfectly uniform. The perspex used for this purpose is $\frac{5}{8}$ths of an in. thick, and while being softened to the required state of plasticity it is covered with a blanket to prevent loss of heat from the surface. In about half an hour it is ready for moulding. The matrix is in a continuation of the hot-plate, and the moulding is done, not by pressure, but by vacuum suction. The team engaged on this process have to work very rapidly. On this occasion a scanner " blister " for the under part of a bomber was required. Throwing off the blanket, the team seized the edges of the sheet of transparent plastic material, which now had the pliability of rubber, lifted it from the hot-plate and moved it rapidly along the smooth surface until it covered a deep depression of the appropriate shape. Here it was fixed in position by weighted clamps and the electrically-operated vacuum suction gradually made a perfect moulding, which assumed its permanent shape in about three minutes. It was then ready for cutting, the surplus material being trimmed off by a mechanical cutter. The nose and canopies of the aircraft are formed in the same way. In the illustration the hot-plate and mould are seen on the left, there is a " blister " on the floor at the end, and two noses, with apertures cut to receive triplex glass windows, are on one of the benches.

Radial drilling and routing section at Preston works

All the automatic hand tools used in this and other departments are pneumatically-operated, the compressors being driven by electric motive power.

The Halifax is an all-metal machine and 30 000 parts go to its construction. Most of these are riveted, and, apart from the tanks, very little is welded. Girls were seen doing spot-welding with machines designed and built by the English Electric Co.

As they saw ribs, outer wings, main centre sections and fuselages assuming shape largely under the hands of women in the assembly departments, the visitors were impressed by the scheme of ordered progress, efficient planning resulting in smooth-running co-ordination of work. These major components are despatched by road for final assembly at the company's aerodrome. Here the main assembly, which includes the installation of the four Bristol-Hercules engines, is carried out in eight stages and occupies four and a half days. On completion the aircraft are tried out by the company's own test pilots.

The visitors were taken in motor coaches to the aerodrome, and after light refreshments in the canteen, they toured the final assembly and flight sheds. Flight demonstrations by test pilots had been arranged, but these had to be abandoned because of bad weather.

Before the war, in 1938, 1 500 workpeople were employed at the Preston works on the production of electric locomotives and motor coach stock, Diesel-electric and Diesel-mechanical traction stock, battery locomotives, railcars, tramcars, trolley-buses, 'bus and coach bodies, electric cookers and cooking equipment, electric fires and water heaters, electric washing machines and small domestic appliances. At the peak period last year the work people numbered 13 500, of whom 40 per cent. were women, drawn mainly from the cotton industry. In addition to bombers, electric cooking and canteen equipment for war industries and British restaurants, have been included among the war-time products.

Inevitability of the War

In proposing at the luncheon the toast of " The Press," Sir George Nelson, referred briefly to the history of the company, and said it was really a group of companies co-ordinated under one management. His association with the company dated from 1930, and the scope of its activities had since extended to cover the whole field of electric power generation, distribution and utilisation. At that date its turnover was about £2 000 000 and it had 4 000 people on its pay-roll. Today its turnover was about £25 000 000 and it employed 25 000 people; those figures did not include those of their subsidiaries.

During the five years before the war he was a frequent visitor to the Continent, and so convinced was he that war was inevitable that he made representations to

Government circles and offered the services of the company's organisation for the urgently needed rearmament. In 1936 their school and training facilities for draughtsmen and tool-makers were greatly extended to be ready to meet any demands that might be made upon their productive capacity.

First Hampden in 15 Months

Sir George emphasised that there was no need when war broke out, for the company to make any step in the direction of aircraft production, because in peace or war the basis of production was electricity, but they did so because of their patriotism and they felt it was necessary for the safety of the people of this country to increase aircraft production. In 1938 they were asked to start with the Hampden bomber, and with complete confidence in the team he had at the back of him he said they could produce a Hampden medium bomber in 18 months. They were able to do it entirely with their own organisation, except for one man loaned to them by the designing firm, in 15 months. Similarly they produced the Halifax 4-engined bomber in 18 months from the time they started, without any outside help.

To meet the eventual production programme the Preston works area was greatly increased, resulting in a total area including the final assembly and flight sheds of nearly 2 000 000 sq. ft. They had to make their own jigs and tools in their own organisation, and for the Hampden bomber they produced 40 000 jigs and tools costing £1 250 000. They had to tackle the production of the Halifax in the same manner, and from designs supplied from the Handley Page works they made a further 83 000 jigs. They did it with skilled labour; there was only 5 per cent. of unskilled labour. It cost somewhere in the neighbourhood of £1 900 000.

Parallel with the production of bombers at Preston they had continued to make cooking equipment for war works canteens. Referring to the production programmes at the company's other works, Sir George Nelson mentioned that at Stafford were made tanks of the Covenanter, Centeur, Cromwell and other types, aggregating thousands; tens of thousands of precision aircraft instruments for various purposes; hundreds of thousands of Service radio transformers; cathode-ray ignition testers for internal combustion engines; electrical equipment for magnetic minesweepers; dynamometers for testing aero engines and at the same time converting their output into usefully employed electrical energy; electric propulsion and auxiliary equipments for submarines, and so on. It could be said that Stafford played a very important part in winning the Battle of the Atlantic. The Rugby works supplied hundreds of Diesel generating sets for ships, including minesweepers, submarines, aircraft carriers and troop transports; Diesel generating plant for aerodromes; complete transportable Diesel-electric engines for locomotives which served with our armies overseas; steam turbines were provided for ships auxiliaries, and many large steam turbo-alternator sets were supplied to various power stations to meet the demands of expanding war industries. The Bradford works were engaged in the production of electric generators for ships auxiliaries and "degaussing" sets for combating magnetic mines; high frequency alternators used in destroying acoustic mines, naval rangefinding, fire direction and control equipment, including gear for the gun mountings and various equipments for stabilising naval depth charge mortars; searchlights, sound locators and predictors, etc., and electric mining locomotives for Russia.

£60 000 000 above Normal Turn-over

Some indication of the additional productive capacity necessitated by these and other war activities, was given by the fact that the value of the products amounted to £60 000 000 above the normal turn-over of the company's established business, and the combined floor area of the four main works was increased from the pre-war figure of some 1 700 000 sq. ft. to the present figure of over 3 360 000 sq. ft.

Speaking of the future, Sir George said it had been demonstrated during the war that the experience and resources of the company had and could continue to make a valuable contribution to design and manufacturing technique of aircraft, the board felt it its duty to once more establish that field as part of its regular activities. They had been fortunate in obtaining the services of Mr. E. Petter, one of the outstanding designers of aircraft, as their chief engineer and designer and he was busy building up his technical team. Their policy would be not to compete with the aircraft industry, but to co-operate with it. That decision would not detract them from their normal activities in heavy electrical engineering, in rolling stock and road vehicles, in steam and water turbines, or Diesel engines, or in the field of domestic electric appliances.

Electrical Workers' Wages.—It is announced that the Industrial Court has rejected a claim that the present war bonus of 6d. an hour in the electricity supply industry should be increased to 8d. an hour. The Court is not satisfied that any substantial change in conditions arising out of the war has taken place which would warrant an increase in the existing war bonus.

Earth Fault Protection—II

By TESTAX

Voltage-Operated Leakage Trips.—Fig. 4 shows the connections of a voltage operated earth leakage trip, the leakage trip coil L being connected between the metal-work enclosing the conductors and the earth electrode; the coil being so designed that when the metal-work exceeds a certain voltage

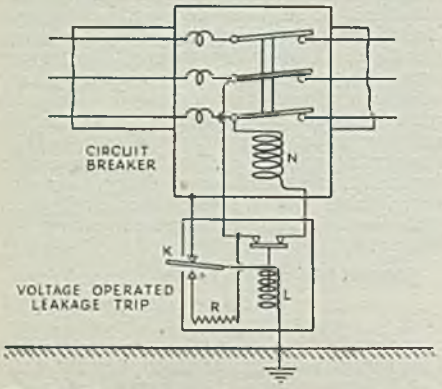


Fig. 4.—Connections of voltage-operated earth leakage trip

above earth, usually less than 40 V, the coil opens contacts to de-energise the no-volt coil N of the switch. Generally a fraction of an ampere leakage is sufficient to operate the trip so that it is not necessary to have a very low resistance earth electrode for the trip coil. Frequently a testing key K is provided by means of which the trip coil can be disconnected from the metal-work of the earthing system and connected to one pole of the supply through the high resistance R.

If one leakage trip is provided for the whole installation, a fault on one item will, of course, cause the whole installation to be put out of action, but this can be avoided by using separate leakage trips for each individual circuit. The advantages of this device are that a low resistance electrode is not necessary, the trip operates without necessitating the passage of a high leakage current, and the trip can readily be tested; these points are decidedly in favour of the use of such trips, at any rate for the heavily rated circuits. The trip must be used in conjunction with some form of circuit breaker.

