SI/Note MAE/72-6
11.12.1972

PSB - RING MULTIPOLES

A Brief summary of the construction, position in the ring and interlock system

A. Arn
G. Schnell

1. General
2. Tables of parameters
3. Lists of drawings
4. Electrical cabling in the PSB ring
5. Interlock system and positions in the PSB ring

1. General

We distinguish two basic types of multipole units, namely Type A and Type B (see Figs. 1, 2 and 3).

Type A

The electrical connections for the octupoles as well as for the sextupoles of all four gaps are connected in series. For the quadrupoles the electrical connections are separated for each gap. Twelve frames with four gaps are mounted with one octupole, one sextupole and one skew-quadrupole in each gap. Four frames with four gaps are mounted with one octupole, on sextupole and one normal quadrupole in each gap.

Type B

Each gap is electrically separated, so there are individual octupoles ("skew octupoles") as well as sextupoles ("skew sextupoles") and quadrupoles. Four frames with four gaps are mounted with one octupole, one sextupole and one quadrupole in each gap, and there is one frame, where only Gap 1 is actually equipped with a set of one skew octupole, one skew sextupole and one quadrupole.

For mechanical, electrical and magnetic parameters, see Tables 1 and 2, paragraph 2.

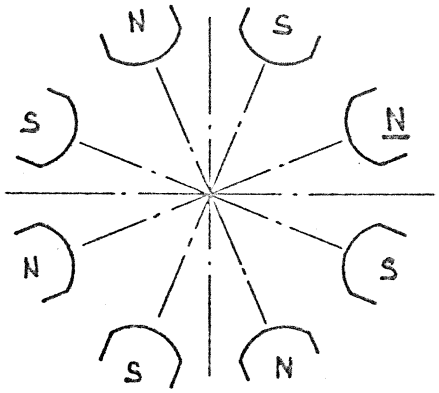
For construction details, see list of drawing numbers in paragraph 3.

For the electrical cabling in the PSB ring see paragraph 4, while paragraph 5 shows the interlock system and positions in the PSB ring.

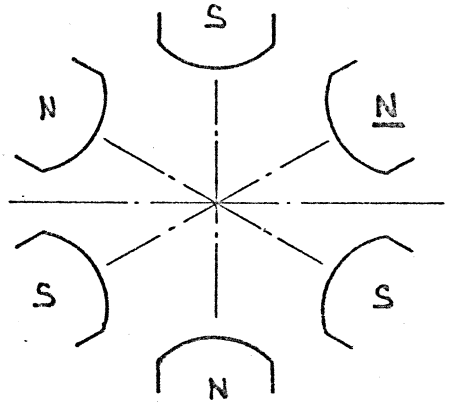
Fig 1. Polarité des éléments multipolaires

pour connections normales

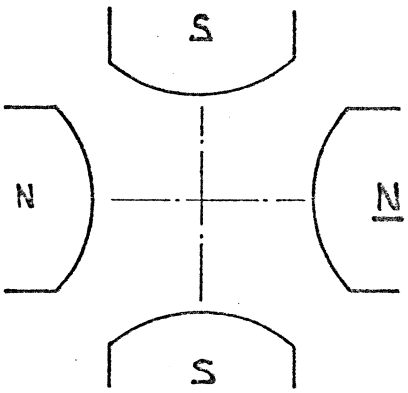
Octupole

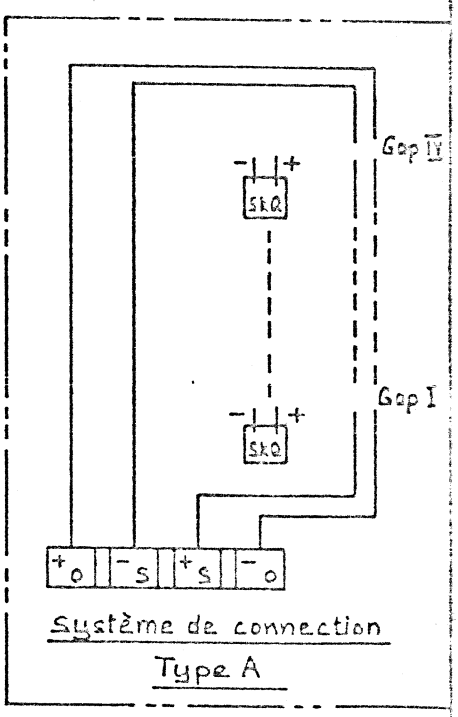


Sextupole



Skew Quadrupole





Système de connection

Type A

SI.1.04.1023.4

Vue côté connexions

(Sens du faisceau ⊗)

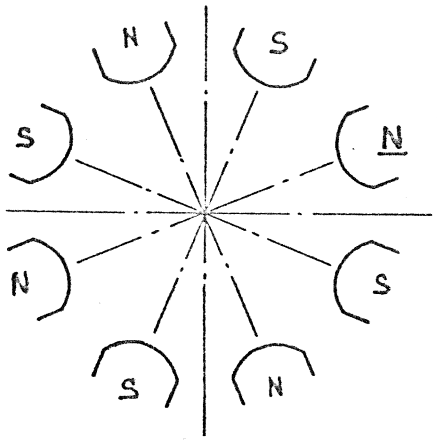
Type I - A

A.S.4.71

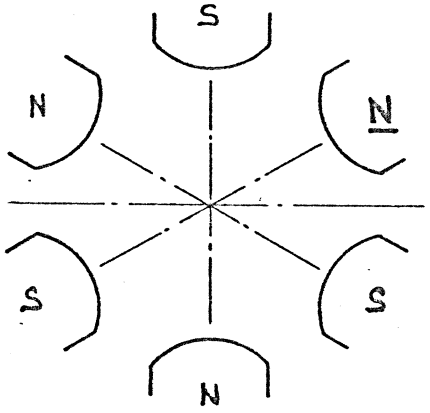
Fig.2 Polarité des éléments multipolaires

pour connections normales

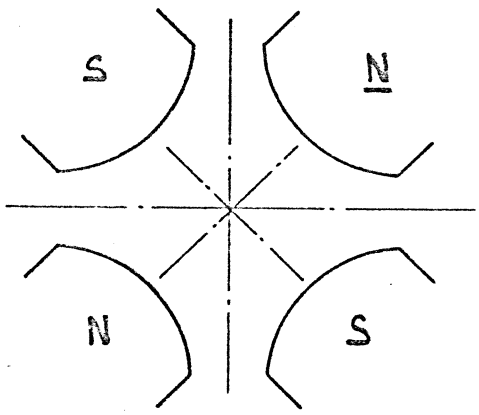
Octupole

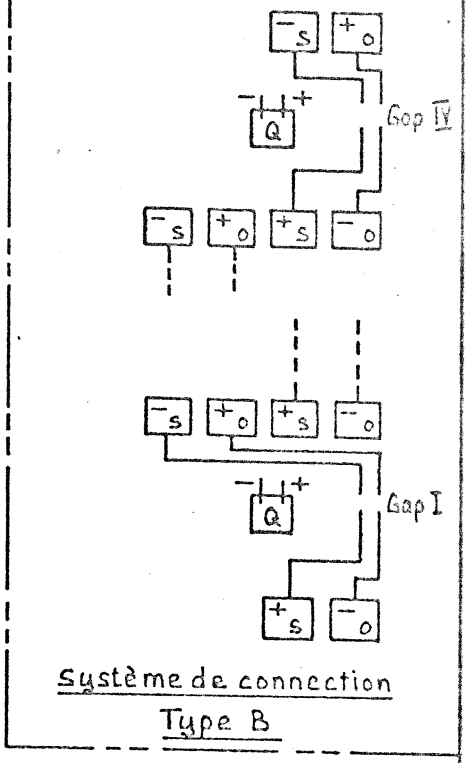


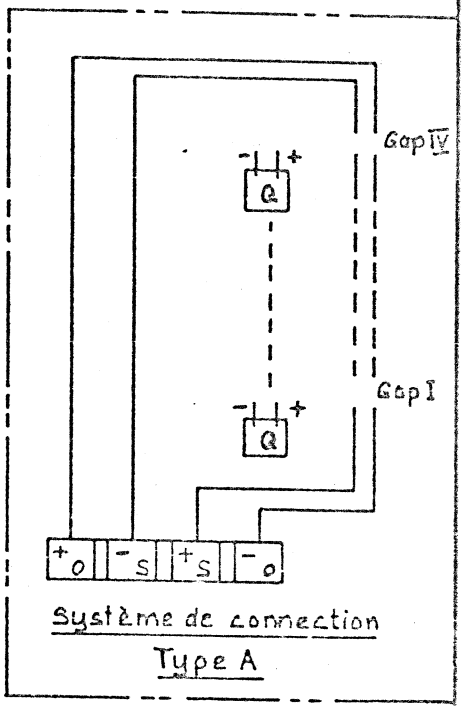
Sextupole



Quadrupole







Vue côté connexions

(Sens du faisceau ⊗)

