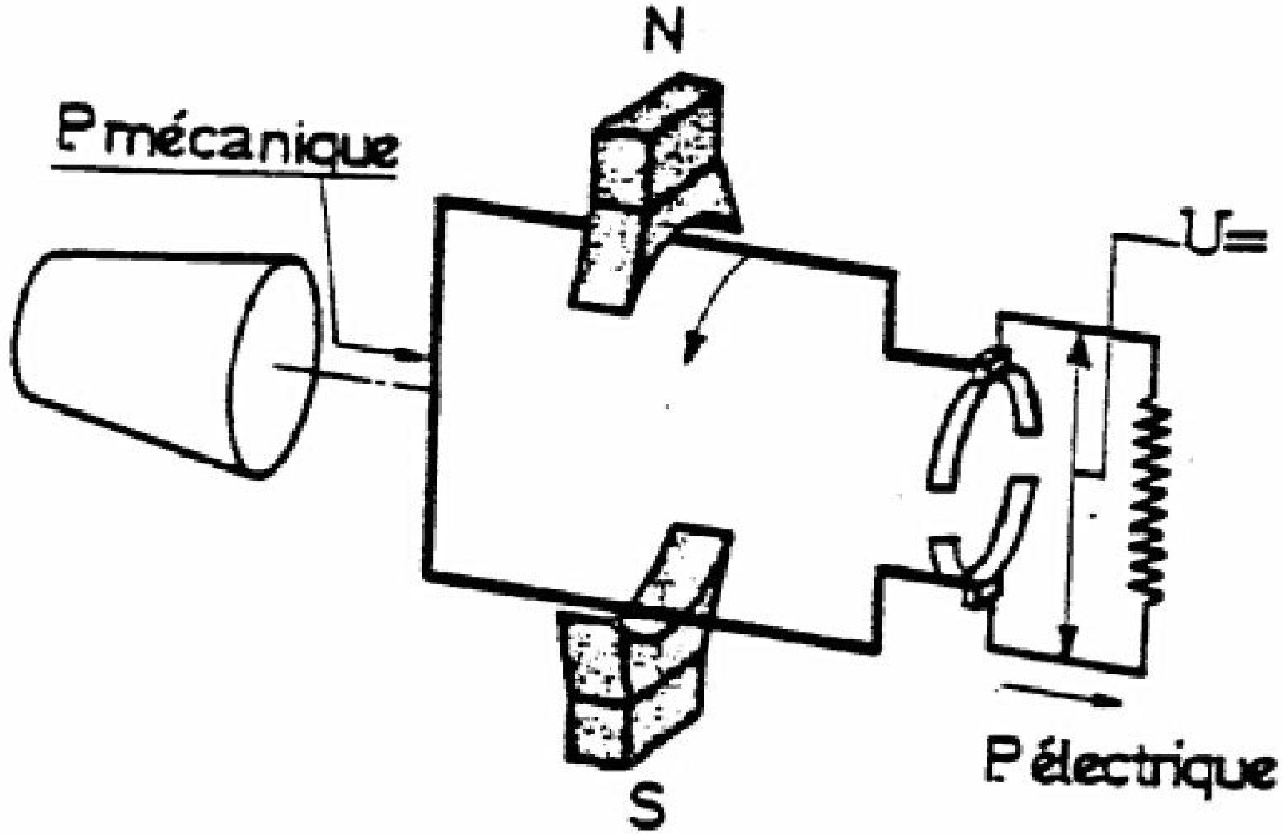
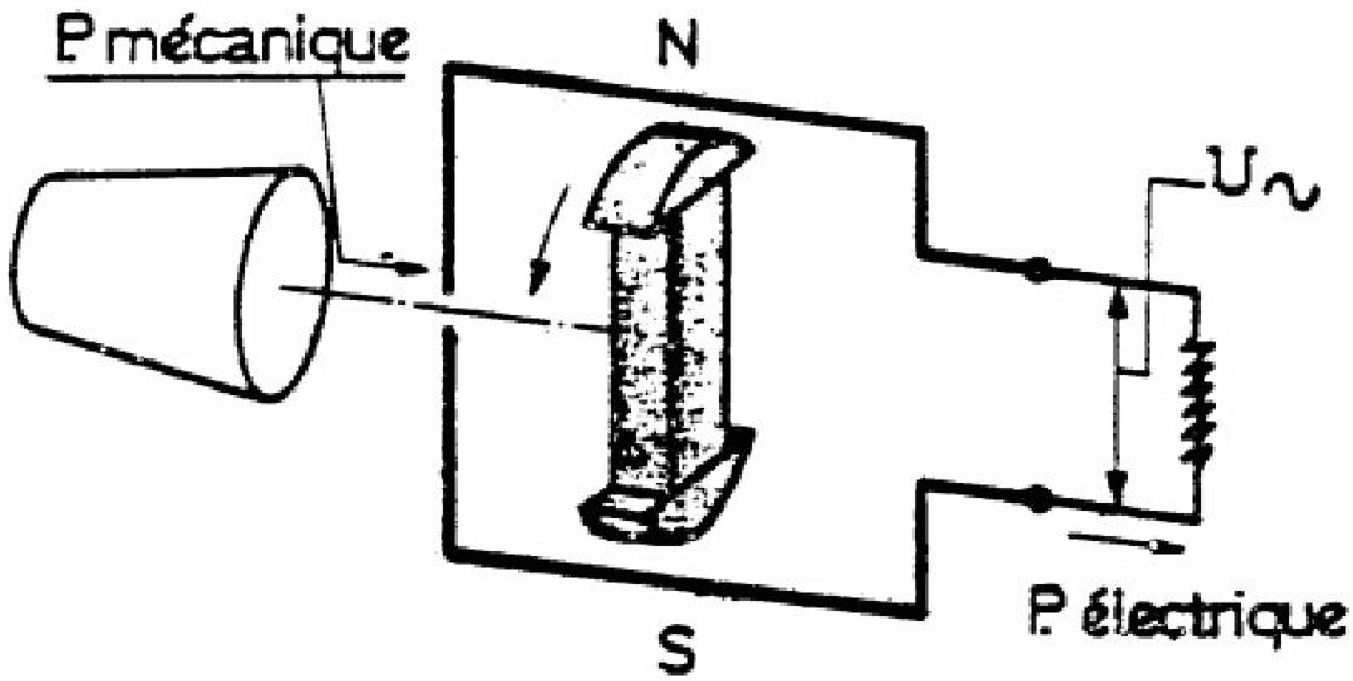
Les machines électriques
Généralités

1. Introduction
2. Méthodes d'études des machines électriques