It should be borne in mind that there must be no possibility of the leakage trip coil being short circuited due to accidental or intentional contact of the metal-work on the installation and earth. A short circuit between the points X and Y in Fig. 5 would cause the trip to operate only on a high volt drop between X and Z. It may, therefore, be desirable to use insulated wire to connect the trip coil to its earth electrode, and the trip coil electrode must be placed outside the resistance area of any other electrode which may be provided for direct earthing. Where an intentional or accidental connection of the metal-work with earth is in existence it is advisable to connect the leakage trip coil to the end of the circuit remote from the direct earth connection. For example, considering a direct earth fault at a motor on an installation fed at 230 V to earth and having a direct earthing electrode of 0.2 ohm resistance and a continuity resistance of 1 ohm, as indicated in Fig. 5. The maximum possible fault current will be $\frac{230}{1.2} = 192$ A, the maximum volt drop from P to Z will be 192 V, with 38 V drop from Z to earth. It will be noted that in spite of the dangerous voltage existing on the case of the motor the leakage trip coil will only receive 38 V, or less if the resistance areas of the electrodes overlap. If, however, the trip coil is connected to the motor case it will receive the full voltage. In many cases the electrode resistance will be higher than the continuity resistance but this may not be the case for, say, a

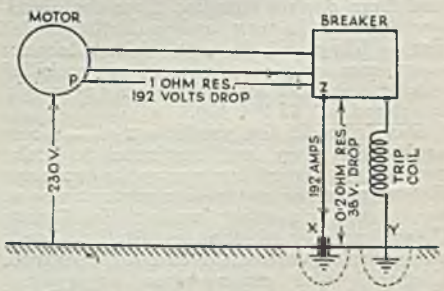


Fig. 5.—Possible effect with direct earthing connection

motor directly-coupled to a pump drawing water from a river or other source. In all cases the continuity resistance should be kept as low as possible in order to avoid such risks. The voltage-operated leakage trip, when properly connected, directly controls the possible voltage on the metal-work but only indirectly controls the possible earth leakage current, this depending

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largely on the resistance of any direct earthing connections.

Current-Operated Leakage Trips and Neutral Point Earthing.—Usually the current-operated earth leakage trips operate on unbalanced current in the supply phases.

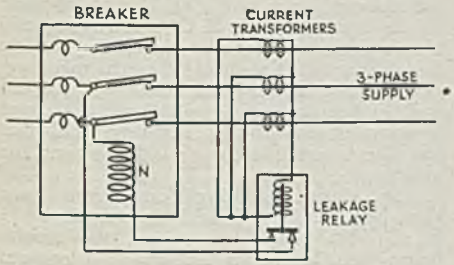

Fig. 6.—Connections of current-operated leakage trip

One current transformer through which all the conductors of one circuit pass, or separate transformers connected as in Fig. 6, may be used to energise the leakage relay. Under normal conditions the algebraic sum of the currents in the circuit will be zero, but if an earth fault occurs the leakage current will pass out through one or two lines and return to the supply plant through the earthing system. There will then be a resultant current in the relay which should trip the circuit breaker, provided the leakage current is high enough. This device must be used with direct earthing protection of low resistance and, whilst it directly controls the maximum leakage current, t only indirectly controls the possible voltage on the framework of the plant, as this will depend on the resistance of the direct earthing system. The trip may be used on the main or on individual circuits and can be used with a circuit breaker or a special type of fuse.

The voltage and current-operated leakage trips can, of course, protect against faults on the consuming side of the circuit breakers only, so that the metal-work on the supply side of such breakers must be efficiently earthed to ensure operation of the protective gear belonging to the supply authority in the event of a fault on the supply side of the main breaker.

Since, in most cases, the earth continuity resistance can be kept reasonably low by careful installation and maintenance, coupled with periodical tests, the main difficulty is likely to occur in maintaining an earth electrode of low resistance. If the earth electrode provided for the supply system is available at the supply plant or main transformer, and the metal-work of the consumer's plant is directly connected to that electrode, the earth leakage current from all metal-sheathed and bonded conductors does not have to pass between the electrode and earth. This is a decided advantage in ensuring the passage of sufficient earth fault to operate the overload trips or fuses, but there exists a risk that a fault on the supply plant or transformer may render the whole of the consumer's metal-work alive at a dangerous voltage if the electrode has a high resistance.

Periodical Tests of Earthing System.—To facilitate the carrying out of periodical tests of earthing resistance required by the various authorities, it is an advantage to have a definite system, otherwise the tests may take a considerable time. The first essential is a diagram of the whole of the earthing system and this may be combined with the general wiring system in the manner indicated in Fig. 7 In this scheme a full line indicates wiring carried in conduit or metallic sheathing which is bonded to the plant at both ends, a double full line indicates a conductor which is used purely for earthing, whilst a dotted line indicates conductors such as cleated v.i.r. which are not surrounded by bonded sheathing.

A chart should be prepared to correspond with the diagram. The chart indicated in

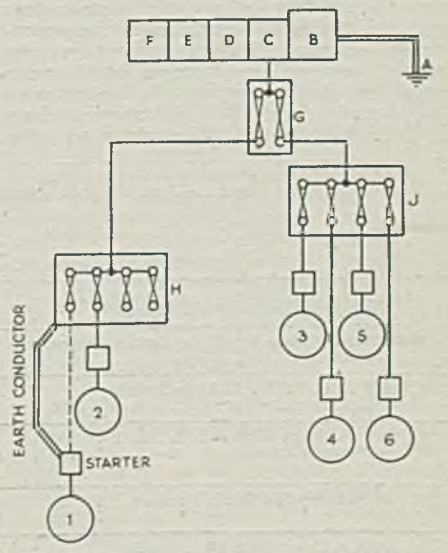

Fig. 7.—Schematic diagram of lay-out of section of power installation

Table 1 acts as a key to the diagram and also provides for the entry of the test results. The earth electrodes may be tested by passing a.c. between the earthing electrode and an auxiliary electrode, measuring the voltage between the earthing electrode and a voltage spike midway between

the electrodes, or by the use of a direct reading ohmeter in the manner previously mentioned. For testing continuity resistance a useful piece of apparatus is a short length of fairly heavy flexible cable having 4 strong spring clips. The earth testing ohmeter may be used or a battery, ammeter, low reading voltmeter, and two testing prongs can be employed. After isolating the circuit, the three phase terminals at the supply end can be short circuited together and to the metal-work at the supply end by means of the flexible and clips, a preliminary test being made by passing current between the terminals and metal-work to ensure the connections are of low resistance.

The testing set can then be taken to the next distributing centre, for instance the set may be used at G with the clips on C. Current is first passed between each pair of phase terminals at G to obtain the resistance of two of the current-carrying conductors in series. It may be found that the results are not the same for each pair of terminals, in which case high resistance connections or contacts on the current-carrying conductors should be looked for. If the results are substantially the same for each pair, half of one reading will give the resistance of one of the conductors and this should be recorded in the appropriate column. Testing current is then passed between one terminal at G and a point on the connection of the outgoing metal-work from G. Subtracting from indicated resistance thus obtained, that of one cable conductor gives the resistance of the earth continuity conductor from C to G. and this also should be recorded in the appropriate column. If the earthing conductor has a high resistance in comparison with the conductor the second test should be repeated to a point on the metal-work on the incoming side of G, a low resistance then indicating that the trouble is due to a high resistance connection of the incoming or outgoing metal-work to G. A further test to the case of G will show the exact location of the faulty bonding, and this may be entered in the remarks column for attention.

The short circuiting connections may then be placed on G and tests made at H in the same way, and so on, the results being recorded as in Table 1. A column is provided for the sum of the total earthing resistance from each point to earth. In the case of sheathed metal-work earthed to the system earth electrode, it is suggested that the resistance of the earth electrode be excluded from the total resistances entered in the sixth column. An alternative method of testing could be employed, the short circuiting connections being left on C and tests made at each point G, H, J, and the starters to give the total earth continuity resistance to C. When the motors are close to their starters it may be convenient to make a single test of the continuity resistance by passing current directly from the starter case to the motor frame, using a trailing return cable. If this is not practicable the stator terminals of

TABLE 1.—METHOD OF RECORDING RESULTS OF EARTH RESISTANCE TESTS.