SI.1.D4.1024.4

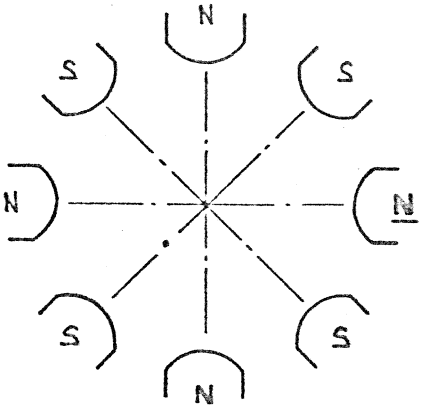
Type II - A & B

A 5.4.72

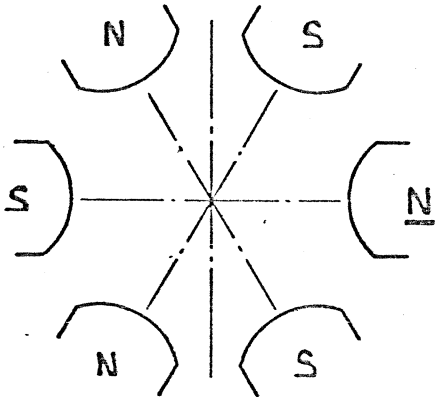
Fig.3 Polarité des éléments multipolaires

pour connections normales

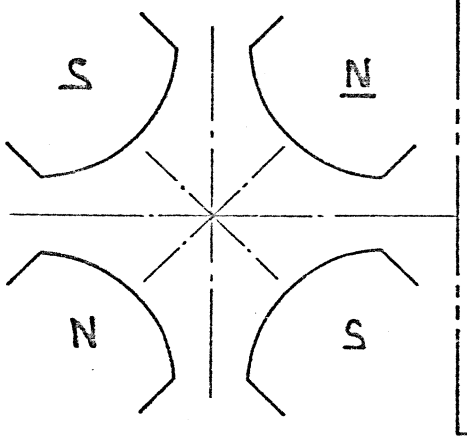
Skew Octupole

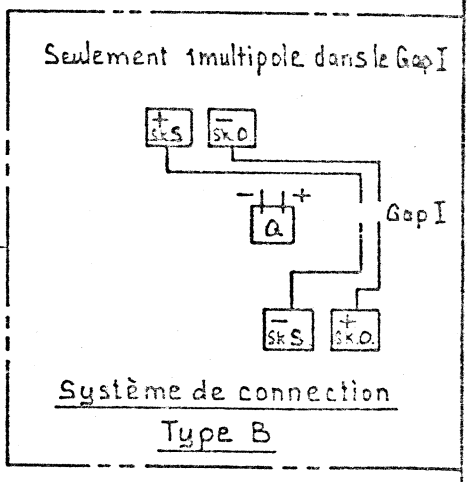


Skew Sextupole



Quadrupole





SI.1.04.1025.4

Vue côté connexions

(Sens du faisceaux ⊗)

Type III - B

A.S.4.71

2. Tables of parameters

Table 1 : Mechanical and electrical parameters of the Multipoles

	Type A	Type B
1. Mechanical :		
length of core	410	410 mm
internal diameter	173	173 mm
vertical distance of magnetic axes	360	360 mm
total weight	600	600 kg
conductor iron sections/number of turns		
quadrupole	49,54 / 14	49,54 / 14 mm^2
sextupole	40,17 / 6	40,17 / 6 mm^2
octupole	40,17 / 4	40,17 / 4 mm^2
water pressure drop	4	4 atm
water flow rate	5,3	5,3 ℓ/min
temperature rise	40	40° C
2. Electrical		
ohmic resistance (20°) per unit :		
quadrupole	14,7	14,7 mΩ
sextupole	4 x 13,3	13,3 mΩ
octupole	4 x 12,8	12,8 mΩ
dc inductance (frequency response) :		
quadrupole	0,65	0,65 mH
sextupole	4 x 0,0165	0,0165 mH
octupole	4 x 0,113	0,113 mH
excitation current (dc) :		
quadrupole	85	85 A
sextupole	270	270 A
octupole	270	270 A

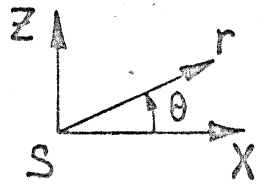
Table 2 — P.S.B. Multipoles

Main magnetical parameters as measured on N°9302 A

	n	nomin. current I (A)	Derivative of magn. field $\frac{\partial^n B_r}{\partial r^n}\left[\frac{T}{m^{n-1}}\right]$	Derivative of magn. field $\int \frac{\partial^n B_r}{\partial r^n} ds \left[\frac{T}{m^{n-2}}\right]$	Multipole coefficient $a_n\left[\frac{T}{m^{n-1}}\right]$	Multipole coefficient $\int a_n ds \left[\frac{T}{m^{n-2}}\right]$	Magn. length l_m [m]
Quadrupole	2	85	0.1724	0.0496	0.0862	0.0248	0.287
Sextupole	3	270	6.37	2.052	1.061	0.342	0.322
Octupole	4	270	213.7	80.41	8.90	3.35	0.377

Definition of multipole coefficients:

$$\left.\begin{aligned} B_r &= n a_n r^{n-1} \sin n\theta \\ B_\theta &= n a_n r^{n-1} \cos n\theta \end{aligned}\right\} \text{ for normal Quad., Sext., Oct.}$$



Magnet to magnet fluctuations of $\int a_n ds$: ±1%

Possible rotation of element around S-axis : $\Delta\theta = \pm 1°$

SI.1.04.1066.4

3 LIST OF DRAWINGS

3.1 Multipole type A

G.A. Multipole unit TYPE "A"	–	3	44	1053	0
Multipole frame Type "A"	–	3	44	1054	0
Multipole frame Type "A"	–	3	44	1055	0
Multipole coil Assembly	–	3	44	1056	0
Multipole coil Assembly	-	3	44	1057	0
Connector Block Assy	–	3	44	1058	3
Main terminal Assy	-	3	44	1059	2

Equipment :- Other correction elements		Group Code	Equip. Code	Serial N°	Format
Designation.	Name.				
Manifold branch tube Assy	-	3	44	1060	2
COVER Assy.	-	3	44	1061	0
Connections of multipoles in frame Type "A" Détail.	-	3	44	1062	0
Circuit diagram	—	3	44	1063	2
Connection of Lenses Type I	—	3	44	1064	2
Connection of Lenses Type II	—	3	44	1065	2
Connection of Lenses Type III	—	3	44	1066	2
Internal supporting tube	-	3	44	1067	2
External supporting tube	-	3	44	1068	2
Connector block	-	3	44	1069	4
Connector block	—	3	44	1070	3
Main terminal	-	3	44	1071	3
Terminal block.	-	3	44	1072	2
Terminal insulating block	-	3	44	1073	3
Insulating plate	—	3	44	1074	3

