

29589
The

THE

P.60/46/II

ELECTRICIAN

THE TECHNICAL NEWSPAPER OF THE ELECTRICAL INDUSTRY

202

25

Getting over difficulties . .

You've probably heard that one about " . . . supplies are limited but we are distributing them as fairly as we can; meanwhile it's worth while waiting for . . ." Enough to make you sick, isn't it? O.K. . . . we won't crack that one then . . . we'll simply say that we're doing all we know (and a lot we don't!) to get over our difficulties and help you with yours.



S. O. BOWKER LTD



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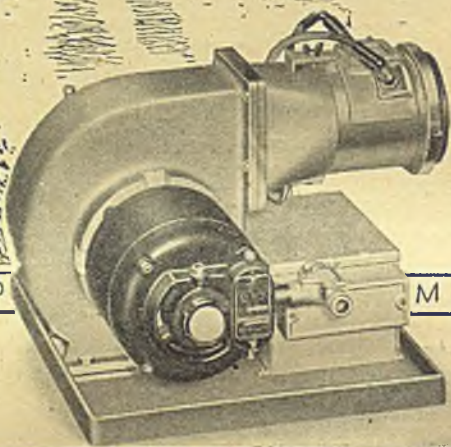
Silence



METROVICK

FRACTIONAL MOTORS are ideal for unit heaters, small pumps and fans used in heating ventilation and air conditioning plants.

This Company, as a result of years of research in the reduction and elimination of noise in electric motors, can offer a motor conforming to the highest possible standards of QUIET RUNNING.



FRACTIONAL HP

MOTORS

The photograph shows a Metrovick quiet-running Fractional Horse-power Motor driving an Oil Burner.



METROPOLITAN Vickers

ELECTRICAL CO. LTD.
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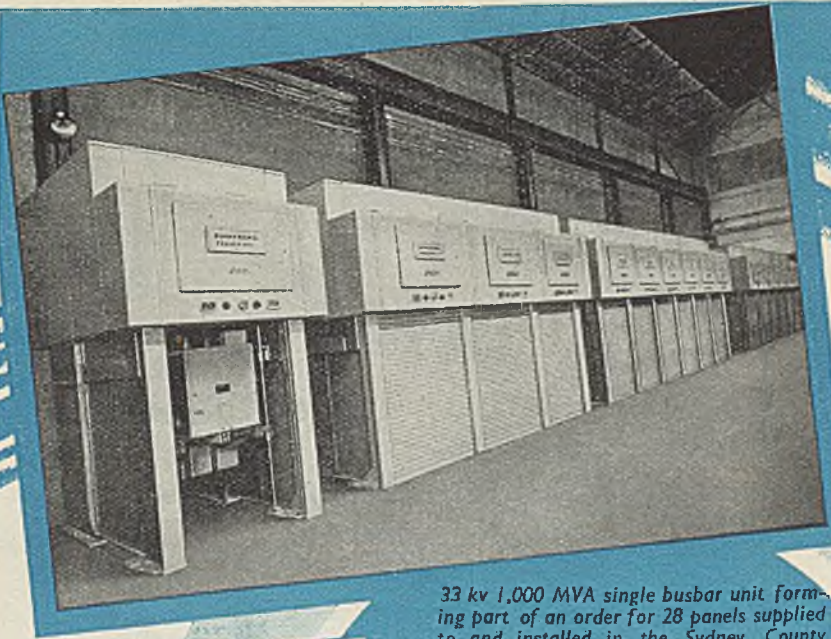
1/C 501

Switch to

METROVICK

Lighting

when daylight fades



33 kv 1,000 MVA single busbar unit forming part of an order for 28 panels supplied to and installed in the Sydney County Council's new Pyrmont 'B' Power Station, New South Wales, Australia.

LOW OIL CONTENT

MAXIMUM PROTECTION

COMPACTNESS

RELIABILITY

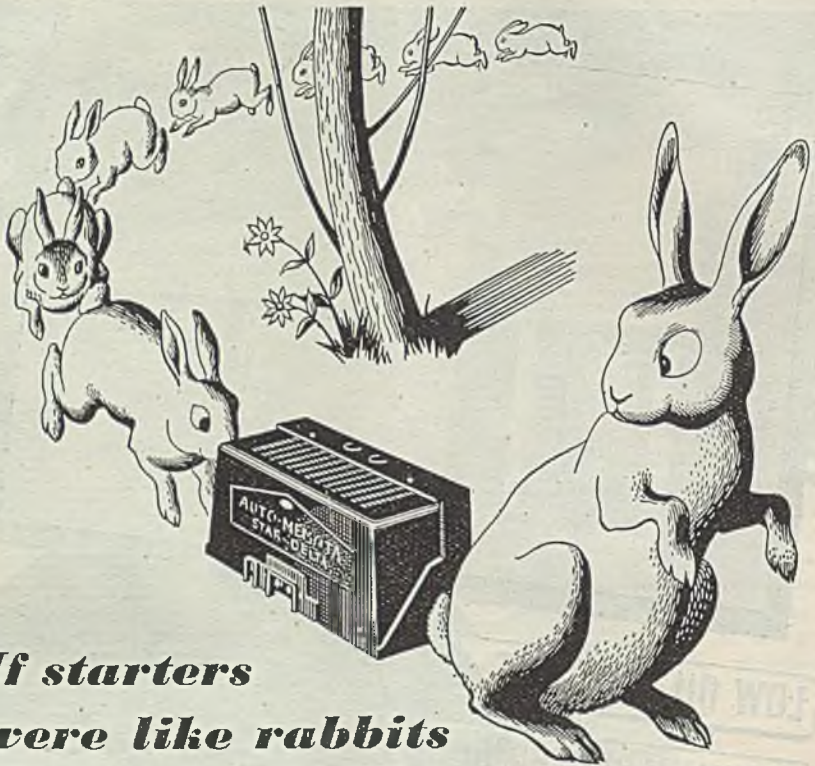
ACCESSIBILITY

G.E.C.

HEAVY DUTY METAL CLAD SWITCHGEAR

By the advanced design of the circuit breakers and the use of condenser bushings for all busbars and the connections the amount of oil and compound in the gear has been reduced to less than that in single break units of similar capacity, while the simplicity and easy maintenance of the double break vertical isolation construction have been maintained. Protection against dirt and fire hazard is provided by the all-steel fabricated construction and total enclosure.

Adv. of The General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2.



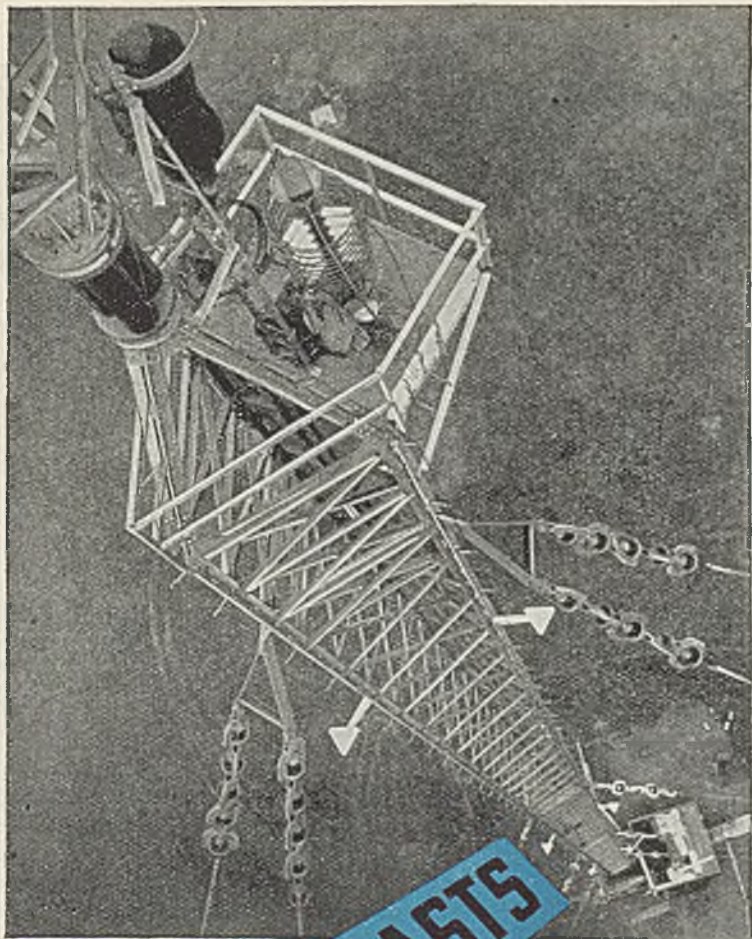
If starters were like rabbits

If starters could reproduce themselves the present heavy demand for M.E.M. motor control gear would be met without delay. But as it is, labour, material and extensive planning are needed. Yet in spite of shortages, controls and restrictions, supplies from the M.E.M. Factory are being steadily increased and goods are going out as quickly as possible to the wholesalers. Their's is the job of distribution and they are doing it magnificently in allocating all available goods fairly and equitably. So keep in touch with *your* wholesaler and he will see that your needs are met as quickly as supplies permit.



MIDLAND ELECTRIC MANUFACTURING CO. LTD., TYSELEY, BIRMINGHAM, 11
 SWITCH, FUSE AND MOTOR CONTROL GEAR, ELECTRIC FIRES
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A3701





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where all is concealed by the can, the surest guide to reliability and long life within the scope of application is the name "Hunts" . . . the rich fruits of many years of specialised experience in the field of capacitors for industrial purposes are yours economically, without risk.



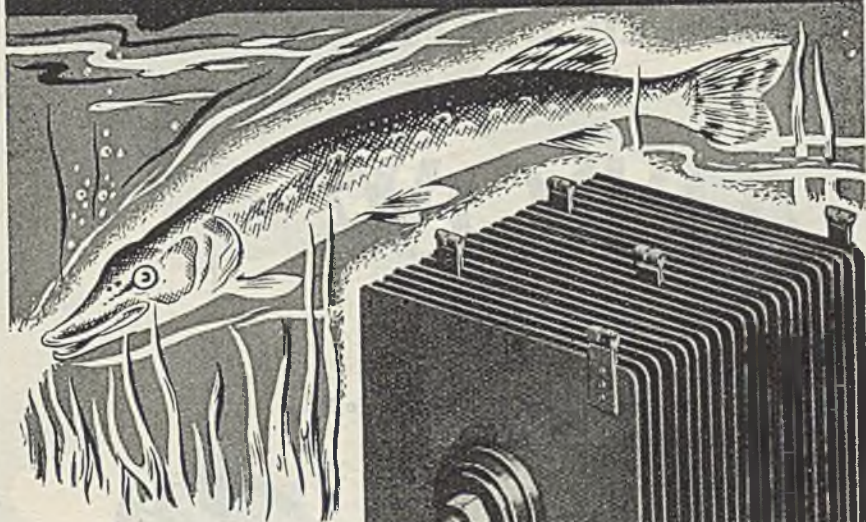
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Capacitor-start Motors — fractional and integral h.p. sizes ● Percussion Welding ● Filter Circuit Smoothing — in medium voltage power rectifiers.

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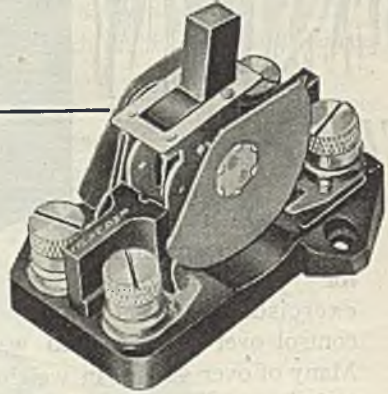
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30 amp. Double Pole - 60 amp. Double Pole



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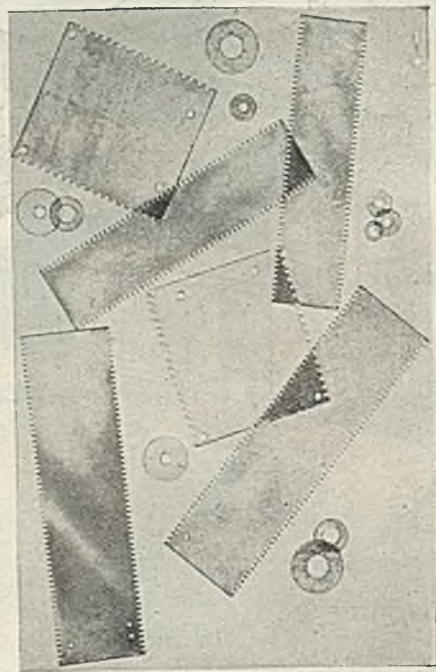
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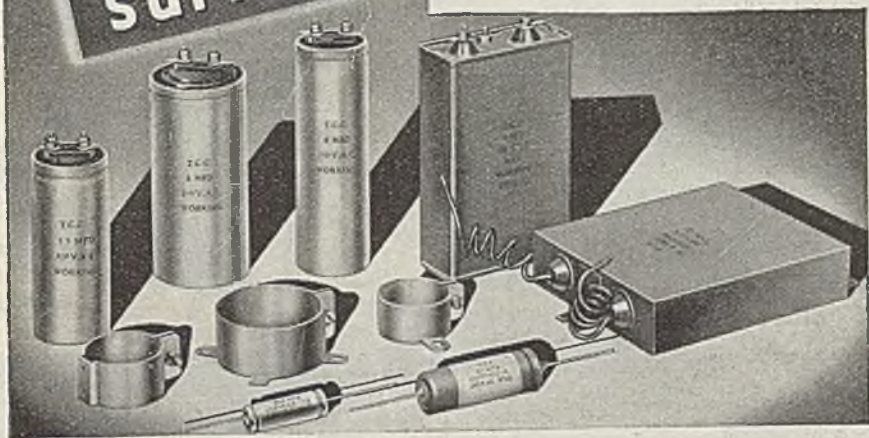
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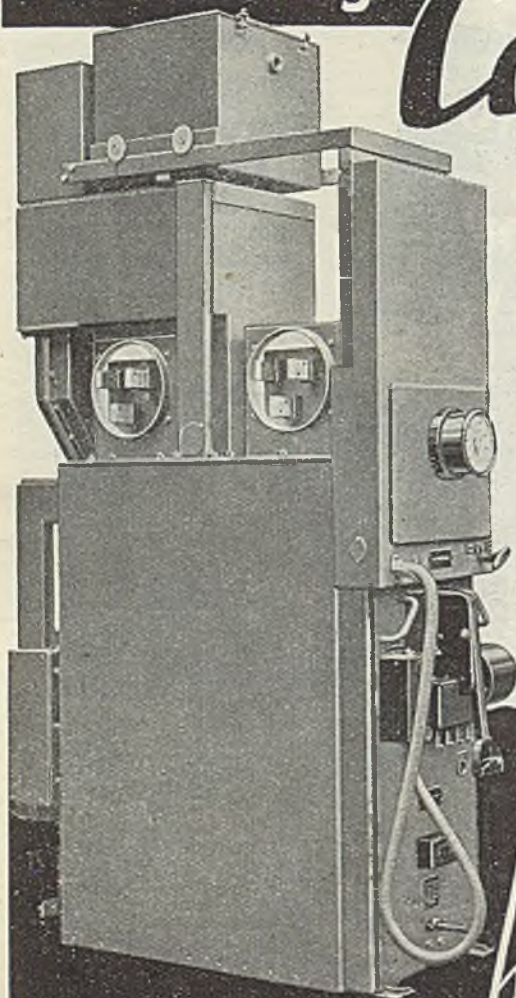
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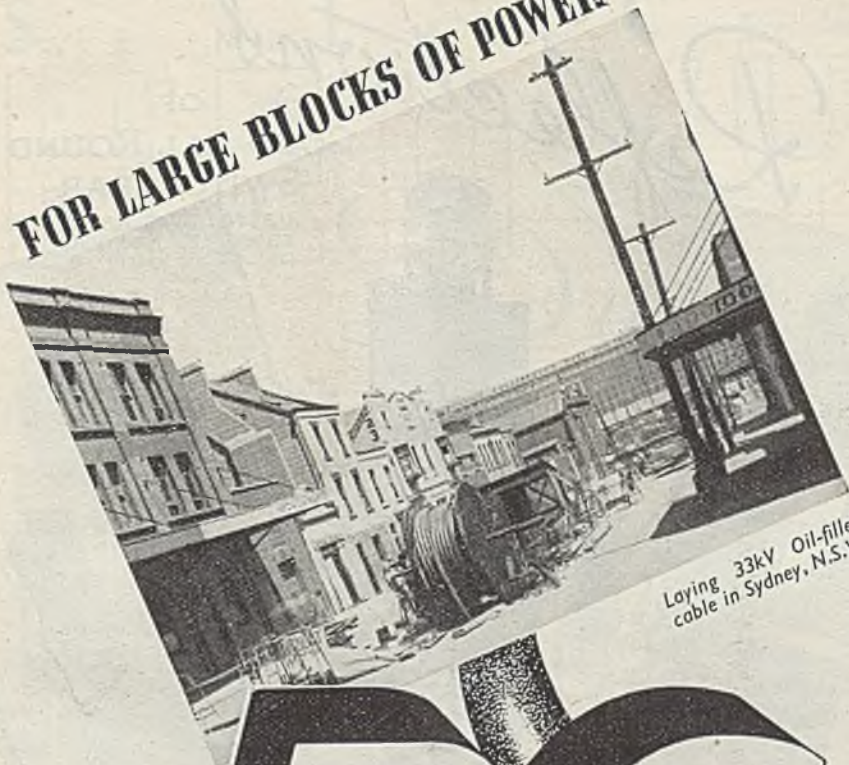
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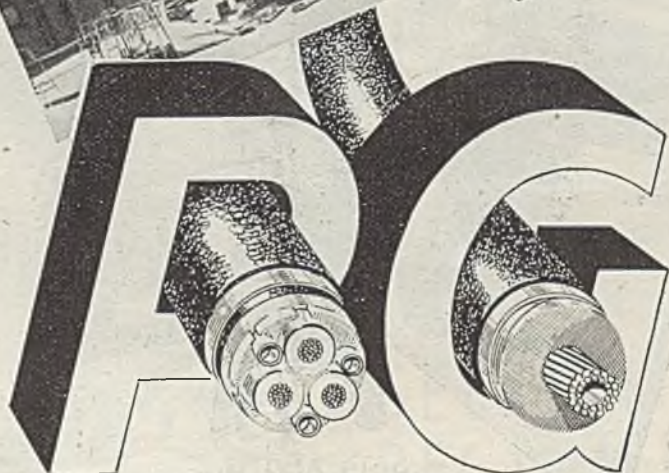
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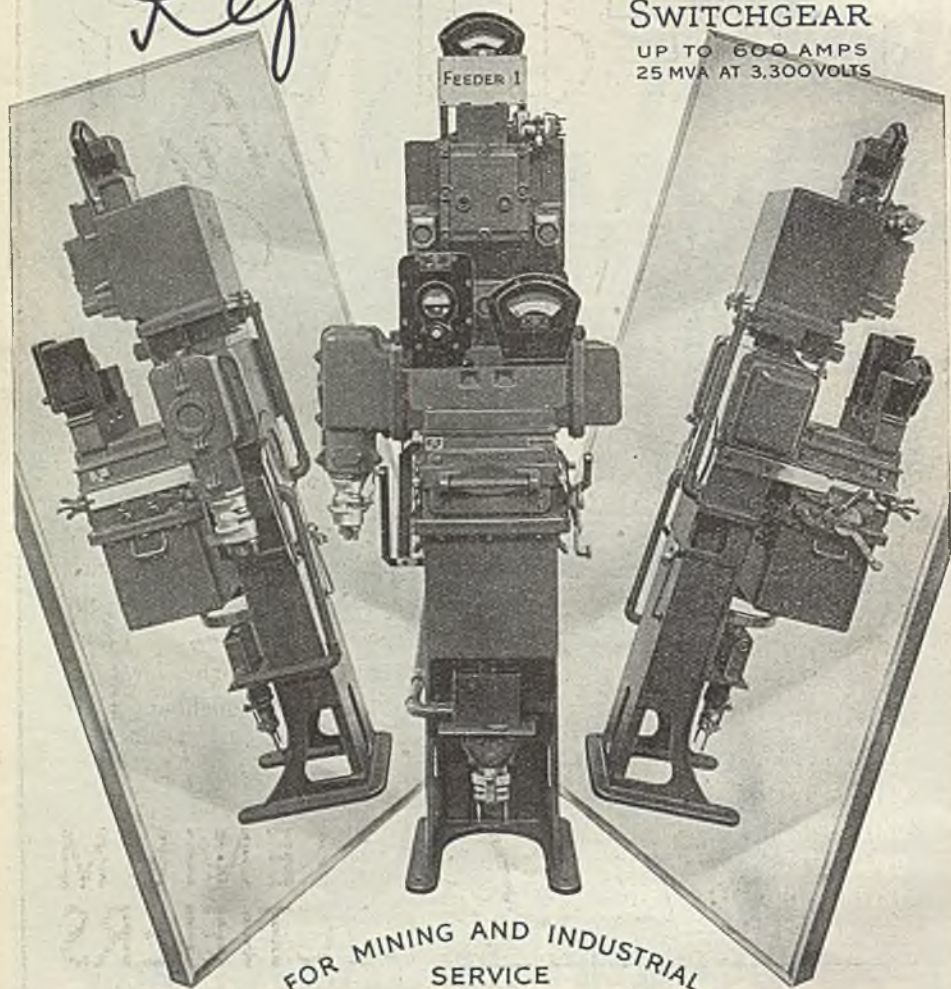
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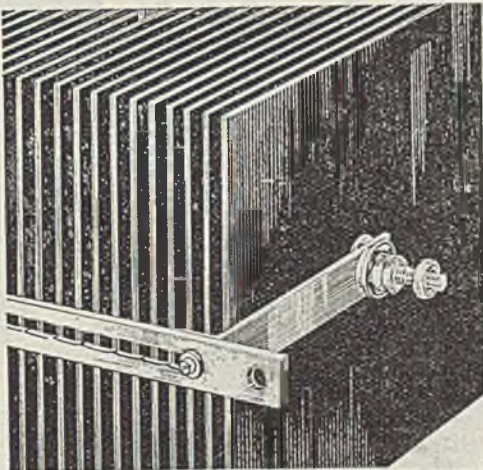
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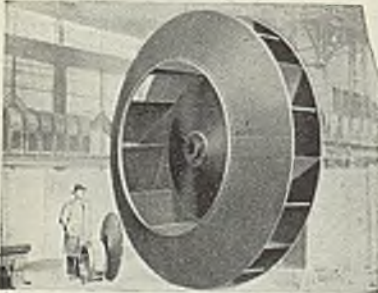
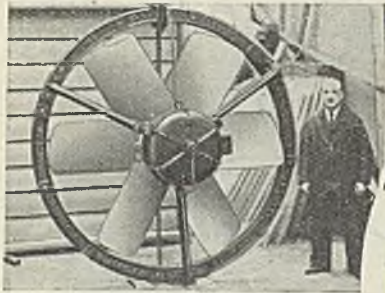
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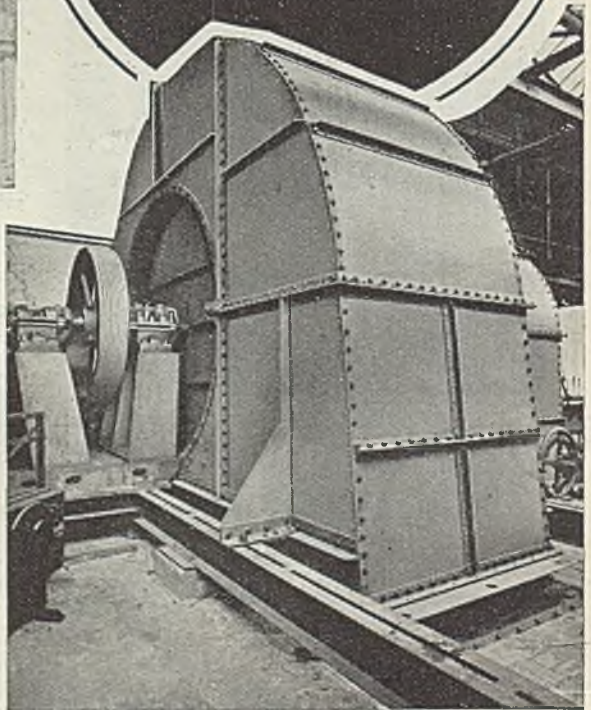
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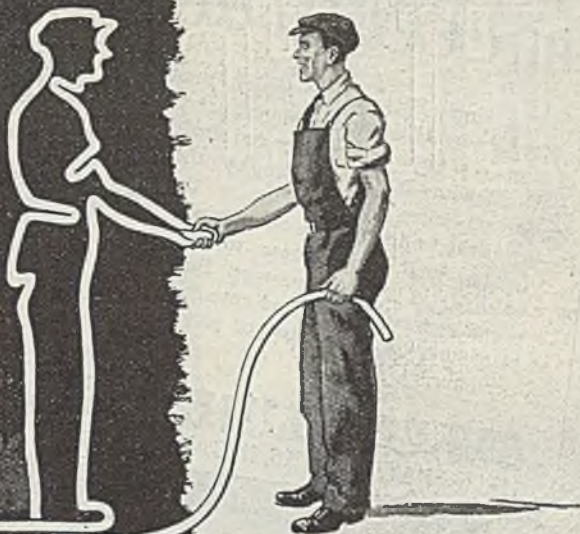
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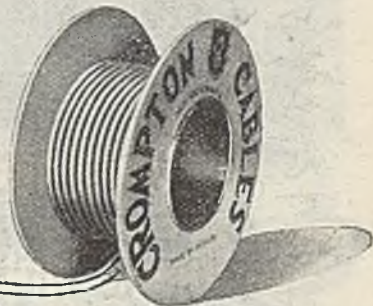
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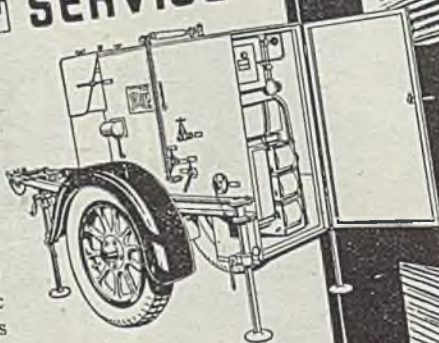
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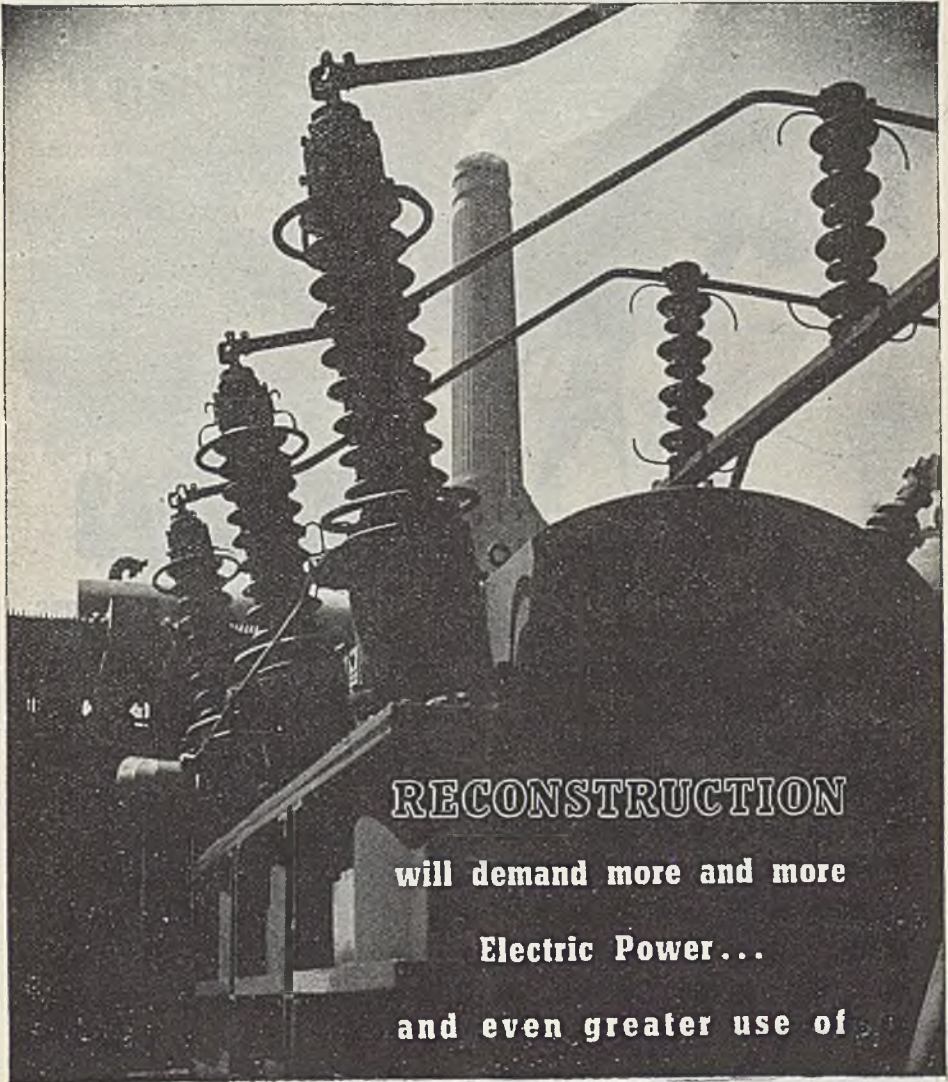
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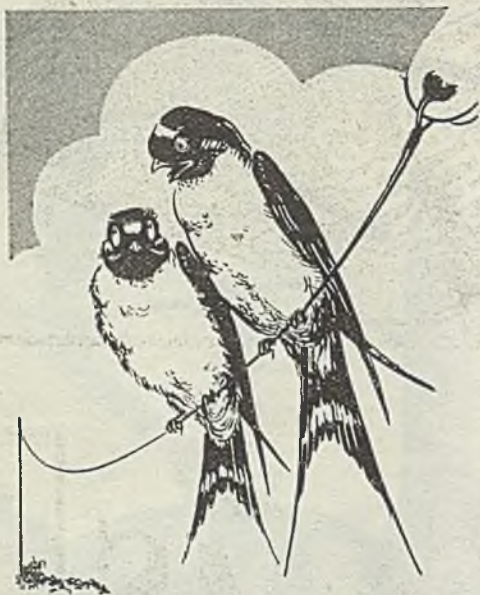
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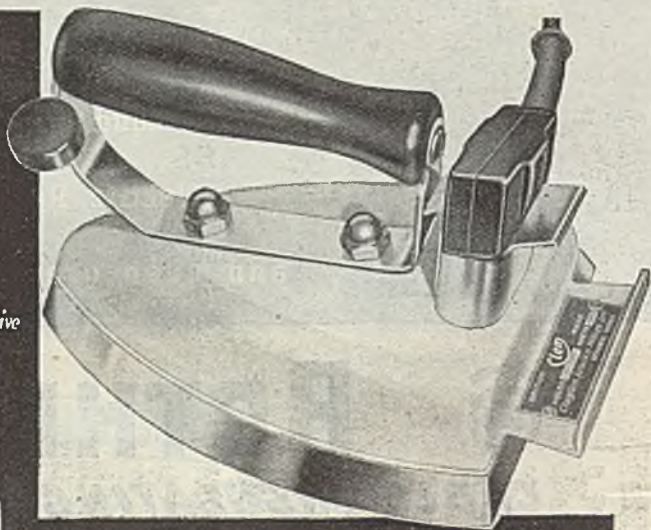
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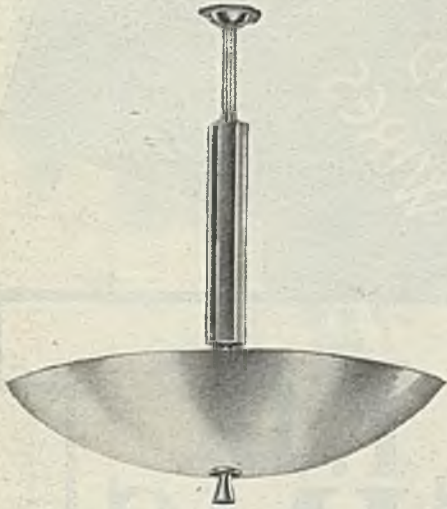
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THE ELECTRICIAN