	Item.	Excess Current Device.	Res. of one Current Conductor.	Res. of Earth Continuity Conductor.	Total Res. to Earth.	Remarks.
A	Earth Plates outside Switch Room	—	—	—	Ohm. 0.32	
B	1 200 A. Main C. B. in Switch Room	Amps. 1 600	—	0·005	0·325	
C	400 A. C. B. No. 12578 in Switch Room	500	—	0·015	0·34	
G	200 A. 2-way Dis. Box in No. 1 Machine Shop	1 290 2 290	Ohm. 0·014	0·045	0·385	Res. of earthing conductor high due to bad bonding to G.
H	60 A. 4-way Dis. Box in Foundry...	1 80 2 80	0·09	0·15	0·535	
1	30 H.P. Compressor Motor outside Foundry	60	0·04 0·08	0·06 0·12	0·595 0·715	
2	30 H.P. Fan Motor No. 22639 in Foundry	60	0·07 0·08	0·038 0·05	0·573 0·623	
J	60 A. 4-way Dis. Box in No. 1 Machine Shop	1 60 2 60 3 60 4 60	0·03	0·04	0·425	
3	25 H.P. Motor No. 13806 in No. 1 Machine Shop (Lathes) ...	50	0·22 0·06	0·12 0·03	0·545 0·575	

the motor should be short circuited to the case and tests made from the starters, first finding the resistance of one of the cables in the usual way. If the starter terminals are short circuited and the tests made at the motor the resistance of the stator windings will give misleading results for the cable resistance.

It is suggested that the overload trip settings or the melting current of the fuses be entered on the chart, as in column 3. It is then a simple matter to calculate if the earthing resistance is low enough to pass sufficient fault current, especially if a table or curve showing the maximum possible fault current with a given earthing resistance is available. For example the maximum possible fault current at Motor No. 1 is $\frac{230}{0.715} = 322$ A which is greater than the operating current of the excess current protective devices back to G. The maximum possible fault current at C, however, is $\frac{230}{0.34} = 678$ A, which is less than the trip setting of B. The principal resistance at C is due to the earth electrode and if this cannot be lowered the switch B might be connected to the earth connection for the system neutral, or a trip operated by leakage voltage or current be employed.

New Ceramic for Fused Plug

A NEW ceramic, named Alorite, which, it is claimed, has unprecedented physical and mechanical properties, was introduced to representatives of the technical Press and others at a demonstration of their domestic standard fused plug and socket held by the directors of Dorman and Smith, Ltd., at the Regent Street Polytechnic, London, on April 4. A description of this fused plug and socket appeared in THE ELECTRICIAN on May 12, last year. The insulating tube housing the fuse and forming the body of one of the pins of the plug is made of Alorite. This material was subjected to severe mechanical tests.

Introduced by Major R. Amberton, Mr. C. Nesbit, sales manager, said the object of the demonstration was to prove to sceptics the claims of the company as to the mechanical and electrical efficiency of the fuse. Experiments with the ordinary electric porcelain for the insulating tube gave one or two failures, so they looked for something of greater mechanical strength and produced a ceramic, which they called Alorite. It was harder than a diamond; sandstone or carborundum stone made no impression on it.

The remarkable strength and hardness of the material was demonstrated by several tests. With one of the small fuse tubes Mr. Nesbit made scratches on a piece of glass. The tube was then subjected to an impact test in a machine with a heavy pendulum that broke a porcelain tube without any check in its swing, but stopped at the Alorite tube without making any impression on it, although swung against it several times. Other tubes of the new material were impressed by a powerful hand press through pieces of $\frac{1}{4}$ in. mild steel and also a piece $\frac{3}{16}$ in. thick. As further proof of the mechanical strength of the ceramic one of the tubes was placed in a lathe, and it cut shavings from carbon steel.

As to its electrical efficiency, Mr. Nesbit said Alorite had all the dielectric qualities one could wish for. One of the tubes was immersed in water for 24 hours and then roughly dried, and no difference in its weight could be detected. When put through the ordinary flash test at 2 000 V there was no flash at all. With the fuse under load up to blowing point the maximum temperature obtained was 55.5° C. above ambient (a total of 75.5° C.).

No rise in temperature could be detected in the pins of a plug that was said to have been carrying 13 A since 9.30 that morning—a period of two hours. It was then tested successfully with 22 A to prove that it was a genuine 13 A fuse and could stand the greater capacity. Its discriminating qualities were demonstrated against a h.r.c. fuse of 15 A capacity. The fuse in the pin blew, leaving the larger one intact. To show that the plug could be handled safely under any circumstances it was plugged in on a heavy short circuit, which was opened without any perceptible flash or report.

The tube housing the fuse has both ends protected by $\frac{3}{8}$ in. brass caps one of which makes contact in the socket. It screws into the terminal block against a spring, which prevents loose contact.

For this domestic standard fused plug and socket it is claimed that it is safe; that its small pin centres make it easy to manipulate; only one size is required for an electric clock or a 3 kW load; the socket goes comfortably into a standard cast iron round B.S.S. conduit box; as a plug is virtually a component of the apparatus to which it is connected it can be provided with the appropriate size of fuse, 2, 5, 10 or 13 A; and both plug and socket are easy to wire.

Gas v. Electricity.—By invitation, representatives of the Wessex Electricity Co. and of the Oxford Gas Co. argued the case for their respective commodities at a parish meeting at Cumnor.

Standing Cost Allocation in Supply

Further Communication Respecting the E.R.A. Method

IN a previous communication* an outline was given of an improved method, evolved by the E.R.A., for allocating the demand-related portion of the standing cost of electricity supply. Its main features are (a) Introduction of the concept of "potential peak periods," i.e., periods during which there exists a potentiality of the annual m.d. on a supply system or part of such a system arising; (b) allocation of demand-related cost to be based jointly on the consumption and the highest demand within the potential peak periods, and (c) no allocation to be made to consumption and demand outside these periods.

Based on principles suggested by the American engineer, W. J. Greene, the E.R.A. method can be best illustrated by using the following symbols and definitions, in which the word "system" denotes both a comprehensive system or a part, depending on the object of the allocation† :— C, total annual demand-related cost in respect of a system; d, highest demand ($\frac{1}{2}$-hour basis) of a component load during the potential-peak periods; D, sum of the d's involved ($D = \Sigma d$); k, annual consumption of a component load during the potential peak periods; K, sum of the k's involved ($K = \Sigma k$); P, annual collective m.d. on the system; T, aggregate annual duration of the potential peak periods; x, a share of demand-related cost, allocated per kWh of consumption during the potential peak periods; y, a share of demand-related cost, allocated per kVA or kW of highest demand during the potential peak period.

The allocation to a component load is given by the formula $kx+dy$.

In order to determine the factors x and y, two equations are necessary. The first expresses the fact that the cost to be allocated must equal the sum of the allocations to the individual component loads involved, i.e.,

$$C = \Sigma(kx) + \Sigma(dy) = Kx + Dy.$$

The second is derived from the consideration that if the magnitude of a component load is constant throughout the potential peak periods, such component is bound to add its full demand to the absolute system peak, at whatever time within the potential peak periods the latter may occur. Consequently, such a load monopolises an amount of system capacity equivalent to its demand. As the total demand-related cost is C and the system m.d. (assumed to equal the system capacity) is P, the corresponding cost per kVA or kW of system capacity is C/P, and this is at the same time the correct allocation per kVA or kW of such a load of constant magnitude. Assuming a

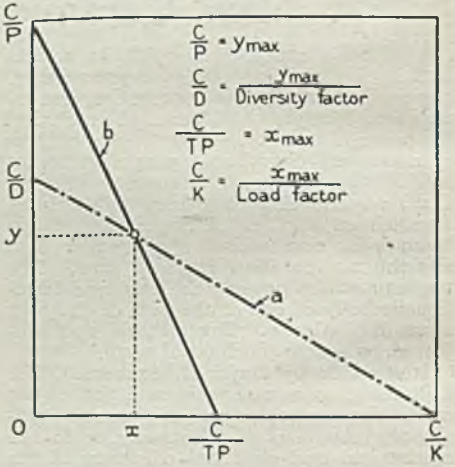

Fig. 1.

power factor of unity, the annual consumption per kW, k, during the potential peak periods is $1 \times T = T$ (kWh). Thus for 1 kW of such a load the allocation $kx+dy$ becomes $Tx+y$, and this must equal C/P. The required second equation is, therefore, $C/P = Tx+y$.

In the actual calculation of x and y it is convenient to express x in £ sterling per 1 000 kWh.

The highest demands, d, and the consumptions, k, during the assumed potential peak periods have, of course, to be ascertained for each of the component loads involved.‡ In the first place, the allocation is to be based on the classes of consumers supplied from the system in question. The annual kWh-consumption of each class is known, and by using an estimated load factor, the corresponding m.d. can be calculated. The preparation of tables for estimating load factors is under consideration. If, in exceptional cases, the annual m.d. of a component load is not expected

* "Standing-Cost Allocation in Electricity Supply," ELEC., April 6, 1945.

† Any allocation of demand-related cost must at least distinguish between h.v. and l.v. systems.

‡ It will be remembered that when applying the peak-responsibility method, the demand of the components at the time of the system peak must be ascertained.

to occur within the assumed potential peak periods, the corresponding d must be estimated from load curves. Sometimes, actual records of the highest demand will be available.