Equipment :- Other correction elements.		Group Code.	Equip. Code.	Serial N°	Format.
Designation.	Name.				
Clamp block.	-	3	44	1075	2
Socket carrier	-	3	44	1076	3
Terminal strip	-	3	44	1077	4
Rear mounting plate	-	3	44	1078	2
Front mounting plate	-	3	44	1079	1
Spacer ring multipoles C.E.R.N.	-	3	44	1080	2
Dowel general purpose special metric sizes	-	3	44	1081	4
M6 STUD	-	3	44	1082	3
Name plate	-	3	44	1083	3
Clamp block	-	3	44	1084	2
Clamp block.	-	3	44	1085	2
Spacer		3	44	1086	4
Nozzle		3	44	1087	2
Manifold Tube		3	44	1088	2
Manifold tube assy		3	44	1089	2

Equipment :- Other correction éléments					
Designation.	Name.	Group Code.	Equip. Code.	Serial N°	Format
Pillar assy	-	3	44	1090	2
Conductor section	-	3	44	1091	4
Conductor section	-	3	44	1092	4
Potting method for multipoles	-	3	44	1093	4
Brazing of copper and copper alloys used in cooling water circuits for electro magnet.	-	3	44	1094	4
Quality requirements for components manufactured in fibreglass	-	3	44	1095	4
Plating requirements for brass couplings		3	44	1096	4

3.2 Multipole type B

Equipment :- OTHER CORRECTION ELEMT (44)		Group Code	Equip. Code	Serial N°	Format
Designation.	Name.				
Connection of Multipoles in Frame Type B Schematic	Arn	1	44	1014	3
Multipole Frame Type 'B'	Arn	3	44	1017	D
Connection of Multipoles in Frame Type B. Detail.	Arn	1	44	1018	D
Protecting Circuit	Arn	1	44	1019	3
Ensemble Bornes - Connexions et appareillage Type B	Arn	1	44	1020	D
Support isolant (long)	Arn	1	44	1021	3
Support isolant (court)	Arn	1	44	1022	3
Cale isolante	Arn	1	44	1023	4
Piece de contact	Arn	1	44	1024	3
Bloc isolant pr. quadripole	Arn	1	44	1025	4
Plaque isolante	Arn	1	44	1026	4
Embout pour pièce contact	Arn	1	44	1027	4
Embout pour Collecteur	Arn	1	44	1028	4
Bouchon	Arn	1	44	1029	4

Equipment :- Other Correcting Elemt (44)		Group Code	Equip. Code	Serial N°	Format
Designation.	Name.				
Tuyau d'eau	Arn	1	44	1030	3
Tuyau d'eau	Arn	1	44	1031	3
Tuyau d'eau	Arn	1	44	1032	3
Tuyau d'eau	Arn	1	44	1033	3
Tuyau d'eau	Arn	1	44	1034	3
Bride pr. tuyau d'eau I	Arn	1	44	1035	3
Bride pr. tuyau d'eau II	Arn	1	44	1036	3
Tige filetée	Arn	1	44	1037	4
Bride pr. conducteur Cu	Arn	1	44	1038	4
Support	Arn	1	44	1039	4
Pièce de contact (Quadripole)	Arn	1	44	1040	4
Position des trous par. de la plaque $\S$I.3.44.1017.0 Pos 3	Arn	1	44	1041	1
Support	Arn	1	44	1042	4

3.3 Interlock multipoles type A+B

Interlock Multipoles Ring part	Arn	1	04	1022	3
Polarité des éléments multipolaires Type I	Arn	1	04	1023	4
Polarité des éléments multipolaires Type II	Arn	1	04	1024	4
Polarité des éléments multipolaires Type III	Arn	1	04	1025	4
QCS in L3 periods 1.3.5.7.9.11.13 & 15	Arn	1	04	1026	4
QCS in L3 periods 2.6.10 & 14	Arn	1	04	1027	4
QCN in L1 Per. 3.8.11 & 16 QCN in L3 Per. 4.8.12 & 16	Arn	1	04	1028	4
SCN + OCN in L3	Arn	1	04	1029	4

Equipment :- CONTROL SYSTEM 04		Group Code	Equip. Code	Serial N°	Format
Designation.	Name.				
SCN in L1	Arn	1	04	1030	4
OCN in L1	Arn	1	04	1031	4
OCN + SCN + QCS (N) périodes 1 à 16 en L3	Arn	1	04	1032	4
OCN + SCN + QCN	Arn	1	04	1033	4
OCS + SCS + QCN	Arn	1	04	1034	4
Schéma interlock châssis 1 Multipoles	Arn	1	04	1035	4sp
Schéma interlock châssis 2 Multipoles	Arn	1	04	1036	4sp
Schéma interlock châssis 3 Multipoles	Arn	1	04	1037	4sp
schéma interlock châssis 4 Multipoles	Arn	1	04	1038	4sp
Schéma interlock châssis 5 + 6 Multipoles	Arn	1	04	1039	4sp
Schéma interlock châssis 7 et 8 Multipoles	Arn	1	04	1040	4sp
Bornes de raccordement intermédiaires Multipoles	Arn	1	04	1041	4sp
P.S.B. Multipoles Magnetic main parameters	Arn	1	04	1066	4

4. Electrical cabling in the PSB Ring

See Figures 4a to 4f.