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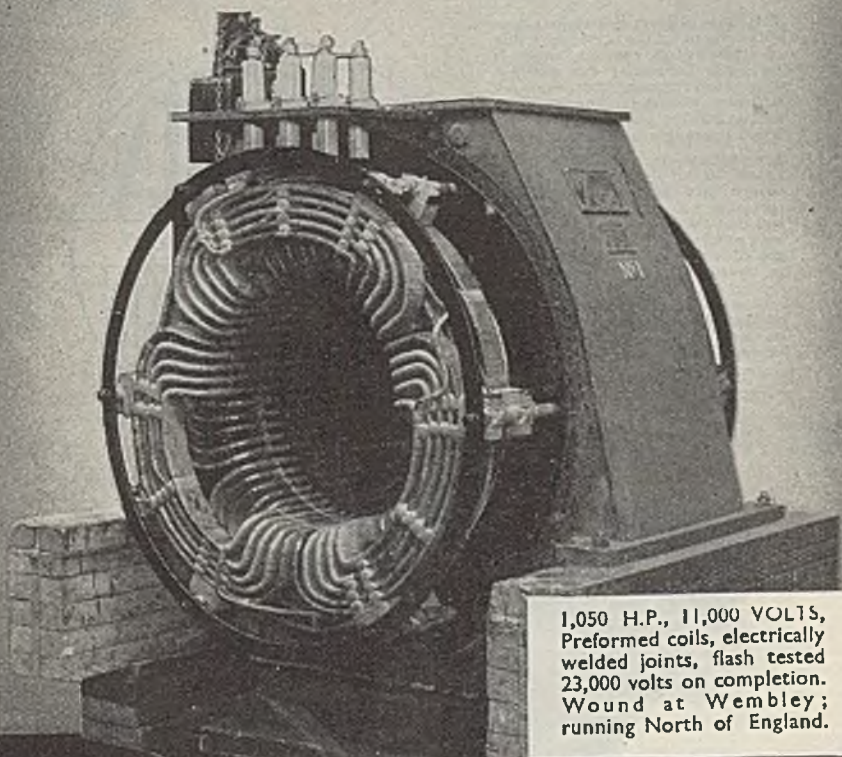
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 Soho Road
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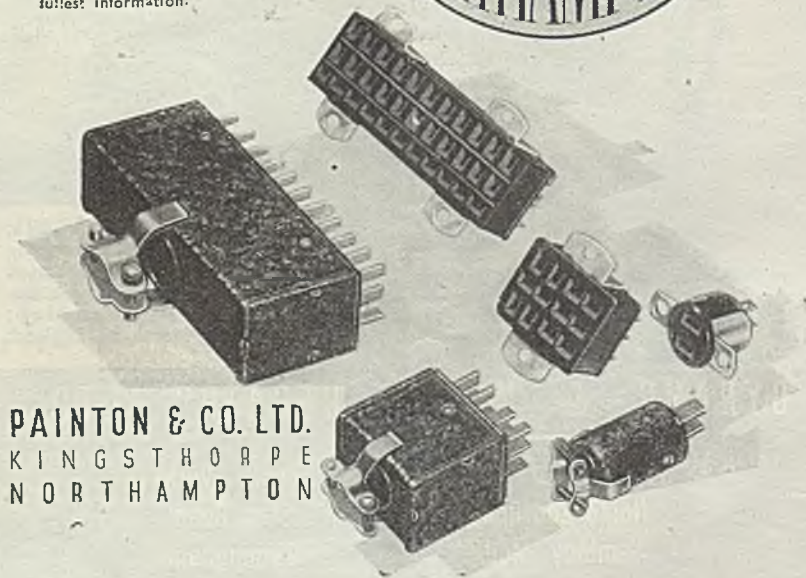
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Plugs & Sockets

This range of plugs and sockets provide a means for the rapid connection of a number of contacts, which is invaluable for linking the different units of an equipment. Units equipped with these plugs can also be connected to test sockets, both on the factory bench and in service test equipments.

The contacts are made of beryllium copper, the properties of which ensure that the resilience of the springs in their sockets is permanent, and that the electrical contact resistance remains very low. This enables the socket to be re-used, even in transmission circuits where any appreciable amount of contact resistance might be serious. The low resistance also enables the contacts to carry up to 5 amperes without excessive heating.

We shall be happy to supply the fullest information.



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CLIPS
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CLIPS



FROM the world-famous Terry factory come steel clips, bronze clips, stainless clips, big clips, little clips, wide clips, narrow clips — in fact clips in every conceivable shape and size.

Illustrated here are two of our stock patterns, 80 and 81, made in a range of sizes to grip from $\frac{1}{4}$ in. to $1\frac{1}{2}$ in.

Maybe a clip of special shape would be necessary for the job you have in mind. Well, we can help you because we make clips for hundreds of uses. We can make to print or specification, or our Research Department will design for you.

Our knowledge of clips has advanced side by side with our 91 years' spring-making experience, and we should like to send you our catalogue.

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HERBERT TERRY & SONS LTD., REDDITCH
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CLIPS

by TERRY SPRINGS



Established 1855

★ and just a few special shapes we have made to order.



T.C.4



COOKER CONTROL - DS PLUG STYLE

THE DS Gooker Control Unit is a compact yet efficient switch and plug unit. It includes a 30-A double-pole switch for the cooker and the famous DS Fused Plug and Socket for the kettle.

Conduit Holes are provided at top and bottom for cable entry but may be provided elsewhere to special requirements.

COOKER DS CONTROL

Announcement of D.S. Plugs Ltd., Manchester, London, Glasgow.

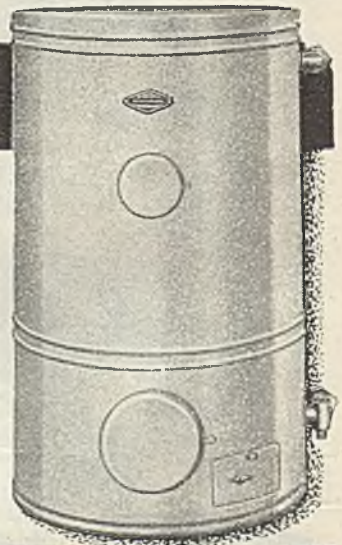
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HOT WATER BY ELECTRICITY

-the modern way

The Sadia TYPE U.D.B. electric water heater provides a completely automatic hot water system for the small house or flat. Like most good things, the Sadia is simple; it needs the absolute minimum of work to install and occupies the least possible space. It requires no flues or ventilation, it does away with complicated piping problems. Many thousands of

Sadias are in use today and we are building more and more each week. Although the number of orders prevent delivery from stock, the Sadia U.D.B. is well worth waiting for. Write for further details now. Delivery of orders supported by W.B.A. Priority can usually be arranged to fit in with the building programme.



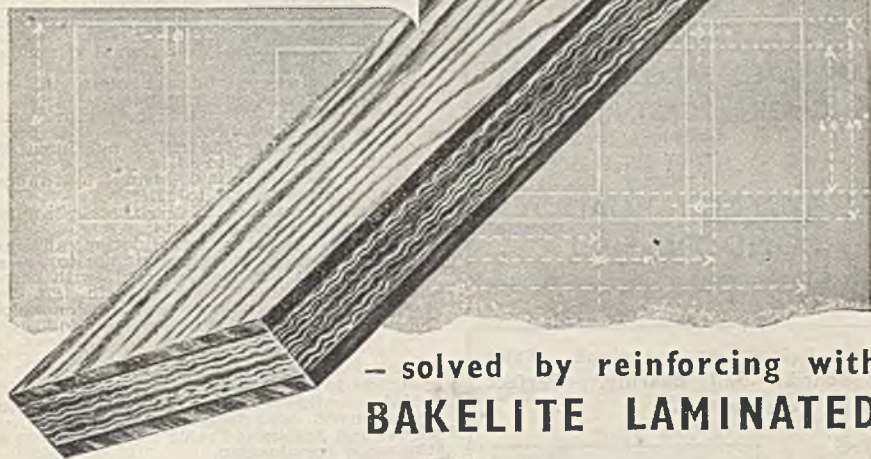
AIDAS ELECTRIC LIMITED, SADIA WORKS, ROWDELL ROAD,
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TYPE U.D.B. ELECTRIC
WATER HEATER


THIS WAS THE PROBLEM

To strengthen wood joints or wooden structural members subjected to abnormal or concentrated loads, without detracting from the lightness and "workability" of the material.



— solved by reinforcing with
BAKELITE LAMINATED

The loads were distributed by reinforcing the area with a high-grade, fabric-base BAKELITE laminated material. The problem of cold glueing the two surfaces was solved by using a special *wood-faced* laminated, adhesion between wood face and core being considerably greater than the shear strength of the wood. The use of this material is well illustrated in the wing assembly of aircraft of the Mosquito type. Many important items on the Mosquito and other aircraft were made from BAKELITE Laminated, wood-faced and other grades.

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The nearest to perfection in drawing office equipment—"MAVITTA" DRAFTING MACHINES made of steel tube with adjustable ball-bearings. Main angles located automatically, intermediate angles by lock.

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SITUATIONS VACANT

THE CIVIL SERVICE COMMISSIONERS announce that a special competition will be held for appointments as Assistant Engineer (New-Style)—Male—in the Post Office Engineering Department and Assistant Traffic Superintendent in the Telephone Department of the General Post Office. Approximately 100 vacancies in each grade will be filled by examinations spread over a period of two or three years.

Candidates must have been born on or after the 2nd August, 1915, and have attained the age of 18 by the 1st January of the year in which they compete. Allowance will be made for service in H.M. Forces prior to 3rd September, 1939.

Men only are eligible to compete for appointment as Assistant Engineer (New Style).

The salary scales are as follows:—

Assistant Engineer (New Style):
London: £230 rising by annual increments of £20 to £580.

Provinces: £265 rising by annual increments of £20 to £560
(including consolidation addition).

Assistant Traffic Superintendent:

Men.—London: £190 rising by annual increments of £18 to £465.

Provinces: £180 rising by annual increments of £18 to £435.

Women.—London: £190 rising by annual increments of £12 to £375.

Provinces: £180 rising by annual increments of £12 to £345.

to which is added a consolidation addition ranging from £78 at the minimum to £90 at the maximum for men over 21, with corresponding addition from £65 to £72 for women over 21. For men and women below the age of 21 the additions are as follows:

| Age | Men | Women |
|-----|-----|-------|
| 18 | £47 | £47 |
| 19 | £55 | £55 |
| 20 | £63 | £59 |

Male candidates may apply to compete for appointment as Assistant Engineer (New Style) and Assistant Traffic Superintendent at the same examination.

There will be prospects of promotion to higher grades.

Candidates now serving in H.M. Forces must send in their application forms in time to reach the Civil Service Commission not later than six months after the completion of their service. All other candidates must send them in by 1st April, 1947, except that for candidates who are under 18 years old on the 1st April, 1947, the latest date for sending in the form is the 1st January following their 18th birthday.

Copies of the Regulations and Forms of Application may be obtained from the Secretary, Civil Service Commission, Burlington Gardens, London, W.1, or from the Chief Officer, Civil Service Commission, at the following addresses, quoting No. 1679:

- (India) 10, Underhill Lane, Delhi.
- (Egypt) 8, Sharia Tolombat, Garden City, Cairo.
- (Italy) c/o. G.H.Q., C.M.F.
- (Germany) c/o. 2nd Echelon, G.H.Q., B.A.O.R.

COSTING and Progress Clerk required for electrical installation contractors' order office. Only man with previous experience should apply. Permanent. Letters first—Etna Lighting and Heating Co. Ltd., 293/295, Broad Street, Birmingham.

ELECTRICIANS at N.F.E.A. "B" rates required in East Anglia. Only fully qualified men need apply to the East Anglian Electric Supply Co., Ltd., Finborough Hall, Stowmarket.

SITUATIONS VACANT
SHEFFIELD CORPORATION ELECTRICITY
DEPARTMENT.
INSTALLATION ENGINEER (ELECTRICAL
CONTRACTING).

APPPLICATIONS are invited for the above position from applicants who have had a sound training and considerable practical experience in the electrical contracting industry. Applicants should be able to prepare estimates and specifications for all classes of electrical installation work, to supervise the carrying out of the work, and to control staff. Experience of development work in the domestic, commercial and industrial applications of electricity would be an advantage.

The salary will be in accordance with Class M, Grade 9A, of the National Joint Board Schedule, commencing at £478 per annum.

The appointment will be subject to the provisions of the Local Government Superannuation Act, 1937. Applicants must preferably be not more than 40 years of age, or have had previous Local Authority service carrying transfer value within the meaning of the Act. The selected applicant would be required to pass a medical examination.

Applications on forms to be obtained from the undersigned are to be returned to me not later than Monday, 6th January, 1947, accompanied by copies of not more than three recent testimonials.

Canvassing or any communication to a member of the Council either directly or indirectly, is prohibited and is a disqualification.

JOHN R. STRUTHERS,

Commercial Street, General Manager.
SHEFFIELD, 1.

TRENT VALLEY AND HIGH PEAK
ELECTRICITY CO., LTD.
WIREMAN ELECTRICIANS.

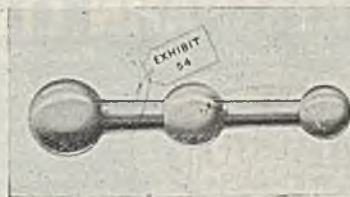
APPPLICATIONS are invited for the above appointment at a wage in accordance with the N.J.L.C. (No. 3) Electricity Supply Industry, Zone "B," at present 26.63d. per hour for 47-hour week. Applicant must have practical experience in all classes of installations, industrial and domestic, including installation of motors and switchgear. Permanent position for successful applicants who will be eligible to join the Staff Pension Scheme. Write, stating age, experience, etc.—
E. J. COOK,

Engineer and Resident Manager.
 Electricity House, Market Place,
CHAPEL-EN-LE-FRITH, Via Stockport.

APPPLICATIONS are invited for the post of Development Engineer in a laboratory in High Wycombe working on radio frequency heating and transmitting equipment. Applicants should be A.M.I.E.E. or equivalent. Sound knowledge of machine design principles is essential. Experience should have covered several of the following subjects: R.F. induction heating, metallurgical engineering, electrical power distribution and switchgear, mechanical or production engineering, workshop practice or high power radio transmitting equipment. Salary would be between £550 and £650 p.a., according to qualifications. Applications should be addressed to—The Personnel Manager, P.R.T. Laboratories Ltd., Commonwood House, nr. Chipperfield, Herts.

LONDON Electrical Wholesalers require representative with car to cover London area and outskirts. Good commission paid with small car allowance.—Write Box L.T.D., "THE ELECTRICIAN," 154, Fleet Street, London, E.C.4, stating experience.

DRAUGHTSMEN required by switchgear engineers. Experienced in contract work, protective gear diagrams or design. Applications in writing, with full particulars, to—**FERGUSON, PAILIN LIMITED, MANCHESTER, 11.**



FROM THE M.R.E. CASE-BOOK

Charge. The defendants were charged with taking 12 minutes to machine a ball handle, Exhibit 54.

Defence. Defendants stated that they had changed their methods and were now using the M.R.E. Profile Turning Roller Box, and producing this component in 24½ seconds. They were also utilizing this tool as standard equipment for turning all components with multi-diameters, contours or tapers.

Verdict. Case dismissed as defendants has shown that they were now anxious to use the best modern methods.

Made in three sizes: $\frac{3}{8}$ ", 1", 1½" Bar Capacity.

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1' 600 YDS. .007 (7/036) 2-core, Lead-covered, Paper-insulated and Jute-served Overall, C.M.A. manufacture. 500 yds. (approx.) 163/018 4-core T.R.S., C.M.A. manufacture, on original drums; 1000 yds. .0225 (7/064) single-core, 250-volt P.V.C., taped and braided, fire resistance, in 100 yd. coils; 4700 yds. .0225 (7/064) 2-core ditto.—Wholesale Electrical Supplies, 8/16, Eliza Street, Belfast. Grams, Megohms. Phone 24097.

FOR SALE.—Nisson Huts 36 ft. by 16 ft., also Wooden Sectional Buildings, all sizes.—Sykes, Tenterfields, Ovenden, Halifax. Tele. Halifax 5802.

SINGLE Phase Slip Ring Induction Motors. 1—30 H.P., 1000 r.p.m., 200/400 volts, by Brook; 1—15 H.P., 1500 r.p.m. 200 volts, by Brook; 1—15 H.P., 1450 r.p.m. 200 volts, by A.S.E.A.; 1—15 H.P., 950 r.p.m. 200 volts, by Fuller; 1—3 H.P., 1450 r.p.m. 460 volts, by Hopkinson, Squirrel Cage. All the above motors fitted with ball and roller bearings.—Oldfield Engineering Company, Ltd., 96, East Ordsall Lane, Salford, 5.

