

International Conference
ON
LARGE ELECTRIC SYSTEMS
AT HIGH TENSION
(CIGRE)

PROCEEDINGS
OF THE
23rd SESSION
24 AUGUST – 2 SEPTEMBER
1970

VOLUME I

INDEX OF SPEAKERS

- Achenbach (H.) (*Germany*). — Gr. 11 : p. 50, 51.
 Adams (N.W.) (*U.S.A.*). — Gr. 22 : p. 21.
 Ahlgren (L.) (*Sweden*). — Gr. 14 : p. 8.
 Ainsworth (J.D.) (*United Kingdom*). — Gr. 32 : p. 59, 60.
 Allen (C.W.) (*United Kingdom*). — Gr. 22 : p. 4, 5, 41.
 Allen (G.Y.R.) (*Canada*). — Gr. 36 : p. 7.
 Andersen (E.) (*Denmark*). — Gr. 14 : p. 3.
 Anderson (R.B.) (*South Africa*). — Gr. 33 : p. 10, 11.
 Anjo (K.) (*Japan*). — Gr. 23 : p. 36, 37. Gr. 31 : p. 4, 5.
 Ann (H.) (*Germany*). — Gr. 23 : p. 20, 21, 22.
 Apetrei (C.) (*Rumania*). — Gr. 11 : p. 44, 45.
 Arkell (C.A.) (*United Kingdom*). — Gr. 21 : p. 40.
 Augé (J.) (*France*). — Gr. 32 : p. 29, 30.
 Austin (K.A.) (*United Kingdom*). — Gr. 22 : p. 13.
- Baatz (H.) (*Germany*). — Gr. 33 : p. 3, 4, 26, 27.
 Bahder (G.) (*U.S.A.*). — Gr. 21 : p. 2, 19.
 Bailey (P.) (*United Kingdom*). — Gr. 12 : p. 24, 35.
 Balériaux (H.) (*Belgium*). — Gr. 32 : p. 12, 13.
 Ball (E.) (*United Kingdom*). — Gr. 21 : p. 28.
 Baltensperger (P.) (*Switzerland*). — Gr. 13 : p. 1, 2, 13, 32, 72.
 Bán (G.) (*Hungary*). — Gr. 33 : p. 23.
 Banks (R.) (*United Kingdom*). — Gr. 12 : p. 3. Gr. 14 : p. 5, 16, 19, 33.
 Bardiaux (Fr.) (*Belgium*). — Gr. 34 : p. 16.
 Baril (G.A.) (*Canada*). — Gr. 33 : p. 54.
 Barnes (H.C.) (*U.S.A.*). — Gr. 31 : p. 1, 2, 3, 15, 18, 44, 48, 53, 55, 56, 57, 58, 59, 60, 61.
 Barret (Ph.) (*France*). — Gr. 11 : p. 33, 34.
 Barthold (L.) (*U.S.A.*). — Gr. 13 : p. 29. Gr. 31 : p. 3, 4, 54. Gr. 32 : p. 2, 3, 4. Gr. 33 : p. 15, 53.
 Bauer (H.) (*Germany*). — Gr. 32 : p. 14.
 Baumann (E.) (*Germany*). — Gr. 13 : p. 76.
 Baumann (J.E.) (*Switzerland*). — Gr. 23 : p. 1, 2, 20, 30, 32, 33, 37.
 Becker (G.) (*Germany*). — Gr. 32 : p. 15.
 Becker (H.) (*Germany*). — Gr. 31 : p. 31, 32, 33. Gr. 32 : p. 31, 32.
 Beer (G.) (*Italy*). — Gr. 15 : p. 4, 5, 10.
 Bellaschi (P.L.) (*U.S.A.*). — Gr. 12 : p. 14. Gr. 33 : p. 55, 56.
 Bennett (G.E.) (*United Kingdom*). — Gr. 15 : p. 20, 21, 22. Gr. 33 : p. 36, 37.
 Berg (A.) (*Norway*). — Gr. 22 : p. 1, 3, 4, 5.
 Berger (K.) (*Switzerland*). — Gr. 33 : p. 5.
 Bergmann (G.R.) (*Germany*). — Gr. 35 : p. 11, 12, 24, 25, 26.
 Bergougnoux (J.) (*France*). — Gr. 32 : p. 22, 23.
 Bergström (L.R.) (*Sweden*). — Gr. 13 : p. 63, 64.
 Bertula (T.) (*Finland*). — Gr. 15 : p. 31, 32.
 Bjurström (B.) (*Sweden*). — Gr. 21 : p. 4.
 Boehne (E.W.) (*U.S.A.*). — Gr. 13 : p. 9, 10, 11, 12. Gr. 33 : p. 38.
- Bokshorn (Y.) (*France*). — Gr. 23 : p. 5, 6, 7.
 Bonin (E. von) (*Germany*). — Gr. 13 : p. 40, 41, 42, 43.
 Böning (W.) (*Germany*). — Gr. 11 : p. 26, 27.
 Booth (R.R.) (*Australia*). — Gr. 32 : p. 26, 27, 28.
 Borremans (P.) (*Belgium*). — Gr. 35 : p. 1, 11, 24, 26, 28, 32.
 Bourgsdorf (V.V.) (*U.S.S.R.*). — Gr. 22 : p. 24, 26. Gr. 31 : p. 21, 22, 23, 24. Gr. 33 : p. 6, 7, 8, 33, 34.
 Boutteau (M.) (*France*). — Gr. 13 : p. 51, 52, 53.
 Bouvier (Miss B.) (*France*). — Gr. 12 : p. 20.
 Bråten (L.) (*Norway*). — Gr. 34 : p. 1, 38.
 Braun (A.) (*Switzerland*). — Gr. 13 : p. 63.
 Brookes (A.S.) (*U.S.A.*). — Gr. 21 : p. 1, 7, 22, 33, 49.
 Bückner (W.) (*Germany*). — Gr. 22 : p. 27, 28.
 Burger (U.) (*Switzerland*). — Gr. 33 : p. 15, 16, 49, 50.
 Buter (J.) (*Germany*). — Gr. 32 : p. 25, 26.
 Byrne (P.J.) (*Ireland*). — Gr. 11 : p. 58, 59.
- Cabanes (L.) (*France*). — Gr. 23 : p. 22, 37, 42, 43.
 Cakebread (R.) (*United Kingdom*). — Gr. 23 : p. 31.
 Calbiac (J. de) (*France*). — Gr. 32 : p. 29.
 Caleca (V.) (*U.S.A.*). — Gr. 31 : p. 3, 20, 44, 46, 47.
 Calverley (T.E.) (*United Kingdom*). — Gr. 14 : p. 10, 18, 40.
 Calvino y Teijeiro (B.J.) (*Italy*). — Gr. 13 : p. 71.
 Carpena (A.) (*Italy*). — Gr. 22 : p. 44, 45, 47, 51, 52, 53.
 Carpentier (L.) (*France*). — Gr. 34 : p. 3, 4.
 Carrara (G.) (*Italy*). — Gr. 33 : p. 1, 12, 13, 18, 19, 20, 22, 43, 44, 52, 57.
 Carrothers (J.K.) (*Ireland*). — Gr. 35 : p. 9, 17.
 Casazza (J.A.) (*U.S.A.*). — Gr. 32 : p. 33, 34.
 Catenacci (G.) (*Italy*). — Gr. 13 : p. 40.
 Causse (L.) (*France*). — Gr. 21 : p. 23, 47.
 Chevalley (Fr.) (*Switzerland*). — Gr. 34 : p. 26, 27.
 Chorlton (A.) (*United Kingdom*). — Gr. 32 : p. 23.
 Church (H.F.) (*United Kingdom*). — Gr. 15 : p. 18, 19.
 Cladé (J.) (*France*). — Gr. 31 : p. 52.
 Claren (R.) (*Italy*). — Gr. 22 : p. 17.
 Claverie (P.) (*France*). — Gr. 33 : p. 34, 35, 36.
 Clerici (A.) (*Italy*). — Gr. 13 : p. 30, 31. Gr. 31 : p. 13, 14, 15, 29, 30. Gr. 33 : p. 16, 17.
 Cliff (J.S.) (*United Kingdom*). — Gr. 13 : p. 2, 36. Gr. 33 : p. 45, 46.
 Coates (R.H.) (*United Kingdom*). — Gr. 34 : p. 12, 13.
 Cojan (M.) (*France*). — Gr. 22 : p. 26.
 Colombo (A.) (*Italy*). — Gr. 13 : p. 29, 30. Gr. 33 : p. 17, 18, 37, 38.
 Comellini (E.) (*Italy*). — Gr. 22 : p. 21, 23, 24, 37. Gr. 33 : p. 21, 50.
 Concordia (Ch.) (*U.S.A.*). — Gr. 11 : p. 39, 40. Gr. 32 : p. 36, 37, 52, 53.
 Constantini (L.) (*France*). — Gr. 21 : p. 11.
 Cooper (C.B.) (*United Kingdom*). — Gr. 31 : p. 33. Gr. 32 : p. 31, 50.

