

## EDDY CURRENT LOSSES IN SINGLE-CONDUCTOR LEAD-COVERED CABLES

**I**N a paper entitled "Eddy Current Losses in Single-Conductor Paper-Insulated Lead-Covered Un-armoured Cables of a Single-Phase System" (*J. Inst. Elec. Eng.*, 89, Pt. 2, No. 12; December 1942), Dr. A. H. M. Arnold gives the results of an experimental investigation made at the National Physical Laboratory on cables carrying a.c. at power frequencies. Measurements were made with single-phase current on two parallel, 1.4-sq. in. cables forming go and return conductors. The total eddy-current losses are divided into four parts, namely, skin effect in the core, proximity effect in the core, proximity effect in the lead sheath when they are bonded together. Each of these is dealt with separately on a theoretical basis, and formulæ are then put forward for estimating the a.c. resistance of a cable from the design data; these formulæ are shown to give good agreement with the experimental figures.

The report is an official communication (Ref. *F/T78a*) from the British Electrical and Allied Industries Research Association and, together with an earlier one (Ref. *F/T55*), permits the following general conclusions to be drawn.

The losses in the core due to spirality effect and in the sheath due to skin effect can be neglected. The loss due to skin effect in the core is substantially the same as that due to skin effect in a solid round conductor of the same d.c. resistance per unit length, and was found to be calculable to within 1 per cent of the total losses by means of a well-known formula. The loss due to proximity effect in the core is less than that due to proximity effect in a solid round conductor having the same d.c. resistance per unit length on account of the higher resistance offered to the proximity eddy currents in a cable which have to flow from strand to strand. A previous formula for proximity effect in solid rods may be used for stranded conductors, provided a conductivity lower than the true conductivity of the copper is assumed; a figure of about 75-80 per cent of the true conductivity should be assumed.

A theoretical formula by H. B. Dwight for the losses due to proximity effect in the lead sheath was found not to be sufficiently accurate on account of its neglect of the modification due to the proximity effect in the core. An empirical factor has been added to Dwight's formula which increases its accuracy considerably. The loss due to circulating currents in the lead sheath was found to approximate closely to that obtained from the formula given in the report, except for cables very close together. At close spacings, the actual loss is less than that calculated, on account of the reduction of the mutual inductance between core and sheath due to proximity eddy currents in the core. This loss reduction can be allowed for largely by assuming that the proximity loss in the lead sheath is non-existent when the sheaths are bonded together.

The complete formulæ put forward for estimating the total losses in a cable, with the sheaths bonded or unbonded, give good agreement with the experimental results. At a frequency of 50 c./s., the maximum discrepancy between the computed and measured losses is less than 1 per cent for a 1.4-sq. in.

cable, and at 100 c./s. the maximum discrepancy is 3 per cent. Tables are given by means of which the ratio of a.c. losses to d.c. losses of any standard cable can be read at a glance for the standard frequency of 50 c./s.

## FORTHCOMING EVENTS

Monday, January 18

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 8 p.m.—Capt. W. E. D. Allen: "Ethiopian Highlands".

Tuesday, January 19

INSTITUTE OF CIVIL ENGINEERS (RAILWAY ENGINEERING DIVISION) (at Great George Street, Westminster, London, S.W.1), at 2 p.m.—Mr. George Ellson: "Modern Trend of Railway Engineering Practice".

Wednesday, January 20

FOLK-LORE SOCIETY (at the Royal Anthropological Institute, 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Dr. J. D. Rolleston: "The Folk-Lore of Children's Diseases".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Prof. W. E. S. Turner, F.R.S.: "New Uses for Glass".

INSTITUTE OF PHYSICS (at the Royal Institution, Albemarle Street, Piccadilly, London, W.1.), at 6 p.m.—Dr. R. K. Schofield: "The Distribution of a Liquid in a Pore-Space".

Thursday, January 21

INSTITUTE OF FUEL (JOINT MEETING WITH THE CHEMICAL SOCIETY, THE INSTITUTE OF CHEMISTRY AND THE SOCIETY OF CHEMICAL INDUSTRY) (in the University Chemical Department, Woodland Road, Bristol), at 5.30 p.m.—Dr. E. W. Smith: "Fuel Economy and the Chemist".

Friday, January 22

INSTITUTE OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. S. A. Couling: "Practice and Experience in the Production of High-Speed Helical Gears, with special reference to the Elimination of Transmission Noises".

## APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER TO TEACH CHEMISTRY in the Department of Chemistry and Metallurgy, Coventry Technical College.—The Director of Education, Council House, Coventry (January 20).

EDUCATIONAL PSYCHOLOGIST—The Secretary, Royal Victoria and West Hants Hospital, Bournemouth (January 22).

SPEECH THERAPIST for Speech Clinic in Harrow—Mr. C. W. Radcliffe, 'R.2', Clerk to the County Council, Guildhall, Westminster, London, S.W.1 (January 23).

TEACHER OF MECHANICAL ENGINEERING—The Principal, Wolverton Technical College, Wolverton, Bucks (January 25).

BOROUGH ELECTRICAL ENGINEER AND MANAGER—The Town Clerk, Municipal Offices, Grimsby (endorsed 'Borough Electrical Engineer and Manager') (January 28).

SPEECH THERAPIST—The Director of Education, Peel Street, Huddersfield (January 30).

EDUCATIONAL PSYCHOLOGIST—The Secretary-Superintendent, Belfast Hospital for Sick Children, 180 Falls Road, Belfast (February 1).

ASSISTANT TO TEACH MATHEMATICS—The Registrar, Wimbledon Technical College, Gladstone Road, London, S.W.19 (February 1).

SPEECH THERAPIST—The Acting Director of Education, Education Offices, Becket Street, Derby.

## REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

### Great Britain and Ireland

Proceedings of the Royal Society of Edinburgh. Section A: Mathematical and Physical Sciences. Vol. 61, Part 3, No. 21: Sylvester's Unravelling of a Ternary Quartic. By W. L. Edge. Pp. 247-259. (Edinburgh and London: Oliver and Boyd.) 1s. [2812]

Transactions of the Royal Society of Edinburgh. Vol. 60, Part 2, No. 18: The Conducting System of the Marsupial Heart. By Prof. D. M. Blair, Prof. Francis Davies and Dr. E. T. B. Francis. Pp. 629-637 + 2 plates. (Edinburgh and London: Oliver and Boyd.) 1s. 9d. [2812]

The Stammering Child and How he can be Helped. Pp. 4. 2d.  
Should we have a Baby in War-time? Pp. 2. 2s. per 100. (London: National Baby Welfare Council.) [2912]

### Other Countries

Commonwealth of Australia: Council for Scientific and Industrial Research, Bulletin No. 149: Production of Dried Grapes in Murray Valley Irrigation Districts, 2: Irrigation, Drainage and Reclamation. By A. V. Lyon and A. L. Tisdall. Pp. 35. (Melbourne: Government Printer.) [2812]