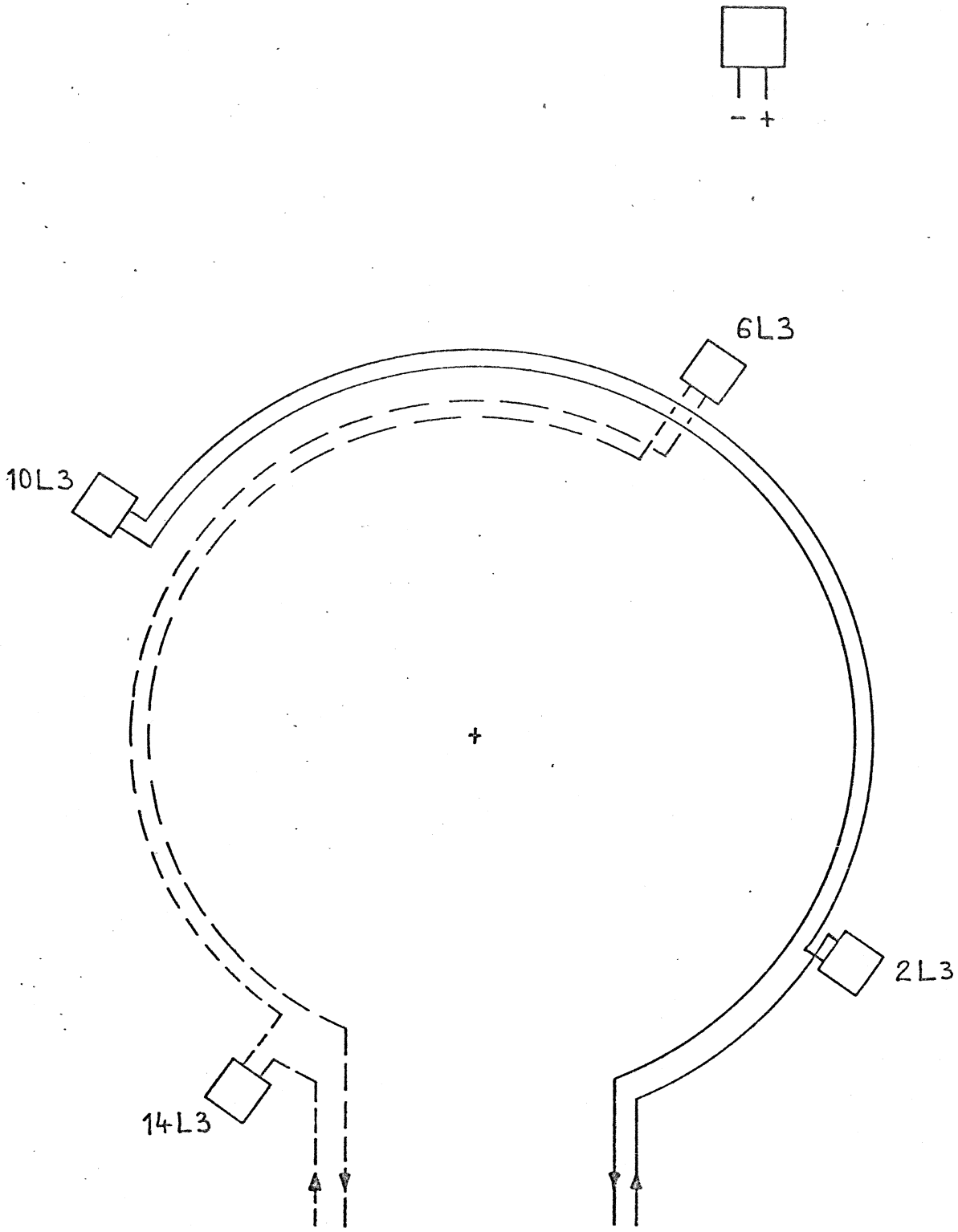


Fig 4a QCS IN L3

(Periods 2, 6, 10 & 14)

Main electrical connections (one ring)

SI.1.04.1027.4

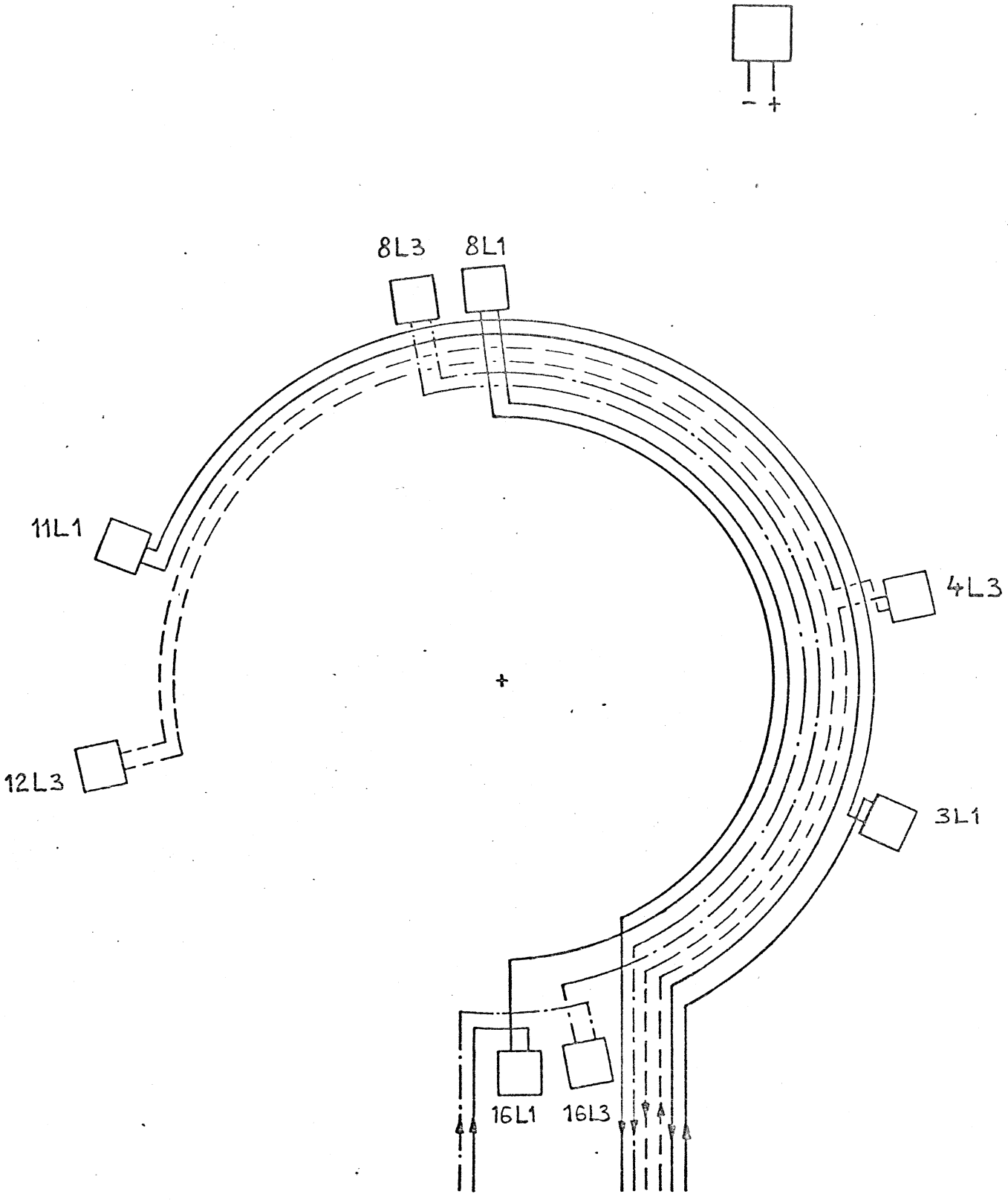


Fig.4b **QCN IN L1** (Periods 3, 8, 11 & 16)

QCN IN L3 (Periods 4, 8, 12 & 16)

Main electrical connections (one ring)