Cooper (E.A.) (U.S.A.). — Gr. 32 : p. 50, 51. Gr. 34 : p. 4, 5.
 Corbery (L.) (France). — Gr. 34 : p. 2, 3.
 Coustère (A.) (France). — Gr. 32 : p. 60, 61, 63.
 Couvreur (M.) (Belgium). — Gr. 32 : p. 49.
 Cruikshanks (H.K.) (Rhodesia). — Gr. 35 : p. 30.
 Csuros (L.) (United Kingdom). — Gr. 14 : p. 1, 9, 10, 33, 36, 41, 42. Gr. 33 : p. 43.
 Cuk (N.) (Switzerland). — Gr. 23 : p. 35.
 Dakin (Th.W.) (U.S.A.). — Gr. 15 : p. 22, 23, 24, 25, 26, 27.
 Delcampinette (P.) (Belgium). — Gr. 22 : p. 61, 62. Gr. 34 : p. 17, 18, 19, 22, 23, 24.
 Dell'Olio (D.) (Italy). — Gr. 22 : p. 31, 32, 33.
 Delsing (R.M.G.) (Netherlands). — Gr. 23 : p. 9, 10, 12.
 Dey (P.) (United Kingdom). — Gr. 22 : p. 10, 11, 64.
 Dienne (G.) (Belgium). — Gr. 34 : p. 1, 2, 9, 11, 12, 13, 14, 37, 38.
 Dieterle (W.) (Switzerland). — Gr. 15 : p. 28, 29, 30, 31.
 Dietsch (Ch.) (France). — Gr. 23 : p. 43, 44.
 Dimo (P.) (Rumania). — Gr. 32 : p. 40. Gr. 34 : p. 5.
 Dorsch (H.) (Germany). — Gr. 33 : p. 31, 33.
 Dragan (G.) (Rumania). — Gr. 12 : p. 30. Gr. 15 : p. 8.
 Dreyfus (H.B.) (United Kingdom). — Gr. 32 : p. 4, 5.
 Dubanton (Ch.) (France). — Gr. 31 : p. 42, 43.
 Edwards (A.T.) (Canada). — Gr. 22 : p. 16, 30.
 Eidinger (A.) (Switzerland). — Gr. 13 : p. 8.
 Ellis (H.M.) (Canada). — Gr. 31 : p. 13. Gr. 33 : p. 56, 57.
 Endacott (J.D.) (United Kingdom). — Gr. 21 : p. 5, 18, 40.
 Erche (M.) (Germany). — Gr. 31 : p. 35, 36.
 Evenepoel (W.) (Belgium). — Gr. 12 : p. 5, 10, 12, 31.
 Fallou (Mrs. B.) (France). — Gr. 15 : p. 1, 2, 3, 8, 9, 10, 16, 17, 18, 25, 26, 32, 33.
 Fallou (M.) (France). — Gr. 15 : p. 13, 14.
 Favez (B.) (France). — Gr. 32 : p. 2, 35, 36, 52, 55, 56, 66, 67.
 Feintuch (P.) (France). — Gr. 31 : p. 4.
 Fernandez Niño (R.) (Mexico). — Gr. 31 : p. 31.
 Ferrari (E.) (Italy). — Gr. 11 : p. 41, 42.
 Fischer (A.) (Germany). — Gr. 33 : p. 52.
 Fischer (R.) (Germany). — Gr. 22 : p. 21.
 Fournié (R.) (France). — Gr. 15 : p. 14, 15, 22. Gr. 21 : p. 16.
 Friedrich (R.E.) (U.S.A.). — Gr. 13 : p. 8, 60, 61, 71. Gr. 23 : p. 4, 5.
 Fritsch (Th.) (France). — Gr. 11 : p. 61, 62.
 Furuno (K.) (Japan). — Gr. 13 : p. 20, 21, 22.
 Gailly (M.) (France). — Gr. 14 : p. 36.
 Galand (J.) (France). — Gr. 15 : p. 5, 6, 12, 13.
 Galli (F.) (Italy). — Gr. 35 : p. 19, 26.
 Gänger (B.) (Switzerland). — Gr. 12 : p. 41. Gr. 15 : p. 6.
 Gary (Cl.) (France). — Gr. 31 : p. 30, 31, 47, 48.
 Gaudette (J.G.) (Canada). — Gr. 35 : p. 17, 20.
 Gaunt (R.) (United Kingdom). — Gr. 22 : p. 16, 17.
 Gert (R.) (Czechoslovakia). — Gr. 13 : p. 2, 3, 14, 15. Gr. 33 : p. 54.
 Gervais (G.) (France). — Gr. 31 : p. 40, 41, 42.
 Glavitsch (H.) (Switzerland). — Gr. 32 : p. 52. Gr. 34 : p. 14.
 Glebov (I.A.) (U.S.S.R.). — Gr. 11 : p. 1, 29, 30, 31, 32, 33, 37, 38, 60, 63.
 Goldstein (A.) (Switzerland). — Gr. 31 : p. 18, 19.
 Goossens (R.F.) (Netherlands). — Gr. 21 : p. 21, 26, 50.

Gosland (L.) (United Kingdom). — Gr. 13 : p. 57, 58, 59. Gr. 21 : p. 36. Gr. 36 : p. 8.
 Gougeuil (J.C.) (France). — Gr. 32 : p. 56, 57.
 Gove (D.) (United Kingdom). — Gr. 11 : p. 59, 60.
 Govers (A.) (Netherlands). — Gr. 22 : p. 41.
 Grand (G.) (France). — Gr. 35 : p. 12. Gr. 36 : p. 8, 14.
 Groza (L.) (Rumania). — Gr. 11 : p. 19. Gr. 22 : p. 15, 16. Gr. 32 : p. 43. Gr. 34 : p. 9.
 Grudko (P.A.) (United Kingdom). — Gr. 22 : p. 50.
 Grundmark (B.) (Sweden). — Gr. 12 : p. 13.
 Grycz (B.) (United Kingdom). — Gr. 13 : p. 56, 57.
 Hall (J.E.) (United Kingdom). — Gr. 32 : p. 58, 59.
 Hamdi Sepen (C.) (Turkey). — Gr. 11 : p. 42, 43, 44. Gr. 32 : p. 58.
 Hanssen (H.) (Norway). — Gr. 32 : p. 54.
 Harrison (R.E.) (Canada). — Gr. 14 : p. 4, 17, 19, 39. Gr. 32 : p. 51, 52.
 Hébert (P.) (France). — Gr. 33 : p. 27, 28.
 Heidinger (P.F.) (Germany). — Gr. 32 : p. 11, 12.
 Henderson (J.T.) (United Kingdom). — Gr. 21 : p. 44.
 Henry (J.C.) (France). — Gr. 13 : p. 15, 16, 17. Gr. 23 : p. 14.
 Héroin (P.) (France). — Gr. 13 : p. 68.
 Hérouard (M.) (France). — Gr. 11 : p. 51, 52. Gr. 32 : p. 64, 66.
 Hessen (P.) (Sweden). — Gr. 12 : p. 28, 35, 40.
 Heuillard (J.F.) (France). — Gr. 11 : p. 15, 16, 17, 18.
 Heyner (G.) (Germany). — Gr. 14 : p. 14, 26.
 Hickling (G.H.) (United Kingdom). — Gr. 12 : p. 25, 35.
 Hileman (A.R.) (U.S.A.). — Gr. 31 : p. 7, 8, 9.
 Hingorani (N.G.) (U.S.A.). — Gr. 14 : p. 6, 26.
 Hippert (M.) (France). — Gr. 34 : p. 32, 33.
 Hochrainer (A.) (Germany). — Gr. 13 : p. 34, 35.
 Hoel (H.) (Norway). — Gr. 34 : p. 7, 12.
 Hofer (P.) (France). — Gr. 12 : p. 33, 40.
 Holder (F.) (United Kingdom). — Gr. 34 : p. 34, 35, 36. Gr. 35 : p. 28.
 Holdup (W.) (United Kingdom). — Gr. 21 : p. 31.
 Holleville (M.) (France). — Gr. 35 : p. 1, 5, 16, 18, 31.
 Holley (C.H.) (U.S.A.). — Gr. 11 : p. 20, 21, 22.
 Holmgren (B.) (Sweden). — Gr. 36 : p. 4.
 Hopkins (R.J.) (U.S.A.). — Gr. 15 : p. 28.
 Hore (R.A.) (United Kingdom). — Gr. 32 : p. 17, 18, 51.
 Horne (L.R.) (Canada). — Gr. 21 : p. 4.
 Hosemann (G.) (Germany). — Gr. 31 : p. 9.
 Hosokawa (K.) (Japan). — Gr. 13 : p. 67, 68. Gr. 21 : p. 13, 22, 26, 39.
 Howard (P.R.) (United Kingdom). — Gr. 21 : p. 15. Gr. 31 : p. 28, 53.
 Huberlant (M.) (Belgium). — Gr. 35 : p. 28.
 Hunt (A.) (United Kingdom). — Gr. 11 : p. 19, 20.
 Hurter (T.) (Switzerland). — Gr. 12 : p. 11, 12.
 Jackson (R.L.) (U.S.A.). — Gr. 13 : p. 20, 40.
 Jaczewski (M.) (Poland). — Gr. 33 : p. 13. Gr. 36 : p. 4, 13, 14, 15.
 James (L.W.) (United Kingdom). — Gr. 11 : p. 9, 10.
 Janischewskyj (W.) (Canada). — Gr. 31 : p. 50, 51.
 Jarrett (G.S.H.) (United Kingdom). — Gr. 14 : p. 9.
 Jocteur (R.) (France). — Gr. 21 : p. 13.
 Joetten (R.) (Germany). — Gr. 14 : p. 9, 35.
 Johnsen (J.N.) (Norway). — Gr. 21 : p. 28. Gr. 22 : p. 11.
 Johnson (B.L.) (U.S.A.). — Gr. 12 : p. 4.
 Johnson (J.) (Australia). — Gr. 31 : p. 38, 39.
 Jørgensen (J.) (Denmark). — Gr. 21 : p. 2.
 Kanngiesser (K.W.) (Germany). — Gr. 14 : p. 26, 38.
 Kaplan (Ch.) (France). — Gr. 34 : p. 8, 9.