SINGLE Flexible Co-Axial Cable (to Government Specification UNIRADIO 1) consisting of 1/.056 Copper Inner Conductor, Solid Polythene Insulation, braided tinned copper outer conductor, sheathed in P.V.C. 45 in. 0/d.—Box L.T.B., "THE ELECTRICIAN," 154, Fleet Street, London, E.C.4.

1—B.T.H. 230/1/50 Alternator, 9 kVA, 1500 r.p.m.; 6—230/1/50 Extractor Fans by Verity, 18 in. dia., 700 r.p.m. 1—B.T.H. M.G. Set, input 400/3/50, output 2.5 kW, 110 volts, D.C.; 1—Crompton Parkinson M.G. Set, input 440 volts D.C., output 12/16 volts, 30 amps, D.C.; 1—Newton M.G. Set, input 220 volts D.C., output 90 volts, 190 amps, D.C.; 1—David Brown Radicon Reducing Gear, output 4 H.P., input speed 1450 r.p.m. Reduction ratio 48:1; 1—Heybeard Rectifier, input 230/1/50, output to suit 26 Cells, 7.5 amps. charge current with Trickle Charging Device; 1—D.C. Welding Generator by Electromotors, 4.4 kW, 29/70 volts, 1200 r.p.m., with Exciter; 1—Crompton Parkinson M.G. Set, input 400/3/50, output 60 volts, 400 amps., with Direct Coupled Exciter.—Oldfield Engineering Company Limited, 96, East Ordsall Lane, Salford, 5.

A SUPERIOR streamlined TOASTER in one mirror finish. Price 39s. 6d. subject. Immediate delivery. Sample 3s. Cash with order.—Metropolitan Distribution, Ltd., Truro.

ROTARY Converter, complete with starter, by Mawdsley, input 440 volt D.C., output 85 kVA, 300 volt, 50 cycle, single-phase, 6 p.f. for spot welding.—Carter and James Ltd., Wenman Street, Balsall Heath, Birmingham.

TRANSFORMER for sale, "Welders" to BSS 171/1936 4 kVA 1 phase 50 Type AN, 400/230-0-90 Volts, Excellent condition. £50. Carriage Paid.—Apply J. Thorn and Sons, Ltd., Brampton Road, Bexleyheath, Kent, Bexleyheath 305.

SECTIONAL TIMBER BUILDINGS, completely reconitioned and equal to new. Sizes 6 ft. by 6 ft., 16 ft. by 8 ft., 20 ft. by 12 ft., 36 ft. by 17 ft., 52 ft. by 20 ft., 54 ft. by 18 ft., 54 ft. by 33 ft. No purchase licence required. Offered subject to being unsold. Further particulars and prices on application.—D McMaster and Company, 38, Mount Bures Works, Bures, near Colchester, Essex. Telephone: Bures 351-352.

ALL Types of ELECTRICAL and CONTRACTORS PLANT, Pumps, Boilers, Engines, etc., in stock.—G. E. WHITTAKER, Wellington Mill, Bolton Road, Blackburn. Tel. 7232.

MERCURY SWITCHES, all types. For details of immediate delivery, apply Quicksilver Tube Mfg. Co., The Grays, High Street, Harlington, Middlesex.

FOR SALE

ONE Philips SB.20 Spot Welding Machine. No reasonable offer refused.—The Superheater Co. Ltd., Trafford Park, Manchester, 17.

RUBBER STAMPS.—Every description. For office, shop and factory. With the usual pre-war cushion backed holders and polished handles.—W. L. Boughton, 53, Kenley Road, Merton, London, S.W.19.

1 240 H.P. L.D.M. SLIP RING MOTOR, 400 volts 3 phase 50 cycles 725 r.p.m. Complete with oil switch and liquid type rotor starter.—Oldfield Engineering Company Ltd., 96, East Ordsal Lane, Salford, 5.

WIRE MEGGERS 500 V. £12 5s. 6d. Record V 500 V test sets, 511. New. Carriage paid.—Robins' Electrics, 222, West End Lane, N.W.6. HAM 0879.

"PIED PIPER" Electric MOUSE TRAPS, automatic, clean, safe. No "setting," just plug in! Type "C" (3 mouse capacity), with 6 ft. flex, 200/250 volts, 12s. 6d., post free.—The Robert Joliffe Trust (Manufacturers), Aston Clinton, Bucks.

LEATHER FINGER STALLS.—Made of Chrome Hide. Very strong and hard wearing. Length 3 in. Price 4s. per doz. Prompt delivery. Sample on application.—Willson Brothers, Industrial Clothing Manufacturers, Epsom, Surrey.

SACKS and Bags in excellent condition for all commodities, as low as 4d. each. Write: John Braydon, Ltd.,

230, Tottenham Court Road, W.1.
Tel. No.: Museum 6972.

SUPERIOR Type Builders' Ladders now in production; also Steps, Trestles and Extension Ladders.—Phone: Shaftesbury Ladders, Ltd., 453, Katherine Road, E.7. Grangewood 3363/4.

ELECTRIC Convector Heaters.—Home and Export market supplied. Prompt deliveries from Weatherhead and Company (Glasgow) Ltd., Electro-Engineering Manufacturers and Distributors, 153, Oxford Street, Glasgow, C.5.

ELECTRIC MOTORS, A.C. and D.C. We supply all types and sizes of Electrical Machinery—Slow Speed Reduction Gears can be supplied to customers' requirements with short deliveries. Send your enquiries to The Electro Power Co. Ltd. (formerly Be. Be. Eng.), 3, Retreat Close, Kenton, Middlesex. Tel.: WORDSWORTH 4928.

VACUUM Cleaner Spares and Accessories. Bags, bearings, belts, brushes, fans, switches, etc. Repairs, rewinding, rebristling. Sent for price list.—Reliance Vacuum Cleaner Service, 152-154, Broadway, Bexleyheath, Kent.

LADDERS, Trestles and Handcarts, from Ramsay and Sons (Forfar), Ltd., Forfar.

2 500 ELECTRIC METERS.—L. Stephenson offers for immediate despatch this large quantity of electric meters of the various types listed, all supplied "On Approval," all correct to very fine margin of error, all cases like new for 200/250 volts supply, A.C. 5 Amp. Meters, 425 No.; 10 Amp. Meters, 1525 No.; 20 Amp. Meters, 70 No.; 40 Amp. Meters, 12 No.; 50 Amp. Meters, 300 No.; Prepayment Meters, 77 No. We also offer Maximum Demand Indicators, 7.5 Amp. Indicators, 50 No.; 10.0 Amp. Indicators, 25 No.; 50.0 Amp. Indicators, 25 No. These Meters and Maximum Demand Indicators are suitable for Service Use or Interdepartmental Use in Factories, Works, Stores, etc., send S.A. Foolscap Envelope for our list No. E.101, with specifications and prices.—L. STEPHENSON, Bay Hall Works, Birkby, HUDDERSFIELD. Tel. 2455. P.S.—Do you require Steel Windows—List W.D.3. Do you require Nissen Type Huts, List N.3 (very large ones). Do you require Reconditioned Timber Huts, List 530. Do you require Wood or Steel Benches, Racks, List M.2.



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"Attracta" No. 1, 2-kw. reflector fire with two strong metal switches, one for each fire bar. Reflector made from polished heavy alloy combined with strong metal frame in assorted crackled colours. Easily carried from one room to another. Strong handle



fitted on top. Suitable length of 3-core flex supplied. Tubular element made from white clay which is easily replaced. Approx. size: Height 15", width 19", depth 7". Immed. steady 230/250 volts and other voltages supplied by special arrangement. Retail price 73s. 4d. each. Generous trade discounts.

This is only one of a multitude of other household electrical appliances available; radiators, heaters, toasters, etc.

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A BARGAIN IN CABLE AND BELL WIRE.—Cable 1/052, V.R. 250 volt, Ref. 4101. Taped Cotton Braided and comp. Flameproof, Black (Craigpark), in 500 yd. coils or on non-returnable reels; 37s. 6d. per 500 yards. Waxed Bell Wire (1 red, 1 blue), 1/036. Twin Twisted, Tinned Copper, pure insulated, Cotton Runners, Cotton Lapped and Paraffined, in 100-yd coils (W. T. Glover), 9s. per 100 yards. 37s. 6d. for 500 yards. Terms net cash with order. Carriage extra. Any quantity supplied.—Wm. Hurlock, Jr., Ltd., High Street, Thames Ditton, Surrey. Phone: Emberbrook 4011.

ATLAS lamps from stock, delivery in London, Surrey, Sussex and Kent; other lines include clocks, toasters, fires, irons, kettles, fans, fittings, chargers, speakers, etc.—Drubel Radio Distributors, Ltd., 39a, Stafford Road, Croydon. Croydon 1107.

VACUUM CLEANER REWINDING SERVICE.—commutators and Bearings. Prompt delivery and full guarantee.—Thomas Anderson, 117, Bowes Street, Blyth, Northumberland. Phone: Blyth 405.

JUNCTION Electric Irons, superior design and quality, supplied with suitable stand. Also Junction Nickel plated Torch Cases. Supplied for home trade and export. Also large selection of household electrical appliances, Fires, Radiators, other electric Irons, Toasters, Table Lamps, Torch cases, Dry batteries, etc. Please write for full list.—Brooks & Bohm, Ltd., 90, Victoria Street, London, S.W.1. Tele.: Vic. 9550/1441.

TWINNED STEEL ARMATURE BINDING WIRE.—All even numbered sizes from 16 s.w.g.—23 s.w.g. supplied from stock on 7 lb., 14 lb. or 28 lb. reels.
FREDERICK SMITH & CO. WIRE MANUFACTURERS LTD., CALEDONIA WORKS, HALIFAX.

VACUUM Cleaners available in limited quantities, and all types of Repairs carried out for all makes of Vacuum Cleaners.—Crown Appliances Ltd., 90, Wellesley Road, Croydon. Cro. 6515

1 AND 5 KW 230 volt D.C. Petrol-driven GENERATING SETS, with Austin Petrol Engines.—Joseph Pugsley and Sons, Ltd., Lawrence Hill, Bristol, 5.

A.C./D.C. Motors and Switchgear can be supplied from stock or at short notice. Send your requirements to John Phillips and Co. Electric, 31, Fortune Green Road, N.W.6. Telephone: Hampstead 8132.

S.ELE-PRIMING ELECTRIC PUMPS.—300 g.p.h. £14 5s.—John E. Steel, Clyde Mills, Bingley. Phone 1066.

GLASS for Sale.—Flash opal, 2 000 sheets 27 in. by 5 in., 24 oz.; a reasonable offer will be accepted for part or whole.—Sutty and Custance, Ltd., 323, Liverpool Road, London, N.7. Tel.: North 4274/5.

ROTARY Converter, D.C. to A.C., Medical Supply, 200 v., 9.5 a. to 136 v., 11 a., with starter. Overhauled. £17 10s.—A. E. Co. Ltd., 18/19, Bellevue Road, S.W.17.

360 FT. Bill Overhead BUSHAR, 4-bar 3-phase and neutral, 250 amp. per phase type OB4, together with 42 T.P. and N. 30 amp. Plug-in Fuseboxes, type OF.30 and 7, incoaming Cable Boxes with 85 Glands, type OCl. These items are new and unused, and are offered for £435 the lot.—United Insulator Co., Ltd., Oakeroot Road, Tolworth, Surrey. Elmbridge 5241.

ELECTRIC MOTORS, 1 H.P. to 35 H.P. New and Second-hand, 150 in stock, state requirements, Vieta Engineering Co., Maidenhead. Phone 50.

REPAIRS

COOKERS.—We can give good deliveries of Sheet Metal Vitreous Enamelled Electric Cooker parts.—JOHN KING & SON (ENAMELLERS), LTD., PYRO WORKS, CHESTERFIELD. Phone: 5305.

NOTICES

ELECTRICITY (SUPPLY) ACT, 1926.
NORTH WEST ENGLAND) AND NORTH
WALES ELECTRICITY (ALTERATION AND
EXTENSION) SCHEME, 1946.

WHEREAS the Electricity Commissioners have prepared and transmitted to the Central Electricity Board a Scheme bearing the above title and hereinafter referred to as "the new scheme," for altering and extending the North West England and North Wales Electricity Schemes, 1923 to 1944, by determining that four new generating stations if and when duly authorised, will become selected stations for the purposes of the Central Electricity Board.

Notice is hereby given that the Central Electricity Board have caused the new Scheme to be published and that any authorised undertakers or other persons interested in the new Scheme and desiring to make representations thereon may do so by forwarding the same by registered letter to the undersigned and posted not later than the 18th day of January, 1947. Copies of the new Scheme with an Explanatory Memorandum, which the Electricity Commissioners have sent to the Board therewith, may be obtained at the price of one penny each from H.M. Stationery Office, York House, Kingsway, London, W.C.2.

Dated this 17th day of December, 1946.

O. A. SHERRARD,

Trafalgar Buildings, Secretary.
 1, Charing Cross,
 LONDON, S.W.1.

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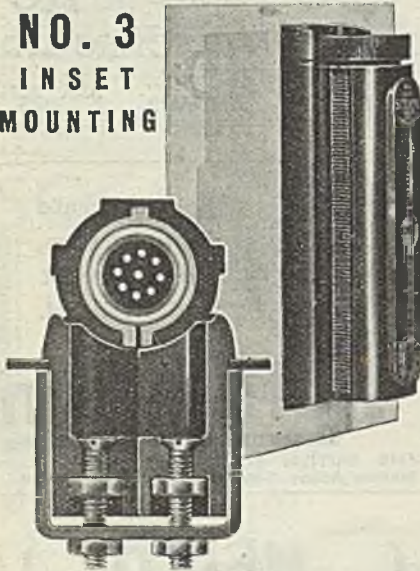
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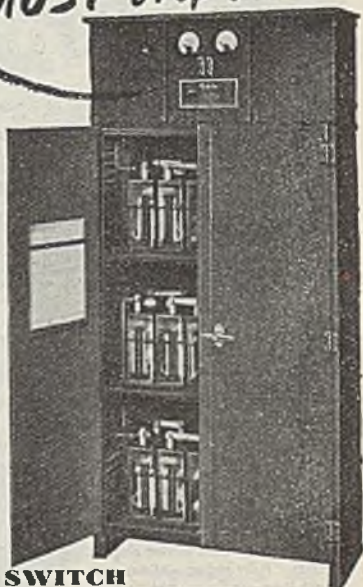
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Plant and Demand

THE number of cuts which were made during November, makes it reasonably clear that the average load on the national supply system was heavier than it had been for some months, and it is not surprising therefore, that the official returns to the Commissioners for November show that the amount of current generated by authorised undertakers during that month was 13.7 per cent. above that of November last year.

This increase, it must be remembered, came about during a time when there was a national fuel economy campaign in operation, and latterly during a time when almost daily appeals were made for reducing electrical load.

Industry, generally, claims to be operating with the least possible demand upon the supply mains consistent with the output requirements of raw materials and manufactured goods, while domestic consumers are reacting as best they may to the broadcast appeals for economy. In the circumstances therefore, the demand for current when the present transition period with respect to generating capacity has been overcome, may reasonably be expected to outstrip the present figures, and thereby is set up a chain of thought which warrants consideration.

The present shortage of generating capacity will, in course of time, be made good, no matter what the inconvenience to consumers meanwhile. Something is at least being done about it and sooner or later the industry will be able to

accept all the demand now offered. Apart from that demand, however, there is growing a potential load offered by consumers not yet connected, nor likely to be until the present distribution system is extended to serve either their premises or areas. Official discouragement of the use of electricity, whether the Ministry of Fuel likes or not, will not prevent either the number of consumers growing or an increasing demand for current in areas where to-day none may exist. In the circumstances therefore, it seems reasonable to suppose that though the present generating capacity position is serious, it must not be allowed to influence the industry against thinking of the future and of the services then likely to be expected, by both industry and the public. The rise in demand shown by the Commissioner's figures is no temporary thing, neither has it been permitted to reach its limit in value. Any suggestion in the minds of the public that the expansion of the industry is not receiving proper consideration during the period of plant shortage must be guarded against.

Chester's Golden Jubilee

THE extent to which municipalities, if they so desire, can develop rural areas is shown by Chester Corporation, the electricity undertaking of which celebrated its golden jubilee last week with an exhibition designed to show the progress made in simplifying the domestic workaday world and the opportunities available to industry. Much of the development of the undertaking is a memorial to the late Mr. S. E. BRITTON, who died last June after having been city electrical engineer since 1904, when the number of consumers was 778 against the present-day figure of 23 547. The Chester undertaking is of special interest also, in that in 1912 it opened a hydro-electric station—our last visit to which was made, incidentally, during a visit to see the autumn illuminations which were such a feature pre-war. The outstanding achievement at Chester, however, is the connecting to the supply mains of no fewer than 1 024 farms and the serving of 9 705 rural consumers. Such an example has not been easy to establish, but it stands to-day as a monument to the work of years and an indication of what can be done when enthusiasm and imagination are properly

applied. The jubilee celebrations last week were conducted at a time when load-shedding is the order, but as Mr. C. T. S. ANNETT pointed out during the occasion, that is no reason why provision should not be made against that time when the present transition period is but a memory.

Graduates and Industry

AN interesting survey carried out by the Manchester Joint Research Council, with a view to assessing the increase to be expected in the number of scientifically-trained men to be employed in industry in the coming years, shows that an appreciable rise is anticipated compared with pre-war. The survey covered a representative cross-section of firms in the Greater Manchester area and so far as engineering is concerned the expected increase is considerable. By virtue of the plea made in the electrical industry for a higher standard of technical education and for a higher standard of manufactured products, the requirement of the firms taking part in the survey for more graduate entrants is not surprising. The information which the survey has produced should be of considerable value to the universities in providing a foundation for the assessment of the extra calls to be expected from industry, for graduates in future years, and of the degree of training called for. A valuable indication is also given to the young man considering his future course, since it shows that of a high percentage of the firms offering employment to graduates, the higher executive positions are open to those who show competence and adaptability.

Need for Enterprise

SPEAKING at the Canadian Chamber of Trade on Monday, Sir Stafford Cripps is reported to have said that a world shortage of raw materials is seriously affecting the possibility of our reaching the export target set by the Government. He was speaking in particular of steel, and appealing to the dollar countries, said that unless we can get imports of this metal from somewhere, it must seriously affect our exports of machinery. A few days ago Sir STAFFORD spoke of the difficulties we should face if we failed to get nearer to a balance of trade in "hard" currencies, and since importing steel from the United States would in-

crease the present deficit of trade in the "hardest" of currencies, something of a dilemma is created. It is an odd thing that whenever a Government spokesman voices an opinion on trade or development, he is more often than not negative in his outlook. Difficulties there are and will continue to be; but instead of attempting to overcome them, a depressing attitude of mind is assumed and instead of making a flanking attack as a solution to the problem, only the more difficult frontal attack is considered. Our need of steel must in the circumstances be balanced against a need in the United States for some commodity within the Empire which is not in short supply. Such a commodity is rubber, another is tin, and if the Government cannot open up negotiations which will ultimately benefit world trade, it is time they made way for those who are trained and experienced in such dealings.

Too Many Meetings ?

MEMBERS of the I.E.E. were kept particularly busy last week for on no fewer than four evenings, meetings were held by the Radio, Transmission, Installation and Measurement Sections, respectively, indicating, thereby, something of the extent in growth of the activities of the institution. Meetings will be equally numerous in the New Year, and with the paper shortage still prevailing it is becoming increasingly difficult to devote to the discussions the space they so rightly deserve. The time claimed by the various institutions and associations for attendance at meetings seems to be greater year by year, and those who conscientiously believe in keeping their knowledge up to date are finding their professional ambitions something of a problem as a result. Despite the increase in the number of papers read before our institutions and associations each week, the standard is high, the presentation good and the subjects selected provoke good discussion. Many in the industry feel that they should attend all meetings where a paper dealing with their particular interest is being read, and suggestions have been put forward to the effect that it would be an advantage if such meetings were fewer. For our part we believe that such a restriction in the activities of the institutions would, at any rate so early in the post-war period, be both

difficult and not in the best interests of the industry. So much remains to be said since the stifling hand of censorship was removed, that it will be a long time before all sections of the industry are as informed on their particular subjects as they might be—even with the present full programme of meetings.

Plastics and Electrical Industry

READERS of THE ELECTRICIAN will have gathered that we have for some time appreciated the importance of plastics in the electrical industry, for we have in the last few months given publication to a series of special articles on the subject. These articles so far, have already covered a very wide field and as time goes on and new materials and applications become known, our coverage will be even wider. Added importance to the development and use of plastics so far as electrical engineering is concerned, was given last week by the reading of a paper on the subject before a meeting of the Installations Section of the I.E.E., when Dr. GUIDO HAEFFLY gave a history of plastics in relationship to the industry and explained the chemical structure of some typical materials. The paper was of the "integrating" type and as members are invited to submit further contributions in this category, it is anticipated that the institution will, sooner or later, be able to record the complete history of this interesting side of electrical progress.

Christmas Greetings

THIS time next week Christmas will have come and gone, leaving behind it for most of us the memory of a well-earned two-day rest. We say well-earned, for during the last twelve months the industry has made such gigantic strides towards recovering its pre-war momentum that all engaged in it must have put aside many of their personal ambitions, so that most of their time and energy might be devoted to the post-war reconstruction process. In the circumstances, the opportunity is taken in this issue to wish all in the industry—and our readers in particular—the Compliments of the Season and to express the hope that, despite the austerity conditions, their Christmas may be a merry one.

TOTALITARIAN ART

by SIR ERNEST BENN

THE planners have enjoyed a fair field and plenty of favour in the matter of the "Britain Can Make It" Exhibition; indeed the comparative immunity from criticism is in itself an indication of the distance travelled since it was our habit to do a little of our own thinking. I should be sorry to stand in the way of a shillings' worth of business by anybody and have, therefore, waited until this official effort at trade promotion has run long enough to expose its own uselessness.

GOVERNMENT PEEP SHOWS

The Government went into the exhibition, or I would rather say peep-show, business, in an extensive way, to keep up the spirits of war workers. It was rightly thought that the drudgery of repetitive work could be relieved by pictures, diagrams and demonstrations designed to show the direct relation between the small metal stamping and the actual fighting. Some of these temporary displays were real triumphs both in propaganda value and window dressing skill and, like Bill Gates and Workers' Playtime, kept up the spirits of the factory girls.

All the tricks used with such success during the grim period of the blackout have now been transported to the Victoria and Albert Museum and exposed to the public as the bases on which the new British prosperity is planned. Plywood and cardboard are the first essentials; cut into shapes which positively shout their new-found freedom from all geometrical restraint, they adopt attitudes and angles so consistently awkward as to defy and defeat the unobservant; it is, it seems, a first principle of the brave new world that nothing must be erect, straight, upright or level. Next come buckets of colour wash mechanically sprayed over the surface of the cardboard; a couple of hidden electric lights give a glow to this tinted vacuum whose purpose turns out to be no more than to show say, a table-spoon, tumbler, or tooth brush, and the psychologists are right in thinking that a dreamy sense of comfort is promoted by the total absence of the marks of work, effort or craftsmanship.

WHAT OF THE MANUFACTURERS?

There is no attempt to sell, no pressure to buy. There are no firms, no name boards, few trade marks, no addresses and no prices displayed to view. The names of makers can be discovered only by the

use of elaborate code number references. The all-pervading inference is that, given an official council or committee, all these things make themselves. Above all, the man who finds the money, conceives the enterprise, discovers the customers, keeps the staff together, and shoulders the risks and responsibilities is no more than a mere redundancy.

Behind and above it all is a well planned attempt to secure control of the public taste, and significance must attach to the hatching of such a plot within the hallowed portals of the Victoria and Albert Museum. From the moment of entry the visitor is impressed with his own ignorance of art, his own inability to judge and his absolute dependence in all such matters upon the authoritative ruling of the official Council of Industrial Design. Every article and item exhibited has been approved and selected by a panel of "experts" and by inference every individual with an idea of his own has been warned off the course.

LIBEL ON OUR REPUTATION

The full title of this libel on our industrial reputation should read to the effect that "Britain can make it just as well as Tibet or Bolivia if supplied with somebody labelled 'technician', another labelled 'executive', and a few machine tools; or, for short, Britain can make it as well as others." The Council of Industrial Design cares nothing for the fact that all over the world the demand is for British goods which bear the marks of British genius and labour. Nearly all the exhibits selected smell of machine oil and most of them could as well be made in Sweden, Switzerland or Saskatchewan. Evidence and marks of origin have been eradicated with a thoroughness almost equal to the Russian suppression of British and American signs from the implements of war. For a nation in need of exports, this is childish stupidity; for a world relying upon a British trade mark it is a serious hardship.