SI.1.04.1028.4

A-29.5.72

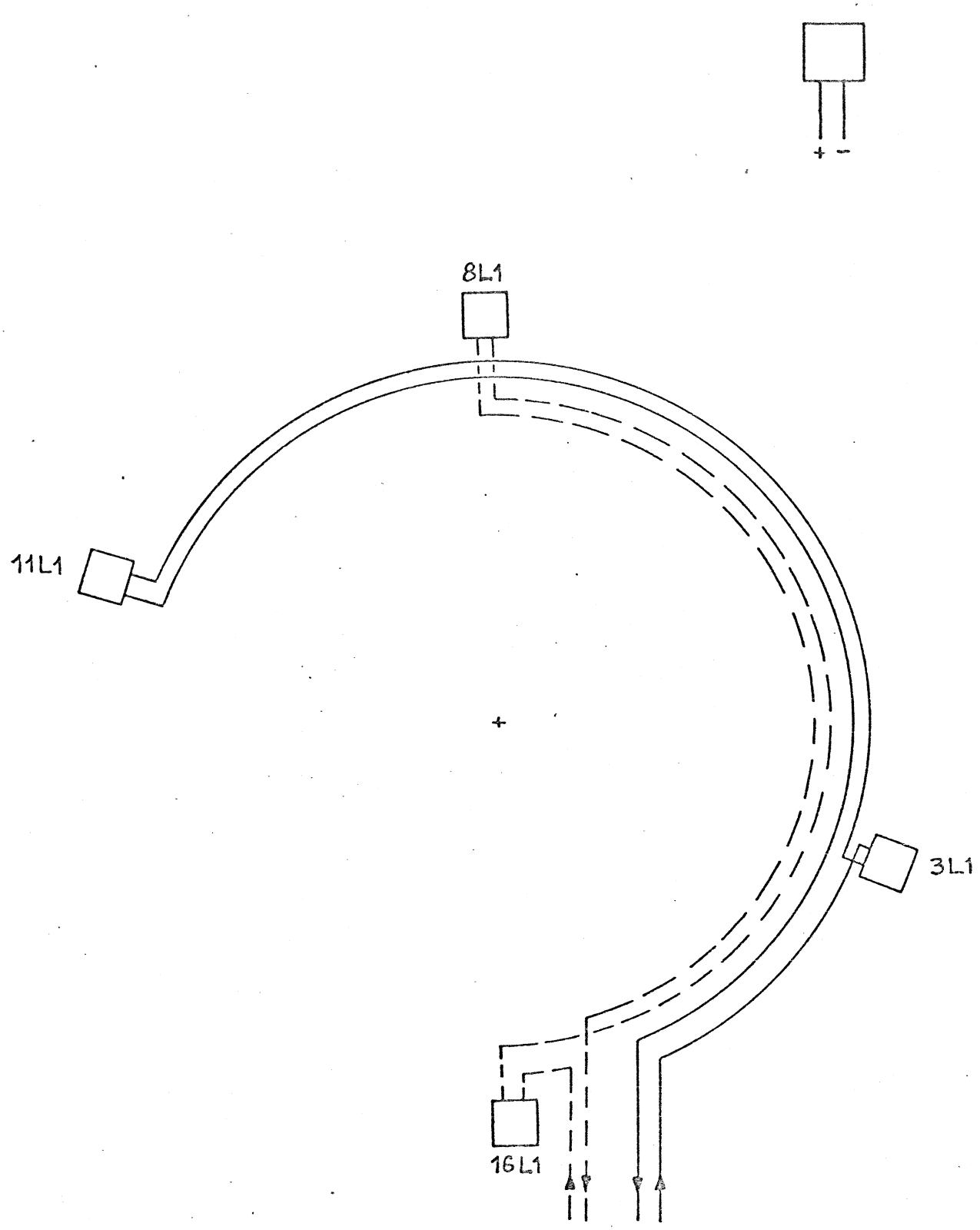


Fig.4c OCN IN L1

Main electrical connections (one ring)

SI.1.04.1031.4

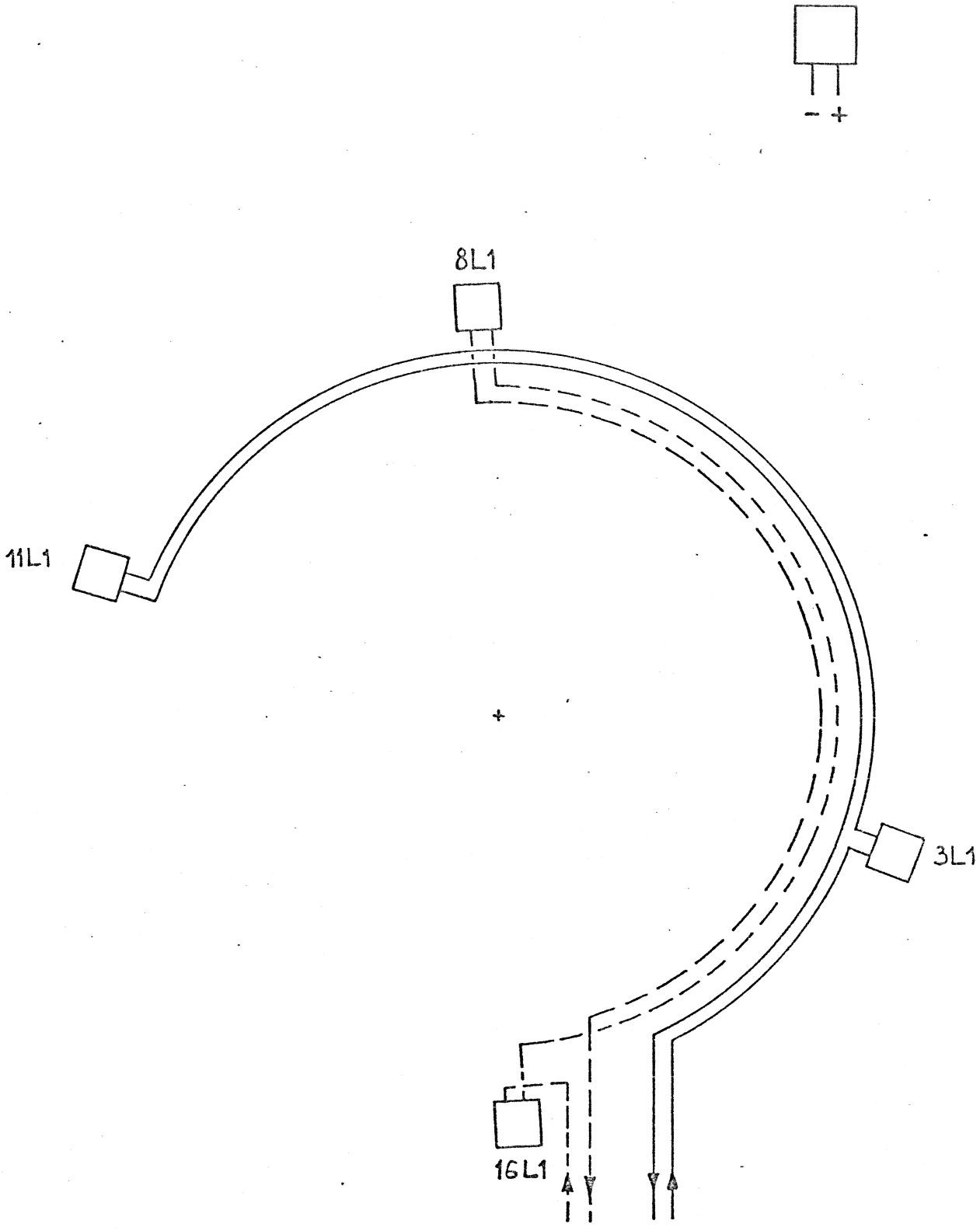


Fig.4d SCN IN L1

Main electrical connections (one ring)