- Karrenbauer (H.) (*Germany*). — Gr. 13 : p. 47, 70.
 Käuferle (J.) (*Switzerland*). — Gr. 14 : p. 20, 37.
 Gr. 32 : p. 56.
 Kellenberger (W.) (*Switzerland*). — Gr. 11 : p. 36, 37.
 Keller-Jacobsen (J.) (*Denmark*). — Gr. 33 : p. 51.
 Kelly (J.G.) (*United Kingdom*). — Gr. 35 : p. 13, 19, 25, 30.
 Kind (D.) (*Germany*). — Gr. 33 : p. 20, 21.
 Kirchmayer (L.K.) (*U.S.A.*). — Gr. 32 : p. 19, 20, 41.
 Kiwit (W.) (*Germany*). — Gr. 23 : p. 41, 42. Gr. 32 : p. 16, 17.
 Knight (G.) (*United Kingdom*). — Gr. 32 : p. 40.
 Knudsen (N.) (*Sweden*). — Gr. 31 : p. 54, 56.
 Koetzold (B.R.) (*Germany*). — Gr. 13 : p. 72, 73, 77.
 Kondo (H.) (*Japan*). — Gr. 14 : p. 18, 22, 33, 40.
 Kotschnigg (J.) (*Germany*). — Gr. 12 : p. 2.
 Krasucki (Z.) (*United Kingdom*). — Gr. 15 : p. 25.
 Kreuger (F.H.) (*Netherlands*). — Gr. 21 : p. 8, 21, 28.
 Kriechbaum (K.) (*Germany*). — Gr. 13 : p. 8.
 Kuijper (C.E.M. de) (*Netherlands*). — Gr. 12 : p. 6, 32, 33.
 Lacoste (A.) (*France*). — Gr. 14 : p. 5. Gr. 21 : p. 5.
 Lageman (B.) (*Netherlands*). — Gr. 13 : p. 69.
 Laine (J.J.) (*Finland*). — Gr. 22 : p. 56.
 Lalander (S.) (*Sweden*). — Gr. 31 : p. 53, 54. Gr. 32 : p. 43.
 Lambeth (P.J.) (*United Kingdom*). — Gr. 33 : p. 43.
 Langer (P.) (*Sweden*). — Gr. 11 : p. 45.
 Lappe (Fr.) (*Germany*). — Gr. 32 : p. 5, 6, 7.
 Larrue (H.) (*France*). — Gr. 23 : p. 24, 25, 26, 38, 39, 41.
 Laurent (P.) (*France*). — Gr. 12 : p. 29.
 Lautensach (H.) (*Germany*). — Gr. 35 : p. 24.
 Leardini (T.) (*Italy*). — Gr. 15 : p. 6.
 Lebedev (B.P.) (*U.S.S.R.*). — Gr. 14 : p. 2.
 Leber (R.) (*Germany*). — Gr. 13 : p. 33, 34, 43, 44, 70.
 Lee (T.H.) (*U.S.A.*). — Gr. 13 : p. 74, 75. Gr. 14 : p. 11, 32, 35.
 Legg (D.) (*United Kingdom*). — Gr. 23 : p. 26. Gr. 33 : p. 24, 25, 26.
 Livingston (A.E.) (*Canada*). — Gr. 22 : p. 6, 9, 13, 17, 30.
 Looms (J.T.S.) (*United Kingdom*). — Gr. 31 : p. 29.
 Lorin (M.) (*France*). — Gr. 22 : p. 48, 49.
 Lund (P.) (*Norway*). — Gr. 21 : p. 26.
 Lundgren (T.) (*Sweden*). — Gr. 21 : p. 7, 21.
 Lutz (H.) (*Switzerland*). — Gr. 12 : p. 1, 2, 3, 4, 5, 6, 8, 11, 12, 13, 14, 16, 18, 20, 22, 23, 24, 25, 28, 30, 31, 32, 33, 35, 37, 42, 43.
 McNeill (W.A.) (*United Kingdom*). — Gr. 33 : p. 42.
 Magnien (M.) (*France*). — Gr. 32 : p. 1, 2, 12, 34, 35, 36, 67.
 Magnus (C.S.) (*Norway*). — Gr. 35 : p. 19.
 Mamikonians (L.G.) (*U.S.S.R.*). — Gr. 11 : p. 25, 26.
 Gr. 35 : p. 2.
 Markussen (K.) (*Norway*). — Gr. 33 : p. 53.
 Martin (D.) (*France*). — Gr. 22 : p. 45, 46, 53, 54, 55.
 Maschio (G.) (*United Kingdom*). — Gr. 21 : p. 12, 35.
 Mason (F.O.) (*United Kingdom*). — Gr. 13 : p. 60.
 Matravets (P.) (*United Kingdom*). — Gr. 13 : p. 67.
 Mattson (B.) (*Sweden*). — Gr. 31 : p. 19, 20.
 Maury (E.) (*France*). — Gr. 13 : p. 18, 19, 20. Gr. 31 : p. 13.
 Maury (F.) (*France*). — Gr. 32 : p. 57, 58.
 Mendès (A.) (*France*). — Gr. 13 : p. 48, 49, 50, 51.
 Meyer (H.) (*Switzerland*). — Gr. 13 : p. 1, 13, 29, 32, 71, 77, 78.
 Modig (R.) (*Norway*). — Gr. 32 : p. 43, 44. Gr. 34 : p. 5.
 Möller (K.) (*Germany*). — Gr. 13 : p. 44, 45, 46.
 Monseu (M.) (*Belgium*). — Gr. 34 : p. 19, 20.
 Moravova (Mrs. H.) (*Czechoslovakia*). — Gr. 13 : p. 54.
 Moreau (M.) (*France*). — Gr. 31 : p. 5, 6, 7, 20, 21.
 Mors (H.) (*Germany*). — Gr. 22 : p. 9, 17, 18, 19, 21, 39, 40.
 Mott (C.W.) (*United Kingdom*). — Gr. 31 : p. 36.
 Mukae (H.) (*Japan*). — Gr. 32 : p. 13, 41, 64.
 Müller (H.G.) (*Germany*). — Gr. 23 : p. 31, 32. Gr. 31 : p. 16, 17.
 Nabholz (H.) (*Switzerland*). — Gr. 12 : p. 18. Gr. 23 : p. 17, 19.
 Nagel (T.J.) (*U.S.A.*). — Gr. 32 : p. 7, 8, 41.
 Nakayama (Y.) (*Japan*). — Gr. 22 : p. 43, 44, 55.
 Naylor (J.H.) (*United Kingdom*). — Gr. 34 : p. 20, 21, 30. Gr. 35 : p. 10, 16.
 Neidhoefer (G.) (*Switzerland*). — Gr. 11 : p. 4, 5, 6, 7, 8.
 Nofri (P.L.) (*Italy*). — Gr. 32 : p. 20, 21, 22.
 Norbäck (K.) (*Sweden*). — Gr. 36 : p. 14, 15.
 Nordström (B.F.) (*Sweden*). — Gr. 32 : p. 18, 19.
 Noser (R.) (*Switzerland*). — Gr. 11 : p. 2, 3, 4.
 Novotny (V.) (*Czechoslovakia*). — Gr. 13 : p. 54, 55, 56.
 Ochel (W.) (*Germany*). — Gr. 21 : p. 10.
 Oeding (D.) (*Germany*). — Gr. 11 : p. 56, 57.
 Olsen (K.) (*Norway*). — Gr. 12 : p. 37.
 Oplatka (G.) (*Switzerland*). — Gr. 32 : p. 8, 9, 10, 11.
 Orgeret (L.) (*France*). — Gr. 23 : p. 19, 20. Gr. 31 : p. 15, 16.
 Östman (N.) (*Finland*). — Gr. 15 : p. 3.
 O'Sullivan (Th.) (*Ireland*). — Gr. 36 : p. 1, 2, 3.
 Oudin (J.) (*France*). — Gr. 21 : p. 1, 6, 27.
 Ouyang (M.) (*United Kingdom*). — Gr. 12 : p. 24.
 Gr. 33 : p. 2, 19, 51.
 Owens (J.B.) (*U.S.A.*). — Gr. 23 : p. 2, 3, 4.
 Paimbœuf (M.) (*France*). — Gr. 36 : p. 7, 10, 11, 12, 13, 14, 16.
 Pais Gromicho (J.N.) (*Portugal*). — Gr. 34 : p. 29, 30, 34.
 Palandri (G.L.) (*Italy*). — Gr. 21 : p. 2.
 Panis (L.M.) (*Switzerland*). — Gr. 11 : p. 52, 53, 54, 55, 56. Gr. 34 : p. 30, 31.
 Paradinas Mohedano (H.G.) (*Spain*). — Gr. 22 : p. 29.
 Paris (L.) (*Italy*). — Gr. 22 : p. 29, 33, 34, 35, 37, 42.
 Gr. 31 : p. 24, 25. Gr. 33 : p. 13, 14, 19, 53.
 Pariselle (R.) (*France*). — Gr. 23 : p. 17.
 Parnell (Th.) (*Australia*). — Gr. 33 : p. 39, 40, 41, 42.
 Passaguin (J.) (*France*). — Gr. 13 : p. 47, 48.
 Pedersen (Aa.) (*Denmark*). — Gr. 33 : p. 34.
 Penescu (C.) (*Rumania*). — Gr. 34 : p. 6, 7, 8, 9, 10.
 Penot (R.) (*France*). — Gr. 14 : p. 4, 10, 13. Gr. 35 : p. 4.
 Percivall (A.E.) (*United Kingdom*). — Gr. 22 : p. 38, 39, 42, 43, 46, 47.
 Persoz (H.) (*France*). — Gr. 32 : p. 24, 25, 48, 49.
 Pesonen (A.J.) (*Finland*). — Gr. 12 : p. 4. Gr. 33 : p. 9, 10. Gr. 36 : p. 12, 13.
 Petersons (O.) (*U.S.A.*). — Gr. 12 : p. 6, 8.
 Pflaum (E.) (*Germany*). — Gr. 13 : p. 64, 65, 69, 70.
 Philipps (W.) (*Germany*). — Gr. 22 : p. 6, 26, 27.
 Pirotte (P.) (*Belgium*). — Gr. 31 : p. 26, 27, 28.
 Plotto (A.) (*France*). — Gr. 23 : p. 33, 35.
 Portela (C.) (*Portugal*). — Gr. 31 : p. 39, 40. Gr. 32 : p. 33.
 Poffenberger (J.C.) (*U.S.A.*). — Gr. 22 : p. 15, 49, 50.
 Poloujadoff (M.) (*France*). — Gr. 13 : p. 22, 23, 24, 25, 26, 27, 28.