Estimation of the consumptions during the potential peak periods is easiest when the latter conform to meter-reading periods, though the practice of " continuous meter reading " entails additional approximation. If, for instance, the potential peak periods for a given system are assumed to comprise the hours from 7 a.m. to 11 p.m. of all the days of the two winter quarters, the k's can be found from the total consumptions during the two quarters by deducting an estimated proportion in respect of consumption during off-potential-peak (night) hours. Such estimate can be based on information as to the composition of the load concerned, load curves, etc.

Once the class allocations have been established, further sub-division within a class can be effected similarly. For example, the amount allocated to the class of domestic consumers may be sub-allocated as between consumers on the " all-in " tariff and the rest.

The import of the two basic equations can be illustrated graphically. In Fig. 1 the chain-dotted line (a) represents the first, and the solid line (b) the second equation, the solution, x and y, being given by the intersection of the two lines. The possible range of x and y is determined by the line (b), since for a given system the demand-related cost C and the capacity (identified with the m.d. P) are given.

The position of the line (a) depends on D, the sum of the component demands, and K, the total consumption, i.e., on the characteristics and composition of the actual load on the system concerned. The illustration shows that the lower C/D in relation to C/K, the lower, relatively, will be y, and the higher x.

As D denotes the sum of the component m.d.'s, it is in fact directly proportional to the diversity factor (as confined to performance during the potential peak periods), which in the above symbols is D/P. On the other hand, K depends on the system load factor (as referred to the aggregate of potential peak periods), represented by K/TP, and the higher this " period " load-factor, the nearer will be the x-intercept of line (a) to be x max, thus making for a relatively higher x.

Hence, with relatively high system diversity a component load having low period load factor, i.e., comparatively high d and low k, will receive a relatively lower allocation ($kx+dy$) than if the diversity were low, and with increasing system load factor the allocation to a component load with high period load factor, i.e., comparatively low d and high k, will become relatively higher than in the case of a load with low period load factor. This shows how the allocations made are influenced by the likelihood of a component load contributing to the system m.d.

If, in special circumstances, one is certain that a particular component load will occur in full at the time of the annual system peak, then such load is, of course, to be treated according to the conventional peak-responsibility theory, and the E.R.A. method applied to the rest only. A case in point is the load due to radiant heaters in systems whose m.d. occurs during cold snaps.

News in Brief

I.E.E. Scottish Centre.—According to the annual report of the Scottish Centre, membership for the 1944/45 session totalled 1 287, as compared with 1 179 for the preceding year. Membership of the Dundee Sub-Centre was 130, and of the Scottish Students' Section, 238, an increase of 50.

Lighting Plant Damage.—At a meeting of the Sheffield Lighting Committee the Engineer reported upon the extensive damage that was being occasioned to street lighting plant. During January and February over 300 small electric lamps had been stolen from street lamps and over 2 400 lantern panes had been maliciously smashed.

Edinburgh V-Day Lighting.—The Streets and Lighting Committee of the T.C. has authorised the fullest possible illumination of the capital on the evening of V-Day. At a meeting of the Committee recently, it was reported that the re-equipping of the lighting standards had made such progress that full pre-war illumination would likely be possible.

Nairobi " Blackouts."—Brief black-outs in the electricity supply in and around Nairobi recently puzzled engineers, until it was discovered that a species of large bird, known locally as " black storks," with a wing span of more than six feet, had collided with supply lines when alighting or taking wing. Over a dozen were found dead below the lines.

Oliver Lodge Scholarship.—To commemorate the 25th Jubilee of the Radio Section of the I.E.E., a research scholarship to be called the Oliver Lodge Scholarship has been founded. It will have a basic annual value of £250 and will be tenable for one year, but may be extended for a second. Further particulars from the Secretary of the I.E.E. The closing date for receiving nominations is May 15.

Electrical Personalities

We are always glad to receive from readers news of their social and business activities for publication in this page. Paragraphs should be as brief as possible.

Dr. H. H. Ballin, for many years lighting engineer with the General Electric Co., Ltd., has been appointed commercial manager of the illuminating engineering department of Thorn Electrical Industries, Ltd. Dr. Ballin, apart from his activities in the field of illuminating engineering, has devoted considerable time to the study of the history of electricity supply and hopes to publish a book on this subject in the near future.

Dr. H. H. Ballin

Mr. T. W. Dann, chief engineering assistant at Poplar, has been appointed borough electrical engineer at Tunbridge Wells.

At Darwen Town Council, on April 6, tributes were paid to **Mr. F. M. Fletcher,** borough electrical engineer for 26 years, who has retired.

Mr. F. J. Cole, borough electrical engineer and manager at West Bromwich, has been appointed electrical engineer at Blackpool in succession to **Mr. H. F. Shanahan,** who is retiring, at a salary of £1 490, rising in two years to £1 750, plus cost of living bonus.

Mr. A. J. Crocker, works manager with C. A. Parsons and Co., Ltd., at Heaton, for 32 years, has received a presentation from the officials and staff of the firm on his retirement. Mr. Crocker joined Parsons in 1896. At the age of 22 he became a foreman, and 10 years later works manager.

As a result of the entrance scholarship examinations, held at Faraday House Electrical Engineering College, on March 20, 21 and 23, the following awards have been made: Faraday Scholarship of 80 guineas a year for two years, Richard Arthur Arno Newman (Raynes Park County School); Maxwell Scholarship of 60 guineas a year for two years, Derek John Thorpe (Council and County Schools); exhibitions of the value of 20 guineas for two years, Alan Francis Durham (Kingston Grammar School), David Jeffery Newnham (Penzance County School), and David John Norton (Oldenham).

Messrs. Charles and **Richard Hinde** have retired after having jointly served 114 years with the Automatic Telephone and Electric Co., Ltd., where they have for many years been engaged on fine instrument design. In 1888 the twins, then 14 years old, started work together with the company. In 1938 each completed 50 years unbroken service, and each was presented with a gold medallion in the design of an automatic telephone dial inset in the ten finger-holes with rubies for each five years of service. They were then working in secrecy on the development of the distant reading gyro-magnetic compass, the story of which has recently been told. They postponed their retirement and continued through the war years to work in secrecy on this and other work closely connected with the war-effort. During the 1914-18 war the brothers worked on an anti-submarine device. As a parting gift their fellow-workers presented each with a clock, set in a representation of an automatic telephone dial in a handsome wooden case. Numeral holes of the dial are engraved with special jobs which the twins have done, entitled "Milestones along a record route."

Charlie (left) and Dick Hinde at work on the distant reading gyro-magnetic compass

Obituary

Commander J. A. Binnie, R.N., works manager of the transformer department of Ferranti, Ltd., since 1931, in action. From Charterhouse, he went to the R.N. College at Dartmouth, passing out in time to serve as a midshipman in the Battle of Jutland. After the last war he went up to Cambridge to study science, and proceeded thereafter to devote himself to research and development, particularly connected with anti-submarine defence, in which he became an acknowledged expert. He rejoined the Navy in 1939.

Process Heating Field

The Place of Radiant and High Frequency Methods

A PAPER on "The Place of Radiant, Dielectric and Eddy-current Heating in the Process-Heating Field," by Messrs. L. J. C. Connell, O. W. Humphreys and J. L. Rycroft, was read at a meeting of the I.E.E. on April 5.

If the fullest advantage is to be gained from the rapid developments which have taken place in connection with radiant and high-frequency methods of heating, stated the authors, care must be exercised in the selection of the applications for which they are recommended. Although many processes can be carried out more effectively by the new methods, there is still a very real place for contact and convective heating. The purpose of the paper was to facilitate this selection.

The paper first reviewed the various methods of heating, indicating the physical laws and practical considerations by which they are governed and the rates of heating which may be obtained. An endeavour was then made to classify, in terms of their technical requirements, the types of application for which each process is best suited. Finally, several specific applications were considered in some detail, and it was shown that processes having a superficial similarity may nevertheless possess features, not at first apparent, which are of sufficient importance to warrant the use of different methods of heating.

Mr. S. G. King (Electric Furnace Co., Ltd.) said that the right way was to consider heating problems from the thermal point of view and then decide what was the best method of bringing about the required temperature. It might be that in some localities gas or oil would be best, and electrical engineers should fearlessly say so. One of the great outlets for eddy-current heating was surface hardening. He felt that the greatest use for induction or eddy-current heating might turn out to be not for this purpose at all, but for the heating of certain shaped parts prior to working on them by stamping, or forging, or some other process. There was great scope for a combination of different heating methods. Much of the literature was rather confusing, and it was useful to think of induction heating as a phenomenon associated with current and dielectric heating as a phenomenon associated with voltage. In the one case high current was required, and in the other high voltage was necessary.