SI.1.04.1030.4

29.5.72

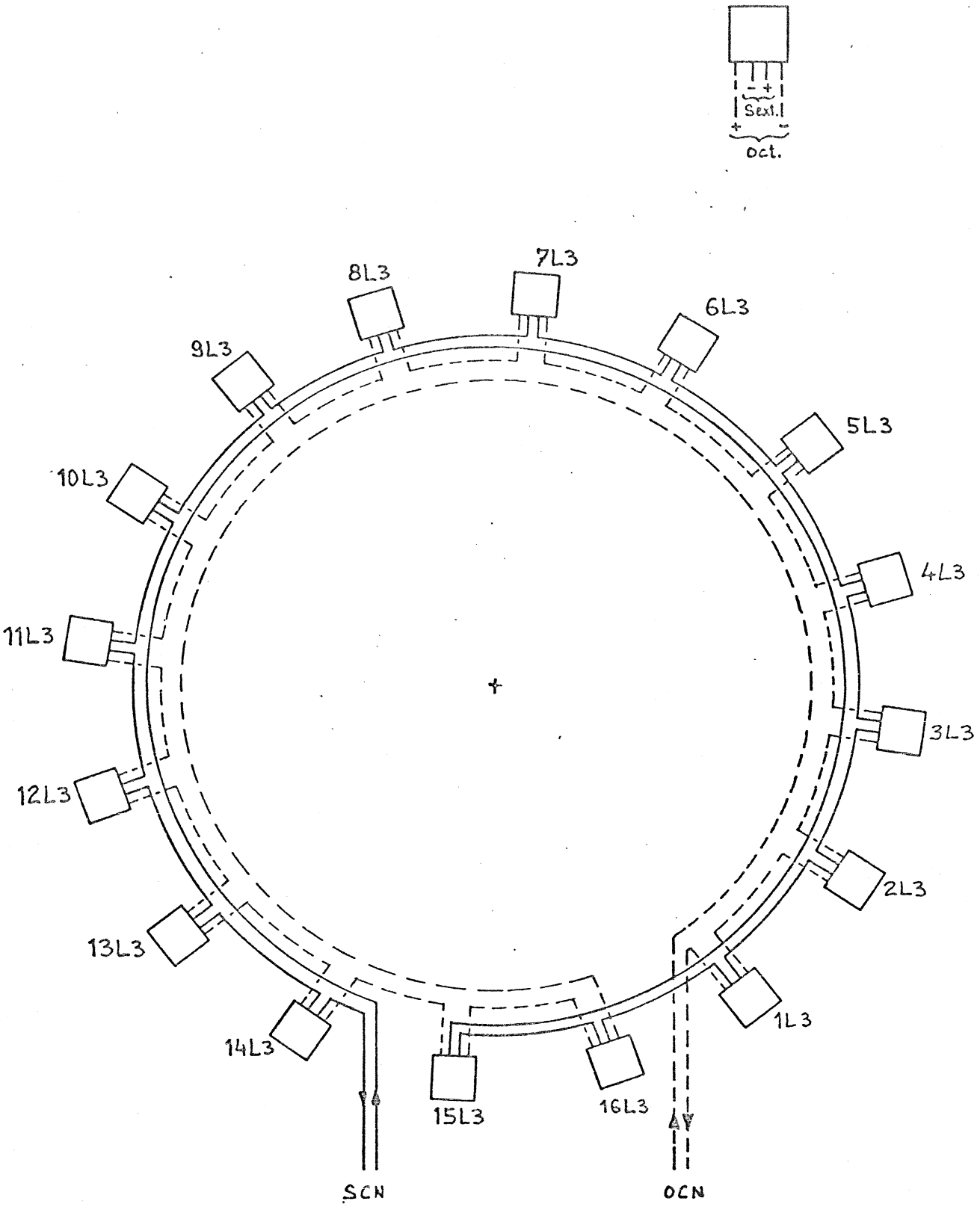


Fig 4e SCN + OCN IN L3

Main electrical connections (4 Gaps)

SI.1.04.1029.4

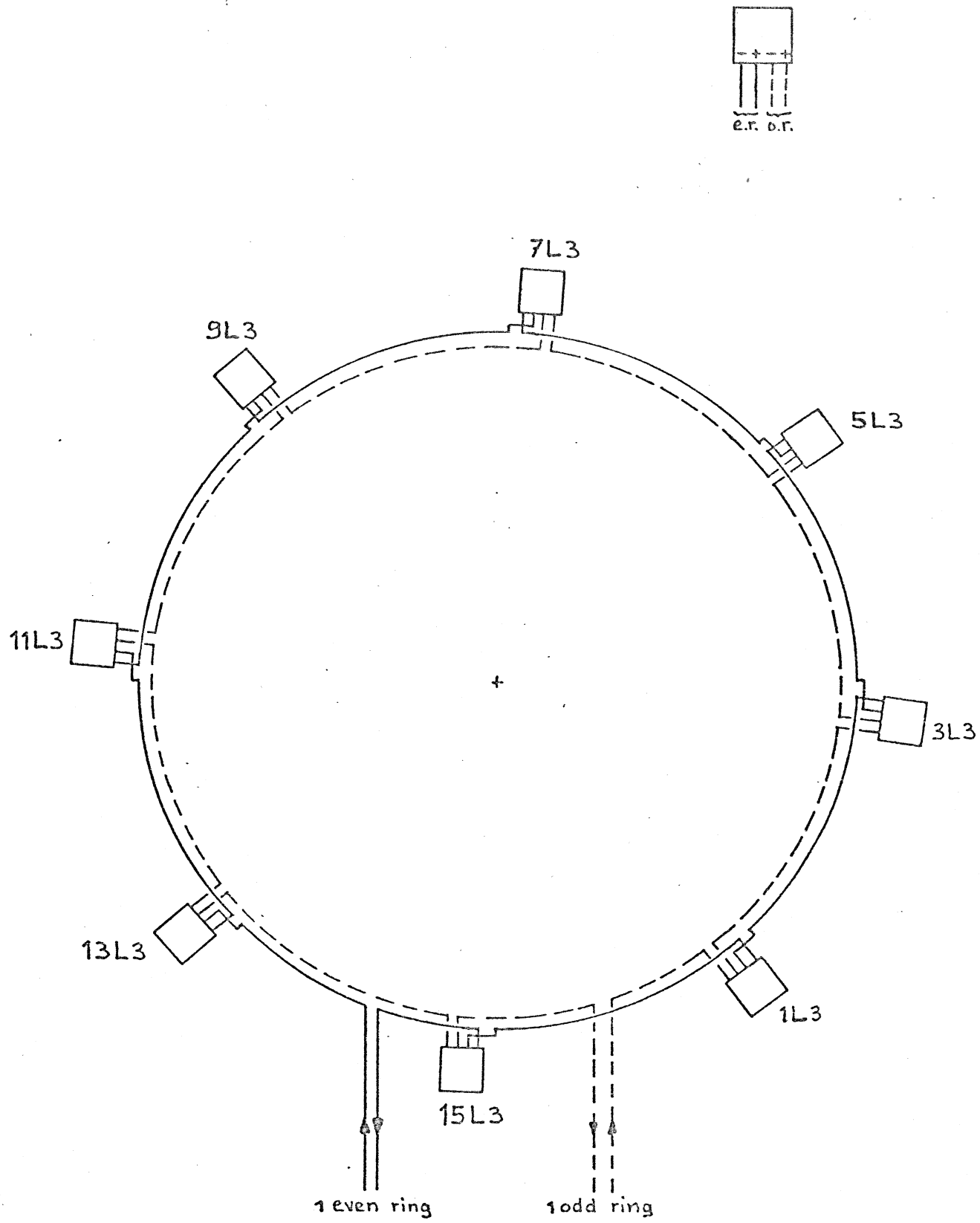


Fig 4f QCS IN L3

(Periods 1, 3, 5, 7, 9, 11, 13 & 15)

Main electrical connections: ═══ even ring ; ═ ═ ═ ═ odd ring

SI.1.04.1026.4

5. Interlock system and positions in the PSB ring

Figs. 5a, b and c show the interlock circuitry on the multipole units.

Fig. 6 shows the position of the different units in the ring.