Popolansky (F.) (*Czechoslovakia*). — Gr. 33 : p. 1, 11, 12.
 Pouget (J.) (*France*). — Gr. 32 : p. 32, 33.
 Pratt (F.C.) (*United Kingdom*). — Gr. 12 : p. 4, 12, 19. Gr. 15 : p. 11, 12.
 Provoost (P.G.) (*Netherlands*). — Gr. 33 : p. 5, 6, 37.
 Pucher (W.) (*Sweden*). — Gr. 13 : p. 76, 77.
 Puerta (M. de la) (*Spain*). — Gr. 34 : p. 32.
 Qazilbash (I.A.) (*Pakistan*). — Gr. 34 : p. 11, 12.
 Quervain (A. de) (*Switzerland*). — Gr. 36 : p. 1, 3, 4, 6, 8, 9, 10, 11, 12, 14, 15, 16.
 Rabanit (A.) (*France*). — Gr. 15 : p. 20.
 Rabus (W.) (*Germany*). — Gr. 12 : p. 24, 34, 39.
 Razevig (D.V.) (*U.S.S.R.*). — Gr. 12 : p. 29, 37, 41. Gr. 33 : p. 2, 3, 52, 53.
 Reggiani (R.) (*Italy*). — Gr. 31 : p. 52, 53.
 Reichert (K.) (*Switzerland*). — Gr. 31 : p. 33, 34, 35, 44.
 Reimers (Th. D.) (*U.S.A.*). — Gr. 23 : p. 28, 29.
 Renchon (R.) (*Belgium*). — Gr. 22 : p. 62, 63, 64, 66. Gr. 32 : p. 37, 38, 39, 47, 48. Gr. 34 : p. 10, 21, 22.
 Reverey (G.) (*Germany*). — Gr. 33 : p. 24.
 Reynolds (E.H.) (*United Kingdom*). — Gr. 21 : p. 19.
 Richardson (P.) (*United Kingdom*). — Gr. 11 : p. 10, 38, 58.
 Ricketts (C.) (*United Kingdom*). — Gr. 31 : p. 47. Gr. 33 : p. 42.
 Riedel (H.) (*Germany*). — Gr. 36 : p. 5, 9, 10, 13.
 Rieder (W.) (*Austria*). — Gr. 13 : p. 66.
 Riez (M.) (*Belgium*). — Gr. 22 : p. 14.
 Ritter (R.J.) (*Switzerland*). — Gr. 35 : p. 5.
 Rivet (G.) (*France*). — Gr. 31 : p. 17, 18.
 Rixse (J.H.) (*U.S.A.*). — Gr. 32 : p. 15.
 Rizk (F.) (*U.A.R.*). — Gr. 31 : p. 9, 10, 11. Gr. 33 : p. 23.
 Robert (P.) (*Belgium*). — Gr. 11 : p. 22, 23, 24.
 Roth (A.W.) (*Switzerland*). — Gr. 23 : p. 27, 28.
 Ruelle (G.) (*France*). — Gr. 11 : p. 2, 34, 35, 38, 39, 62, 63.
 Rumpf (E.) (*Germany*). — Gr. 14 : p. 10, 22, 40. Gr. 32 : p. 54, 55.
 Ruoss (E.) (*Switzerland*). — Gr. 13 : p. 15.
 Sarbach (E.) (*Switzerland*). — Gr. 12 : p. 8.
 Saunamäki (Y.) (*Finland*). — Gr. 12 : p. 11.
 Saveliev (V.P.) (*U.S.S.R.*). — Gr. 33 : p. 47, 48.
 Schamberger (J.M.) (*U.S.A.*). — Gr. 31 : p. 51, 52.
 Scheer (G.B.) (*U.S.A.*). — Gr. 32 : p. 34.
 Schektman (N.) (*France*). — Gr. 13 : p. 53.
 Schneider (C.) (*Switzerland*). — Gr. 34 : p. 27, 28, 29, 31, 32, 34.
 Schober (J.) (*Switzerland*). — Gr. 15 : p. 7, 8, 10, 11.
 Scott (M.) (*United Kingdom*). — Gr. 13 : p. 31.
 Sealy (T.) (*United Kingdom*). — Gr. 35 : p. 10, 18.
 Setälä (O.) (*Finland*). — Gr. 12 : p. 42.
 Sforzini (M.) (*Italy*). — Gr. 33 : p. 29, 30, 31.
 Shackshaft (G.) (*United Kingdom*). — Gr. 32 : p. 53, 54.
 Sheppard (H.J.) (*United Kingdom*). — Gr. 32 : p. 11.
 Sie (T.H.) (*Switzerland*). — Gr. 12 : p. 26.
 Skipper (D.J.) (*United Kingdom*). — Gr. 21 : p. 3, 45, 46.
 Slethei (T.O.) (*Norway*). — Gr. 22 : p. 14, 15, 24.
 Smith (R.) (*Australia*). — Gr. 35 : p. 30.
 Soldner (K.) (*Germany*). — Gr. 12 : p. 17, 20. Gr. 15 : p. 8.
 Sollergren (B.) (*Sweden*). — Gr. 12 : p. 2, 13, 14, 16, 22, 23, 28, 32, 33, 37, 42. Gr. 33 : p. 21, 22.
 Soper (J.) (*United Kingdom*). — Gr. 11 : p. 45, 46, 47, 48, 49, 60, 61.