Dr. L. Hartshorn (National Physical Laboratory) said that in studying this subject the authors had very properly taken the conventional point of view, but it was useful to approach it from several different points of view. Deliberately taking one which was scientific or theoretical he had been impressed not with the essential difference between eddy-current and dielectric heating, but with the essential sameness of these together with radiant heating. It had been said that radiant heating was a class in which an external source of heat was employed, but from the scientific point of view the lamp used for radiant heating was no more a source of heat than was the h.f. oscillator used for h.f. heating, or the radio transmitter. They were all generators of magnetic waves and the efficiency in all cases was very much the same. A point he insisted on, not as having any great practical importance but as important in giving a useful insight into the nature of the process, was that all that was effected was the absorption of electromagnetic energy, and that that absorption was measured by the absorption coefficient or power factor, which were merely different measures of the same quantity. But a useful point brought out in his approach to the problem was that it was assumed that the efficiency was controlled by power factor or absorption coefficient. Theoretical considerations, however, showed that this was not so. The methods of heating dealt with in the paper were not in competition with old-established general purpose methods. They were special tools to be used judiciously to meet the special details of individual problems.

Mr. J. C. Lowson (B.T-H. Co., Ltd.), confining his remarks to lamp radiant heating, said that controlled ventilation was of considerable importance to obtain the most efficient result. By comparatively simple means it was possible to avoid overheating the equipment and at the same time to avoid cooling the work unnecessarily. He showed a slide indicating the basic principle of a ventilation control system which has been found to work very well in practice. In this system, the equipment was kept cool; the incoming air was warmed by contact with the lamp bulbs; and the low velocity air over the entire lamp bank formed a cushion which prevented the fumes from reaching the reflectors, thus helping to keep them clean. A light screen, open at top and bottom, placed around the tunnel, prevented direct draughts from blowing through the equipment and obviated glare from the lamps.

He challenged the authors' implication that for general applications the trough was more efficient than the individual circular reflector and thought it was misleading to take as a criterion of efficiency the number of watts that could be put into a given size of plant. The important thing was the ratio of input watts to useful work done, and a more fundamental criterion of efficiency was the watts expended per article produced. The only fair way of comparing two such heating systems was to compare the watts input of two plants giving the same production of the same article. Where it had been possible to make such a comparison, the individual circular reflector system showed a saving of 25 per cent. or more as compared with the trough system. It was interesting that American practice was based on the individual reflector.

Mr. F. E. Rowland (General Electric Co., Ltd.) said he wished to dispel any idea that lamp heating was still largely in the experimental stage. Not only was it well established, but there were operating equipments having a capacity of from less than 1 kW to 500 kWs. This form of heating could be applied in small units, which made it very flexible, and at the same time to conveyor production lines. Lamp heating had achieved outstanding results during the war, one instance being connected with the manufacture of huge numbers of petrol cans, which had played an important part in our victories from El Alamein to the Ruhr. Other instances were the drying of finishes of aircraft components. In these and in many other directions the drying times had been enormously reduced. He showed slides illustrating a large number of applications of lamp heating and included one of an adjustable plant for stoving painting repairs on aircraft. Finally, an illustration was shown of the most up-to-date construction, this being in sections which were withdrawable for servicing.

Dr. J. H. Nelson (Messrs. Lucas), referring to the latest American practice, said the type of lamp with a reflector incorporated in the bulb had been adopted, thus enabling a closer spacing of the lamps. These were mounted in a double walled enclosure so that very good heat insulation was obtained and the contacts were kept cool. One of the difficulties in this country was that our lamps would not withstand high temperature and it was necessary to lose the benefit of some of the enclosure in order to keep the contacts cool. However, by keeping the contacts out of the oven, the problem was solved. The application of lamps for small installations made possible the use of lamps of the dull emitter type, and these were available in 700 W size instead of 250 W, which made them particularly attractive. He wished that more had been said by the authors with regard to the gas oven, as although the problems of control were difficult they had been overcome. Very uniform heating was obtained by this means.

Dr. H. P. Zade (Arc Manufacturing Co., Ltd.,) mentioned a number of instances in which the problems involved were solved only by a judicious use of two heating methods. In the case of drying the coating on arc welding electrodes, for example, it was necessary to adopt a combination of forced convection heating and radiant heating, the latter being applied for a short period after the former had dealt with the large amount of moisture in the coating. The original attempt to do the work solely by radiant heating did not bring about the desired result.

Mr. Humphreys replying to some of the points raised in the discussion, said that as to the relative merits of trough reflectors and individual reflectors, he would not advocate the former in all cases. For large plants there was no doubt that lamps with internal reflectors were wanted. There was such a reduction in maintenance and such an increase in intensity that he could not see how they could fail to be the most suitable so long as the plant was sufficiently large for any lack of concentration in reflection to be unimportant. With a single reflector irradiating a small object, it was essential to control the radiation very closely, but in the case of a plant heating thousands of objects, if the radiation missed one it would strike another, and that was all that was required. Undoubtedly there was room, in radiant heating, for more than one method just as in any process of heating there was room for several methods. As to gas tunnels, they were excellent from many points of view, but one purpose of the paper was to give guidance as to whether to adopt radiant heating, and having decided to do so, then one could make a choice between electricity and gas.

Electric Kettles and Irons.—The Central Price Regulation Committee has approved the following prices for kettles and irons manufactured by Verona (Jabez Bate and Co. Ltd.): 5 pint electric kettle, No. X91: manufacturer's selling price, 21s.; wholesale, 24s. 9d.; retail, 33s. 5 pint electric kettle, No. X91/B: 25s. 8d., 30s. 3d. and 40s. 4d. Electric iron No. 312: 11s. 3d., 14s. 1d. and 18s. 9d. Electric iron No. 312.B: 10s. 8d., 13s. 4d. and 17s. 9d. These prices are exclusive of purchase tax. The following prices for the Criterion electric iron, complete with flex', manufactured by Criterion Electric Ltd., have been approved by the Committee: Manufacturer's selling price, 18s. 8d.; wholesale, 23s. 4d.; retail, 31s. 1d. These prices are exclusive of purchase tax.

Electricity Supply

Sheffield.—Mains are to be extended at a cost of £17 592.

Hackney (London).—The Electricity Committee is seeking sanction to borrow £3 500 for meters and sub-station plant.

Southwark (London).—The Electricity Committee is to provide a supply to Metco Ltd., at a cost of £2 100.

Battersea (London).—Telpher plant is to be replaced by the Electricity Committee at a cost of £4 000.

Bexhill.—Sanction has been obtained by the Electricity Committee to borrow £1 000 for cookers and electrical apparatus.

Darwen.—The Electricity Committee has undertaken to lay a cable for the supply of current to Sunlight Laundry.

Warrington.—The Gas Committee has decided that the lighting of the gas showrooms shall be by electricity.

York.—The Electricity Committee is seeking sanction to borrow £1 670 for extending the supply to Upper Poppleton.

Birkenhead.—The Electricity Committee is to provide supply to bungalows at Bebington at a cost of £3 365.

Chesterfield.—The Electricity Committee is seeking sanction to borrow £1 200 for supply to Boythorpe colliery.

Salford.—The Light Heat and Power Committee is seeking sanction to borrow £16 500 for sub-stations.

Southport.—The Electricity Committee is to change over supply in the Birkdale area at a cost of £9 505.

Guildford.—The Electricity Committee is to provide supply to the Stoke Hill estate at a cost of £8 745, and to the Westborough estate at £4 197.

Barking.—The Barking and Ilford Joint Sewerage Board is to purchase a Diesel engine for the pumping station at a cost of about £6 000.

Cheltenham.—The meter rental of 1s. per quarter for consumers taking supplies under the domestic two-part tariff, has been abolished.

Nelson.—The T.C. is making application to the Electricity Commissioners for sanction to borrow £1 500 for unspecified works.

St. Pancras (London).—The Electricity Committee is to extend distributing mains in Albany Street, Rechill Street, and Parkway at a cost of £930.

Morecambe.—An interconnecting feeder cable is to be laid between Lancaster Road and Broadway sub-stations at a cost of £1 397.

Coventry.—The Electricity Committee is to instal plant at Longford power station at a cost of £9 600, reinforce the distribution system at a cost of £40 000 and provide a new primary sub-station in the Whitley area at a cost of £100 110.

Darlington.—The T.C. has applied to the Electricity Commissioners for sanction to borrow £3 465 for the supply of electricity to Neashams Brickworks. Alterations are proposed by the Council to the e.h.t. supply in the Eastbourne area at £3 184.

Manchester.—The Electricity Committee is to reconstruct the railway viaduct at Stuart Street power station at a cost of £25 550; provide ash disposal plant at Stuart Street at £55 900 and lay a 33 000 V main transmission line from Barton power station to Bechill sub-station at a cost of £15 900.

Poplar (London).—The Electricity Committee has decided that an annual charge of £1 10s. be made for each post-office telephone kiosk supplied with electrical energy, such charge to be based on the use of a 25 W lamp, and that a *pro rata* increase be made where higher voltage lamps are used.