It has been my lot to visit and report as a working trade journalist, upon hundreds of exhibitions, starting with the Paris Exposition of 1889, and it is depressing to reflect that our Civil Service amateurs have been permitted to attach the name of Britain to a circus which a few years ago would, I feel, hardly have been tolerated in a fifth rate Continental City.

ELECTRIC TOOLS AND P.M.H.

In this article "Supervisor" expresses his personal views on the merits of high-frequency a.c. operated electrically-driven series-wound or universal type of motor. The views put forward are not necessarily those of the Editor, and are prompted by the publication of the book by Mr. F. C. Orchard, on electricity in the building industry, reviewed in this journal two weeks ago.

THE insistent call to-day is for increased production per man-hour, as only by this means can the flow of goods for export be brought to the required level, the manufacture of raw materials for, and the erection of, houses be accelerated, and a greater reward for labour ensured. The only possible solution of the problem is the use of more tools of the self-operated types, and it is generally assumed that this must of necessity mean an increased use of electrically-operated tools.

As regards the use of fixed and portable power tools in the building industry—probably the foremost direction in which this contribution can be made at present—a recently published book should go far to bridge the present gap between the builder and the electrical engineer. This book was reviewed in the issue of December 6,* and will not be dealt with further here, except to say that the previous efforts of the author in the direction of advocacy and demonstration of power tools for the building industry, coupled with the production of this book, represent the most practical attempt yet made to secure a fuller understanding of the benefits to be derived from the wider adoption of such labour-saving and convenient devices.

A CONTROVERSIAL POINT

In one direction, however, the present writer does not see eye-to-eye with the author of the book in question, as it is felt that the real answer to the easily-portable and reasonably efficient pneumatic tool is the high-frequency a.c. operated electrically-driven tool, and not that powered by the series-wound or universal type of motor. It is agreed that there are two distinct sets of conditions to be met; one, that of the small user, or the beginner in the use of portable tools, and for whom the series-wound motor represents an easily-applied commencement. For the larger user, however, the installation of a frequency-changer represents no greater outlay or difficulty than the installation and use of a compressor.

The low speed and average power-weight ratio of the standard three-phase

motor on 50 cycle supplies make it, in some cases, unsuitable for use with portable tools. The maximum rotor speed is 3 000 r.p.m., excluding slip, which compares in a general way unfavourably with the 10 000-15 000 r.p.m. of the universal type of motor, or of the compressed air tool. The power-weight ratio of the three-phase induction motor can be brought in line with these other types, however, by increasing the frequency to 200 cycles, which gives a speed of 12 000 r.p.m. with four times the power from a given size of motor. This frequency has been standardised as being the most practical for portable tool use and provides, in general, a safe speed for ball bearings and rotating parts.

INDUCTION OR UNIVERSAL MOTOR?

There are, however, other advantages possessed by the simple induction motor over the universal type of motor, and even over the compressed air tool, and one is the constant speed characteristic. Although the universal type of motor may have a nominal speed of, say, 15 000 r.p.m., this falls off under load, and may, in fact, drop to no more than 50 per cent. of this speed for all practical purposes. The practically indestructible rotor of the induction motor compares very favourably with the fine-wire wound armature of the series-wound motor, and the fact that there are no commutators, brushes or brushgear to give rise to trouble has a considerable bearing on the maintenance problem of portable tools.

The author of the book previously referred to is also very much concerned with safety for the operator in connection with portable electric tools used under usually severe building site conditions, and it has to be agreed that this is a very real and pressing problem. In this connection, too, the high-frequency tool has some advantage, as the changer output rarely exceeds 100-125 V, as compared with the 200-250 V of the public supply. Opinions appear to differ as to whether the increased frequency of 200 cycles has any bearing upon the safety question, and there is no direct evidence either way, so far as the present writer knows. With the isolation of the changer output side from earth, accidents due to earth fault on the motor should

*"Electricity in the Building Industry," by F. C. Orchard, M.I.E.E., A.M. I. Mech. E.

be to some extent reduced, as two faults would have to occur at once to set up dangerous conditions.

The majority of faults to earth on portable tools appear to originate in the armature windings, or by reason of deposition of copper and carbon dust on the small insulating bushes used on the brushgear. The use of the high-frequency induction motor with its solid rotor and absence of brushgear must eliminate at least some of these possibilities, as there remains only the field windings and control switches, and none of these is very liable to insulation failure. The failure of flexible conductors and internal connections is possible in all types of motor, but a reasonable claim would be that with the induction motor the possibility of insulation failure, or fault to earth, is reduced.

The writer would add a further claim, which is, that the complication of the universal type of motor leads to small faults which are so often attended to by the man on the spot, often possessing meagre electrical knowledge. Many accidents originate

from this cause, and any form of construction that will tend to reduce this possibility must have a considerable bearing on the overall safety aspect.

It is difficult to obtain comparable costs of operating portable electrically-driven tools as compared with compressed air tools, but some rather remarkable figures were published in 1940, which were as follows. On manganese castings the work done by a high-frequency grinder in 46 minutes was equal to that done by a compressed-air grinder in 56 minutes, with a wheel wear of $\frac{1}{8}$ inch with electricity and $1\frac{1}{2}$ inches with air. The running cost with electricity was 5d. compared with 1s. 3½d. with air, showing a considerable saving.

These views are advanced with considerable diffidence, however, in view of the wide experience of the author of the book in question, but it seems to the present writer that in any intention to enter into competition with established methods, nothing but the best of the electrical methods should be advanced.

Accessories and the W.B.A. Licence

INTERFERENCE with the development of rural electrification is being experienced for want of wiring material and accessories, added to which confusion is caused by the statement by the Minister of Supply, Mr. J. Wilmot, that the manufacture of accessories reached 80 per cent. of the pre-war figure in the first six months of this year.

Before the war the supply industry effected 800 000 installations annually. Taking the smallest house as an example, say one of five lights, twenty accessories would be required for each of these 800 000 installations, made up of 1 distribution board, 1 main switch, 5 lamp-holders, 5 ceiling roses, 5 switches, and 3 socket outlets. Thus, if the whole of the installations were of this order, 16 000 000 accessories would be required.

Mr. Wilmot stated—and his accuracy is not questioned—that 80 per cent. of this number was being produced. That is to say, sufficient for 600 000 installations, or 12 000 000 accessories. According to the Ministry of Health the number of houses under construction at the end of September was 181 000 (including temporary houses), and 85 000 houses had been completed. This gives a total of 266 000 houses but, allowing for a generous estimate, only 200 000 of these received their full complement of electrical accessories.

From this it will be seen that in the ab-

sence of the 400 000 houses the balance of the electrical equipment referred to by Mr. Wilmot should be available. That is to say 8 000 000 accessories.

Electrical wiring components can only be obtained provided the would-be purchaser is able to present a W.B.A. licence, but Edumundsons Electricity Corporation have experienced such difficulty in obtaining these licences that they recently wrote to the Electricity Commissioners on the subject and received the following reply: "The Commissioners have discussed the position with other departments concerned with a view to ascertaining how far there is, at the moment, some surplus of electrical components which can be allocated for purposes other than new houses, and what steps are being taken to increase production of such components." The letter concluded, "In all the circumstances, the Commissioners are assured that as soon as sufficient supplies are available it is the intention to widen the W.B.A. priority to cover requirements of, *inter alia*, existing premises where no reasonable alternative facilities are available."

In sending us these details the corporation points out that the root of the trouble appears to be the W.B.A. system of priorities, under which, according to the letter written by the Commissioners, rural electrification is limited exclusively to new houses.

MODERN SWITCHGEAR

by R. N. BUTTREY, M.Sc.TECH., A.M.I.E.E.

Short-Circuit Operation.—In the following, Part VI* of the series, a brief account is given of the main phenomena occurring during circuit interrupting processes. In designing circuit-breakers to operate satisfactorily under short-circuit conditions (and also special load breaking), four distinct functional criteria must be satisfied, namely:—

1. Satisfactory interruption of the short-circuit current under given conditions of the electrical circuit parameters R , L and C .
2. Satisfactory mechanical operation of the circuit-breaker structure under the influence of electro-magnetic forces.
3. Necessary insulation of the circuit-breaker against normal voltage conditions, transient conditions occurring during current interruption and transient conditions arising from external sources such as lightning over-voltages whose magnitude is controlled by the established maximum level of the system.
4. Thermal conditions based on short time rating, e.g. 1 sec., 2 secs. or 5 secs. at the maximum short-circuit current.

Circuit Interruption.—Early work on circuit interruption assumed a basis of performance defined by the product of short-circuit current and recovery voltage, the latter being the value of power frequency voltage attained across the terminals of the circuit-breaker immediately after current interruption. Since, except with very small values of current, interruption occurs at a normal current zero, the recovery voltage has been measured on oscillograms from the envelope formed by the first three complete $\frac{1}{2}$ cycles of voltage appearing after interruption. The time-lag between current interruption and the occurrence of the first peak of voltage was regulated by specifying a maximum permissible value of power-factor, so that at zero power-factor the instant of the first peak corresponded to the current zero at which interruption occurred. Since such a conception assumes the application of, in operational terminology, a unit function wave with infinite slope of wave-front, it is obvious that such an immediate reappearance of voltage across circuit-breaker terminals would not only be impossible but would also permit no time for dispersion of the ionised arc paths assumed necessary for successful interruption.

Such considerations have led to the additional qualification of rate-of-rise of recovery voltage so that the total voltage

which appears across terminals at the instant of interruption is the sum of the normal power frequency voltage wave and the natural high-frequency oscillatory voltage wave of the system, the latter being a function of values and disposition of inductance, capacitance and resistance in the circuit. Several methods of defining "rate-of-rise" have been considered, the most acceptable being by means of a tangent

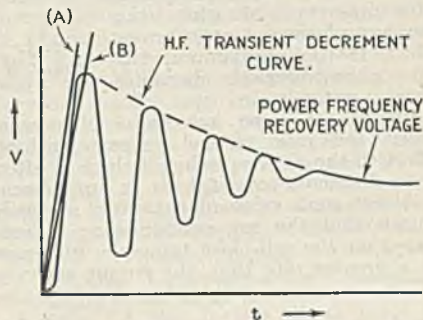


Fig. 1.—Measurement of "rate-of-rise" of striking voltage for a single frequency transient

from voltage zero Fig. 1A or a straight line joining the voltage zero and the first peak Fig. 1B in the case of single frequency oscillations. For multi-frequency transients, considerable difficulty is experienced in defining a value of "rate-of-rise" which would enable a single frequency wave to be substituted for test purposes to constitute an equivalently severe condition on a circuit-breaker. Another factor to be appreciated is that such values measured as indicated in Fig. 1 do not qualify voltage rise conditions near the base of the voltage wave, which conditions, being applicable immediately after interruption, may be considered as important in the current interrupting operation.

Other investigations of the current interrupting process, dealing with conditions immediately prior to the current zero and relating deionising influences during this period to external circuit parameters, has led to a different aspect of the problem and the introduction of the term "circuit severity." Such conditions, being more difficult to understand than the "rate-of-rise" theories, have not superseded the later in the definition of circuit conditions up to the present although they enable a much more exact description of "circuit severity" to be made.

Circuit-Breaker Capacity.—On the now generally accepted basis of defining the

* Parts I, II, III, IV and V of this series appeared in THE ELECTRICIAN of July 25, August 16, September 27, October 25 and December 6, respectively.

circuit-breaker breaking capacity in terms of current, voltage and rate-of-rise of recovery voltage (or natural frequency of the circuit), the fundamental operation on different types of circuit-breakers, e.g., oil with or without arc control devices, and gas-blast, is similar although the influence of "rate-of-rise" over the range of short-circuit currents differs. Whilst the air-blast circuit-breaker, with an external constant extinguishing source of compressed air at constant pressure, is subjected to the most severe conditions (for interruption) when the product of current and "rate-of-rise" is a maximum, the oil circuit-breaker becomes most critical in its performance at some low value of current where the ratio of the arc extinguishing effort to the above product (which is often termed circuit severity) is a minimum.

Above such value of current it is easily shown that the arc extinguishing effort, based on the self-blast principle, increases at a greater rate than the circuit severity

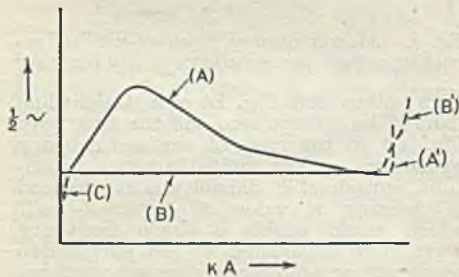


Fig. 2.—Arc duration characteristics of: (A) Oil circuit-breaker with self-blast arc control device; (B) air-blast circuit-breaker; (A') failure due to bursting of arc control device; (B') failure due to circuit severity exceeding interrupting effort; (C) critical region in which forced current interruption occurs

so that the well known arc duration characteristics are obtained as shown in Fig. 2.

Arcing Time Characteristic.—Extensive research and development has been carried out in the last few years to improve the arcing time characteristic of the higher voltage oil circuit-breaker in order to obtain a more uniform arc duration throughout the range of short-circuit currents without giving rise to undue pressures in the arc control pot itself. Various devices have been employed, including provision of pressure release valves, spring loaded pistons, etc., although adequate control of the pressure/current characteristic without resort-

ing to moving parts in the arc control pot has produced arcing times which, in conjunction with the simpler and faster mechanism of the oil circuit-breaker, give overall operating times comparable with

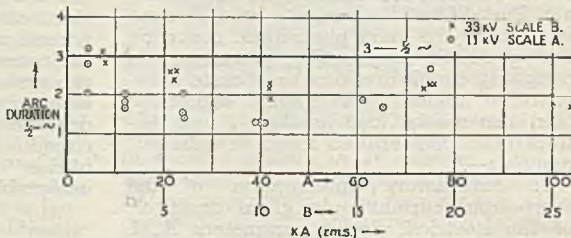


Fig. 3.—Arc duration characteristics at maximum test plant value of rate-of-rise of recovery voltage for modern single-break type oil circuit-breakers

the air-blast breaker. Fig. 3 shows characteristics for 11 kV and 33 kV single-break oil circuit-breakers.

In order to utilise the full breaking capacity of each arc control device of a multi-break circuit-breaker, some means of distributing the recovery voltage between breaks is necessary, this expedient taking the form of resistance (linear or non-linear) or capacitance. The latter form of voltage distribution is often employed on air-blast circuit-breakers employing two or more breaks in series whilst, when resistance is employed, this is often utilised to modify the restriking voltage transient.

The influence of the amount of gas generated in an oil circuit-breaker during interruption is threefold.

1. In the case of the plain-break circuit-breaker, successful interruption in any phase is often dependant upon the total turbulence and pressure due to the short-circuit current in the other two phases so that it is difficult to obtain consistent single-phase operation without creating excessive pressures in the case of three-phase operation. When arc control devices are fitted, the interphase dependance is eliminated.

2. The total gas generated during interruption emerges from the arc control devices and creates a static pressure in the circuit-breaker enclosure until released by some venting device, the latter usually being restricted as much as possible to minimise the throw of oil. In modern arc control devices, it is possible to predetermine the quantity of gas generated and provide air cushioning in the circuit-breaker enclosure to limit the tank pressure to a specified value.

3. The release of gases from the arc control devices into the main enclosure, such gases consisting mainly of hydrogen, may seriously lower the dielectric strength of the circuit-breaker unless the gases are

suitably directed away from live parts. For this reason "unit" testing of multi-break circuit-breakers has to be augmented, in so far as testing plant permits, with full-scale testing at maximum recovery voltage.

The amount of gas generated in an arc control device is a function of the "circuit severity," i.e., current, and rate-of-rise of recovery voltage, this amount being dependant upon the particular design of pot and also "severity" conditions prevailing at the critical values of current. As already mentioned, at values of current above this critical value the gas generated is in excess of the requirements for successful interruption.

Insulation.—In addition to the possibilities of internal insulation failure due to presence of hot gases which, possessing a high di-electric strength whilst at high pressure in an arc-control device possess relatively small insulation value when at reduced pressure in the circuit-breaker enclosure, other problems, such as reduction of insulation in arc-control devices due to charring and presence of carbon deposits and also excessive over-voltage caused during the switching operation, arise. The presence of a combination of ionised and conducting paths in an arc-control device often results in post-arc conductivity currents which are not normally discernible on a short-circuit oscillogram but which may attain values of the order of a few amperes immediately after interruption. Such currents are usually of no detriment and often assist extinction by modifying the restriking voltage characteristic; these currents do, however, complicate the problem of obtaining uniform voltage distribution in multi-break circuit-breakers. In the case of air-blast circuit-breakers such post-arc conductivity currents are much smaller in magnitude and usually difficult to measure.

Over-voltages produced by pre-zero suppression of transformer magnetising currents will occasionally cause external spark-overs during testing of a circuit-breaker, the important feature being that the spark-over must not occur across the terminals of one pole of the circuit-breaker. If this point is satisfied then such spark-overs, being on the isolated side of the circuit-breaker, will be successfully cleared by the latter in the eventuality of a follow-through short-circuit. This feature has been demonstrated frequently on test plants, especially when a high voltage step-up transformer was controlled by means of an air-blast circuit-breaker. Such over-voltages are much more easily demonstrated with air-cored reactors than with iron-cored reactors or transformers in which iron losses provide some alleviation.

Yet another problem of insulation, which a circuit-breaker may have to deal with repeatedly in service, is in the interruption of line charging currents in which complete voltage reversal, i.e., twice line voltage, may occur across the circuit-breaker terminals with the added hazard of transient over-voltages should spark-over occur between the circuit-breaker contacts during the interruption process.

Of the points 2 and 4 outlined above, problems of electro-magnetic forces have been dealt with in Part IV of the series. The thermal problems which arise are generally quite straightforward, short-time current ratings being based on the thermal capacity of conductors, normal dissipation (conduction, convection and radiation) being neglected. Although the permissible temperature rise for a period of a few seconds is usually based on the prevention of damage to insulation in close contact with a conductor, attention must be paid to the possibility of reduction in mechanical strength of certain alloys at quite moderate temperatures in the region of say 200° C.

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Birmingham I.E.S.

CAN the I.E.S. Code be profitably employed in industry, was the subject for a debate at the third sessional meeting of the Birmingham Centre of the Illuminating Engineering Society on December 6. Before the meeting commenced, members paid tribute to the late Mr. G. H. Wilson.

Mr. R. Mackenzie was in the chair, and the principal speakers were Mr. R. O. Ackerley (for), and Mr. W. G. Markwick (against).

Mr. Ackerley, opening, said the code was arbitrary, and there might be reasons for going to higher or lower values than those stated, though he could not see how any one of the clauses relating to quality could not be profitably applied. Controlled tests had shown that the code could and had been profitably applied.

Mr. Markwick, taking the opposite view, agreed that there were benefits to be derived from the code, but the industrialist who had to foot the bill wanted to know what he would get out of it. Production was not now so great as when lighting installations were poorer.

Fluorescent Stage Lighting

Striking Illuminated Curtain in Scottish Pantomime

WHAT is believed to be a unique application of discharge-tube lighting was first shown to audiences at the Metropole Theatre, Glasgow, last week, at the opening night of the Christmas pantomime. Designed, planned and constructed at the Glasgow branch of Franco Signs, Ltd., under the direction of Mr. Walter Macmillan, it is an illuminated "curtain" composed of fluorescent tubes, and has already drawn considerable approval from audiences. Important possibilities for cinema, theatre, dance-hall and other displays are, it is believed, now opened.

Altogether, 1 000 discharge-tubes, bent into various shapes, are employed, the colours being natural neon red, from clear tubes, and fluorescent orange, yellow, blue, green and white. The design, very suitably, has a Scottish motif, the main figures being lions rampant and thistles, surrounded by flashing stars.

The complete unit is a hollow alloy box, 18 in. deep and measuring 20 ft. by 18 ft., and is constructed in sections for easy assembly and dismantling. A winch carries it up into the flies. During its transit to the stage, it is under electrical control the whole time and, despite the number and fragility of the tubes, raising and lowering has been achieved without risk of damage. The sectionalised construction is said to make transportation of the entire assembly, by road or rail, quite practicable, only the l.t. connections having to be made on site.

Low tension supplies to the unit are at 250 V, and some 38 h.t. transformers, located in the various sections, provide the tube supplies of 10 000 V. Flashing stars are controlled by motor-driven switches. Elaborate precautions have been taken to ensure that the system is entirely safe, and the Glasgow Corporation officials, who have approved the installation, regard it as fool and shockproof.

The curtain was designed, in collaboration with the management of the theatre, as the "set piece" of the pantomime, and is in use for a few minutes towards the end of the show. All the house lights are dimmed to obtain the maximum effect from the demonstration, which is attended by a march-on of Scottish pipers, and the phosphorescent after-glow of the tubes is a particularly striking feature.

Discussing the curtain in an interview with a representative of THE ELECTRICIAN, Mr. Macmillan said that he was satisfied that they were on the right lines and that this would open up very considerable

possibilities for the use of discharge-tube lighting in connection with the entertainment industry. Earlier efforts by the company, although not of a curtain type, had been successfully experimented with, and had been toured over a group of theatres. The experience gained on this installation, which will be on view for about six months, would, it was hoped, lead to a very considerable expansion of that policy.

Fuel Conference

THE Conference on Pulverised Fuel which is being organised under the auspices of the Institute of Fuel will be held in Harrogate from June 3 to 6 next. Over 50 papers are being contributed from the supply industry, water-tube boiler makers, the Fuel Research Station, the British Coal Utilisation Research Association, the National Coal Board, the British Refractories Research Association, and from other branches of industry concerned with the manufacture and use of pulverised fuel-fired plant. Contributions are also expected from South Africa, Australia, the U.S.A., France, Holland and Germany.

In order to allow of time for discussion, the papers will not be read, but are to be published in a book which will be sent four weeks before the opening session to all who take up membership of the conference. The book will contain, in addition to the papers, an index to authors, subjects, and programme for each session. Each programme will set out the points to be discussed at that session with a cross-index to the comments of the authors upon them. Each session will be opened by a rapporteur who will survey the matters to be discussed and summarise the statements made and facts given relative to them in the papers. Reports of the discussion, with the rapporteurs' contribution, will appear as a second volume to be issued shortly after the conference. Social events will include a civic reception and dance, a luncheon, dinner, and ball with cabaret. Outings for ladies and works' visits will also be arranged. Membership of the conference will not be confined to members of the institute but will be open to anyone interested in pulverised fuel. The full programme is not yet complete, but the Conference Committee has opened a list of persons interested (apart from members of the institute) to whom full particulars will be sent. Names should be sent to the Committee, Institute of Fuel, 18, Devonshire Street, London, W.1.

The Case for 240V

Importance of the Grid and Standardisation

THE importance of the national grid to-day and the future tasks of electrical engineers were among subjects mentioned by Mr. E. R. Wilkinson (commercial manager, C.E.B.) in his address to the Lancaster Engineering Society, on December 12.

ELECTRICAL DEVELOPMENT

The turning point in the development of electrification, Mr. Wilkinson said, might prove to be the 1930s, when standardisation of frequency was carried out and the grid was constructed. Nobody to-day questioned the wisdom of the decision to standardise frequency, but one was apt to forget the anxiety with which the task was undertaken. In 1924, 17 different frequencies were in use and no less than 80 supply undertakings were using frequencies other than 50 c.p.s. Over 1 900 000 h.p. of consumers' motors were changed over without dislocation of industrial production, and more than 900 000 kW of generating plant without interference with the security of supply.

The new decision to standardise upon 240 V for l.t. distribution might seem a retrograde step in view of the fact that more than half the total number of existing l.t. consumers were supplied at 230 V. Several factors, however, had to be taken into account. In the case of systems operating above the proposed standard voltage, distribution capacity would obviously be reduced by standardisation, and the additional expenditure on mains involved in lowering 250 V systems to 230 V would be considerable. If 230 V systems were raised to 240 V, their capacity would be increased, a factor of particular importance at the present time, with the prospect of continued shortages of materials and labour. There were other considerations, such as the readier adjustments of transformer ratios by raising voltage than by the reverse. After taking all such factors into account, there was a balance of nearly £8 000 000 in favour of the 240 V decision. Experience with the standardisation of frequency suggested that the problem was within the capacity of the supply industry to surmount, but that experience also indicated that the work should be done with the utmost urgency, if the costs involved were to be kept within reasonable bounds.