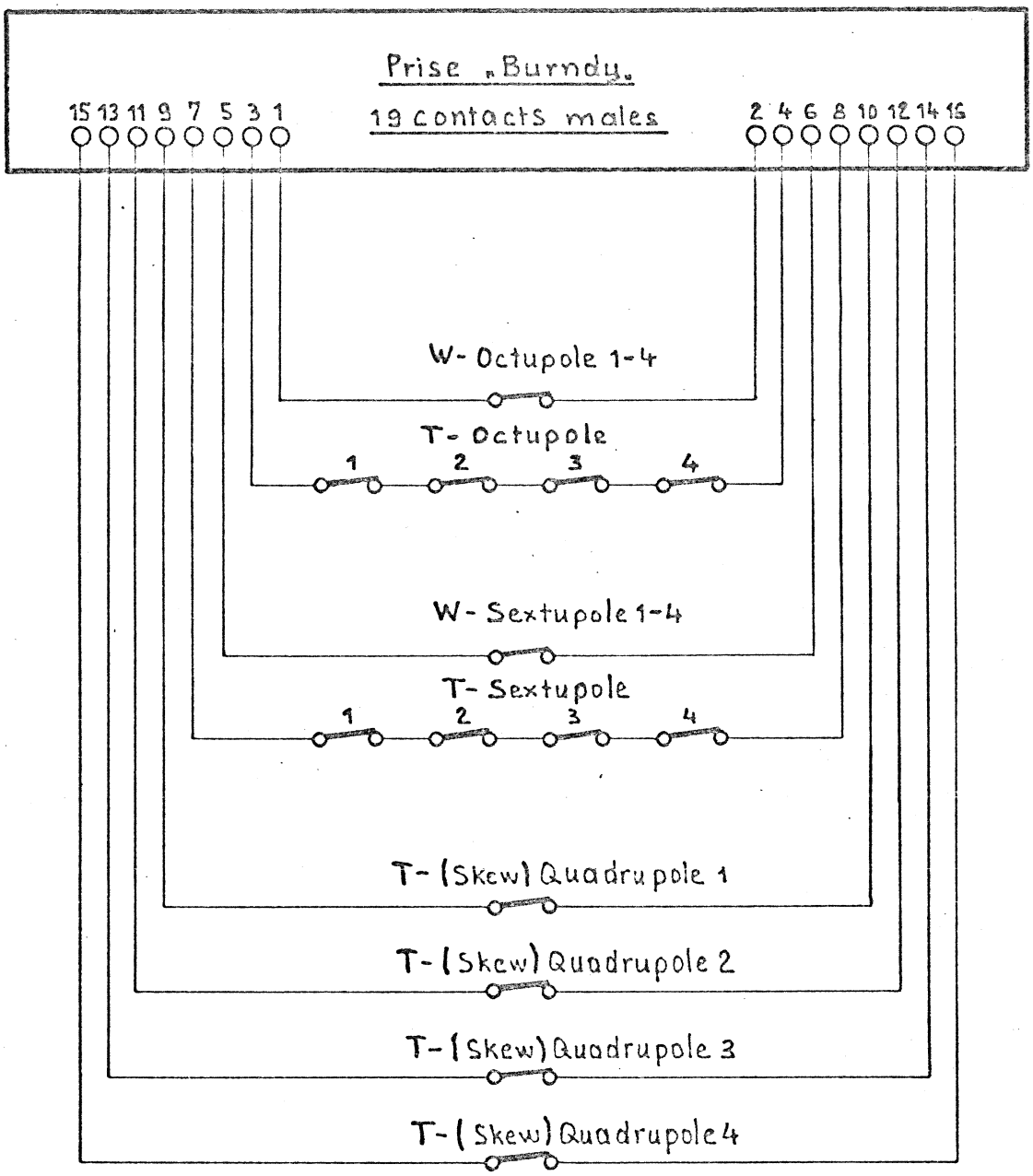
Drawings 1 to 6 give the circuits on the rack 258 in the BCR.

Drawing 7 shows the interconnection panel of the rack 258 in the BCR.

(Drawings 1 to 7 on request)

Annexe

Multipole



T : Thermomètre
W : Débitmètre

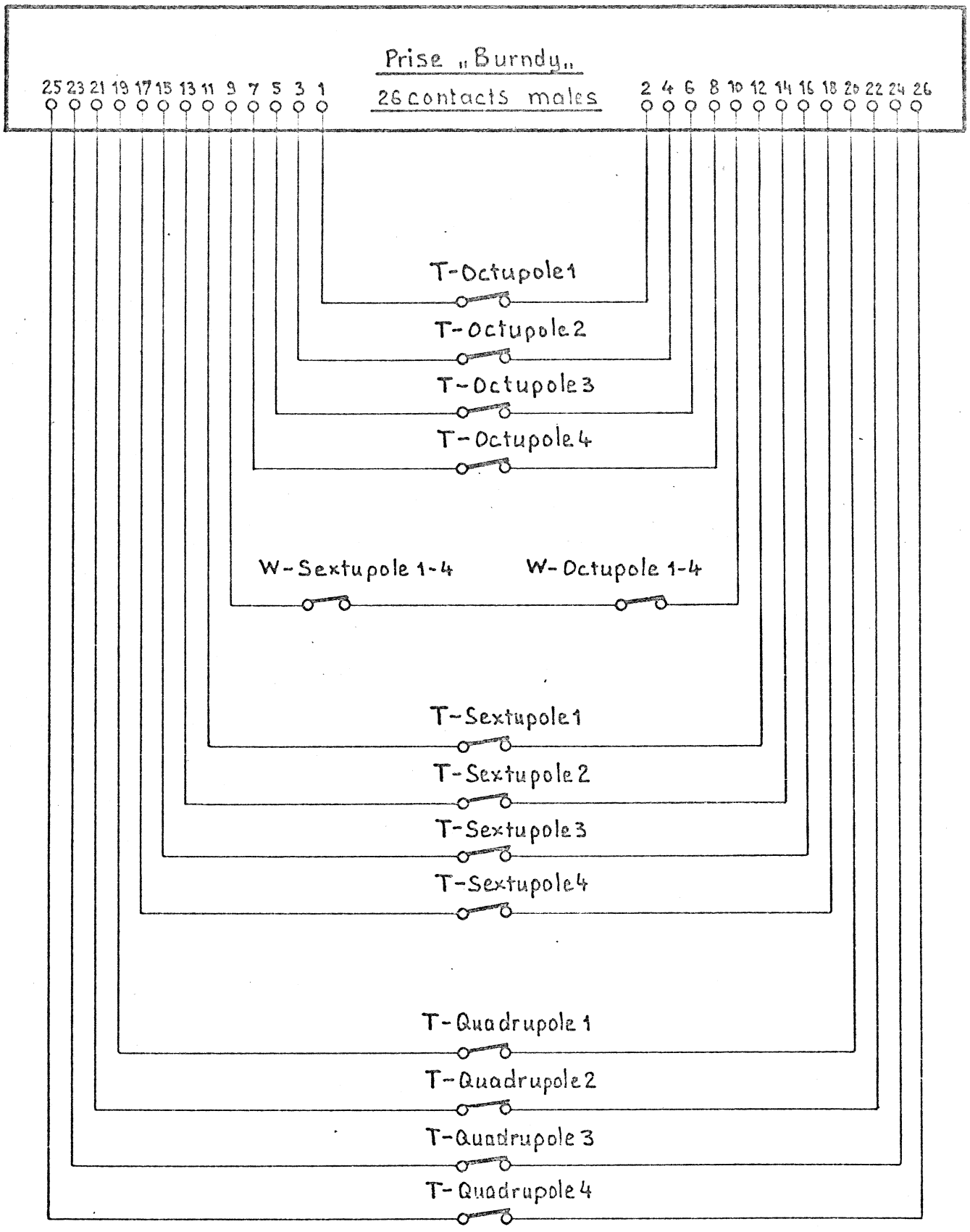
Fig. 5a — QCN + SCN + QCS (N)