Souillard (M.) (*France*). — Gr. 34 : p. 10, 24.
 Sporn (Ph.) (*U.S.A.*). — Gr. 31 : p. 60, 62.
 Stadlin (W.O.) (*U.S.A.*). — Gr. 32 : p. 39, 40.
 Starr (E.C.) (*U.S.A.*). — Gr. 14 : p. 5. Gr. 32 : p. 34, 35.
 Stauch (B.) (*Germany*). — Gr. 23 : p. 1, 26, 29, 32, 41, 43, 45, 46.
 Stavnes (J.) (*Norway*). — Gr. 12 : p. 33, 38.
 Stoll (U.) (*Germany*). — Gr. 22 : p. 57, 58, 59, 63.
 Stromme (R.) (*Norway*). — Gr. 32 : p. 5.
 Swingle (T.M.) (*U.S.A.*). — Gr. 35 : p. 4, 25, 28.
 Swoboda (G.) (*Austria*). — Gr. 35 : p. 12.
 Szczerba (Z.) (*Poland*). — Gr. 32 : p. 44, 45.
 Szendy (K.) (*Hungary*). — Gr. 32 : p. 30, 31.
 Szente Varga (H.P.) (*Switzerland*). — Gr. 13 : p. 3, 4, 5. Gr. 23 : p. 7, 8, 22.
 Taschini (A.) (*Italy*). — Gr. 31 : p. 12. Gr. 33 : p. 16.
 Tengstrand (C.) (*Sweden*). — Gr. 11 : p. 10.
 Thaler (R.) (*Switzerland*). — Gr. 13 : p. 13.
 Thelwell (M.J.) (*United Kingdom*). — Gr. 11 : p. 27, 28. Gr. 21 : p. 23, 32.
 Therby (M.) (*France*). — Gr. 11 : p. 11, 12, 13, 14, 15.
 Thoeng (A.T.) (*Netherlands*). — Gr. 12 : p. 24.
 Thoren (B.) (*Sweden*). — Gr. 13 : p. 29. Gr. 33 : p. 48.
 Thuries (E.) (*France*). — Gr. 13 : p. 7, 8.
 Tillberg (H.) (*Sweden*). — Gr. 35 : p. 25. Gr. 36 : p. 11.
 Uhlmann (E.) (*Sweden*). — Gr. 14 : p. 2, 18, 20, 28.
 Ungrad (H.) (*Switzerland*). — Gr. 34 : p. 14, 15, 16, 36, 37.
 Urbanek (J.) (*Switzerland*). — Gr. 13 : p. 5, 62.
 Väisanen (J.) (*Finland*). — Gr. 35 : p. 10.
 Valtorta (M.) (*Italy*). — Gr. 32 : p. 15, 16.
 Van Hoek (G.A.L.) (*Netherlands*). — Gr. 32 : p. 45, 46, 47.
 Venikov (V.A.) (*U.S.S.R.*). — Gr. 32 : p. 53. Gr. 34 : p. 4.
 Verma (M.P.) (*Germany*). — Gr. 33 : p. 23, 24.
 Vermeer (J.) (*Netherlands*). — Gr. 15 : p. 13.
 Vigreux (J.) (*France*). — Gr. 13 : p. 37, 38, 39. Gr. 23 : p. 29, 30.
 Voipio (E.) (*Finland*). — Gr. 11 : p. 40, 41.
 Vontobel (J.) (*Switzerland*). — Gr. 23 : p. 15, 17.
 Voutilainen (P.) (*Finland*). — Gr. 23 : p. 30, 31.
 Wächli (H.) (*Switzerland*). — Gr. 11 : p. 36.
 Wagner (C.L.) (*U.S.A.*). — Gr. 13 : p. 13, 14, 31. Gr. 33 : p. 14.
 Wallenstein (M.) (*Hungary*). — Gr. 11 : p. 28, 29.
 Watson (W.) (*Canada*). — Gr. 32 : p. 45.
 Weber (J.) (*Germany*). — Gr. 14 : p. 24.
 Wedepohl (L.) (*United Kingdom*). — Gr. 35 : p. 25, 27, 29.
 Weise (E.) (*Germany*). — Gr. 23 : p. 12, 13, 14.
 Westbye (T.) (*Norway*). — Gr. 23 : p. 22, 24.
 Wettre (G.) (*Norway*). — Gr. 21 : p. 46.
 White (H.B.) (*Canada*). — Gr. 22 : p. 1, 5, 6, 9, 10, 13, 14, 17, 24, 30, 31, 41, 42, 44, 48, 53, 55, 56, 57.
 Whitehead (E.R.) (*U.S.A.*). — Gr. 33 : p. 8, 9.
 Willyoung (D.M.) (*U.S.A.*). — Gr. 11 : p. 24, 25, 35, 36.
 Witzig (M.) (*Switzerland*). — Gr. 34 : p. 25, 26.
 Wood (A.B.) (*United Kingdom*). — Gr. 22 : p. 5, 16, 30, 41, 47, 63.
 Woodson (H.) (*U.S.A.*). — Gr. 31 : p. 49, 50.
 Wretemark (S.) (*Sweden*). — Gr. 21 : p. 10.
 Wüthrich (H.R.) (*Switzerland*). — Gr. 13 : p. 6, 7.
 Yakub (Yu.A.) (*U.S.S.R.*). — Gr. 23 : p. 37, 38, 44, 45.
 Zanobetti (D.) (*Italy*). — Gr. 15 : p. 19, 20.
 Ziegler (W.) (*Germany*). — Gr. 14 : p. 15.
 Zielinski (J.) (*Poland*). — Gr. 33 : p. 44, 45.

CONTENTS

NOTES ON THE 1970 SESSION	Pages
I. <u>General</u>	3
II. <u>Opening Ceremony</u>	4
III. <u>Closing Ceremony</u>	23
IV. <u>General Reports</u>	25
— Group 11 (Rotating Machines)	25
by G. Ruelle.	
— Group 12 (Transformers)	28
by B. Sollerger.	
— Group 13 (Switching Equipment)	33
by P. Baltensperger.	
— Group 14 (A. C./D. C. Converting Plant)	34
by L. Csuros.	
— Group 15 (Insulating Materials)	36
by Mrs. B. Fallou.	
— Group 21 (H. V. Insulated Cables)	39
by A. S. Brookes.	
— Group 22 (Overhead Lines)	40
by H. B. White.	
— Group 23 (Substations)	41
by J. E. Baumann.	
— Group 31 (Transmission Systems)	42
by V. Caleca.	
— Group 32 (System Planning and Operation)	45
by B. Favez.	
— Group 33 (Overvoltages and Insulation Coordination)	48
by G. Carrara.	
— Group 34 (Protection, Automation and Remote Control Devices)	50
by G. Dienne.	
— Group 35 (Communication)	52
by M. Holleville.	
— Groupe 36 (Interference)	53
by A. de Quervain.	
V. <u>List of Participants</u>	55

VI. Papers and Discussions.

1st Section (Plant and Equipment)

Group 11 (Rotating Machines)

Papers*

- 11-01. — J. A. Soper, L. W. James, A. C. Conway and T. Miller (United Kingdom). — *Dual Axis Excitation and Control of Synchronous Turbo-Generators.*
- 11-02. — M. Wallenstein and R. Tuschák (Hungary). — *Some Problems Concerning Big Hydrogen-Cooled Turbo-Alternators.*
- 11-03. — P. Robert and G. Fortpied (Belgium). — *Performance of Alternator Excitation Systems.*
- 11-04. — J. Hlavác and M. Pivrnec (Czechoslovakia). — *Development of the Cooling System for a 500 MW Turbo-Generator Rotor.*
- 11-05. — I. A. Glebov, Ya. B. Danilevitch, G. M. Khoutoretsky, I. M. Postnikov, L. Ya. Stanislavsky and A. P. Tchistikov (U.S.S.R.). — *Investigation of the Losses and Temperature Rises in the End Parts of Direct-Cooled Turbo-Generators.*
- 11-06. — C. H. Holley and D. M. Willyoung (U.S.A.). — *Conductor-Cooled Rotors for Large Turbine-Generators : Experience and Prospects.*
- 11-07. — V. Easton (United Kingdom). — Paper presented in the name of Study Committee No. 11 (Rotating Machines) by the Working Group on « Mechanical Problems in Large Turbo and Hydro-Generators ». — *Magnetic Vibration in Turbo-Generator Stators.*
- 11-08. — P. Barret (France). — Paper presented in the name of Study Committee No. 11 (Rotating Machines) by the Working Group on « Excitation ». — *New Development and Main Problems of Excitation Systems in Large Synchronous Machines.*
- 11-09. — J. Debernardi, T. Fritsch, R. Boulet, M. Therby, A. Barral and Duréault (France). — *Excitation Systems for Large A. C. Generators-Arrangement. Tests. Performance Criteria.*
- 11-10. — W. Kellenberger (Switzerland). — *Balancing Flexible Turbo-Rotors with the Aid of the Theory of Orthogonal Functions.*
- 11-11. — P. Barret, A. Coustère and J. F. Heuillard (France). — *Stresses on Turbo-alternators under Unbalanced Conditions.*

Discussion* 11-1 to 63

Group 12 (Transformers)

Papers*

- 12-01. — M. Ouyang, B. J. Halpin, D. H. Ryder, A. J. Wakeling, R. C. Hughes and F. C. Pratt (United Kingdom). — *Switching Impulse and Lightning Impulse Strengths of Oil-Immersed Insulation Structures and the Relevance of these Comparisons to Service and Test Voltage Requirements of Transformers.*
- 12-02. — R. Müller, K. Potthoff and K. Soldner (Germany). — *The Analysis of Gases Dissolved in the Oil as a Means of Monitoring Transformers and Detecting Incipient Faults.*
- 12-03. — B. Grundmark (Sweden). — *High-Voltage Shunt Reactors. Trends in Design and Testing.*
- 12-04. — R. Andersson, S. Hyryläinen and K. Pönni (Finland). — *Moisture of Insulation as a Measurement and Maintenance Problem in Oil Impregnated Power Transformers.*
- 12-05. — *A Preliminary Discussion of the Three Preferential Subjects Concerning Shunt Reactors, Maintenance and Insulation Co-ordination.* Paper presented in the name of Study Committee No. 12 (Transformers).
- Part 1. — W. Evenepoel and P. Ceuppens (Belgium). — *Problems Posed by the Design, Tests and Operation of Shunt Reactors.*
- Part 2. — K. Olsen (Norway). — *Maintenance of Transformers Including Ageing Problems and Measures of Prevention.*
- Part 3. — H. R. Moore (U.S.A.). — *Co-ordination of Internal Transformer Insulation with Respect to Service and Test Voltage Requirements.*
- 12-06. — A. K. Lokhanin, T. I. Morozova, I. D. Voevodin, Z. M. Beletsky, G. S. Kuchinsky and D. A. Kaplan (U.S.S.R.). — *Problems of Co-ordination of Dielectric Strength of Extra High-Voltage Power Transformer Major Insulation.*

Discussion* 12-1 to 43

* Papers and discussions are classified in numerical order of Groups. Within the Groups Papers are also classified in numerical order and the discussions following them are individually paged.