Saving that many misconceptions still existed among engineers as to the functions of the grid, Mr. Wilkinson explained

that the underlying principles were not long-distance transmission but rather the concentration of electricity production upon large and efficient stations, in positions favourable to economical production. This enabled small and inefficient stations, unfavourably sited, to be superseded. The interconnection of the efficient stations made possible mutual assistance, reduced the proportion of reserve plant required and, since all the stations associated with the grid were operated under central control, the highest practicable load factor could be secured for the most efficient plant in the system, reserving the less efficient for short period peak load purposes.

Manufacturing the equipment for the grid, Mr. Wilkinson continued, had enabled British firms to demonstrate their ability in the design and construction of large high-voltage power equipment. During the war, by permitting the large-scale movement of industry, the grid had been of the utmost importance. Illustrating this latter remark, the speaker said that at the winter peak of 1938-39, South-West England had exported 7 000 kW and South-East England had imported 96 000 kW. By 1942-43, however, South-West England was importing to the tune of 244 000 kW, and South-East England was exporting no less than 292 000 kW.

PRODUCTIVITY AND POWER

Looking to the future, Mr. Wilkinson said that the increase in national productivity, which was so essential, could only be achieved by a much greater use of machine power, and effecting this was the supreme task for every electrical engineer during the critical years of reconversion which lay ahead. Attention should also be given to the most economical use of our fuel resources. Atomic energy might become a practical source of power within the next 10 or 20 years, and the most logical course for development appeared to be that fuel-fired generating stations would be gradually superseded by central stations driven by atomic energy.

We were now embarking upon the electrical age, he concluded, and the possibilities of the electric motor, electric lighting and the thermionic valve were by no means fully explored. It was to the electrical engineer that the community must look for guidance in all the many aspects of electrical service.

Electrical Personalities

MR. A. COOKE, assistant mains engineer in the Scarborough electricity department, has been appointed chief electrical engineer to the Barnoldswick U.D.C.

MR. ARTHUR PARKINSON has been appointed an executive director of Crompton Parkinson, Ltd. He is the son of the late Mr. Frank Parkinson, who was chairman of the company, and has been with the firm since 1936, apart from a period of service with the R.E.M.E. at home and in the Middle East, during which he attained the rank of captain. Mr. Parkinson is sales manager for lamps and lighting equipment.



MR. A. PARKINSON

MR. CYRIL G. GRIFFIN has retired from the Board of Frigidaire, Ltd.

MR. R. A. HEYWOOD has succeeded Mr. G. H. Tipper as Director of Mica. Mr. Tipper, who has resigned on health grounds, will however, act as consultant on mica to the Board of Trade.

BRIG. GENERAL WADE H. HAYES, managing director of Edinundsons Electricity Corporation, is spending a holiday in America, and will probably return in February.

MR. JOHN LAWTON has been appointed by Ferranti, Ltd., as area manager, Eastern Counties, vice Mr. R. J. Hebbert, whose duties at Hollinwood now occupy his whole time. Mr. Lawton has been in the company's service since 1917 and is an expert on the subject of large scale metering.

MR. J. HUGHES, with Mr. F. J. Kelgour, Mr. L. R. Jones, and Mr. T. E. Chadwick, temporary assistant turbine engineers in the Liverpool electricity department, have been recommended by the Electric Power and Lighting Committee for appointments as assistant turbine engineers.

PROF. G. W. O. HOWE has retired from the James Watt Chair of Electrical Engineering in the Glasgow University. At a presentation ceremony in his honour his successor, Prof. Bernard Hague, handed to him a cheque for £200 on behalf of the university. Prof. Howe passed over the gift to Sir Hector Hetherington, principal

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.

of the university, for the endowment of a prize for the most outstanding graduate in electrical engineering. Sir Hetherington said that when material and labour became available there would be a large expansion of the electrical engineering building and equipment.

MR. WILLOUGHBY STATHAM SMITH, formerly joint managing director of the Telegraph Construction and Maintenance Co., Ltd., Old Broad Street, E.C., left £178 730.

MR. A. G. MILNE, who has been technical superintendent with the Blackburn electricity undertaking since 1945, has been appointed deputy city electrical engineer at Bath. On leaving Faraday House Electrical Engineering College, where he obtained an Honours Diploma, he went through the steam and electrical test departments and the electrical research department of C. A. Parsons and Co., Ltd., and then held successive appointments with the London Electric Supply Co., Ltd., Thomas Firth and John Brown, Ltd., Sheffield, and the Yorkshire Electric Power Co.

DR. C. F. BAREFORD has been appointed manager and head of the new Mulard electronics research laboratory at Cross Oak Lane, Salfords, near Horley, Surrey. He took a first-class honours B.Sc. in physics in 1930; a year later he was awarded the M.Sc. degree, and in 1933 the Ph.D. degree for work on the spark discharge in vacuo. He worked in this field until 1934, when he joined the British Thomson-Houston Co., Ltd., as a vacuum physicist. There he worked on the design of radio valves and other electronic devices. In 1936 he went to the Royal Naval Signal School at Portsmouth, which became the Admiralty Signal Establishment. In those two establishments he was engaged on research and development work connected with radiolocation, direction finding and telecommunications.



DR. C. F. BAREFORD

Dr. Bareford has gone to the Mullard Radio Valve Co., Ltd., direct from the Admiralty, and will be closely connected with the development of electronics as applied to industry.

MR. E. G. BATT has been appointed director of the British Refrigeration Association, of which he has been independent chairman since its inception three years ago. The appointment takes effect from March 1. Born in London, in October, 1888, Mr. Batt was educated at Rugby, after which he received works and technical training with the British Thomson-Houston Co., Ltd., at Rugby. Following



MR. E. G. BATT

Continental experience, he joined the General Electric Co., Ltd., in May, 1915. He next served in the war as an officer in the R.N.A.S., Airship Division, returning to the company in February, 1919. He was then appointed to handle association work and has continued to do so. In addition to representing the company on the B.E.A.M.A. and other trade associations, he has held a number of appointments in which he represented the electrical industry itself. He has been intimately concerned with the work of the B.E.A.M.A., the British Standards Institution, the E.R.A., the International Electro-Technical Commission, the F.B.I., the Fan and Allied Manufacturers' Association, the E.D.A., the Electric Water Heater Manufacturers' Association and the Electrical Fair Trading Council. He is the author of a number of papers dealing with domestic electrical appliances and their application and has been chairman of the section of the B.E.A.M.A. dealing with that subject for 27 years. He was responsible for the formation of the Domestic Electric Refrigeration Association and the Commercial Electric Refrigeration Association, which were amalgamated in the British Refrigeration Association some three years ago. In connection with the prefabricated housing programme Mr. Batt presented the industry's co-ordinated views in discussions with the Government departments dealing with the electrical equipment.

MR. HARRY S. ELLIS, for over 23 years general manager and chief engineer to the West Gloucestershire Power Co., Ltd., whose pending retirement at the end of this month was briefly announced in our last issue, received his early training in the Cardiff Corporation electric light and

tramways department. In 1904 he entered the service of the Bradford Corporation as assistant engineer, and subsequently became deputy city electrical engineer and manager. He was appointed borough electrical engineer at South Shields in 1907, and held a similar appointment at Southampton from 1912 until he became a consulting engineer for a period before taking up his present position.

Obituary

MR. EDMUND TREVOR LLOYD WILLIAMS, senior member of the board of Electric and Musical Industries, Ltd., on December 8, aged 87 years. He was the first chairman of the Gramophone Co., Ltd., in 1899, and held that office until just before the merger of that company with the Columbia Graphophone Co., Ltd., when E.M.I., Ltd., was formed in 1931.

MR. G. O. H. HORSTMANN, formerly chairman of the Horstmann Gear Co., Ltd., at Bath, on December 10, aged 83 years. After opening a watch and clockmakers' shop, he entered the ranks of the pioneers in pedal cycle manufacture, which business he continued from about 1900 to 1905. Later he joined his brother in the business his father had established in Union Street, Bath, in 1854, as watch and clockmakers. In 1904 the Horstmann Gear Co., Ltd., was established to develop certain inventions of the brothers and Mr. G. O. H. Horstmann was appointed chairman, a position he occupied until he retired about two years ago.

MR. FRANK KNIGHT JEWSON, who had been associated with the telecommunications' industry for 49 years, suddenly, in London, on December 4, aged 66 years. Educated at Finsbury Technical College under Prof. Sylvanus Thompson, he joined the Western Electric Company (predecessor of Standard Telephones and Cables, Ltd.) in 1897 and was concerned, successively, with apparatus and cable testing and telephone installations. He installed the first equipment in England for marshalling the troops at the Diamond Jubilee Review. He also gave the first demonstration to the G.P.O., and the National Telephone Company of the use of loading coils and assisted the N.T. Co. in equipping the first loaded cable in Europe (between London and Croydon). From 1907 onwards he occupied various positions on the commercial side—as export sales manager, assistant general sales manager and assistant to the managing director. In 1928 he transferred to the International Standard Electric Corporation, of which he became an assistant vice-president. During the war he returned to Standard Telephones and Cables, Ltd. Mr. Jewson had been an associate member of the I.E.E. since 1904.

Motor Speed Control

MERCURY ARC RECTIFIERS AND THEIR APPLICATIONS

A SURVEY of modern mercury arc rectifier technique, followed by a description of the rectifier control of d.c. motors, was given in the paper read by F. T. Cowley, at the December meeting of the Association of Supervising Electrical Engineers, on Tuesday.

EARLY RECTIFIERS

The earliest mercury arc rectifier, Mr. Cowley began, was the glass bulb type, for which there were two methods of initiating the discharge. In the first, a "dipper" carrying a 60 V a.c. supply was pulled in and out of the pool, at which a spark was formed, and in the second, a "neck" or "bridge" of mercury lay between the main cathode pool and an arm on the side. A heavy current passing through this neck caused the bridge to shrink and finally split, so creating a spark which caused the exciter to light up. Glass bulb rectifiers were made in various standard sizes between 5-500 A.

For heavy loads, above 2 000 kW, the water-cooled steel tank rectifier had been developed, but these were obsolescent, and a more modern method was the pumpless air-cooled steel tank which, electrically, was exactly similar to the glass bulk rectifier.

In America, the Ignitron, or single anode controlled ignition rectifier, had been in use since the late 1930s. It consisted of a single chamber containing a mercury pool at the bottom and a single large anode at the top, in close proximity to the mercury. A third electrode, made of a high resistance refractory material, was mounted in the tank and dipped in to the mercury. When a voltage was applied to this electrode, it would initiate the mercury arc, but the actual reason for this had not been definitely established. Since the refractory electrode would overheat if permanently connected, it was impulse excited at the commencement of each positive cycle on the main anode. Ignitrons had a capacity of 1 000 to 20 000 A.

GRID-CONTROLLED EQUIPMENT

The speed control of d.c. motors, Mr. Cowley said, was wasteful if carried out by varying field or armature currents by resistance methods, especially on larger machines. The Ward-Leonard system also had disadvantages, in that at least two rotating machines were necessary in addition to the variable speed motor itself. By means of a grid-controlled rectifier, however, the motor speed could be infinitely variable exactly as with the Ward-

Leonard set, and a higher overall efficiency could be obtained. Grid-control would permit the output of a large rectifier to be varied at will by means of a suitably designed grid circuit which, at most, consumed only a few watts.

With a mercury arc rectifier, made with a grid between anode and cathode, the discharge would start as soon as the grid became positive. By controlling the instant at which this occurred, therefore, one could vary the d.c. voltage output of the rectifier and thus the armature current of a d.c. motor. Mr. Cowley then showed a slide on which anode and grid waveforms were superimposed. The alternating grid potential was, however, lagging by about 30° on the anode waveform and the total period of firing was, therefore, reduced to only 60° of the positive half-cycle. When the grid voltage was caused to lag still further, the anode current was proportionately reduced, and if a sufficient phase shift of the grid voltage was available, the anode current could be varied from a maximum to zero. The same principle, Mr. Cowley added, could be applied to three- or six-phase circuits.

PHASE SHIFT

One method of obtaining the phase shifts on the rectifier grid was by fitting an auxiliary winding, which was centre-tapped and had a variable resistance and an inductance connected in series across its outers, to the main transformer secondary. The primary of a small grid transformer was connected between the centre point of the winding and the junction of the resistance and inductance, and the grid transformer secondary was connected to the grids of the bulb via current limiting resistors. By varying the resistance value, the proportion of the voltages dropped across the resistance and inductance was controlled, so that, with the resistance completely out, the rectifier gave zero d.c. volts and with the resistance all in, the maximum supply to the motor armature was obtained.

In conclusion, Mr. Cowley described a complete grid-controlled equipment, and explained the purposes of the various safety relays and reversing contactors which were normally provided. In America, he said, rectifier equipments using thyatrons had been manufactured, with which, it was claimed, the motor speed could be kept within ± 1 per cent., irrespective of the load on the motor, and a 20:1 speed range obtained.

War-time Measuring Instruments

A Millisecond Chronoscope—Sensitive Recording Magnetometer

TWO instruments produced during the war were the subjects of papers read at the meeting of the I.E.E. Measurements Section on December 13.

The first, a chronoscope developed by the National Physical Laboratory in response to a request from the Ministry of Supply for an instrument to measure time intervals ranging from a few milliseconds up to about a second for the primary purpose of measuring the delays of bomb fuses, was described in a paper by Mr. R. S. J. Spilsbury and Mr. A. Felton.

The paper opened with a discussion of various methods of measuring short time intervals and then proceeded to describe a condenser chronoscope suitable for the measurement of intervals initiated and terminated by momentary or sustained makes or breaks in electrical circuits. The range is from 2 millisecc. to 1 000 millisecc. The voltage on the condenser is measured by a simple valve voltmeter which is used only as a transfer instrument, the final reading being given on three decade dials of a potentiometer. This reading is converted into milliseconds by the use of specially prepared tables. The instrument is self-contained and transportable, power being obtained from dry batteries. The accuracy, which is limited chiefly by dielectric absorption in the condenser and by leakage in the components, is of the order of 0.5 millisecc. on short intervals, or 0.5 per cent. on long intervals.

COL. J. D. PAXTON-PETTY (Chief Superintendent, Armaments Design) paid a tribute to the National Physical Laboratory for the manner in which it had taken up the matter when the requirements were placed before it, and the chronoscope had now been used for several years for a tremendous variety of accurate measurements and it had also been loaned to other establishments, who had nothing but praise for its performance and the ease of maintenance of the equipment. Tests had indicated that the instrument had not departed very far from its original settings and there was an excellent record of accuracy. He suggested it would add to the value of the equipment if some internal calibrating device, or some handy external calibrator could be incorporated.

MR. C. G. GARTON (E.R.A.) said the errors in the instrument seemed to be much greater than would have been expected from theory. The authors gave a

figure of 2½ per cent., but it surely ought to be very much smaller, and he had not been able to get to the bottom of that matter. Was there any possibility of an abnormal rate of absorption? In the case of mica, the absorption should not be more than 0.1 per cent., and the error from that cause should be negligible. There were better dielectrics from the point of view of long term absorption. Polythene and polystyrene had been found to be very good. He asked if the authors could explain why the instrument was more erroneous than it should be theoretically.

MR. J. MCGAVIN (Automatic Telephone and Electric Co., Ltd.) showed a slide of a circuit which, he said, was capable of giving as good accuracy as the authors' apparatus, but with somewhat easier operation and a less complicated circuit. There seemed to be no need for four relays; indeed, he claimed the same results could be obtained with two relays. The authors' instrument had been developed for a special purpose, but for general use a chronoscope of this sort did not take into account armature oscillation. Therefore, it was often essential to use an oscillograph of some sort to obtain a record of what had happened. He added that he had used a timer which made use of gas discharge tubes.

MR. D. PITMAN referred to another type of chronoscope which, he claimed, would not give any trouble from random electric disturbances. He asked what agreement was obtained between the various instruments if the authors' chronoscope was made in quantities, and said he would anticipate trouble with the relays.

MR. FELTON replying to the discussion, said he was pleased to hear what Col. Paxton-Petty had said because this was the first time they had had the customer's reaction to that instrument. The authors agreed it would be useful to put in a self-contained checking device and they would bear that in mind, although it seemed a little difficult. He agreed that the error mentioned by Mr. Garton had surprised the authors. He believed the Americans had used polythene experimentally in some timing circuits. There was not much information available about the long period accuracy of the instrument, except what Col. Paxton-Petty had said, but when the instruments were set up new he believed they could be relied upon to read

the same within $\frac{1}{4}$ per cent. or a $\frac{1}{4}$ -millisecond, and he did not see why they should not maintain that accuracy for a considerable time.

Mr. A. Butterworth, of the E.R.A., in the second paper, on "A Sensitive Recording Magnetometer," gave details of a new recording magnetometer, suitable for measuring changes in any component of the earth's magnetic field. The changes in field are registered by making a continuous record of the resultant impedance variations of a length of Mumetal wire situated in the field to be studied.

MR. D. C. GALL (H. Tinsley and Co., Ltd.) said he had tried some years ago to do what the author had done so successfully, but failed to get any stable results at all. Therefore, he was extremely impressed by the ingenious way in which the author had overcome the instabilities. He (the speaker) abandoned Mumetal and went to the suspended magnet method, which was an entirely different principle. The treatment of the wire, he imagined, played a little part in the success. He asked what governed the choice of diameter of the wire and also the frequency. Why were 1 000 cycles chosen instead of something very much higher?

DR. G. A. V. SOWTER (Telegraph Construction and Maintenance Co., Ltd.), remarking that he had had a great deal to do with Mumetal in the early days, said

it was originally a chromium Mumetal, having a 4:1 ratio to iron with some chromium. He understood, however, that the later types of Mumetal contained molybdenum, and not chromium, and was a different alloy with very much better qualities. Dr. Harrison had done a great deal of confidential work at the Admiralty in this connection, and he thought the information available should be made public. He understood that the manner in which the strip was brought from the hot rolled to the cold rolled condition had a great influence on the permeability.

DR. W. B. WHITNEY referred to the satisfactory results which were obtained with this magnetometer in making ships safe from the magnetic mine, and said that a number of them were placed under water at Tilbury in 1940 and worked perfectly for two years without any attention, in a 4-knot tide. Some of the instruments operated until the end of the war without any trouble, with the exception of one failure, the reason for which was not known.

DR. S. WHITEHEAD (director, E.R.A.) said this was just one instrument among many which had been developed by the author and his colleagues during the war, and it had to fulfil certain conditions. A feature of it was that it avoided anything in the nature of moving parts.

MR. BUTTERWORTH briefly replied.

Chester Electricity Jubilee

CHESTER electricity undertaking which supplies an area of 144 sq. miles and has 23 547 consumers, celebrated its golden jubilee by holding a historical exhibition of electrical equipment at the Town Hall from December 11 to 14.

Ald. R. Matthewson, chairman of the Electricity Committee, who presided at the opening ceremony, paid tribute to the part played in the development of the undertaking by the late Mr. S. E. Britton, who died in June last after having been city electrical engineer since 1904, when the number of consumers was 778 and the units sold 1 273 213. The electricity works were opened on December 17, 1896, and Chester was amongst the first undertakings in the country to open a showroom. This was extended to its present dimensions in 1931 and last year nearly 100 000 people made use of the showroom. Twenty-five per cent. of the total sales of the showroom and contracting department repre-

sented goods supplied to contractors in the city on trade terms.

In 1912 the hydro-electricity station was opened and in 1923 the Queen's Ferry power station was purchased. The undertaking was noted for its pioneering work in respect of rural development; there were 1 024 farms connected to the mains, and in the rural areas the consumers numbered 9 705 and the consumption 23½ million units.

Mr. C. T. S. Arnett, manager N.W. England Central Electricity Board, who opened the exhibition, said that the public had not appreciated until recent years that electricity could be in short supply. In the circumstances it might be asked, why hold an exhibition when electricity consumption was being discouraged? The reason was that the short supply was merely transient. The Minister of Fuel and Power was most interested in the electrification of rural areas and so far

as municipalities were concerned, Chester had shown the way.

In the exhibition were displayed domestic equipment illustrating developments during the last 50 years. For example, the development of bed warmers from the old copper bowl to the electrically-heated blanket; the solid cast iron to the electric steam iron; the wooden roller mangle to the electric washer. In the industrial section there was a model of the Litt'e Barford generating set installed in 1944, and photographs of the Chester stations. Arrangements were made for the public to inspect the hydro-electric station and the Crane Bank sub-station.

Some idea of the growth of the undertaking can be gained from the following statistics for 1945-46, the figures in parentheses being those of the first year (1896-97): Consumers, city, 13 842; rural, 9 705 (city only, 211); units sold, 55 549 275 (50 289); maximum demand, 19 228 kW (131 kW); units generated and purchased, 62 576 269 (62 638); cost per unit generated, 0.754d. (1.433d.); price per unit sold, 1.2d. (3.785d.); effective capital expenditure, £989 543 (£1 014). In 1945-46 the capital cost per unit sold was 4.275d., and in the first year of the undertaking 9s. 10.265d. The city electrical engineer is Mr. S. C. Harling.

Equipment and Appliances

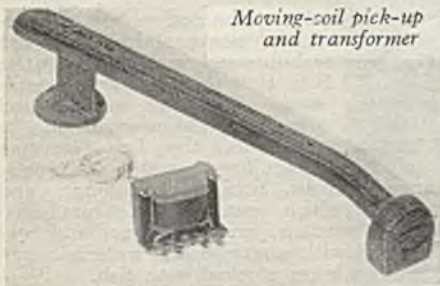
A NEW moving-coil gramophone pick-up, distributed for Southern Electrical Industries by Brooks and Bohm, Ltd., of Victoria Street, S.W.1, will be of interest to enthusiasts of high-fidelity record reproduction. The response, it is claimed, is approximately flat between 250 and 12 000 c.p.s. when the pick-up is used in conjunction with the step-up transformer provided, and the output, depending upon the record, varies between 0.1 and 0.2 V r.m.s. The coil impedance is 2 ohms, and the transformer is suitable for matching it into a 50 000 ohms load at the amplifier. Used in conjunction with the transformer.

models, in the "A" series, are assembled with heavy angle-iron clamps and have ratings from 750-3 500 VA. All their transformers, the makers state, comply with B.S. specifications. Tappings can be provided to suit customers' requirements, and fixing centres can be adjusted at works, for various methods of mounting. Tropical as well as inland impregnation is available, as required.

S.E. Area E.D.A.

THE second of the series of S.E. and E. (E.D.A.) Area Lecture Meetings was held on December 16 at Croydon electricity showrooms through the co-operation of Mr. Rendell-Baker, borough electrical engineer. The attendance was 140 and the subject "Electric Water Heating Development," was dealt with by the Lecturer, Mr. P. Honey. The different types of water heater were explained and special attention was paid to the avoidance of common installation errors. The value of the load to the supply industry and the fact that electricity could solve any water heating problem were stressed. A discussion followed and the proceedings terminated with a tour by conducted parties round the showroom and office premises.

Following the recent successful showing of films to 98 members of the London and S.E. branch of the Industrial Catering Association by the S.E. and E. area of the E.D.A., a programme which featured "Cooking for the Million" was presented in London on December 12 to over 100 members of the S.E. branch of the Institutional Management Association. At the end of the show, the Area Officer gave a talk on "The Economic Aspects of Electric Catering."



Moving-coil pick-up and transformer

the pick-up is suitable for direct replacement of moving-iron types, without the need for any additional amplification.

A range of mains transformers, from 10 V to 10 kVA, is marketed by the Transformer and Electrical Co., Ltd., of Eastern Works, Walthamstow, E.17. Among their smaller products, the "S" type, which is available from 15-60 VA, has coils wound on Bakelite bobbins, rigid strip-steel legs with slotted feet and, for external connections, terminal blocks or loose ends to windings, as required. The heavier

Generating Plant and Demand

Central Electricity Board Views on Prospects Up to 1950

THE opinion that the electricity supply situation would be as difficult in the next two winters as in this was expressed by Mr. Harold Hobson, chairman of the Central Electricity Board, at a Press conference on Tuesday. "It is no use blinking the fact," he said, "that there is no physical possibility of re-establishing a proper balance of plant and demand in this country before 1949 and probably 1950. The next two winters are going to be even more difficult than this if we get cold weather. It may be a little better in 1949, but I think it will be 1950 before we can get back to pre-war services."