Tynemouth.—At a meeting of the Electricity Committee the Electrical Engineer reported that as a result of the industrial development of the West Chirton estate, inquiries were being received regarding the terms on which the Corporation was prepared to supply electrical energy for industrial purposes, and he recommended that the terms which had already been quoted in certain cases should be adopted as a standard tariff for large factories. The Committee fixed the price at £4 5s. per kW of m.d. per annum plus .5d. per unit.

Contracts Open

WE give below the latest information regarding contracts for which tenders are invited. In the case of overseas contracts, particulars are to be had from the Department of Overseas Trade, Millbank, London, S.W.1 (corner Horseferry Road), unless otherwise stated.

Tees-side Railless Traction Board, April 20.—Supply of two 300 kW mercury arc rectifiers and associated equipment. Specification from the Clerk to the Board, Municipal Buildings, Middlesbrough; deposit, £5 5s.

Cleethorpes T.C., April 23.—Supply, delivery (and erection of high tension, low tension switchgear) for the following: (a) H.t. switchgear; (b) l.t. switchgear; (c) 500 kVA transformer and (d) h.t. cable. Specification from Mr. B. S. Lord, Electricity Showrooms, Grimsby Road, Cleethorpes.

Industrial Information

Export Research Organisation.—Among the five industrial companies who have been enrolled in the British Export Trade Research Organisation, in addition to the 18 original founder members, are Babcock and Wilcox, Ltd., and R. A. Lister and Co., Ltd.

Production and Engineering Bulletin.—The April issue of this publication by the Ministries of Labour and Production, contains special articles on aids to industrial safety, some aspects of re-instatement, and quality control in die-casting.

Drumm Battery Co., Ltd.—It is announced that the board of directors of the Drumm Battery Co., Ltd., Eire, have recommended to the Eire Minister for Industry and Commerce that the company should close down. The Minister has accepted the board's recommendation, and arrangements are being made for the company to go into voluntary liquidation.

Osram Bulletin.—In the current Osram bulletin and G.E.C. progress sheet there are articles on "Air Movement for Ventilation," by R. H. Holbreche; "Electronics and the Electrical Industry," by F. E. Henderson; "A Re-lighting Scheme in Western Australia;" "Electrical Cooking Equipment in Aircraft," by F. E. Buckell; "Infra-red Lamp Heating in Industry," and "Osram Fluorescent Tubular Lamps."

Language Courses for Business People.—Special facilities for the study of Russian, Polish, Czechoslovak, Roumanian and Serbo-Croat are offered by the School of Slavonic and East European Studies, a central activity of the University of London, to people sent to them by commercial firms with a view to foreign trade relations. Fresh courses are planned for next October. Special emphasis is laid on acquiring a good commercial vocabulary for trade agents; and a technical vocabulary for engineers.

Machinery, Plant and Appliances (Control) Orders.—The Machinery Licences Division of the Board of Trade has been merged with the Industries and Manufactures (Engineering) Department. In future all applications for licences to supply controlled goods under the Machinery, Plant and Appliances Orders, and all related correspondence, should be addressed to the Assistant Secretary, Industries and Manufactures (Engineering) Department, Board of Trade, Millbank, London, S.W.1.

Export Licensing Relaxations.—Further relaxations in export licensing control are made by a new Board of Trade order which came into operation on Monday. Under this order various classes of goods, including electric lamps, are removed from the export control schedule and consequently will in future require export licences only when sent to the small number of countries to which the export of all goods is still controlled. The U.S.S.R., Turkey, and Rio de Oro have now been removed from the list of destinations to which the export of all goods is prohibited.

The Electrical Age.—The April issue of this quarterly magazine of the E.A.W., includes a detailed account of the visit which Miss C. Haslett recently made to Sweden and Finland. Miss Vera Norvick contributes an article entitled "What is Electrical Education?"

Additions to our Diet.—No. 66 of the Cheerful Rationing series of cards published by the E.A.W., gives recipes for the Swedish meat loaf, doughnut rings, soda cakes and other dishes. A fuel hint suggests that the household lighting installation might be improved by a systematic overhaul.

New Industries at Belfast.—Three new factories are being established in Belfast under the auspices of the Ministry of Commerce. One is already in existence and producing electric batteries. The second is nearing completion, and the third is intended for the production of dry cell batteries.

Metal Prices

		Monday, April 9. Price.	Inc.	Dec.
Copper—				
Best Selected (nom.)	per ton	£60 10 0	—	—
Electro Wirebars ...	,,	£62 0 0	—	—
H.C. Wires, basis ...	per lb.	9 7/8d.	—	—
Sheet	,,	10 7/8d.	—	—
Phosphor Bronze—				
Wire(Telephone)basis	,,	1s. 0 1/16d.	—	—
Brass (60/40)—				
Rod, basis	,,	—	—	—
Sheet ,, ...	,,	—	—	—
Wire ,, ...	,,	10 7/8d.	—	—
Iron and Steel—				
Pig Iron (E. Coast Hematite No. 1)...	per ton	£7 13 6	—	—
Galvanised Steel Wire (Cable Armouring) basis 0.104 in. ...	,,	£28 5 0	—	—
Mild Steel Tape (Cable Armouring) basis 0.04 in. ...	,,	£20 0 0	—	—
Galvanised Steel Wire No. 8 S.W.G. ...	,,	£26 0 0	—	—
Lead Pig—				
English	,,	£26 10 0	—	—
Foreign or Colonial	,,	£25 0 0	—	—
Tin—				
Ingot (minimum of 99.9% purity) ...	,,	£303 10 0	—	—
Wire, basis... ...	per lb.	3s. 10d.	—	—
Aluminium Ingots ...	per ton	£85 0 0	—	—
Spelter...	,,	£25 15 0	—	—
Mercury (spot) Warehouse	per bott.	£69 15 0	—	—

Prices of galvanised steel wire and steel tape supplied by the C.M.A. Other metal prices by B.I. Cables Ltd.

Company News

RHEOSTATIC CO., LTD.—Fin. div. 8%, mkg. 12% (same). Net pft. £9 730 (£8 784).

WILLIAM DOXFORD AND SONS LTD.—Intm. on ord 5% (same).

CANADIAN MARCONI.—Div. 4 cts. per sh. (Can. curr.), payable June 1.

COLUMBIA GAS AND ELECTRIC CORPORATION.—Div. 10 cts. per sh. on com.

STEWARTS AND LLOYDS, LTD.—An. div. on defrrd. stk. 12½%, less tax (same).

BRAZILIAN TRACTION LIGHT AND POWER CO., LTD.—Div. on no par value ord. $ per sh. (same).

A. REYROLLE AND CO., LTD.—Fin. div. on ord. of 7½% (same) for 1944, again mkg. 12½% for yr. Net pft. £114 771 (£117 532).

PENNSYLVANIA POWER AND LIGHT CO.—Gross inc. 1944 $50 944 521 ($49 500 305), net inc. $5 645 583 ($5 828 009).

CRAVEN BROS. (MANCHESTER) LTD.—Fin. div. 15%, mkg. 20% (same). Net pfts. are stated as £70 366 (£69 235), £1 131 increase.

LOUISIANA POWER AND LIGHT.—Gross income 1944 $13 309 726 ($12 332 236). Net income $1 082 829 ($923 752). Earned per 1st prefd. sh. $18.22 ($15.54).

TELEGRAPH CONSTRUCTION AND MAINTENANCE CO., LTD.—Fin. div. 5% (same), mkg. 10% (same). Net pft. 1944. £50 710 (£51 488).

MEXICAN ELECTRIC COS.—Net operatg. rev. for 1943 $2 439 653 ($2 470 867). Blce. of cons. income $1 119 579 ($1 287 399). Deficit fwd. $3 049 027, (£3 195 553).

PINCHIN JOHNSON AND CO., LTD.—Fin. div. on ord. 7½% (same), mkg. 10% less tax (same). Net pft. for 1944 is stated as £526 661 (£573 237).

FESCOL LTD.—After taxn. £11 000 (£28 000), etc., net pft. 1944 £6 829 (£6 738) plus £10 881 (£10 294) brot in. To pref. div. £1 925 (same), ord. div. 9d. per sh. (same) £1 873, gen. res. £2 000 (£2 353), fwd. £11 912.

NIAGARA HUDSON POWER CORPN. (U.S.)—Consd. operatg. revs. 1944 $115 302 911 ($117 735 040). Net income $5 380 306 ($5 583 150). Earned per 1st prefd. sh. $14.20 ($14.74).

BRUSH ELECTRICAL ENGINEERING CO., LTD.—Fin. div. 6%, mkg. 10%, less tax (Fst. and fin. 9%). Pft. for 1944. £147 257 (£175 002). To gen. res. £40 000 (£25 654), and £11 560 (£11 532) is carried fwd.

GENERAL HYDRAULIC POWER CO., LTD.—Gross receipts £180 107 (increase £22 918) from London and Liverpool undertakgs.. Yr's net receipts £27 395 (£22 975), less fees, N.D.C. and superannuatn. leavg. pft. £22 857 (£20 216). Deduct pref. and ord. divs. leavg. £24 861 (£24 504) carrd. fwd.