Group 13 (Switching Equipment)

Papers*

- 13-01. — N.S. Ellis, M.A.S. Hick, D.P. Longworth, F.O. Mason and J.G. Steel (United Kingdom). — *Synthetic testing with A.C. Recovery Voltage.*
- 13-02. — M.J. Battisson, J.P. Bickford, J.C.W. Corcoran, R.L. Jackson, M. Scott and R.J.S. Ward (United Kingdom). — *British Investigations on the Switching of Long E.H.V. Transmission Lines.*
- 13-03. — M. Hosokawa, S. Yamazaki, Y. Nakano, J. Tomiyama and M. Oyama (Japan). — *Synthetic Testing of A.C. Circuit-Breakers Fitted with Shunt Resistors.*
- 13-04. — S. Fukuda, Y. Ozaki, K. Furuno, M. Fukunishi, K. Anjo, O. Taguchi, H. Kinoshita and A. Tanaka (Japan). — *Switching Surge Reduction with Circuit-Breaker Resistors in Extra High-Voltage Systems.*
- 13-05. — L. Ferschl (Austria), H. Kopplin, E. Pflaum, E. Slamecka and W. Waterschek (Germany). — *Three-Circuit Arrangement for Testing High Voltage Circuit-Breakers under Short-Line Fault Conditions.*
- 13-06. — E. von Bonin, H. Karrenbauer and R. Leber (Germany). — *The Cascade-Weil-Circuit, a New Circuit for Synthetic Testing of Circuit-Breakers with Very High Breaking Capacities.*
- 13-07. — R. Petitpierre and H. Watschinger (Switzerland). — Paper presented in the name of Study Committee No. 13 (Switching Equipment). — *Transient Recovery Voltage Conditions to be Expected when Interrupting Short-Circuit Currents Limited by Transformers.*
- 13-08. — B. Grycz (Czechoslovakia). — *The Equivalence of the Fundamental Circuits for Synthetic and Direct Testing in View of the Interaction between the Arc and the Circuit.*
- 13-09. — B. Lageman, M.W.A. Schmitz and W.J. Wijker (Netherlands). — *Results of Comparison Tests with an Air-blast Circuit-Breaker in a Direct Circuit and in Synthetic Circuits with Both Voltage and Current Injection.*
The Influence of the Transient Recovery Voltage (Time Delay) on the Breaking Capacity of an Air-blast Circuit-Breaker.
- 13-10. — E. von Bonin, B. Koetzold, K. Möller, G. Oberdorfer, J. Schwarz and H.G. Thiel (Austria). — *A Method of Current Interruption in HVDC Networks by means of A.C. Circuit-Breakers with Adapted Arc Characteristics and Energy Absorbers.*
- 13-11. — W.M. Leeds, R.E. Friedrich, C.L. Wagner and T.E. Browne Jr. (U.S.A.). — *Application of Switching Surge, Arc and Gas Flow Studies to the Design of SF₆ Breakers.*
- 13-12. — P. Héroin, M. Bouteau, A. Mendès and N. Schektman (France). — *Influence of Parameters Relating to the High Voltage Source during Current Injected Synthetic Testing.*
- 13-13. — R. Thaler and H. Wüthrich (Switzerland). — *Influence of the Line Dropping Transient Recovery Voltage on the Voltage Grading of Multi-Break Circuit-Breakers.*
- 13-14. — P. Baltensperger and E. Ruoss (Switzerland). — *Switching Overvoltages in EHV and UHV Networks.*
- 13-15. — B.J. Calvino, S. Favretto, G. Frate, G. Mazza and S. Rovelli (Italy). — *Recent Experience on the Evaluation of the Equivalence Between Direct Full Power and Synthetic Tests on H.V. Circuit-Breakers.*

Discussion* 13-1 to 78

Group 14 (A.C./D.C. Converting Plant)

Papers*

- 14-01. — K. Hidaka, H. Kondo, T. Horigome, N. Ito and T. Sogawa (Japan). — *Development of Thyristor Converter and Digital Computer Control for HVDC Transmission.*
- 14-02. — R. Foerst and G. Heyner (Germany). — *Model Tests on Three Terminal HVDC Systems.*
- 14-03. — M.T. O'Brien (New Zealand). — *Operational Experience of the Benmore-Haywards HVDC Transmission Scheme.*
- 14-04. — J. Hengsberger (Germany), R. Wüthrich (Switzerland) and F. Scherbaum (Germany). — *An Oil-Cooled HVDC Thyristor Valve for Outdoor Installation.*
- 14-05. — F.H. Last and R.M. Middleton (United Kingdom). — Paper presented in the name of Study Committee No. 14 (A.C./D.C. Converting Plant). — *A Survey of the Performance of H.V.D.C. Transmission Schemes throughout the World for 1968-1969.*

Discussion* 14-1 to 42

* Papers and discussions are classified in numerical order of Groups. Within the Groups Papers are also classified in numerical order and the discussions following them are individually pagged.

Group 15 (Insulating Materials)

Papers*

- 15-01. — **Z. Krasucki and H.F. Church** (United Kingdom). — *Impregnated Plastic Film Power Capacitors.*
- 15-02. — **G. Beer, A. Bossi, C. Mirra and A. Oberti** (Italy). — *Experimental Contribution to the Study of the Deterioration Produced by Partial Discharges on Oil Impregnated Paper Insulation.*
- 15-03. — **R. Wilputte** (Belgium). — *Contribution to the Study of the Evolution of Gas in Insulating Liquids and Solids under the Action of Electric Stress.*
- 15-04. — **D. Zanobetti** (Italy), **G. A. Gertsch** (Switzerland), **R. J. Hopkins** (U.S.A.), **A. Rabanit** (France) and **K. Wenzel** (Austria). — Paper presented in the name of Study Committee No. 15 (Insulating Materials). — *Power Capacitors with Mixed Paper and Polypropylene Dielectric.*
- 15-05. — **D. Moraru, C. Popesco, M. Stoica and F. Tanasesco** (Rumania). — *Detection of Degradation Produced by Partial Discharges in Paper-Oil Insulation.*
- 15-06. — **T. Bertula, Y. Saunamäki and N. Östman** (Finland). — *Ageing of Oil-Paper Insulation with Special Reference to the Effect of the Electrical Field on Impurities in the Oil.*
- 15-07. — **B. Fallou (Mrs.), F. Viale, A. Devaux, R. Fournié, J. Galand and P. Vuarchex** (France), **I. Davies, R. R. Rogers and E. H. Reynolds** (United Kingdom), **E. Dörnenburg** (Switzerland). — Paper presented in the name of Study Committee No. 15 (Insulating Materials) by the Working Group on « Paper-Oil ». — *Application of Physico-Chemical Methods of Analysis to the Study of Deterioration in the Insulation of Electrical Apparatus.*

Discussion* 15-1 to 33

2nd Section (Cables, Lines and Substations)

Group 21 (H. V. Insulated Cables)

Papers*

- 21-01. — **T. Lundgren, S. Wretemark and H. O. Hansson** (Sweden). — *Studies of Impurities and Voids in Cross-linked Polyethylene Insulated Cables. Pre-fabricated Terminations.*
- 21-02. — **F. H. Kreuger** (Netherlands). — *Polyethylene Insulated Cable with Diffused Gas.*
- 21-03. — **J. D. Endacott, H. W. Flack, H. W. Holdup, F. J. Miranda, A. M. Morgan, D. J. Skipper and M. J. Thelwell** (United Kingdom). — *Thermal Design Parameters Used for High Capacity E.H.V. Cable Circuits in Great Britain.*
- 21-04. — **S. Takahashi** (Japan). — *Recent Technical Progress of High Voltage Power Cables in Japan.*
- 21-05. — **P. Lund, H. Teslo and G. Wrette** (Norway). — *300 kV Oil-Filled Cable with 2000 mm² Aluminium Conductor and Cross-Bonded Aluminium Sheaths for the City of Oslo.*
- 21-06. — **R. Arrighi, R. Ridon, L. Causse and P. Benard** (France). — *Contribution to the Study of the Thermal Environment of Buried Cables.*
- 21-07. — **I. Eyraud** (France), **L. R. Horne** (Canada) and **J. M. Oudin** (France). — *The 300 kV Direct Current Submarine Cables Transmission between British Columbia Mainland and Vancouver Island.*

Discussion* 21-1 to 50

Group 22 (Overhead Lines)

Papers*

- 22-01. — **J. A. Hetherton and A. H. Stevenson** (Australia). — *Development and Testing of a Porcelain Insulator-Arm for 330 kV Transmission Towers.*
- 22-02. — **A. Matoba, K. Aiki, H. Sugaya and K. Kaneko** (Japan). — *Study Result on Bulk Towers and Present Status of EHV 500 kV Transmission Lines. Construction in Japan.*
- 22-03. — **A. Govers** (Netherlands). — *On the Impact of Uni-Directional Forces on High-Voltage Towers Following Conductor-Breakage.*
- 22-04. — **K. P. Ewelt, H. Kollwe and U. Stoll** (Germany). — *A Thermal Model for Determination of Temporary Overhead Line Ampacity Dependent on Weather Conditions.*
- 22-05. — **A. Berg, S. Ege, M. Ervik and T. O. Slethei** (Norway). — *Recent Development in Conductor and Fitting Design.*

* Papers and discussions are classified in numerical order of Groups. Within the Groups Papers are also classified in numerical order and the discussions following them are individually paged.