Mr. Hobson mentioned that the Board had made arrangements for the installation of some six million kW of new plant, involving an expenditure of the order of £200 million, by 1950, and said, in reply to questions, that if the Government were to give the manufacture of such plant first call on labour and materials, he believed it would be possible to instal it a year earlier. For the last four years at least, the Board had been pressing the Government to control the production of domestic electrical equipment, particularly fires, and although up to the present they had done nothing about it, he had reason to believe that the supply of raw materials for the manufacture of radiators and other appliances was to be reduced. Such action was a little belated, he thought, in that he believed that over half a million fires were sold in this country in the first six months of this year.

The object of the conference was to give publicity to the arrangements that have been made to give warning of impending cuts in electricity supply to prevent inconvenience and danger in industry. In the first instance, the Chairman explained the reasons for the cuts. Many people, he said, seemed to suffer from the delusion that the cuts were caused by shortage of coal. It was possible that in the New Year supply authorities would be in difficulties over coal, but up to the present the cuts in electricity had nothing to do with coal. They arose from the shortage of generating plant in the country to carry the full load demanded by the public.

Plant intended for commissioning this year and next was not going into operation as quickly as was the intention for a variety of reasons, such as shortage of man-power, shortage of materials and manufacturing works, and shortage of building labour. The delay had been

serious. The Board had a programme for this year of some 900 000 kW of new plant, of which up to date little over 200 000 kW had materialised. He doubted whether they would get more than half the total, 450 000 kW, in operation by the end of February.

With regard to warnings when cuts would be made, Mr. Hobson said that in addition to broadcast warnings given at 7 and 8 a.m. and at other times, the B.B.C. had agreed to give warnings of imminent cuts between the items in the Light Programme in the afternoon period and possibly at other times. In the last few weeks the demand for power had been at least a million kW higher than it was last year, and the Board had only 200 000 kW of extra plant.

The E.I.B.A.

BROOME Park, Surrey, an estate of 25 acres, has been given to the Electrical Industries Benevolent Association as a home for old people by Mr. and Mrs. J. Cunning as a memorial to their son, James Erskine Cunning, who was killed in a raid over Essen in 1941. Mr. Cunning, who is now retired, was a well-known Harley Street surgeon, and Mrs. Cunning is also a doctor. The donors had no connection with the electrical industry, but they were so impressed with the activities of the E.I.B.A. that they decided to withdraw the estate from the market and instead to give it to the association.

The gift includes the fine Georgian mansion in magnificent state of repair, three cottages, ancillary buildings, and grounds which comprise pleasure and kitchen gardens, orchards, woodland and parkland with a stream and waterfall, and with two lakes stocked with fish.

The estate lies just south of the junction of Reigate Hill and Box Hill, and has easy access to Dorking, Reigate and Redhill, and is within five minutes walk of Betchworth Station.

The home will have no institutional flavour, and there will be the fullest respect for the privacy of the individual. The residents will have their own separate quarters while having the communal advantages of common rooms, care during illness, etc., facilities for a library, hobbies and music, and the ability to organise concerts and other social events, to which they will be able to invite visitors.

Industrial Information

European Public Utilities Panel

On the occasion of the visit to England in December of the Public Utilities Panel of the Emergency Economic Committee for Europe, the delegates were entertained to luncheon at the Café Royal by the Council of the B.E.A.M.A. and the Executive Committee of the British National Committee of the World Power Conference. Sir Harold Hartley, chairman of the latter Conference, presided, and among those present on behalf of the B.E.A.M.A. were Mr. G. L. Wates, Mr. H. W. Bosworth, Mr. I. R. Cox, Mr. D. Z. Ferranti, Mr. S. C. Hurry, Mr. T. F. Lister, Mr. J. S. Ramsden, Mr. D. D. Walker, Mr. B. H. Leeson, Mr. V. Watlington, Mr. J. R. Rea. On behalf of the World Power Conference were Col. C. M. Croft, Sir Johnstone Wright, Dr. C. H. Lander, Dr. A. Parker, Mr. C. H. Gray. The delegates included M. Varlet, M. Grezel, M. Bardon, M. Crescent, Mr. G. J. T. Bakker, Mr. Van Dam Van Isselt, Lt.-Col. D. W. Thorpe, M. Smits, M. de Heem, Mr. V. Bodson, Mr. Tresch, Mr. Simon, M. E. H. Etienne, Mr. Hamerschlag, Mr. C. B. Blydt, Mr. Tuxen, Mr. J. H. Angus, Capitaine and Mme. de Fargues, Mr. C. W. Jeffers, Mr. R. Asher, Mrs. K. H. Munro, Mr. R. P. Letter, Wing-Commander C. A. Francis.

Paint Stoving by Infra-Red Oven

In order to step up production of electric water storage heaters, Johnson and Phillips, Ltd., have recently installed a Metrovick electric infra-red oven capable of paint stoving outer cases from 1½ to 30 gal. capacity. This new oven, which completely paint stoves each body in five minutes, shows a considerable improvement on the older methods of drying. Ninety-six infra-red lamps are used, having a total loading of 24 kW. In addition to its ability to save time, this plant requires a minimum of floor space occupying only 12 ft. by 4 ft. by 13 ft., and is readily adapted to any change in factory layout.

Christmas Dance

An illuminated Christmas tree, a large spray of mistletoe, bunting and fairy lamps gave an appropriate festive atmosphere to the scene at the St. Pancras Town Hall on Friday, December 13, when a Christmas dance was held by Thorn Electrical Industries, Ltd. There was an attendance of over 400 people, including members of the

staff from the Ferguson Radio factories, who danced blithely to the music of the Regina Dance Orchestra until 11.30 p.m., novelty numbers and the award of numerous spot prizes adding zest to the proceedings. Mr. A. S. Shier, a director of the company, deputising for Mr. Jules Thorn, who was prevented from attending by illness, gave a short speech, in which he read a telegram from the managing director. Mr. H. Weenan, who shared the duties of M.C., in company with Mr. G. A. Shea, then read the text of a reply on behalf of the staff, wishing Mr. Thorn a speedy recovery.

Polytechnic's Golden Jubilee

To mark the completion of fifty years' work as an educational body, the Northampton Polytechnic last week held a dinner, at which many well known electrical figures and past instructors were present, and the following day opened its doors to visitors. A number of old students, prospective employers and those interested in adult education took the opportunity of seeing, in the form of laboratory demonstrations, the varied types of training which are now provided. Exhibits of particular interest in the electrical field included some modern X-ray equipment, a well-equipped discharge-lamp laboratory, and a telecommunications section in which, among more conventional apparatus, a working cavity magnetron



A Metrovick electric infra-red oven for paint stoving

was on view. Demonstrations of installation work, motors and switchgear and arc welding were also seen. Mr. T. H. Holmes, clerk to the Governing Body, stated that the problem at present was accommodating the phenomenal number of students who were applying for enrolment. Large industrial concerns were taking full

advantage of the part-time training schemes for numbers of their younger employees, and men returning from the Forces—who were given priority of vacancies—were keen to continue their service technical training up to degree or National Certificate standard. One useful result of the war was that the London County Council had made a payment of £19 000 for munitions work done in the Polytechnic workshops. This had enabled considerable quantities of test equipment and machinery to be purchased from the Ministry of Supply, and many instruments, supplied during the war for the use of Service trainees, were now available for other purposes.

Employment of Trained Personnel

Information obtained from a survey carried out by the Manchester Joint Research Council with a view to assessing the increase to be expected in the coming years in the employment of university graduates in the industries of the Greater Manchester area, shows that in the case of engineering, the percentage increase in the number of firms employing graduates in future years compared with 1939, is 35 per cent; in the number of graduates to be employed c.f. 1939, 62 per cent.; firms in favour of a period of post-graduate research at a university before recruitment, 20 per cent.; firms offering openings for graduates in scientific (research and development) capacity, 41 per cent.; in technical capacity, 87 per cent.; in a managerial capacity, 59 per cent.

Generating Plant for Argentina

British Oil Engines (Export), Ltd., export sales division of Associated British Oil Engines, Ltd., announce that they have secured a contract for the supply of thirty-five Diesel-electric generating sets, valued at more than £100 000, to the Argentine Government. The sets comprise Diesel engines manufactured by Mirrlees Bickerton and Day, of Stockport, with electric generators and control gear built by the Brush Electrical Engineering Co., Ltd., of Loughborough. Four have TLB5 type five-cylinder engines, developing 262 B.H.P. at 600 r.p.m., each direct coupled to a protected type salient-pole, revolving-field, three-phase alternator, of 220 kVA output at .8 p.f. 400/230 V 50 cycles, with overhung exciters. The remaining 31 sets will be TLB3 type three-cylinder engines, rated at 157 B.H.P. at 600 r.p.m. coupled to similar Brush machines, but having an output of 125 kVA at the same voltage and conditions.

Diesel-Electric Development

Aided by the combined resources of the manufacturers of Petters, Mirrlees, McLaren's, Petter Fielding and Cub engines,

and of the Brush Electrical Engineering Co., Ltd., A.B.O.E. (Associated British Oil Engines, Ltd) and B.O.E.X. (British Oil Engines (Export), Ltd.) are planning to establish a new organisation designed to intensify the development and sales effort of Diesel-electric combinations for power stations, rail traction and marine propulsion. The activities of the A.B.O.E.-Brush association are being co-ordinated by Mr. Alan P. Good, chairman of A.B.O.E., who has resumed his position of managing director of the Brush Electrical Engineering Co., Ltd.

Cast Iron Research Association

In its twenty-fifth annual report the Council of the Cast Iron Research Association states that the amount of work passing through the laboratories reached exceptional figures during the war. In the year 1943-44 tests in all laboratories—chemical, microscopic, mechanical, physical and sands—numbered 56 300, and there were only slightly fewer in 1944-45. While the total number of tests carried out has fallen owing to the reduction of war work, it is still double the pre-war maximum, and the work is approximately evenly divided between the research and development departments. The number of ordinary and trade members at the close of the year was 485. The research programme has been considerably expanded, and additions to both staff and equipment have been made.

Notes for Contractors

Members of the National Federated Electrical Association have been informed that for all hours worked on Christmas Day employees are to be paid at the rate of double time, and on Boxing Day at time-and-a-half. Where local working rules in respect of holidays apply to Friday, December 27, time-and-a-half is payable for all hours worked on that day. Where New Year's Day is prescribed as a holiday time-and-a-half is also payable for all hours worked. Unless agreement is reached by the N.J.I.C. prior to Christmas in connection with the claims submitted by the E.T.U. for the payment of wages at normal rates upon bank holidays, statutory and national holidays when no work is performed thereon, no wages will be payable upon any of the days mentioned above, which are observed as holidays. No wages will be payable in respect of any additional days observed as holidays in individual establishments over the Christmas and New Year periods. Should operatives be called upon to work on such additional holidays, bare time and overtime rates will be payable. As a result of discussions by the N.J.I.C. in respect of the industry's war period agreements, the agreement

dated July 20, 1939, introducing special conditions as to the engagement of labour on the site of a contract, and the War Risks Allowance Agreement, dated February 9, 1944, have been cancelled as from November 11. The effect of the decision to suspend Clause 4 of the National Working Rules is that henceforth apprentices completing their apprenticeships shall be entitled to the full journeyman electrician's rates of wage upon attaining the age of 21 years.

Shaw Play Produced

The North Wales Power Co.'s Amateur Dramatic Society gave a performance of Bernard Shaw's "Pygmalion" at Acton Schools, Wrexham, recently.

Price Increase

E. K. Cole, Ltd., announce an increase in the price of their "Bandspread" model A.28, with effect from Monday, December 16.

Change of Address

The address of the head office of the Electricity Board for Northern Ireland is now Danesfort, 114, Malone Road, Belfast. (Telephone: 68211; telegrams: Norelect, Belfast.)

Staff Dinner

A.B. Metal Products, Ltd., held a staff dinner at the Savoy Hotel, London, on Friday, December 6. Mr. Sidney Marks, managing director, paid a glowing tribute to the staff, and said he did not know of another company who changed so rapidly from war production to peace-time activities. Mr. Arthur Marks, a director, mentioned that arrangements had been made to acquire a new factory.

The Combustion of Fuel

The fifteenth Andrew Laing Lecture was delivered before the members of the North-East Coast Institution of Engineers and Shipbuilders at Newcastle-upon-Tyne, on December 13, by Sir Alfred C. Egerton, F.R.S., who took for his subject "The Combustion of Fuel." He stated that in the past we had thrown away valuable coal amounting to thousands of millions of tons, owing to inefficient methods of combustion. A large number of independent central heating boilers could well be replaced by hot water transmitted throughout an estate from a single boiler plant. The steam from turbo-generator sets could be passed out at, say, 200° F. and exchanged into water, the heat being transmitted by circulation of the water throughout a whole district. The efficiency of such a combined thermal-electric plant could then be raised from about 25 per cent., for electricity generation, to about 70 per cent. when generating heat and electricity, and about half the fuel needed to heat the

same district by present methods would be saved, while providing at least 32 per cent. more heat and the same amount of electric power.

Holiday Closing

The head office of the Jackson Electric Stove Co., Ltd., 143, Sloane Street, London, S.W.1, will be closed from mid-day on Tuesday, December 24, until Monday, December 30 for the Christmas holidays.

Trade Publications

A catalogue from Hendrey Relays, Ltd., Bath Road, Chippenham, Bucks., giving particulars and illustrations of their relays and control apparatus.

List No. OE 31, from Metway Electrical Industries, Ltd., King Street, Brighton, giving details and prices of their conduits and lighting fittings; miscellaneous wiring and porcelain accessories.

"Tin and Its Uses," a review issued by the Tin Research Institute, Fraser Road, Greenford, Middlesex. One of the features in the current number deals with new corrosion-resistant coatings of tin-zinc alloy, produced by electroplating.

New Generating Stations

THE Central Electricity Board have received from the Electricity Commissioners a further Amending Electricity Scheme for N.W. England and N. Wales providing for four new generating stations, with first sections, each comprising an installation up to 130 000 kW, to be constructed and become selected stations. Twenty-nine stations are at present operating in the area under the existing schemes, which also make provision for the construction of three further new stations. In making representations to the Commissioners for the formulation of the present scheme, the Board pointed out that all the new stations specified in the earlier schemes have already been allocated and indicated that, as a result of a review of the prospective plant requirements, it would be necessary to take steps for the establishment of at least four other new stations. Of these, one is required in time to meet the estimated demand arising in East Lancashire in 1950 and the others to meet the anticipated growth in the demand in other parts of the scheme area in later years. Copies of the scheme entitled "The North West England and North Wales Electricity (Alteration and Extension) Scheme, 1946," together with an explanatory memorandum by the Commissioners are on sale at the Stationery Office.

Plastics in Electrical Industry

Growing Importance of New Insulating Materials

A PAPER by Dr. Guido Haefely on "The Growing Importance of Plastics in the Electrical Industry," was read before the I.E.E. Installations Section on December 12.

The merits of plastics, strikingly demonstrated during the war, and the expectations attached to their peace-time developments, stated the author, justified a special paper on their importance as dielectrics to those electrical engineers who, during the last few years of intensive professional activity, had not found time to keep themselves informed on general progress. The history of plastics in relationship to the industry was referred to and an attempt was made to explain, in a simple manner, the fundamental chemical structure of some typical materials, with the intention of stimulating a desire for a deeper knowledge of this young and expanding science. Since the electrical industry could not have reached its present importance in everyday life without those new plastic insulating substances, the chief consideration was given to their particular function of solving new problems, and of improving existing electrical apparatus by taking the place of older materials. The principal plastics were briefly discussed without, however, entering into detailed descriptions of their manufacture or properties. A small section was devoted to the service which plastics could render the installation engineer.

MR. T. R. SCOTT (Standard Telephones and Cables, Ltd.), assured the author that cable makers had for a long time appreciated the plastics situation, and added that one of the most difficult things in the world was to convince users of existing materials that they should change over to new materials. Plastics had been used in the electrical industry for insulation, or the like, in nine out of ten cases, when there was no other specific material which it was known would do the job. Thermoplastic cables during the war were received with great suspicion, because rubber cables had been so long established in the industry, and engineers and chemists would not spend time and money on developing things which the general buyer would not use. Whilst engineers should do more to improve that state of affairs, it had to be admitted that there was very much lacking in plastics from the electrical insulation point of view. They were not yet trouble free and they had some very grave defects to be remedied before they

could become universally applicable. Whilst it was true that a large number of plastics did not take up water by absorption they did, without exception, allow moisture to pass through them to the paper or fabric inside the body of the shielding plastic. Some silicones were strongly water repelling, but that was not a sign that there was no water diffusion. Therefore, in considering the use of plastics for insulation purposes, full consideration must be given to the defects. From the moisture point of view it was necessary to eliminate all fibrous material, but from the strength and other points of view, bushings and many other things made of pure plastics without any reinforcement of fibres might not be completely satisfactory. He could not see for many years the paradise of plastics made in Great Britain on a large scale and at a cheap price, which some people thought was round the corner. Again, economics was not the only question. We had the coal, but there did not seem to be any great drive to convert it into the chemicals which were needed. There was no background of chemical industry at the present time which would give us the plastics required for the insulation business on a large scale, and if it were not on a large scale it could not be cheap, and if it were not cheap nobody would use it. We would have to encourage the manufacture of plastics on a national basis, because he could not see any other basis on which we could hope to export the plastics to which the author had so optimistically referred.

MR. A. E. J. JERVIS expressed surprise that the author had not referred to laminated wood as a plastics material of construction, in addition to the other materials mentioned in the paper. Laminated wood was the strongest all-round plastic yet discovered, and during the war several million pounds worth of "electrical" laminated wood was used by the Admiralty and also by electrical manufacturers. He could not understand why it was not more widely used, having regard to the acute shortage of wood poles for overhead construction. It would be possible to get over part of this difficulty by making laminated wood poles from short lengths of timber. Referring to silicones, he said it should be emphasised that a great deal of work was being done in this country at the present moment, and that silicones were due to Prof. Kipping's work

at Nottingham University. Side by side with silicones, another very useful material was coming into production, viz., ethyl-silicate. This year marked the centenary of the discovery of ethyl-silicate by Ebelman, and mixtures containing ethyl-silicate and a filler should have a future in the electrical and plastics industry. In regard to the suggestion in the paper that plastic sheets might replace paper in transformer bushings, was there any evidence to support the idea that they would be better than, say, Empire cloth? As to the suggestion that paper condenser bushing manufacture was a peculiar art, this dated back to about 1927 when 110 kV and 132 kV bushings had to be imported from Switzerland, and perhaps Germany, because they were not, or could not be produced here. As to the suggestion that insulation problems were just as great in cable manufacture, a cable was a much more symmetrical thing to design than a transformer bushing and the possibilities of breakdown were therefore less. He thought the 220 kV and the 380 kV bushing field should be left to manufacturers of multi-tubular porcelain bushings, which ought to come out cheaper than paper bushings. It was owing to shortage of natural rubber that plastics had been used considerably in the cable industry, and did not the author think that, for financial considerations, plastic insulation material would be replaced, now that natural rubber was available again? For outdoor work he could not imagine any other substance, apart from glass, which would stand up to bad weather conditions and arcing during flashover better than porcelain.

MR. F. C. WALMSLEY (Micanite and Insulators Co., Ltd.) said the solemn note of warning of the author regarding over-emphasis of attributes coupled with the neglect of limitations of plastics could not be too strongly endorsed. At the same time, it would have been advantageous if he had more fully illustrated, by examples from practice, the pitfalls which users had already found or skirted. The user had been inundated with information on a vast array of plastics and his main difficulty was one of correct choice for the purpose in view. Too often judgment was outrun by enthusiasm, which could be tempered by advice from specialist manufacturers. He was interested in bushings, and although the points the author had made regarding their behaviour were not without foundation, he could not confirm the gloomy picture portrayed of weaknesses due to discharge. The erosion phenomenon had not been found in bushings of conventional British design, although Continental experiences of failure in bushings due to this cause were not unknown. Again, on the matter of audible discharge, thousands of

bushings had been made and passed into service over a period of 25 years, and many would not meet the specifications now applicable, but no evidence that breakdown had been occasioned by them was known. The opinion was now held by many that the risk had been somewhat exaggerated. That room for improvement in bushing materials and manufacturing technique existed would not be denied, but this was common to many engineering products. While some of the newer plastics appeared to offer advantages of economy in material, a balance must be struck between those and the demands of service conditions, ignoring the question of cost. He assured the author that all possibilities in plastics and methods were continuously under review by bushing manufacturers. From experience, he considered that the installations applications of plastics were perhaps more onerous than many others. The need for extreme reliability and robustness under adverse circumstances, probably coupled with mal-treatment, whilst expecting the insulating properties to be maintained, created extremely difficult manufacturing problems, not only in selection of materials but also in design. He urged manufacturers of appliances and accessories to use to the full the sources of information regarding properties which were available, whilst encouraging the installation engineer on the job to give his experiences in the spirit of constructive criticism.

MR. W. G. OAKES (City and Guilds College), as a chemist, thought the author might have stressed more the chemical structure of some of the plastic materials, and that the distinction was not drawn clearly enough between the two types of plastics, viz., the thermo-plastic and the thermo-setting resins. The first was one which could be warmed up and softened, whilst the second was plastic in its early stages, but once it had been heated it remained set. Thus the two materials were of different types.

MR. W. A. COOK (Bushing Co., Ltd.) said the electrical engineer was faced with the problem that what he needed was not just an insulating material. He needed a material which was a good insulator, was highly resistant to moisture, had high mechanical strength, would not burn, and had innumerable other properties. Hitherto it had not been difficult to find a material which was a good insulator, but it had been difficult to find a material which was entirely moisture resisting and strong, and there were hopes that the development of plastics would bridge the gap towards the attainment of the ideal combination of those good properties. However, apart from future developments

in that direction, there were many applications for existing forms of plastics which had not been adequately considered. It was unfortunate that the author had painted a very one-sided picture, and exaggerated to a very large extent, the limitations of synthetic resin laminated material, without corresponding reference to the other side of the picture. It was true that such materials, owing to their nature—since they employed fibrous material—were not entirely resistant to water, and that they were liable to include small gaseous cavities in which discharge might occur, but it was unfair to suggest that where the manufacturer and designer had taken those two factors into account, there was any lack of reliability of such products. On the contrary, they had given excellent performance. Finally, he criticised the author's suggestion that with those laminated materials voltage gradients of the low order of 60 V per mil could be sufficient to cause damage over a period of years, which might finally lead to failure owing to the cumulative effect of local thermal instability. It was possible for laminated fibre, under certain conditions, to withstand much higher stresses in bushings provided end stresses could be avoided.

MR. P. G. ASHLEY (Metropolitan-Vickers Electrical Co., Ltd.) thought that certain features of the paper were disappointing in that they tended to mislead some sections of the industry. Some of the statements with regard to bushings made him imagine supply engineers hurrying home and getting rid of all their existing bushings, but the position was not as bad as that. Then there was the phenomenon known as "hissing." He recalled an instance, some 20 years ago, when some 33 kV switchgear bushings exhibited this phenomenon and they were cut up and examined, but nothing was discovered which by any stretch of imagination could indicate failure in service, due to hissing, although they had, in fact, failed. It seemed to be the fear of the unknown which had led to the "hissing" being blamed for the failure. All kinds of bushings up to 165 kV had proved satisfactory in service, and only a very minute percentage of failures due to "hissing" had occurred. He maintained that "hissing," of itself, was not an indication of a dangerous state of affairs. As to moisture absorption, we had been continually striving for surface coatings which would reduce or eliminate this, and if anyone could tell him of any materials that had not been tried, he would be very pleased to consider them. He asked what was going to happen to thermoplastic materials in switchgear and transformers where the

operating temperatures might be 85°C? At present he was concerned with a particular contract for the C.E.B., involving more than 1 000 bushings of 12 different sizes. They could not have faced the making of moulds for those different sizes, but they could be very well manufactured from laminated material.

MR. R. W. J. COCKRAM (the Plessey Co., Ltd.), referring to water absorption, said that a little while ago he had been interested in the use of p.v.c. cable with electric water heating equipment where it would be subjected to high temperature and considerable humidity, and in making some tests he got what was to him a rather remarkable result. In cold water, the insulation test showed infinitely, but in boiling water the insulation resistance fell. Furthermore, on plotting the insulation resistance against temperature, the results showed a definite hysteresis effect. That was a point which had been worrying him for some time and he asked the author to elucidate it.

MR. F. C. FUKU spoke of the great possibilities for plastics in the domestic field and appealed to designers to produce something which was worth looking at. Moreover, the question of moisture absorption depended to a considerable extent on design. One material not mentioned in the paper was glass-bonded mica powder, known as Micolex in this country, and it had some outstanding properties.