Périodes 1 à 16 en L3

Circuit de protection

SI.1.D4.1032.4

Multipole



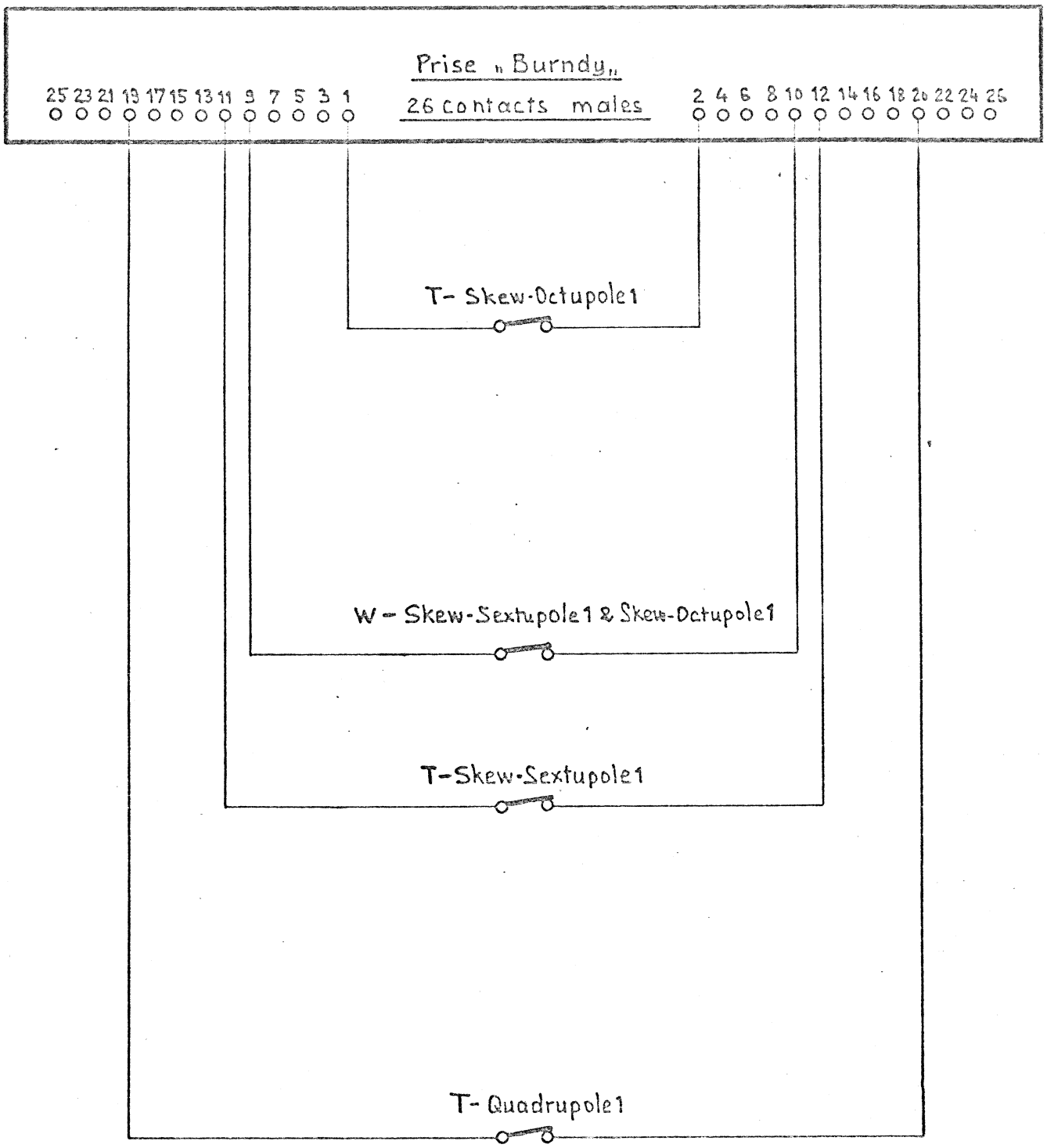
T: Thermomètre
W: Débitmètre

Fig. 5b DCN + SCN + QCN

Périodes 3 & 8 + 11 & 16 en L1

Circuit de protection SI.1.04.1033.4

Multipole



T : Thermomètre
W : Débitmètre

Fig.5c QCS + SCS + QCN

Période 3 en L1s

Circuit de protection

SI.1.04.1034.4

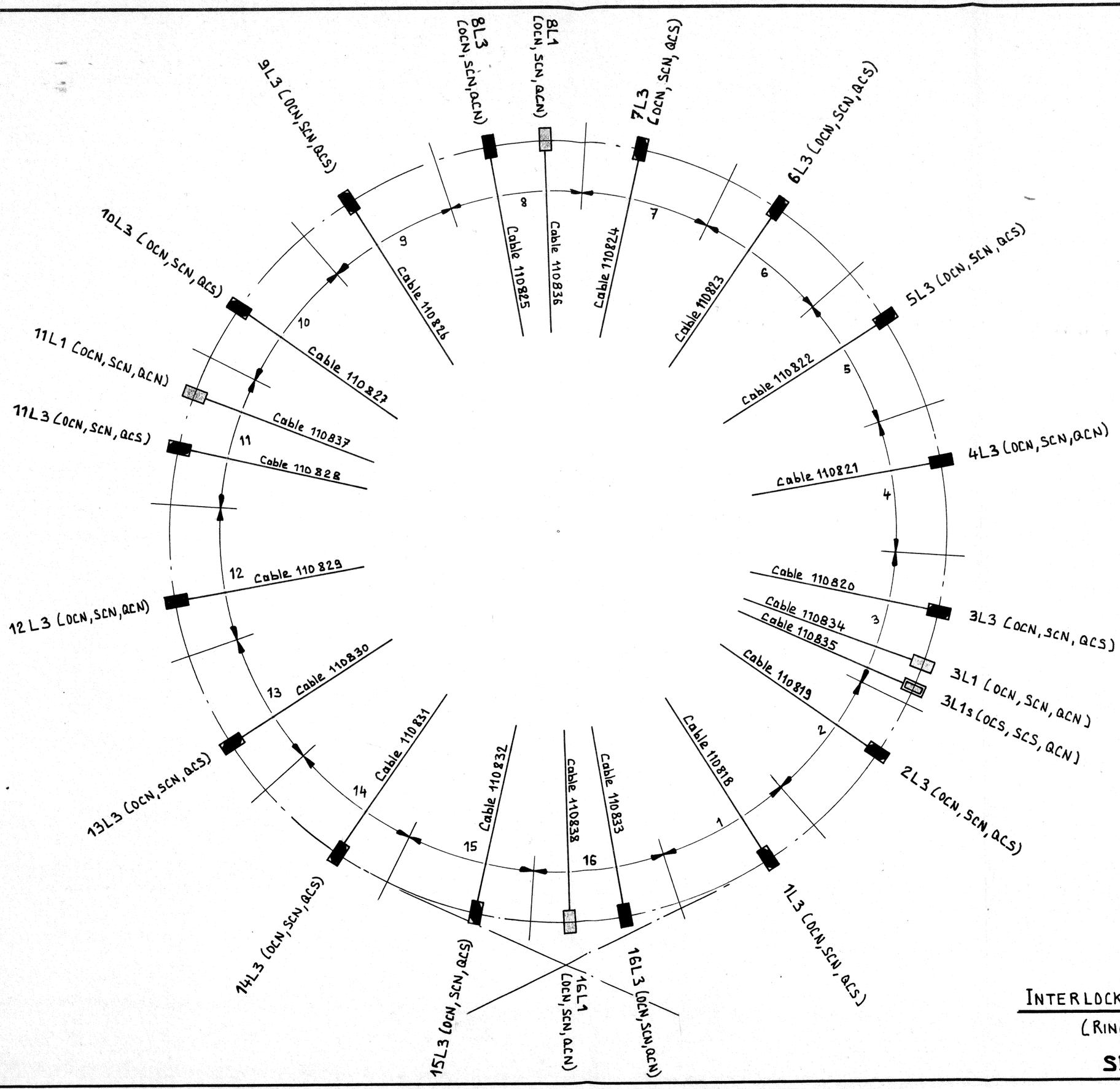


Fig.6

INTERLOCK MULTIPOLES

(RING PART)

SI.1.04.1022.3

References

1. C. Bovet, K.H. Reich, Correction magnets for the PSB: their choice, location and performance specification.
SI/Int. DL/69-3

2. M. Giesch, Design of the PSB correcting lenses (multipoles)
SI/Note MAE/70-3

3. Technical specifications for the correcting multipoles of the 800 MeV Booster Synchrotron (PSB)
CERN/SI/Int. MAE/70-1

4. M. Gabriel, Le cheminement des cables dans les bâtiments du Booster
SI/Note DL/70-4

5. K.H. Reich, Further thoughts on the correction magnets for the PSB
SI/Note DL/70-8

6. B. Godenzi, Proposition pour l'alimentation des éléments de correction du PSB
MPS/ED Note/70-2

7. R. Debordes, PSB multipoles, proposition d'organisation du système hardware
MPS-SI/Note CO/71-19

8. C.E. Rufer, Nomenclature and abbreviation of PSB elements
SI/Note ME/71-2

9. K.D. Lohmann, PSB correcting lenses, dynamic properties
Manuscript 6.4.1972