- 22-06. — **V. Winants and M. Riez** (Belgium). — *Conductor Galloping on Overhead Lines.*
 22-07. — **A. Carpena** (Italy). — *Special Lightened Shapes for H. V. Towers.*
 22-08. — **M. Castanheta** (Portugal). — *Dynamic Behaviour of Overhead Power Lines Activated by the Wind.*
 22-09. — **A. I. Kurnosov and F. I. Lyalin** (U.S.S.R.). — *Reinforced Concrete Towers for 330-500 kV Transmission Lines in the U. S. S. R.*
 22-10. — **R. C. Black and R. S. Throop** (Canada). — *A Live Line Method for Retensioning Transmission Line Conductors.*
 22-11. — Paper presented in the name of Study Committee No. 22 (Overhead lines) by Working Group 01. — *Aeolian Vibration on Overhead Lines.*

Discussion* 22-1 to 67

Group 23 (Substations)

Papers*

- 23-01. — **G. Hosemann, H. G. Müller, K. H. Schneider and E. Weise** (Germany). — *Magnitude and Frequency of Extreme Voltage and Current Stresses and their Influence on the Technical and Economic Design of High-Voltage Substations.*
 23-02. — **F. M. Novoa** (Chile). — *Earthquakes and the Substation Equipment Arrangement and Specification.*
 23-03. — **A. W. Roth** (Switzerland) and **J. B. Owens** (U.S.A.). — *Dielectric Investigations of Components for Gas Insulated Switching Stations and Conductor Systems for Extra High Voltages.*
 23-04. — **T. D. Reimers and J. B. Owens** (U.S.A.). — *345 kV Metal-Clad Pressurised SF₆ Substation Design.*
 23-05. — **A. I. Tarasov and Yu. A. Yakub** (U.S.S.R.). — *Simplified Step-down Substations in the U. S. S. R.*
 23-06. — **E. Maury, R. Pariselle and J. Vigreux** (France). — *Commissioning and Initial Operating Results of 225 kV SF₆ Insulated Metal-Clad Substations.*

Discussion* 23-1 to 46

* Papers and discussions are classified in numerical order of Groups. Within the Groups Papers are also classified in numerical order and the discussions following them are individually paged.

International Conference
ON
LARGE ELECTRIC SYSTEMS
AT HIGH TENSION
(CIGRE)

PROCEEDINGS

OF THE
23rd SESSION

24 AUGUST – 2 SEPTEMBER

1970

VOLUME I

75 - PARIS 8^e

International Conference on Large Electric Systems at High Tension
112, boulevard Haussmann

NOTES ON THE 1970 SESSION

I GENERAL

As the preceding Session, the 1970 Session was held in the Conference Building of UNESCO, 125, avenue de Suffren, Paris 7^e, from August 24th to September 2nd.

Number of participants.

The total number of Delegates was 2019 and the total number of accompanying ladies was 600.

The following table shows the attendance to Sessions as from the inception.

Session	Number of participating countries	Number of delegates	Number of accompanying Ladies	Total
1921	12	231	80	311
1923	20	394	121	478
1925	27	530	220	750
1927	28	544	216	760
1929	29	703	283	986
1931	36	738	260	991
1933	31	751	250	1 001
1935	46	834	288	1 122
1937	41	871	304	1 175
1939	41	814	290	1 103
1946	30	877	130	1 007
1948	40	1 144	180	1 324
1950	42	1 252	325	1 577
1952	45	1 351	305	1 656
1954	50	1 529	365	1 894
1956	51	1 810	505	2 315
1958	42	1 764	420	2 184
1960	47	1 908	515	2 423
1962	50	1 945	542	2 487
1964	59	2 098	590	2 688
1966	54	2 155	623	2 778
1968	54	1 975	467	2 442
1970	57	2 019	600	2 619

Distribution of Delegates per country.

Registered Delegates were coming from 57 countries and in majority from:

France	483	Norway	55
United Kingdom ..	197	Yugoslavia	46
Germany	170	Canada	42
Switzerland	160	Denmark	41
Belgium	115	Portugal	35
Italy	105	Japan	29
United States	79	Austria	28
Spain	69	Finland	28
Sweden	68	Czechoslovakia ..	20
Netherlands	67		

Programme.

The programme of the Session was as follows:

Monday 24 August	Opening Ceremony Gr. 15 (Insulating Material) Gr. 36 (Interference)
Tuesday 25 August	Gr. 12 (Transformers) Gr. 22 (Overhead Lines)
Wednesday 26 August	Gr. 13 (Switching Equipment) Gr. 21 (H.V. Insulated Cables)
Thursday 27 August	Gr. 14 (A.c./d.c. Converting Plant) Gr. 23 (Substations)
Friday 28 August	Technical Visits
Saturday 29 August	Gr. 33 (Overvoltages and Insulation Co-ordination) Gr. 11 (Rotating Machines)
Sunday 30 August	Excursions
Monday 31 August	Gr. 31 (Transmission Systems) Gr. 34 (Protection, Automation and Remote Control Devices)
Tuesday 1 September	Gr. 32 (System Planning and Operation) Gr. 35 (Communication)
Wednesday 2 September	General Assembly and Closing Ceremony

Discussion Meeting Officers.

Group	Chairman	Special Reporter	Secretary
11 Rotating Machines	I. A. Glebov (USSR)	G. Ruelle (France)	A. Coustère (France)
12 Transformers	H. Lutz (Switzerland)	B. Soliergren (Sweden)	Y. Tournier (France)
13 Switching Equipment	H. Meyer (Switzerland)	P. Baltensperger (Switzerland)	J. Passaquin (France)
14 AC/DC Converting Plant	K. S. Smedsfelt (Sweden)	L. Csuros (United Kingdom)	A. Lacoste (France)
15 Insulating Materials	T. Leardini (Italy)	Mrs. B. Fallou (France)	Miss B. Bouvier (France)
21 H.V. Insulated Cables	R. F. Goossens (Netherlands)	A. S. Brookes (U.S.A.)	R. Arrighi (France)
22 Overhead Lines	A. B. Wood (United Kingdom)	H. B. White (Canada)	G. Orawski (United Kingdom)
23 Substations	B. Stauch (Germany)	J. E. Baumann (Switzerland)	M. Jacot-Descombes (Switzerland)
31 Transmission Systems	H. C. Barnes (U.S.A.)	V. Caleca (U.S.A.)	J. T. Lusignan (U.S.A.)
32 System Planning and Operation	M. Magnien (France)	B. Favez (France)	Y. Thomas (France)
33 Overvoltages and Insulation Coordination	V. Palva (Finland)	G. Carrara (Italy)	R. Gert (Czechoslovakia)
34 Protection, Automation and Remote Control Devices	L. Bråten (Norway)	G. Dienne (Belgium)	P. Røed (Norway)
35 Communication	P. Borremans (Belgium)	M. Holleville (France)	J. Henrioul (Belgium)
36 Interference	M. Paimbœuf (France)	A. de Quervain (Switzerland)	G. Grand (France)

Papers presented.

The 122 papers presented to the Session were distributed as follows :

Germany	8	Czechoslovakia	3
France	8	Australia	2
United Kingdom	8	Austria	2
U.S.A.	8	Finland	2
U.S.S.R.	8	Hungary	2
Sweden	7	Rumania	2
Switzerland	7	Bulgaria	1
Belgium	6	Chile	1
Italy	6	U.A.R.	1

Japan	6	Ireland	1
Canada	5	Mexico	1
Norway	3	New-Zealand	1
Netherlands	3	Portugal	1
Poland	3		

International Papers	4
Study Committee Papers	12

122

II OPENING CEREMONY

The Opening Ceremony of the Session took place on Monday 24th August 1970 at 10.30 a.m. It was presided over by Mr. Jean COUTURE, Secretary General for Energy, representing the Minister of Industrial and Scientific Development in the French Government. Were also on the platform Mr. Andrew R. COOPER, President of CIGRÉ, Mr. Ch. CHEVRIER, Deputy General Manager, Electricité de France, Chairman of the French National Committee, Mr. Paul DELOUVRIER, Chairman of the Board of Directors Electricité de France, Mr. R. PELLETIER, President, Syndicat Général de la Construction Electrique, Mr. A. EVSTAFIEV, representing the UNESCO Director General and Mr. François CAHEN, Delegate of the Council of CIGRÉ.

After an address by Mr. A.R. COOPER, followed by a reply by Mr. J. COUTURE, Mr. Ch. CHEVRIER gave a lecture on the following subject : Electricity in France, yesterday, today and to-morrow. The texts of both addresses and the lecture are shown hereafter :

Address by Mr. A. R. Cooper, President of CIGRÉ

Mr. Secretary General,

It is my very great privilege to thank you on behalf of the Delegates assembled here today for agreeing to preside over the opening ceremony of our Session. We appreciate the compliment you are paying us in leaving your pre-occupation with State Affairs in order to be with us.

The nature and probably the extent of our activities will already be known to you and your colleagues for this is the 23rd biennial Session which has been held in Paris. The only difference between them is that each one is better than the last.