RADIO CORPN. OF AMERICA.—Consd. gross income 1944 $326 421 913 ($294 535 362). Taxes $29 947 900 ($26 124 000). Net income $10 263 191 ($10 192 452). Pref. divs $3 152 801 ($3 182 535). Common $2 771 123 ($2 771 088). Earned per commn. $.51 ($.50). Earned surplus $43 645 087 ($41 605 651).

HOUSTON LIGHTING AND POWER (U.S.).—Operatg. revs. 1944 $20 041 002 ($19 255 396). Taxes $2 929 893 ($3 916 196), net pft. $2 958 413 ($2 831 233). Prefd. divs. $387 148 ($315 078), surplus for com. £2 571 265 ($2 516 155). Earned per com. $4.96 ($5.03).

WORTHINGTON SIMPSON LTD.—Trdg. pft. 1944 £194 933 (£134 629). To taxn. £146 675 (£88 494), depreen. £12 495 (£12 396), dirs.' fees £1 200 (same), deb. int. £4 444 (same), staff pension fund £7 027 (£6 889), leavg. net pft. £23 092 (£21 106), plus £30 064 (£28 189) brot. in. Pref. div. absorbs £3 111 (£3 031). Ord. div. 8% (7%), gen. res. £5 000 (£5 000 defrd. maintenance), fwd. £30 965.

AUTOMATIC TELEPHONE AND ELECTRIC CO., LTD.—Net tradg. pft. for 1944, £279 206, increase £23 769. Div. from subsids., etc., £20 594 (£25 515). Pft. £299 800. Depreen. takes £65 963 (£58 833), fees £2 453 (same), off patent rights, etc., £1 455 (£1 634), leavg. blce. £14 366 higher at £226 678 for inc.-tax gives net pft. £97 771,£12 937 increase. War contingencies receive £30 000 (£20 000) and pref. and ord. divs. £73 185. £124 934 fwd.

BRITISH INSULATED CABLES LTD.—Int. and div. from subsids., £208 873 (£189 714), mkg. with tradg. pft. total of £1 106 358 (£1 130 253). After chargg. £249 264 (£256 626) for depreen., £11 712 (£11 662) dirs.' fees and bonus, £3 965 £3 671) dirs.' works committee remunern. and £493 284 (£566 482) provision for inc. tax, net pft. £348 133 (£291 812). Pref. div. and intm. on ord. absorbed £78 750 and fin. and bonus on ord. £150 000, again mkg. total distributn. 20% for yr. After transferrg. £100 000 (same) to contings. res: carry-fwd. £409 867 (£390 484).

CENTRAL LONDON ELECTRICITY, LTD.—Rev. total £3 450 345 for 1944 (£2 956 887). Sale of current rose £486 980 to £3 284 238 and rental of apparatus £5 450 to £84 771. Rents £76 673 (£75 607) and sundry receipts £4 664 (£4 701). Exes. £2 265 998, £22 289 increase. Net rev. blce. £1 184 348 creditg. gross int. of £44 127 (£34 948), makes available £1 228 475 (£748 126). Deb. int. £41 061 (£41 261) and other int. £10 827 (£9 975)—gross in both instances. Sinkg. fund "A" £218 847 and sinkg. fund "B" £295 597 (£67 426 and £158 302). Inc. tax takes £109 176

(£26 004), and net income £552 967 (£445 158). Carry fwd. £1 790. Associated Electricity Undertakings (Holding Co.) net pft. for 1944 £238 211, (£244 423), includg. surplus tax funds of £23 646 and £17 889. A further £24 000 (£16 000) from res. is added to pfts., also £615 brot. in, mkg. £262 826. Pref. divs. take £75 400 and the 4% less tax, on ord., will absorb £186 368, leavg. £1 058 fwd.

LANCASHIRE ELECTRIC LIGHT AND POWER CO., LTD.—At the annual meeting held in London on March 27 Sir Joseph Nall, the chairman, said that in the year 1944 the company sold 1 401 million units of electricity, including surplus sold to the Central Electricity Board. This compared with 862 million units sold in 1939, an increase of 539 million units. The gross operating revenue in 1944 amounted to £3 301 000, compared with £1 576 000 in 1939, an increase of £1 725 000, while gross operating expenditure in 1944 was £2 516 000, compared with £916 000 in 1939, an increase of £1 600 000. Their three generating stations, which were scheduled by the Central Board as "selected" stations, operated without interruption throughout the war period and the maximum demand imposed upon the undertaking reached the record high level of 217 000 kW during 1944.

LANCASHIRE DYNAMO AND CRYPTO LTD.—The annual meeting was held in London on April 5, when Mr. H. W. Bosworth, the chairman, stated that the balance sheet disclosed a most satisfactory position, output and profit having achieved a fresh record. During the year the company had exported a very appreciable percentage of its output and would gladly play its part in carrying out any export policy laid down by the Government.

COMPANY MEETINGS

British Insulated Cables

Extract of Chairman's Statement

The annual general meeting of British Insulated Cables, Ltd., will be held on April 19, in Liverpool.

The following is an extract from the statement of the chairman, Sir Alexander Roger, K.C.I.E., circulated with the report:—

The total profit for the year is down, on balance, by £23 895. The final distribution on the ordinary capital is at the same rates as for some years. Our production of cables and insulated conductors has been enormous, and for such widely diversified uses as in tele-communication, ships, aircraft, tanks, and all other mechanical vehicles; in the equipment of munition plants and airfields, and in the maintenance and extension of essential supply services.

Our production of insulated wires has been astronomical; in five years approximately 18 000 000 miles have been supplied to the Services for use in electrical apparatus, instruments, mines, and even dam-busters. The company has achieved an equally impressive output of condensers and other components for radio, telephone and telegraph equipment, aircraft navigating instruments, anti-submarine devices and mines; of moulded plastic products for Service equipment; and of electric welding machines and magnetic moulding machines for munition factories—also large quantities of shell and bomb cases and a variety of shell bands, fuses and primers.

We are giving an increasing amount of thought to the post-war era. Plans cannot be finalised until uncertainty is removed, in particular as to the degree of controls in the future.

Automatic Telephone

"George" and Other Aircraft Equipment

The twenty-fifth ordinary general meeting of the Automatic Telephone and Electric Co., Ltd., will be held at Liverpool on April 19.

The following is an extract from the statement of the chairman, Sir Alexander Roger, K.C.I.E., circulated with the report:—

The profit on trading is £279 206 compared with £255 437, and net profit is £226 678 compared with £212 312. The directors recommend a final dividend of 7 per cent. on the ordinary stock, making 10 per cent. for the year, plus a cash bonus of 2½ per cent., and a dividend of 10 per cent. on the deferred stock and shareholders plus a bonus of 2½ per cent.

You will have noticed during February the release of details regarding the distant reading compass which has provided a degree of reliability and adaptability under operational conditions, which has proved a tremendous factor in the success of bombing. This amazing aid to air navigation was designed for mass production by your company. Among other items are the automatic pilot known affectionately as "George", aircraft radio, Piezo crystals, aircraft wiring and many other forms of electrical equipment.

Due to E.P.T., the sum available for dividends and reserves has not increased to any great extent. This is symptomatic of British industry and illustrates the heavy financial burdens which have to be carried. I, with chairmen of other companies, have been expressing the urgency of a re-examination of our taxation structure if British industry is not to find itself at a financial disadvantage vis-a-vis its overseas competitors.

COMPANY MEETINGS

ASSOCIATED ELECTRICITY UNDERTAKINGS

Lord Lytton's Review

The annual meeting of London Associated Electricity Undertakings was held in London on April 11.

In moving the adoption of the report and accounts for the year, the Earl of Lytton, chairman of the company, said:—

The last published accounts of Central London Electricity were those for the year 1939.

The years 1941 to 1943 were most anxious and difficult. Sales of units fell from 432 million in 1938 to 303 million in 1943, a reduction of 129 million, or 30 per cent. The number of consumers fell from 86 000 to 53 000, or 39 per cent. The cost per unit was greatly increased owing to the fixed charges (in the case of generating costs, 40 per cent. of the total) falling on a much smaller output and to progressive increases in the price of coal. In 1938 it was 2s. 2d. per ton; in 1944 it was 45s. 4d., an increase of 116 per cent.

For 1942 and 1943 a readjustment of Sinking Fund contributions was granted by the Electricity Commissioners, subject to the funds being restored to normal at the earliest opportunity and payment of dividends being subject to the Commissioners' consent until this had been done.

Bulk supply stations were damaged on 55 occasions; 139 transformer chambers were damaged; 1 424 cables were put out of action. The amount of war damage is estimated at £600 000.

1944 showed a recovery over the preceding year. Units sold increased to 348 millions, and the number of consumers to 76 684. Revenue increased by £487 000.