The author, in a brief reply to the discussion, said that in the electrical industry impregnated wood was not regarded as a plastic, although it was most useful for some secondary applications. We wanted more true plastics, chemical substances which could be synthesised with predetermined properties to a degree which could not be thought of with natural substances. As to the criticism of his remarks upon bushings, he had merely intended to put his finger on some of the weak spots. Indeed, he would be delighted to prepare a separate paper on bushings.

In its annual report the Industrial Welfare Society states that a satisfactory number of new members had joined during the year. Membership covered a representative cross-section of industry, both as regarded size of firm and trade, and the majority of the members showed very great interest in the activities of the society and in the use they could make of its services. Over 20 conferences were held during the year in London and the provinces and were attended by 1 879 representatives from member firms. Visits to member firms numbered 629.

Lightning Surges on Power Lines

Investigation of Disturbances on Irish Supply System

AN account of some investigations made recently of lightning disturbances on the Electricity Supply Board's system in Ireland was given in a paper by Mr. R. C. Cuffe, entitled "Lightning Surges on Transmission Lines in Ireland," read before the I.E.E. Transmission Section on December 11.

Figures for the average lightning faults per 100 miles of line per annum for the 110, 38 and 10 kV systems, quoted by the author, were derived from a 10-year record of such faults. Using the records of the 10 kV system as a basis, Mr. Cuffe constructed a map showing the variation of lightning trouble intensity for different localities in Ireland.

An account was also given of some magnetic link observations of lightning surges on the earth leads from 110 kV overhead earth-wires and from 38 kV lightning arresters. The results obtained appeared to show that a large proportion of the discharge currents of such arresters had values below 1 000 A. Since the usual practice had been to mount magnetic links so that only currents in excess of about 3 000 A were recorded, it would seem that many arrester operations might have escaped detection, and the results of such observations could therefore lead to erroneous conceptions as to the frequency of operation of medium-voltage arresters.

Since modern lightning technique is largely a question of the economics of individual applications, the author stressed the importance of obtaining adequate local lightning data whenever possible.

MR. R. DAVIS (N.P.L.) made what he called a rough analysis of the author's experimental results with his 38 kV arresters, with the object of trying to answer the question whether the majority of the strokes were induced strokes or direct strokes. He dealt with the matter mathematically and said it was possible that on a line flashover the currents which the author got, ranging from 1 000 A downwards, could have been obtained by indirect surges due to lightning in the vicinity. If the current was greater than 1 400 A there would be a line flashover, and from that he inferred that there was just as good a chance that the currents which the author had measured were due to direct strokes, as to indirect strokes. Asking whether any information could be obtained from the polarity of the magnetic links, he pointed out that in 70 per cent. of the cases, the polarity of the links was negative. If it

were assumed that the majority of the clouds that gave rise to lightning contained a negative charge, then the induced charge on the conductor would be positive and the arrester current would, in general, be more positive than negative. Therefore, the fact that 70 per cent. were negative suggested that in 70 per cent. of the cases the stroke was not indirect, but direct. The author stated that in 38 per cent. of the cases all three phases showed there had been current in the arresters. When there was a voltage on the system due to an induced charge, the probability was that all the lines would carry similar voltages, so that the arresters would all operate. If there was current only in a single arrester, that was very unlikely to be an indirect stroke, but a direct stroke to a conductor or a tower, which led to a back flashover on one line only. When two phases were affected, the probability was that there had been a direct stroke to a line, causing back flashover on two of the arresters receiving current. In the 38 per cent. of the cases in which all three phases had been affected, it might have been an induced stroke, but the remaining 62 per cent.—and it might possibly be 100 per cent.—had had a direct stroke. Therefore, his inference was that the operation of those arresters was in all probability due to direct rather than indirect strokes.

DR. J. L. MILLER (British Insulated Callender's Cables, Ltd.) said he had proposed to follow the same line of attack as Mr. Davis, and added that he differed from him in his last section of his analysis, because it ignored the coupling between the lines and the effect of induction. The paper illustrated how difficult it was to get together vital statistics relating to lightning in the field, or experimentally, on any particular system. Work of that nature must go on for several years before a satisfactory basis of discussion could be arrived at. The author had been most careful in his deductions and had not arrived at any unwarranted conclusions. He hoped that work in Eire would be continued. He was specially interested in the arrester position, and there was certain information he would like in order that he and others could know better how to direct their efforts in the future. For instance, what types of arresters were used; what values of earth resistance were maintained at the arresters; were there any records of strokes near to the line,

or to a tower flashing over near the arresters; what records of failures of arresters were kept; what happened to them, and why? Information like that was very necessary, and it was specially important to himself, because manufacturers relied upon users to give them information so that designs could be altered from time to time, and in many other fields, apart from transmission lines. Again, the author had not said much about the surge voltages to line. Was it the author's intention in the future to measure those voltages? Surge current by itself was not the only variable about which information was required when dealing with lightning protection on overhead lines. It was also desirable to know something about the earth; perhaps the values would be small in a country like Ireland with its wet climate, but he did not know. There was no doubt, as the author said, that the whole question of lightning protection was one of economics.

MR. J. S. FORREST (C.E.B.) displayed a slide indicating what happened in a certain relatively severe thunderstorm. The slide showed some thousands of flashes with which the system had to contend, and it was pointed out that there were 19 breakdowns in 12 hours on that system, which covered a radius of 60 miles, but only five of them caused an interruption to supply. Moreover, only one of the breakdowns caused damage by way of transformer breakdown, and he suggested that such a state of affairs did not justify any drastic action in the provision of protection devices. Moreover, such a severe storm might occur only once in ten years. Referring to the section of the paper dealing with fault rates on various voltage systems, he said he had tried to compare the fault rate on the 110 kV line in Ireland and the 132 kV system in this country. The author gave a figure of 0.95 faults per 100 miles per year for his line, but in this country the frequency of lightning was higher, and in order to correct that to the conditions in this country the figure should be increased to 1.4. The next point was that the author's system could suppress 80 per cent. of the total number of faults, and if that were corrected for the solidly earthed system in this country, the 1.4 became five times as much. One would have expected a fault incidence of about .6 for the solidly earthed system in this country, but actually the figure was .35. The Irish system had no overhead earth wires, whereas the British grid had, so that the earth wires seemed to have some effect in reducing the fault incidence. He asked for some details of the transformer breakdowns, and pointed out that the

author did not mention automatic re-closing switchgear. Had he considered that? Experience showed that 90 per cent. of the faults on the 132 kV lines in this country could be switched in again, and that high speed automatic re-closing eliminated a large number of breakdowns.

MR. W. FENNELL said that although the author stated that initially protective gaps were used on the low voltage networks, and that the lower voltage was more troublesome, this was the one instance where protection had been removed. He suggested that there was some interesting information behind that. There was apparently an art in handling the magnetic links and he thought some code should be drawn up dealing with the matter. It was not possible to get information of the number of likely lightning strokes in an area until a line was put up, and the best policy seemed to be to put up a line without protection and watch what happened during the next three or four years. Indeed, that was what most engineers had been doing. Until more information was available it seemed to him that that was the right policy.

MR. H. M. LACEY (E.R.A.) congratulated the author on concentrating on lightning currents, which, he said, was the most important parameter from which it was possible to deduce most of the other information required. Similar statistical investigations would provide an immense amount of useful knowledge, and E.R.A. was attempting that work by endeavouring to obtain the necessary statistics from supply authorities throughout the country. That work had not proceeded very far yet, due mainly to shortage of staff, but it was hoped to get the information in time.

DR. J. McCOMBE (Yorkshire Electric Power Co.) suggested that the fault rate did not tell the whole story and said that not only must they be considered in relation to the lightning, but transformer faults must also be considered. On the Yorkshire Power Company's system, whenever there was an outage, they called it a fault whether repairs had to be carried out or not. On 1 042 miles of 11 kV lines, there had been 401 faults in 10 years, or 4.1 per 100 miles, which was the same as on the Irish system. Comparing the faults on the Yorkshire Power Company's 66 kV lines with the Irish 110 kV lines, the figure was slightly higher, viz., 1.7, compared with 0.95. But he did not think that completed the story. There might be burned-out transformers which did not show up in overhead line faults and, indeed, that had been found to be the case on the Yorkshire Power Company's system. Experience showed that the damage to transformers could be consider-

able and must be related to lightning protection. In his company the view was held that the loss of a line for a few minutes was not serious, provided damage to insulators and conductors was prevented, and certain steps had been taken to prevent that. He suggested that the author might consider copper lines and arcing horns in preference to expensive lightning arresters and expensive earth wires.

MR. R. H. GOLDE (E.R.A.) said that in the author's comparison of different lines, he did not make it clear whether the wooden poles had metal cross arms and whether they were earthed. If not, the difference mentioned was not surprising. Although the author referred to polarity reversal, a puzzling feature was that a lightning current was not oscillatory and there was no reason why polarity reversals should appear in a lightning discharge.

MR. J. A. SUMNER (city electrical engineer, Norwich) said that in his area there had been an enormous number of faults due to lightning storms this year, and he had had very careful investigations made, going back over some 17 years. The extraordinary fact he had found was that there were cycles of eight years. For instance, it might be that for seven years they would say everything was going beautifully, but then would come a year when considerable trouble was experienced. He would be interested if the author could say whether there was any significance in that cycle of eight years. If we could get more knowledge regarding the time incidence curves for various undertakings, it would be of great value to all undertakings. He believed that overhead earth wires had an enormous effect in reducing outages on overhead lines.

MR. D. P. SAYERS (Birmingham electricity supply department) asked whether the author had examined the prevalence of lightning in relation to the geological conditions. It had been suggested in the past that lightning was more prevalent where there were abrupt geological changes in the subsoil.

MR. C. G. GARWOOD (West Hampshire) thought the paper demonstrated that line construction must be adapted to local conditions if the best combination of technical and commercial efficiency was to be obtained. The paper indicated considerable differences in the effect of lightning in places only a few miles apart, and observation in this country pointed in the same direction. There had been a conspicuous movement in this country, inspired by legitimate considerations, towards the standardisation of overhead

line construction, but the paper rather conveyed a warning that there was no single standard type of line which could be relied upon to give the best results everywhere.

The author, in the course of his reply, said the paper must be regarded as an interim report on an investigation which it was hoped to continue. It had now been going on for three years. Mr. Davies had given an interesting analysis of the direct and indirect stroke, but, personally, he had an open mind on that question and that was why he had left it out of the paper. In reply to Dr. Miller as to how the arresters had performed, there had been no failures yet, but not in all cases had they protected everything in the station. The figures asked for by Dr. Miller regarding earth resistance values were given in the paper, but there was a percentage of wood poles with steel cross arms which were not earthed. As to the cost of installing arresters, he did not altogether agree that because the cost was a small proportion of the total cost, therefore, the very best should be used or none at all. There was a wide divergence between station-type lightning arresters and line-type lightning arresters, and it was only in certain cases that expensive arresters were necessary. In reply to Mr. Forrest, he said that even if the earth wire was better than the Petersen coil, it was considerably more expensive. As to reliability of supply, mentioned by Mr. Fennell, although that was the aim all the time, the fact remained that in the case of rural lines many people would not be able to afford a supply at all if considerable expense was gone to in order to afford complete protection from breakdown. In Ireland, the scheme provided for supply to farms as small as 20 acres and a 100 per cent. non-interrupted supply could not be afforded. In reply to Mr. McCombe, he said the figures in the paper included transformer faults. The records showed that spark gaps on transformers did protect them, and they were used. As to reversal of polarity, referred to by Mr. Golde, since the paper was written there had been published evidence that this could be detected, and his own records showed that reversal could occur with an arrester of the type used. Mr. Sumner's reference to a cycle of eight years seemed almost too good to be true. His own records only went back to 1927, when the Electric Supply Board came into existence. As to the correlation of lightning strokes with geological formation, he had not done anything in that connection; he understood the C.E.B. had, but he did not know the result.

Answers to Technical Questions

We produce below the answers to a selection of questions which have been sent to us by readers. The co-operation of students and others in making this feature one of general interest is invited

What is the "Potier" reactance of a synchronous machine?

The Potier reactance is the name given to the leakage reactance of a synchronous machine when the value of this is obtained in a particular way from a test at zero lagging power factor. In the zero power factor test the field current is determined at normal terminal voltage with full-load zero-power-factor armature current. Such a test requires no power, other than that to supply the losses, and can be carried out provided a suitable lagging load, e.g., another synchronous machine operating underexcited, is available. To find the Potier reactance the open-circuit characteristic and a point, also at full-load current, on the short-circuit characteristic are required in addition to the zero-power-factor measurement.

Suppose that on Fig. 1 there is plotted the field current required to give full-load current at zero terminal voltage (short-circuit) and normal terminal voltage and zero lagging power factor, as shown by points A and B respectively.

When the machine is on short circuit the terminal voltage is zero and the whole of the e.m.f. generated is used in overcoming the leakage reactance drop $I X$ and is shown by OE in Fig. 1. The field m.m.f. or field current is used partly in overcoming the armature m.m.f., which is directly demagnetising since the short circuit current may be assumed to lag by 90° , and partly in producing the flux to generate OE . The total field current OA on short circuit may be divided into

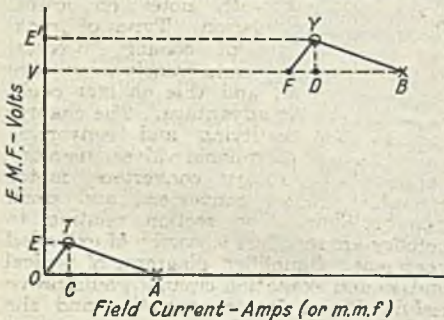


Fig. 1.—Principle of the Potier method

these two parts— OC to produce the e.m.f. OE and CA to overcome the armature m.m.f. Since OC is the field current producing the e.m.f. OE , the point T on

Fig. 1 must be a point on the open-circuit characteristic of the machine. The triangle TAO can be drawn as shown, the perpendicular TC being the leakage reactance drop.

Now consider the machine at normal voltage with the same full-load current and a zero lagging power factor. The arma-

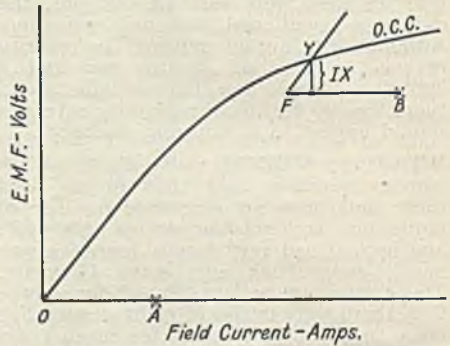


Fig. 2.—Construction for finding the Potier reactance

ture m.m.f. will be exactly the same as on short circuit, and may be subtracted from the total m.m.f. on the poles, represented by VB , to give VD , the resultant m.m.f. producing the e.m.f. generated in the machine. BD thus represents the armature m.m.f. and is equal to CA . The e.m.f. generated will be greater than the terminal voltage V by the reactance drop, since this drop and V are in phase as the current is lagging by 90° . The e.m.f. can thus be represented by OE' where VE' is equal to OE . The m.m.f. VD is producing an e.m.f. OE' and point Y is therefore another point on the open-circuit characteristic. YF can be drawn parallel to TO making the triangle YBF exactly similar to TAO . The perpendicular YD thus represents the leakage reactance drop.

The above shows that the o.c.c. can be found from a knowledge of the short-circuit and zero-power-factor points A and B , the leakage reactance and the armature m.m.f. It is, however, desired to find the leakage reactance when the points A and B and the open-circuit characteristic are known. This can easily be done by reversing the above process as shown in Fig. 2.

From the known point B set off to the left a distance equal to OA giving point F .

Through F draw a line parallel to the straight part of the o.c.c. (parallel to OT of Fig. 1), to cut the o.c.c. at Y. A perpendicular dropped from Y on to FB gives the leakage reactance drop IX volts and, since the current is known, the leakage reactance X can be found. The value of leakage reactance found in this way is the Potier reactance, and it generally agrees with the value obtained by other methods.

Due to saturation the value obtained varies with voltage, i.e., if the zero-power-

factor point B is obtained at voltages other than normal and the above procedure repeated. The variation for a particular typical machine is from 25 per cent. reactance at 125 per cent. normal voltage to 35 per cent. reactance at 50 per cent. normal voltage. It may be noted that the method described becomes inaccurate or impossible unless the line YF cuts the o.c.c. at a fairly sharp angle, i.e., it cannot be used for voltages below that at which the o.c.c. begins to bend over.—E. O. T.

Book Reviews

Electric Traction for Cranes. By R. A. WEST. (London: Pitman and Sons.) Pp. 88. Price 15s. net.

Selecting motors for crane drives is usually done empirically and sometimes results in burnt-out motors or, with d.c. series motors, in the cranes running at unsuitable speeds. The author of this book endeavours to provide data and fairly simple methods of calculation whereby a proper selection may be made; there are so many factors in these problems which cannot be accurately assessed that methods which are academically correct would be a waste of time and those described by the author, although fundamentally sound, involve a number of short cuts and give quite adequate accuracy without an unreasonable amount of labour. Purely descriptive matter concerning motors, control gear, or the mechanical arrangement of the cranes is not included. Attention is devoted chiefly to the long-travel motion of steel-mill cranes, although the methods described can easily be adapted to cross-travel motions or to cranes for less arduous duties. Both a.c. and d.c. drives are discussed, although more attention is given to the latter on account of the rise in speed of the d.c. series motor on low loads—this has advantages, although it complicates the calculations. The early part of the book gives an outline of the general problems involved and includes some valuable data regarding friction and mechanical efficiency; this is followed by discussions on the drawing of speed-time curves for the motion, on motor heating and general power requirements and, finally, by series of curves which can be used to select a suitable motor for a drive having given particulars. Numerical examples are given throughout to illustrate the various procedures described. Although the book is a little difficult to read in places, due, no doubt, to its having been severely condensed on account of paper restrictions, it is a valuable work on a subject which has previously received little or no attention

in the literature of industrial drives. We can therefore strongly recommend it to any electrical or mechanical engineers concerned with the design of cranes.—E.O.T.

"Alternating Current Practice."—By C. H. C. COOKE, A.M.I.E.E. (London: Crosby Lockwood.) Pp. 232 + 93 illustrations. Price 15s. net.

This book was originally planned to provide a practical survey of elementary a.c. practice and serve as a guide to installation engineers. The book is divided into eleven chapters, and the principal a.c. circuits met with in practice are discussed; worked examples are included to show their application. Two chapters dealing with motors outline the constructional features and characteristics of the various types of a.c. motors, and though much of the information given is of a general nature, it is nevertheless clear and concise. The different methods of starting a.c. motors are next discussed, and the starting torques and currents associated therewith are enumerated. The fundamental equations for transformers are given, together with notes on losses, efficiency and regulation. Types of transformers, methods of cooling, booster, instrument and auto-transformers are briefly described, and this chapter could be extended with advantage. The chapter dealing with rectifying and converting plant includes thermionic valves, mercury arc rectifiers, rotary converters, motor generators, motor converters, and small type rectifiers. The section relating to mercury arc rectifiers is worthy of extended treatment. Simplified diagrams of typical ignition and excitation circuits would prove useful. Power factor correction and the methods of effecting improvement are compared and worked examples included. The author has endeavoured to cover as wide a field as possible, and within the limits of such a publication has to a great extent achieved this.—T. H. C.

Electricity Supply

Hexham.—The Rural Council is to approach the North-Eastern Electric Supply Co., Ltd., on the question of extending electricity supplies in the rural area.

Aberdeen.—Fluorescent street lighting will be tried out in St. Nicholas Street. Eight lamps will be used and installation should be complete in February.

Warrington.—The electricity undertaking made a net profit in the year ended March 31, of £11 095, after making a contribution of £10 000 to relief of rates.

St. Marylebone.—Stating that there are many firms in the borough dealing with such equipment, the Electricity Committee has announced that it does not contemplate the sale of radio and television sets.

Manchester.—The City Council has approved a report by the Electricity Committee recommending the building of a new power station at Carrington, near Flexton, estimated to cost £5 500 000. The station will be built in two sections, one to be in use by July, 1949, and the other a year later.

Peterborough.—The old power station will be taken out of commission next spring and new central evaporating plant, costing £7 600, and additional distribution main switchgear, at a cost of £19 820, is to be installed. High-voltage cable networks in the northern and southern parts of the city and low voltage networks in the north of the city are to be reinforced, at an estimated cost of £39 579.

Southport.—The Electricity Committee is to make application to the Electricity Commissioners for sanction to borrow £14 000 for extensions in connection with the change-over of supplies in the Birkdale area from d.c. to a.c. Permission is also being sought to borrow £6 000 for the erection of a sub-station in the Trafalgar Road area, and £2 609 and £3 386 for outdoor sub-stations in Arundel Road and Carr Lane, respectively.

Poplar.—The Electricity Committee is to invite quotations for civil engineering, constructional steelwork, coal-handling plant, jetty cranes and turbine room travelling cranes for the new power station at Brunswick Wharf. The Electricity Commissioners have stipulated that the station shall be so designed as to permit of the installation of plant for the prevention of the discharge of sulphur and its compounds into the atmosphere.

London.—The London Power Co., Ltd., has applied to the Electricity Commissioners for consent to the installation of two 22 kV, three-core, transmission lines, with pilot protective and telephone cables, from the company's generating station at

Battersea to its distributing station in Horseferry Road. The cost of the transmission lines is estimated at £68 000, and the cost of the switchgear and transforming equipment £32 000.

Wallasey.—The Electricity Committee, with Ald. J. L. Gill as its chairman, is arranging for the celebration, on January 29, of the borough's electricity jubilee. A brochure dealing with the history and development of the electricity undertaking is being prepared.

West Hartlepool.—The Borough Electrical Engineer has reported that the introduction of four monthly accounts during the war coincided with a 15 per cent. increase in electricity, and the cumulative effect has been to produce an exaggerated impression of the cost of electricity. It was suggested that the three monthly basis was more desirable, and the Town Council has agreed to revert to this plan at the beginning of 1947.

Accrington.—In spite of a suggestion that there is no need at the present time for increased charges, and that such increases would cause hardship, the Town Council has approved a recommendation of the Electricity Committee setting out an alternative tariff for lighting, heating and domestic purposes for houses only on a rateable value basis. Electricity used for power where accounts are rendered quarterly will be charged at the rate of 1.1d. per unit, as against 0.9d. per unit. Monthly power accounts will be subject to an increase of 0.2d. per unit.

Electricity Generation in November.—The official returns rendered to the Electricity Commissioners show that 3 938 million units of electricity were generated by authorised undertakers in Great Britain during November, 1946, as compared with the revised figure of 3 463 million units in the corresponding month of 1945, representing an increase of 475 million units, or 13.7 per cent. During the past eleven months of 1946 (i.e. up to the end of November) the total number of units generated by authorised undertakers was 36 868 million, as compared with the revised figure of 33 608 million for the corresponding period of 1945, an increase of 3 260 million units, or 9.7 per cent. The total number of units sent out from the generating stations of authorised undertakers during November, 1946 (i.e. units generated, less units consumed in the stations by auxiliary plant and for lighting, etc.), was 3 722 million. The total sent out from these generating stations during the past eleven months of 1946 was 34 782 million units.

In Parliament

Some Electrical Questions Asked and Answered

Norway, H.T. Scheme.—In reply to a question by Mr. Thornton-Kemsley, the Minister of Fuel and Power stated that he was not considering the possibility of importing supplies of electricity by submarine cable connecting Norway with the North-East of Scotland.

U.S. Heating Experiments.—The Minister of Fuel and Power was asked by Mr. Driberg if, in view of the prospect of a steadily increased demand for electric current, he would investigate the results of the experiments now being conducted by the Chattanooga Electric Power Board, U.S.A., in the heating of homes with well water which had a temperature of 58° F. Mr. Shinwell replied that he was making inquiries about the experiments.

Consents to New Stations.—Asked by Mr. Palmer if he would take steps to reduce the delays now experienced in obtaining consent to the building of urgently required new power stations, Mr. Shinwell replied that close consultation was already taking place among the Departments concerned which, it was hoped, would expedite the issue of the formal statutory consents required under the Electricity Supply Acts and Town and Country Planning Legislation.

Neasden Conversion.—Mr. Errol asked the Minister of Fuel and Power what improvements in operating efficiency were expected to result from the conversion of the L.P.T.B.'s Neasden power station to fuel oil burning. Mr. Shinwell answered that the conversion had been undertaken by the L.P.T.B. as a matter of expediency to ease the coal position. It was impossible to predict the exact effect of the alteration in fuel on operational efficiency, but no great change was likely.