Many of us know from experience that merely growing older is not necessarily a sign of improvement but I can safely say that CIGRÉ as an Institution is probably more alive and alert to the changing pattern of world conditions than at any time in its history. In other words we have made it our business to move with the times and maintain our position in the forefront of technical and scientific progress.

At a time when world opinion is being mobilised to rescue our environment from the forces of destruction and to raise the standard of living in its various interpretations we count ourselves fortunate in being associated with the provision of electricity supplies to every part of the globe. For we regard an abundant supply of electricity as one of the great civilising influences of mankind. Its cleanliness, flexibility and comparative cheapness are making it possible to remove low grade drudgery from the home, to provide unlimited power to our industries and to make it possible for light, heat, power and even entertainment to be available to the humblest citizen. Our work continues to grow and so does our enthusiasm for dealing with the technical problems which increasingly confront us.

We are fortunate in being able to hold our discussions in such pleasant and convenient surroundings as these and I would like you to know how much we appreciate the interest which you and your government have always shown in our work.

Ladies and Gentlemen,

Welcome to the 23rd Biennial Session of CIGRÉ. Many things have happened since our last Session but I will refer only to those of greatest importance to CIGRÉ.

Many of you will already know of the sad loss we have sustained in the passing of Mr. ATTWOOD and shortly afterwards of Mr. BORGQUIST. Both of these distinguished men were members of CIGRÉ from its earliest days and in their different ways made outstanding contributions to its development and growth and to the advancement of its technical achievements.

The American membership of CIGRÉ was founded on the pioneer work of Mr. ATTWOOD and he was for a good many years the Chairman of their National Committee. The name of ATTWOOD will always be associated with our American Membership.

Mr. BORGQUIST was a brilliant engineer of international reputation whose work in the field of high voltage transmission will always be recognised. He will be remembered with affection by all those who were sufficiently fortunate to be his friends not only for the warmth of his personality but also for the dignity with which he bore a serious illness during his later years.

Losses of this nature are inevitable with the passage of time, but it is appropriate that we should put on record our appreciation of these two fine colleagues.

There are certain matters of organisation to which I will refer briefly.

The Rules of Procedure and the Rules for Study Committees have been adopted by the Council and the General Rules for Sessions will be submitted for final approval at the Council meeting on August 29. The fourteen new Study Committees were set up in 1968. Three former Chairmen remained in office and eleven new Chairmen have been appointed. On the

Council, Mr. SHINDO replaced Mr. TAKAI of Japan who to our great regret passed away on March 12th, 1969 and Mr. WHITE succeeded Mr. MERIGAN as the representative of our Australian National Committee.

The IEC have asked CIGRÉ to advise them on matters associated with the upper working limits of ultra high voltage and this is receiving the attention of our Study Committees.

On the passing of our founder, Mr. TRIBOT-LASPIÈRE in 1963 at the age of 82, the Council decided that a search would be made for a much younger man as his successor but that Mr. CAHEN should act as Delegate of the Council to carry out the duties previously performed by the General Delegate until the new appointment was made. We have been successful in finding a new Secretary General in the person of Mr. PÉLISSIER who takes up his duties on the 1st of October. From the end of next month therefore he will be our Chief Executive and we wish him every success in his new career. Miss DOURY and the other members of our small Permanent Staff will, I am confident, give him the same support they have given to his predecessors.

I should be failing in my duty if I did not make some reference to the work Mr. CAHEN has done over the past five years in assisting the Statutes Revision Committee to formulate the new Statutes and the Rules of Procedure and in implementing them after they were approved. He has also done outstanding work in the reorganisation of the Study Committees and largely due to his efforts we are now in a position to face the future with a well-organised team designed to deal with modern conditions. We shall always be grateful to him for his good work.

I cannot conclude this section without paying a tribute to Miss DOURY and her staff for the excellent work they have done, not only in making arrangements for the Session but also for all they have done in the past two years in connection with the administration of CIGRÉ, the production of *Electra* and the thousands of things which all help to make an organisation run smoothly.

So far as this Session's arrangements are concerned, I must once more extend our warmest thanks to Mr. René MAHEU, Director General of UNESCO, represented at this meeting by Mr. EVSTAFIEV, for having placed such convenient premises as the Conference Building at our disposal and to his staff for all the help they have given us in making the detailed arrangements.

On another hand I am pleased to be able to say that once again we are fortunate in having the help of Madam AILLERET in taking care of the ladies Committee. I would like to thank her in retrospect for all she has done in this connection at previous Sessions and in anticipation for what I know she will do so well during the days ahead.

You will see from your programme that we have two interesting post-Session tours: one international to the French-Italian Hydro Station at Mont-Cenis and the French-Swiss Hydro Station at Emosson, and the other, for the first time, in England. This tour kindly arranged by the British National Com-



FIG. 1

Opening Ceremony

*Part of the platform; from right to left : Mr. J. COUTURE, Secretary General for Energy,
Mr. A.R. COOPER, President of CIGRE, Mr. P. DELOUVRIER, President of EDF,
Mr. R. PELLETIER, Président, Syndicat Général de la Construction Electrique Française.*



FIG. 2

Opening Ceremony

*Part of the platform; from left to right : Mr. Ch. CHEVRIER, Deputy General Manager of EDF,
Mr. Fr. CAHEN, Delegate of the Council of CIGRE; Mr. A. EVSTAFIEV, representing the UNESCO General Manager.*

mittee will visit the Nuclear Power Stations at Dungeness, the gas turbines at Hastings and the CEGB Central Research Laboratories at Leatherhead.

I think that I have covered those items which concern us most but if I have made any significant omissions I hope that I shall be forgiven.

I have great pleasure, Mr. Secretary General, in thanking you once again for being with us and in asking you to declare this Session open.

**Address by Mr. J. Couture
Secretary General for Energy**

Mr. President,

Thank you for the kind words you have addressed to me in the name of those attending the 23rd Session of the International Conference on Large High Tension Electrical Systems. In turn I address to our guests a cordial welcome and I want them to know how much we appreciate their renewed choice of Paris for their meetings.

Mr. F.X. ORTOLI, Minister for Industrial and Scientific Development, prevented by overriding obligations from taking part in this Session, has asked me to make his excuses to you and to offer you in his name his good wishes for the complete success of your work.

I want to tell you also, Mr. President, of my satisfaction: this International Congress is devoted to a problem in which my Department has the greatest interest: the transmission of electrical energy is indeed invested with a three-fold importance: that linked with the transport function, necessary to every modern economy, which is changing and is founded upon inter-relationships. That of energy, fundamental motive power, thus rendered available and freed from the restrictions of localisation. That of electricity, which is the most refined and the most flexible form of energy at present delivered to the user.

The widest possible co-operation in this field at national and international levels has for all these reasons a fundamental usefulness. It is particularly happy that an Association such as this should make this its principal objective.

You have, Mr. President, very rightly drawn the attention of your audience to the inestimable service which electricity renders and will continue more and more to render to the civilised world. Moreover, we recognise the prodigious development of its applications since the beginning of the century. Electrical energy must be transmitted right to the place where it is consumed. It is clear that the systems used for this transmission are growing at an increasing rate, moreover, they often cross national frontiers and form wider and wider interconnected systems. They are thus one of the best instruments in the search for an international optimum in the use and exchange of energy.

You have chosen this field for the principal activities of your Association. I congratulate you. Looking at the reports of the 23 Sessions which it has organised during 50 years, one can indeed follow the growth and the progress of many techniques brought into operation by the transmission of electrical energy. It can also be stated that CIGRÉ has played and continues to play a primary part by the extent and the quality of the information which it distributes throughout the whole world, by the emulation which it excites between research workers and engineers of industrial countries, and by the subjects which it proposes for their research and development work.

What is striking, and which arises from your meetings, Conferences, Study Committees, Working Groups or Colloquia, is the quality of the relationships established between research workers and engineers from many countries, the freedom which pervades their exchanges of views, and the wide distribution ensured of the ideas which they express on the occasion of their contacts and of the results of the experience acquired. All this allows the avoidance of many trials and hesitations in finalising new techniques and a considerable shortening of the time necessary for the application of the latest progress in all countries.

In addition, engineers from the different countries draw from these meetings real benefit, which contributes to the diffusion of new methods, for their own work.

In this way one avoids the multiplication of parallel and simultaneous research, which would involve an appreciable waste of effort and of the material means used. Very important economies can thus be realised throughout the whole world, if one thinks of the enormous amount of study, experimentation and testing made necessary by technical research founded on scientific research and of the considerable resultant expenses.

Thus CIGRÉ adds to the transmission of energy the exchange of information and techniques, which is the most modern and the most complete way of assuming the essential function of TRANSMISSION.

Certainly technical progress, under whose sign our civilisation is placed, does not constitute an end in itself. But the constant diminution in the cost of production which flows from it has the effect of raising man's standard of life while increasing his well-being; that is one of the essential conditions of social progress.

On all these counts, the contribution of CIGRÉ to the organisation and the improvement of our economy and our industrial society is substantial. Gentlemen, I want to renew the assurance that the French Government has a lively interest in your efforts and your work and in their results.

In its name and in my own personal name I offer you my best wishes for the complete success of your Session and I wish you a pleasant stay in our Capital.

I declare open the 23rd Session of CIGRÉ.