The balance sheet shows a very liquid position. Cash in hand and on loan to subsidiaries at short notice total £1½ million. The dividend paid on ordinary capital was 3 per cent. for 1944. Balance carried forward is £1 790.

Dividends received from Central London Electricity amount to £215 175, as compared with £226 824 last year. The directors propose to transfer £24 000 from stockholders' reserve account, and recommend a dividend of 4 per cent. Stockholders' reserve account stands at £35 000.

ASSOCIATED ELECTRICAL INDUSTRIES

Record Orders

The forty-fifth annual general meeting of Associated Electrical Industries Ltd. was held on Thursday, April 5, in London.

Lieut.-Col. Sir John R. Chancillor, G.C.M.G., G.C.V.O., D.S.O., presided, and in the course of his speech said:—

The proprietors will have noted with satisfaction the strength of the balance sheet, and particularly of the consolidated balance sheet.

We anticipate that for some time to come there will be no lack of orders and that we shall be fully employed on our normal products after the war comes to an end.

For many years before the war the combined research departments of the group occupied a premier position in the electrical industry, and they have contributed in no small degree to recent scientific discoveries and to the improvement of engineering design and technique which these discoveries have brought about.

So far back as 1936 the Metropolitan-Vickers Co. began to assist the Government in the development and manufacture of various forms of equipment for the fighting Services. Since then the scope and volume of that work has steadily grown. Full accounts of our contributions to the defence and war programme and of the achievements in this direction cannot yet be given, but it is now permissible to indicate the wide range that this work has covered.

The most notable of that company's contributions have been in connection with the development and manufacture of Radar equipment, automatic pilots, gun mountings and controls and aircraft. Some idea of the magnitude of this work can be gauged by the fact that during the period indicated it has been found necessary to increase our manufacturing floor space by more than 50 per cent.

At this stage of the war it is natural that the thoughts of directors and officials should be turned to the problems of the post-war period; and in our deliberations the measures to be taken to maintain and increase our export business have occupied a prominent place.

We have been told that in order to pay for the imports necessary to enable us to maintain our present standard of living, the value of our exports must be increased by 50 per cent., but with Germany and Japan out of action for some years to come it should not be beyond our power.

Commercial Information

County Court Judgments

NOTE.—The publication of extracts from the "Registry of County Court Judgments" does not imply inability to pay on the part of the persons named. Many of the judgments may have been settled between the parties or paid. Registered judgments are not necessarily for debts. They may be actions. But the Registry makes no distinction. Judgments are not returned to the Registry if satisfied in the Court books within 21 days.

ROSE, Leslie H., 173, Dovercourt Road, Horfield, Bristol, wireless repairer. £17 8s. 11d. Jan. 25.

PURVES, Wm. R. C., 3, Sandringham Avenue, West Bridgford, radio engineer, £11 19s. 6d. Jan. 17.

COOKSLEY, T. C., 72, Gayfere Rd., Stoneleigh, electrical contractor. £30 11s. 3d. Feb. 5.

DIALS RADIO (a firm), 7, Dyke Road, Brighton, radio dealer, £28 3s. 9d. Feb. 8.

Satisfactions

EAST FERRY CRANE AND ENGINEERING CO., LTD., Rainham.—Sat'n. Feb. 21, of deb. and collateral charge reg. Mar. 11, 1939.

E. A. GARDNER AND SONS LTD., Maidstone, engineers.—Sat'n. Mar. 9, of charge reg. May 2, 1936.

Mortgages and Charges

NOTE.—*The Companies Act of* 1908 *provides that every Mortgage or Charge shall be registered within* 21 *days after its creation, and that every company shall, in its annual summary, specify the total amount of debt due from it in respect of mortgages or charges. The following mortgages and charges have been registered. The total debt prior to the present creation, as shown in the annual summary, is given—marked with an *—followed by the date of the summary, but such total may have been reduced.*

SOUTH WESTERN ELECTRICAL ENGINEERING CO. LTD., Twickenham. February 23, £2 000 debenture, to Thames Photographic Co. Ltd., general charge. *Nil. September 2, 1944.

WAGHORN ELECTRICAL CONTRACTORS LTD. London, S.W. March 10, debenture, to Barclays Bank Ltd. securing all moneys due or to become due to the Bank; general charge.

Application for Discharge

TREW, Donald Archibald McDonald, 36, Binley Avenue, Binley, Coventry, lately carrying on business at 59, Primrose Hill Street, Coventry, as "Trew Electrical Service," electrical dealer. Date of hearing April 16, 1945, 11 a.m., The County Hall, Coventry.

Coming Events

Friday, April 13 (To-day).

I.E.E., N.E. STUDENTS' SECTION.—Newcastle-on-Tyne. "CO_2 Measurement," R. Lord. *6.30 p.m.*

Saturday, April 14.

I.E.E., LONDON STUDENTS' SECTION.—Visit to the Nine Elms Works, Battersea, of the Gas Light and Coke Co. Ltd. *2.30 p.m.*

A.M.E. and M.E., SOUTH WALES BRANCH.—Cardiff. "Turbine Maintenance," E. Hartmann. *5.45 p.m.*

Monday, April 16.

I.E.E., LONDON STUDENTS' SECTION.—Savoy Place, London, W.C.2. "The Lumen Method of Illumination Calculation," G. S. H. Mogford. *7 p.m.*

FARMERS' CLUB.—Royal Empire Society, London. "Present and Future Aspects of Electricity in Agriculture," H. W. Grimmitt. *2.30 p.m.*

Tuesday, April 17.

I.E.E., RADIO SECTION.—London, W.C.2. Discussion. "Design of Broadcast and Television Receivers for the Post-War Market," L. H. Bedford. *5.30 p.m.*——N.W. CENTRE.—Manchester. Visit of the President, Sir Harry Railing. *6 p.m.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS.—E.L.M.A. Lighting Service Bureau, London, W.C.2. Lecture, "Post-War Electrical Installations," E. J. Sutton. *6.15 p.m.*

LUTON ELECTRICAL SOCIETY.—Town Hall. Annual general meeting. *7.30 p.m.*

Wednesday, April 18.

I.E.E., SHEFFIELD SUB-CENTRE.—Address by the President, Sir Harry Railing.

ILLUMINATING ENGINEERING SOCIETY.—E.L.M.A. Lighting Service Bureau, London, W.C.2. "Circuits for Discharge Lamps," R. Maxted and J. N. Hull. *5.30 p.m.*

BRITISH INSTITUTION OF RADIO ENGINEERS, N.E. SECTION.—Newcastle-on-Tyne. "Dielectric Heating by the Radio Frequency Method," L. Grinstead. *6 p.m.*

ROYAL SOCIETY OF ARTS.—London, W.C.2. "The Work of the Department of Scientific and Industrial Research," Sir E. Appleton, F.R.S. *1.45 p.m.*

Thursday, April 19.

I.E.E., DEVON AND CORNWALL SUB-CENTRE.—Electricity Showrooms, Taunton. "The Electrical Aspects of Farm Mechanisation," C. A. Cameron Brown. *3 p.m.*——WEST WALES SUB-CENTRE.—Swansea. Informal discussion. *6 p.m.*

BRITISH ELECTRICAL AND ALLIED MANUFACTURERS' ASSOCIATION.—Connaught Rooms, London, W.C.2. Annual meeting. *2.45 p.m.*

Friday, April 20.

I.E.E., MEASUREMENTS SECTION.—London, W.C.2. "An Electrical Moisture Meter," L. Hartshorn. *5.30 p.m.*——N.W. CENTRE, RADIO GROUP.—Manchester. "Frequency Modulation," K. R. Sturley. *6 p.m.*—I.E.E., BRISTOL STUDENTS' SECTION.—Bath. "Protection of A.C. Circuits and Plant," J. Fitzpatrick. *7.15 p.m.*

INSTITUTION OF ELECTRONICS.—Royal Society of Arts, London, W.C.2. Lecture, "Dynamics of Electron Beams," Dr. D. Gabor. *5.30 p.m.*

Saturday, April 21.

I.E.E., N.E. STUDENTS' SECTION.—Visit to the Washington Chemical Co.

A.M.E. AND M.E., LONDON BRANCH.—39, Victoria Street, S.W.1. Joint meeting with Kent Sub-Branch. *4.30 p.m.*

JUNIOR INSTITUTION OF ENGINEERS.—Connaught Rooms, Great Queen Street, Kingsway, W.C. Annual luncheon. *1* for *1.30 p.m.*

REPLACEMENT *Kettle Elements*

- Guaranteed reliability
- Quick delivery
- High efficiency and quick boiling
- Similar construction to the Metrovick Radiant boiling plate
- Loading: 1,500 watts at 230 volts; Voltage range: 200/250 volts.

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The *Right* LIGHT METROVICK FLUORESCENT TUBES AND TROUGH FITTINGS

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