Electrical Components.—Mr. C. Thomas asked the Minister of Health if he was aware of the difficulty in obtaining 15 A. switch plugs, main d.p. fuses and wood blocks for fixing 5 A switches, in Cardiff; and what steps he was taking to increase the supply. Mr. Tomlinson answered that he was aware of a general shortage of these components throughout the country, and he had taken steps to ensure that the most urgent requirements, both in Cardiff and elsewhere, were met with the least possible delay.

Plant Shortage.—Mr. H. D. Hughes asked the Minister of Fuel and Power to what extent the shedding of load was due to plant deficiency; and what steps were being taken to remedy the situation. Mr.

Shinwell replied that the present shedding of load was due to shortage of generating plant, and did not arise from shortage of coal. The shortage of plant was due to the fact that very few power stations could be built during the war, while consumption of electricity had increased by 55 per cent. above 1938. A large programme of new power stations was approved as soon as the war ended, but these stations took several years to complete. All possible steps to expedite the construction of these stations were now being taken.

Load Shedding.—Col. J. R. H. Hutchison asked the Minister of Fuel and Power on how many occasions since November 1, 1946, had compulsory cuts of electric power been inflicted on industry; and in what areas. Since that date, Mr. Shinwell replied, the C.E.B. had found it necessary on 18 days to issue instructions to electricity undertakings to shed 5 per cent. or 10 per cent. of their load for periods averaging half an hour. All seven areas of the Board into which Great Britain was divided had been affected, but the districts most affected were the Midlands and South-East England. Load shedding did not necessarily involve cuts in electricity supplies. In many cases, the strain on the load was lightened by a reduction of voltage; in other cases, large industrial consumers, on receiving an intimation, transferred part of their load to off-peak hours.

Wind Power.—Sir William Darling asked the Minister of Fuel and Power if he was aware that, under S.R. and O., 1942, No. 2 510, Control of Fuel Order, the use of a wind-driven lighting set for house or shop had been forbidden by his Department in Edinburgh; and if he would reconsider the utilisation of the considerable wind power of Great Britain for the production of light for domestic and business purposes. Mr. Shinwell, replying, said that the order referred to prohibited the consumption of fuel, which included electricity for lighting or other fittings or appliances used for business or advertisement purposes. He regretted the necessity for this prohibition, but he regarded it as important for indirect as well as direct fuel-saving purposes, and it would not be fair to traders generally to allow exceptions. The answer to the second part of the question was that his Department, in consultation with other Departments concerned, was already looking into the matter.

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 Board of Trade, Millbank, London, S.W.1 (corner Horseferry Road), unless otherwise stated:—

Romford, December 23.—Electrical installations in 144 three-bedroom and four-bedroom type permanent houses on the Gobions Estate. Specification from Borough Engineer and Surveyor, Town Hall, Romford; deposit, £2 2s.

Forres, December 23.—Electrical work on 32 houses at Fleurs Place, Forres, for Town Council. Particulars from Town Clerk, Forres; deposit, £3 3s.

Rhondda, December 28.—Supply and delivery of six 300 kVA, three-phase, oil-immersed static transformers, 11 000/415/240 V, 50 cycles. Particulars from Electrical Engineer, Electricity Works, Porth, Glam.

Brighton, December 30.—Manufacture, delivery, setting to work of electrically driven booster pump, motor, control gear, etc., at Aldrington station, capable of normal output of 60 000 galls. per hour. Particulars from Waterworks Engineer, 12, Bond Street, Brighton, 1; deposit, £2 2s.

Exeter, December 30.—Supply, delivery and erection of two 12 000 kVA transformers. Specification from City Electrical Engineer, Electricity Offices, 46, North Street, Exeter.

Leeds, December 30.—Supply and delivery of electrically operated pumping plant, with motors, switchgear, etc. Particulars from Sewerage Engineer's Office, Civic Hall, Leeds.

Newport, Mon., December 31.—Electrical installations in 134 houses on Alway Farm estate. Specification from Borough Electrical Engineer, Electric House, Dock Street, Newport, Mon.; deposit, £1 1s.

Ulverston, January 1.—Supply and installation of 11 kV and 400 V cable, switchgear and 500 kVA transformers. Specifications from Electrical Engineer, Electricity Offices, Theatre Street, Ulverston.

Manchester, January 3.—Supply, delivery, and erection at Partington Gas Works of one 150 kW mercury arc rectifier equipment. Specification from Chief Engineer and Manager, Electricity Department, Town Hall, Manchester, 2.

Shoreham-by-Sea, January 4.—Taking down of existing street lamps and erection of new steel or concrete columns, complete with lanterns, sodium discharge lamps, etc., giving a mounting height to

lamp of 25 ft. Specification from Surveyor's Office, 31, John Street, Shoreham-by-Sea; deposit, £3 3s.

Keighley, January 11.—Supply and delivery of street lighting posts and fittings for housing schemes at Bracken Bank and Woodhouse. Particulars from Town Clerk, Town Hall, Keighley.

Hastings, January 13.—Manufacture, supply and delivery of two 2 000 kVA Scott-connected transformers, and two switch kiosks. Specifications from Borough Electrical Engineer and Manager, 12 and 13, York Buildings, Hastings.

Manchester, January 13.—Supply, delivery and erection, over period of two years, with option to terminate at end of first year, of 6.6 kV sub-station switchgear. Specification from Chief Engineer and Manager, Electricity Department, Town Hall, Manchester, 2.

Sheffield, January 15.—Tenders for purchase and removal of redundant plant from Neepsend power station, including two turbo-alternators and ancillary plant, 12 500 kW; electric feed pumps; spare motors, etc. Details of plant available from General Manager, Commercial Street, Sheffield, 1.

Newark, January 16.—Supply and delivery of p.i. and armoured cable, for electricity department. Particulars from Borough Electrical Engineer, Municipal Buildings, Baldertongate, Newark, Notts.

North of Scotland Hydro-Electric Board, January 20.—Supply, delivery and erection of h.t. and l.t. distribution lines. Tender documents from Mr. T. Lawrie, Secretary, 16, Rothesay Terrace, Edinburgh, 3; deposit, £1 1s.

Camberwell, January 20.—Supply of electric lamps for 12 months. Particulars from Engineer and Surveyor, Town Hall, Camberwell, S.E.15.

North of Scotland Hydro-Electric Board, January 21.—Construction, completion and maintenance of the Pitlochry dam and power station, Tummel-Garry hydro-electric project. Particulars from the Engineers, Sir Alexander Gibb and Partners, 39, Northumberland Street, Edinburgh, 3, and Queen Anne's Lodge, London, S.W.1; deposit, £5.

Metropolitan Water Board.—Supply of eighteen 200 kW alternators and six 300 kW alternators, new or second hand, three-phase, 400/440 V, 50 cycles, one or two bearings, with or without switchgear, for coupling directly to Diesel engines running at 600 r.p.m. Further details from Mechanical Engineer, Offices of the Metropolitan Water Board, Rosebery Avenue, London, E.C.1.

Company News

MANN, EGERTON AND CO., LTD.—The company will double its dividend on the ordinary by the payment of 30 per cent. for the year ended September 30, as against 15 per cent. for 1944-45.

BARBADOS ELECTRIC SUPPLY CORPN., LTD.—Net prft. for yr. to June 30 £21 759 (£19 572). To tax £12 000 (£11 500), div. 5%, tax free (same), £10 000 (£8 000), fwd. £1 653 (£1 894).

SUN ELECTRICAL CO., LTD.—Net prft. for yr. ended April 30 £20 106 (£18 015). To dirs.' fees £1 500 (same), lease redemptn. res. £1 500 (same), tax res. £3 500 (£4 000), pref. div. £9 375 (same), ord. div. $4\frac{1}{2}\%$ (2 $\frac{1}{2}\%$) £4 199 (£2 333); fwd., £2 144 (£2 112).

MARCO REFRIGERATORS, LTD.—After dephen. £1 994 (£1 685), etc., net prft., before taxn. to September 30, £56 699 (£31 526), plus res. acct. transf. £4 035 (nil). To taxn. £42 200 (£27 745), div. 10% (5), fwd. £20 993 (£8 234).

BRITISH ROLA, LTD.—Blee. of trdg. acct. for yr. ended March 31, plus sundry income incldg. £5 987 (nil) recvd. on completn. of Govt. contracts, £65 253 (£63 255); rehab. exes. written off £2 164 (£88); pref. sh. red. £1 421 (£1 347); tax, £53 795 (£53 500); div. 15% less tax (same); fwd. £1 120 (£2 105).

LAURENCE SCOTT AND ELECTROMOTORS, LTD.—The company has advertised the issue of £250 000 $4\frac{1}{2}\%$ per cent. cumulative preference £1 shares. Proceeds of the issue, after allowing for £9 250 expenses, will be used to acquire additional plant and augment working capital. The total issued capital, with the addition of the new shares, will now be £801 005.

BRITISH ELECTRIC TRANSFORMER CO., LTD.—Announcing a profit for the year of £59 645, the directors have recommended a dividend of 5 per cent. on the preference shares and a final dividend on the ordinary shares of 6d. per share, making, with the interim dividend paid on September 30, 1946, a distribution at the rate of 2s. 6d. for the year. A balance of £437 remains to be carried forward, compared with £323 in the previous year.

CROMPTON PARKINSON, LTD.—The accounts for the year ended September 30, 1946, show a profit of £440 363, compared with £434 283 for the preceding year. Meeting on November 29, the directors recommended the following dividends, to be paid on December 31 after deduction of income tax: 4 per cent. on the first preference stock for the six months ended September 30, 1946; 3 per cent. on the second preference stock, for the same

period, and a final dividend on the ordinary and "A" ordinary stock of $7\frac{1}{2}\%$ per cent., actual, making, with the interim dividend of $7\frac{1}{2}\%$ per cent. paid on June 29, 1946, a total dividend for the year of 15 per cent., actual. A special cash bonus of $7\frac{1}{2}\%$ per cent. on the ordinary and "A" ordinary stock was also recommended. The trustees of the Central Benevolent Fund are to receive £5 000, and there will remain a balance of £797 902 to be carried forward, as compared with £690 039 at September 30, 1945.

AERONAUTICAL AND GENERAL INSTRUMENTS, LTD.—Speaking at the 10th annual meeting, Mr. W. McClelland (chairman) referred to the extensive experimental and research design work which had been undertaken by the company, and said that, in addition to two new sales companies, the older subsidiaries, including Radio Instruments, Ltd., continued to expand and enhance their prestige. During the meeting, a resolution authorising the increase of capital by approximately £150 000 was approved. Announcing the proposal, the chairman said that the sum was greater than was required for the company's immediate needs, and left a margin for the potential needs of the future. Preference would be given to existing shareholders in the allotment of the new shares, and it was intended that an application for permission to deal be made in due course. The total dividend for the year would be $16\frac{1}{2}\%$, of which $6\frac{1}{2}\%$ had been paid in June last.

CRABTREE ELECTRICAL INDUSTRIES, LTD.—Speaking at the annual meeting, the chairman, Dr. Herbert Schofeld, said that the operating company had negotiated the change from war to peace production very satisfactorily, and was now doing its utmost to satisfy the demands for its products. In particular, it was endeavouring to assist the Government in equipping homes. Labour was still in short supply and essential materials were difficult, in some cases impossible, to obtain. The profit and loss account showed, the chairman said, that the company had made a record trading profit of £246 442, which, coupled with a much lower provision for taxation, had enabled it to show an increase in the net profit of 37 per cent. Providing no breakdown occurred in negotiations, they proposed to extend their existing factory at Walsall by the provision of new buildings, at an estimated cost of £120 000, in an endeavour to reduce to more reasonable proportions the embarrassingly large order book.

Commercial Information

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.

FENRISS (1932), LTD., London, N.W., wireless dealers.—November 14, debenture, to Barclays Bank, Ltd., securing all moneys due or to become due to the Bank; general charge. *—April 24, 1945.

SCIENTIFIC RADIO AND INSTRUMENTS, LTD., Luton.—November 15, £3 000 mortgage, to C. W. Cooke, Welwyn Garden City; charged on 31, Guildford Street, Luton. *—September 20, 1946.

METALUX (ELECTRIC), LTD., London, W.—November 20, £1 200 mortgage, to Abbey National Building Society; charged on 61, Bellamy Drive, Kenton. *Nil. April 3, 1946.

SOUTHERN BATTERY CO., LTD., Southampton. November 20, £2 000 (not ex.) debenture, to Lloyds Bank, Ltd.; charged on land, office stores and workshops 126, McNaghten Road, Bittern Park, Southampton. *Nil. November 6, 1946.

Dividends

GRIFFIN, James Stanley, 50, Havelock Street, Luton, Beds., carrying on business at 108, High Town Road, Luton. Electrical engineer. Court: Luton. Amount per £: 5s. 8½d., supplemental. Payable December 24, 1946, at the Official Receiver's Office, 6, The Parade Northampton.

Application for Discharge

MACDONALD, Henry Mark, lately trading as Mac's Radio and Cycle Stores, present address unknown, but lately carrying on business at 164, Garratt Lane, Wandsworth, S.W.18. Court: Wandsworth. Hearing, January 16, 1947, 10.30 a.m., at the Court House, Garratt Lane, Wandsworth. (Amended notice.)

Order for Discharge

JACOBS, Louis, 27, Crownstone Court, Crownstone Road, London, S.W.2, lately carrying on business at 162, High Street, Peckham, London, S.E.15, as Loujay Radio. Radio dealer. Court: High Court of Justice. Date of Order: October 31, 1946. Bankrupt's discharge suspended for four months.

HANCOCK, Sam, electrical engineer, residing at 4, Pinfold Drive, Creadle

Hulme, Chester, and carrying on business as G. Hancock and Co., at Clydo Street, Holt Town, Manchester. Court: Manchester, October 28. The Court ordered that bankrupt's discharge be suspended for one month, and that he be discharged as and from November 28.

Intended Dividend

GRANGE, William Henry, "Broadlands," Thunder Lane, Thorp Saint Andrew, carrying on business as "The Talbot Electrical Company," at 14, Plumstead Road, Thorpe Saint Andrew, Norfolk. Electrical engineer. Court: Norwich. Last day for receiving proofs—December 20, 1946. Trustee: Walter, F. R. D., Castle Chambers, Opie Street, Norwich.

Receiving Orders

BRITTON, Albert Sydney, who resides and carries on business at 9, Moorside Road, Heaton Moor, Stockport, in the county of Lancashire, and who also carries on business at 123, Higher Hillgate, Stockport, aforesaid. Radio engineer and electrical contractor. Court: Stockport. Date of Receiving Order—November 18, 1946.

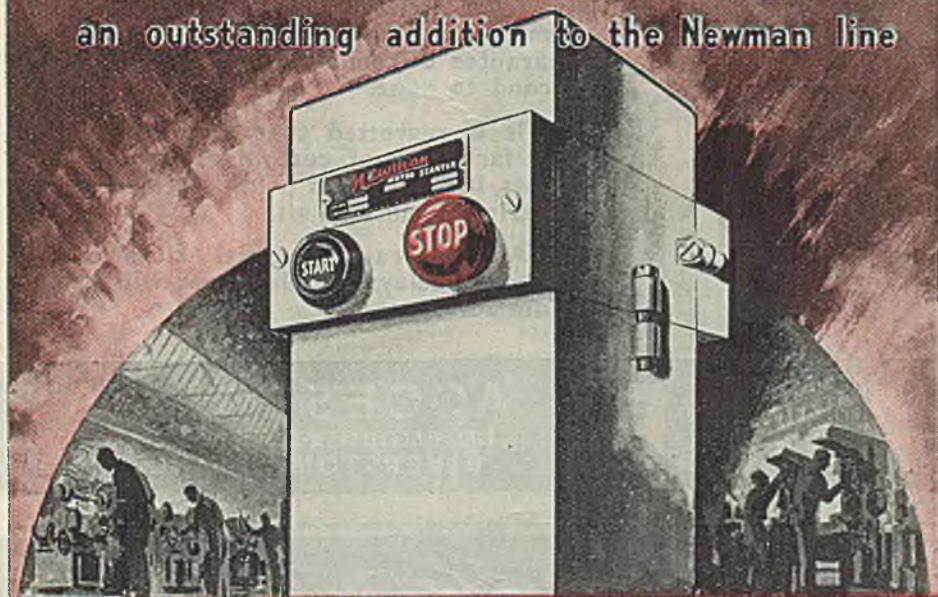
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| | Monday, Price | December 16 Inc. Dec. |
|---|-------------------|--------------------------|
| Copper— | | |
| Best Selected (nom.)...per ton | £96 10 0 | — |
| Electro Wire bars ... " | £98 0 0 | — |
| H.C. Wires, basis ... " | £112 5 0 | — |
| Sheet ... " | £138 10 0 | — |
| Bronze Electrical quality | | |
| 1% Tin— | | |
| Wire (Telephone) basis per ton | £134 0 0 | — |
| Brass (60/40)— | | |
| Rod basis ... " | 10¾d. | — |
| Wire ... " | 1s. 3¾d. | — |
| Iron and Steel— | | |
| Plg Iron (E. Coast Hematite No. 1) ...per ton | £8 19 0 | — |
| Galvanised Steel Wire (Cable Armouring) basis 0.104 in. ... " | £33 0 0 | — |
| Mild Steel Tape (Cable Armouring) basis 0.04 in. ... " | £21 15 0 | — |
| Lead Pig— | | |
| English ... " | £56 10 0 | — |
| Foreign and Colonial... " | £55 0 0 | — |
| Tin— | | |
| Ingot (minimum of 99.9% purity) ... " | £384 0 0 | — |
| Wire, basis ... " | per lb. 4s. 10½d. | — |
| Aluminium Ingots ...per ton | £72 15 0 | — |
| Spelter ... " | £55 0 0 | — |
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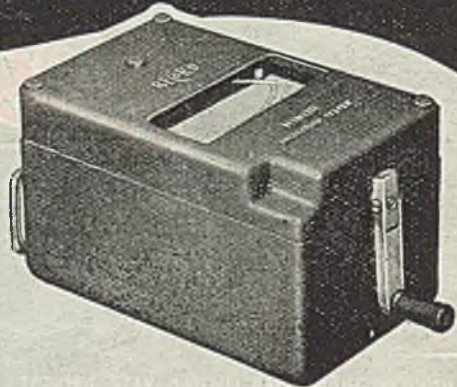


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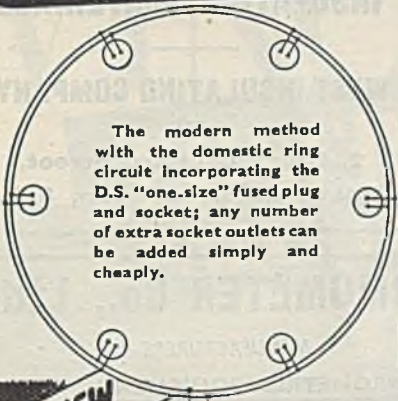
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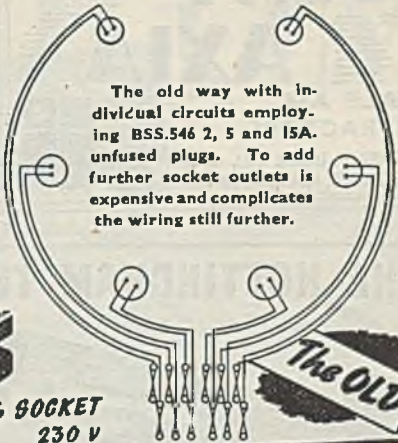
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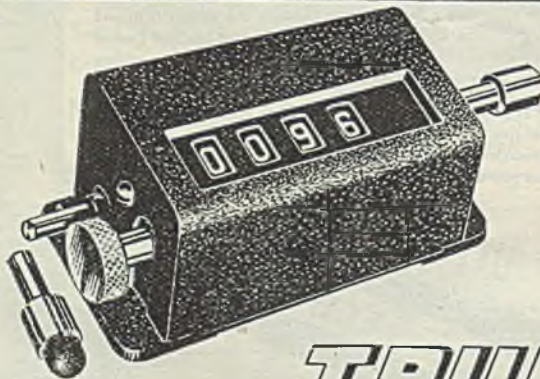
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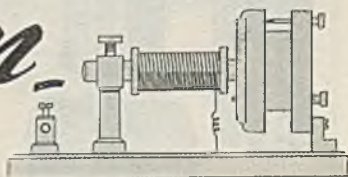
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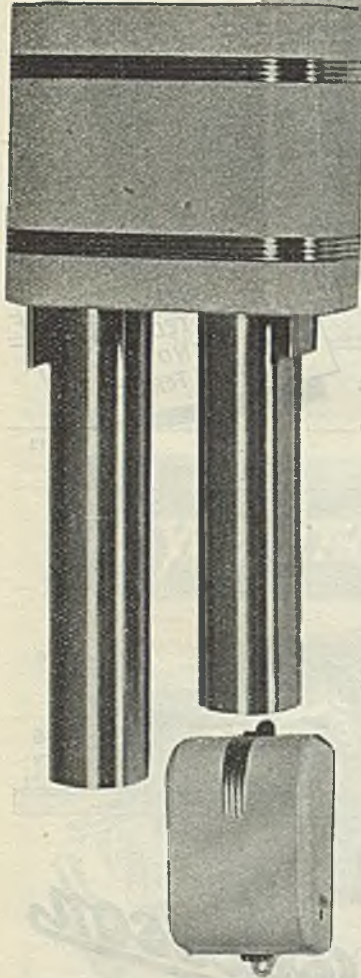
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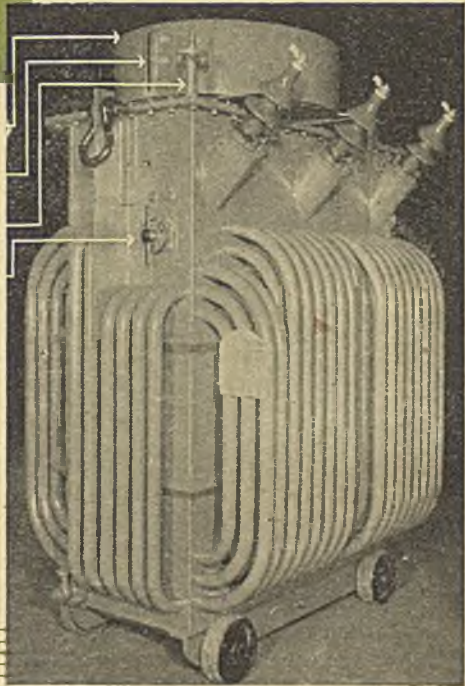
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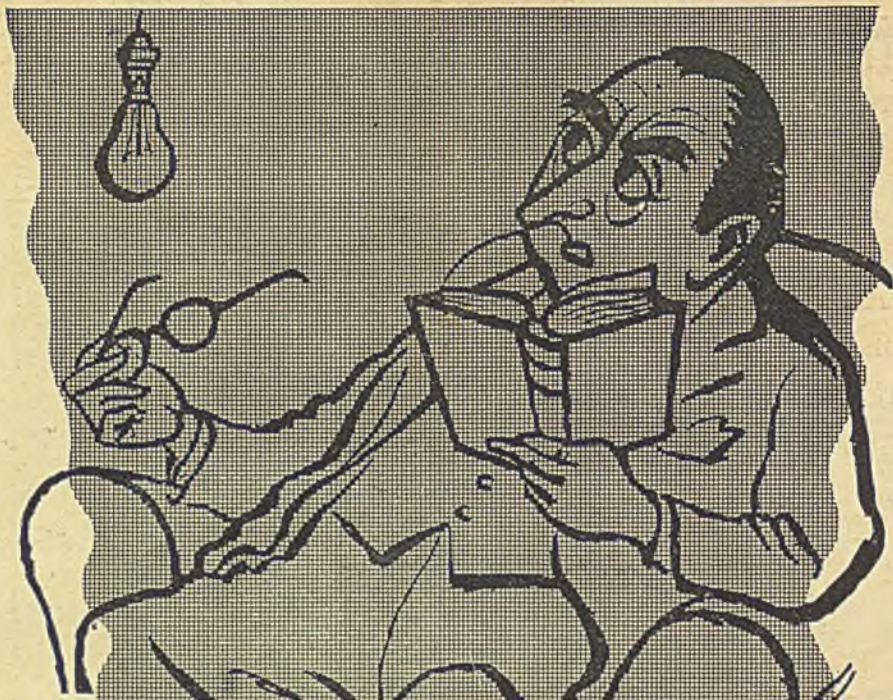


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