3. Principes de fonctionnement
4. Composants des machines électriques
5. Grandeurs caractéristiques des machines

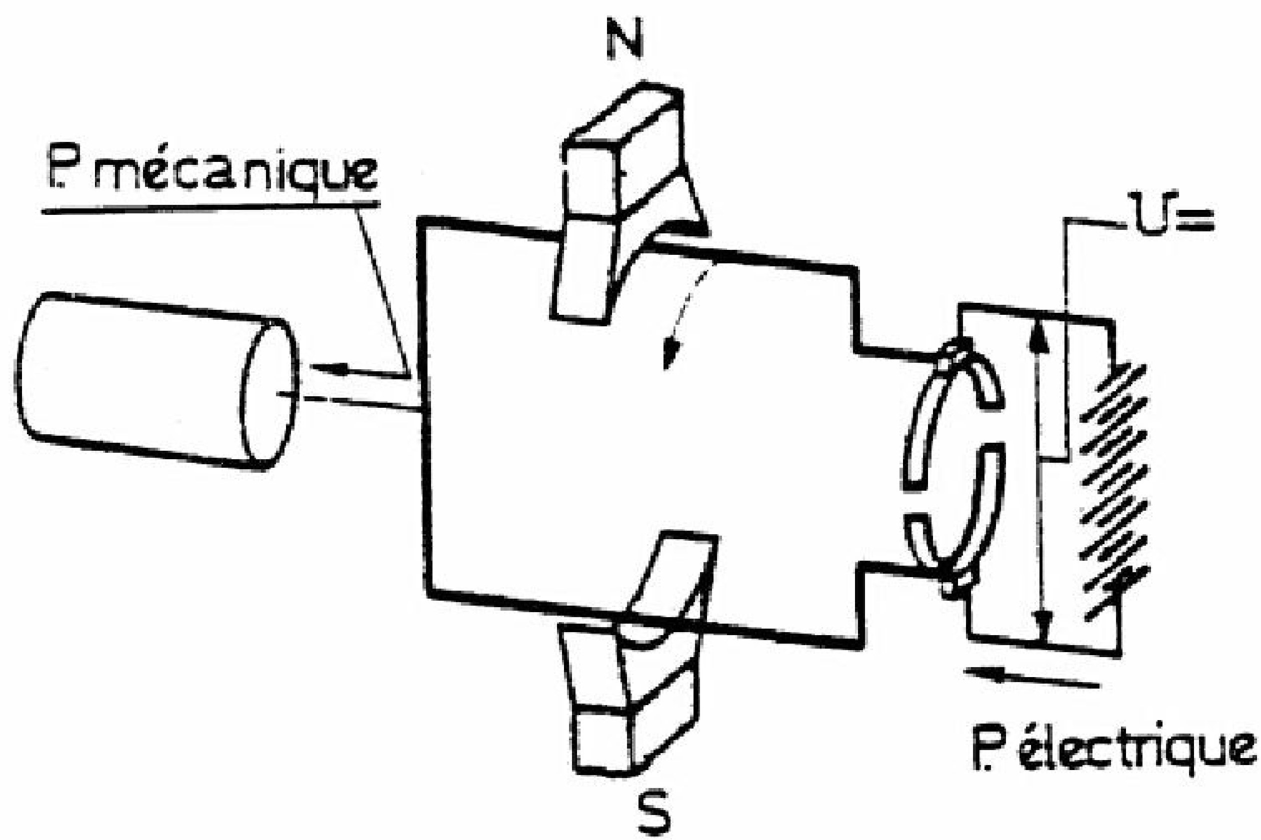
DYNAMO



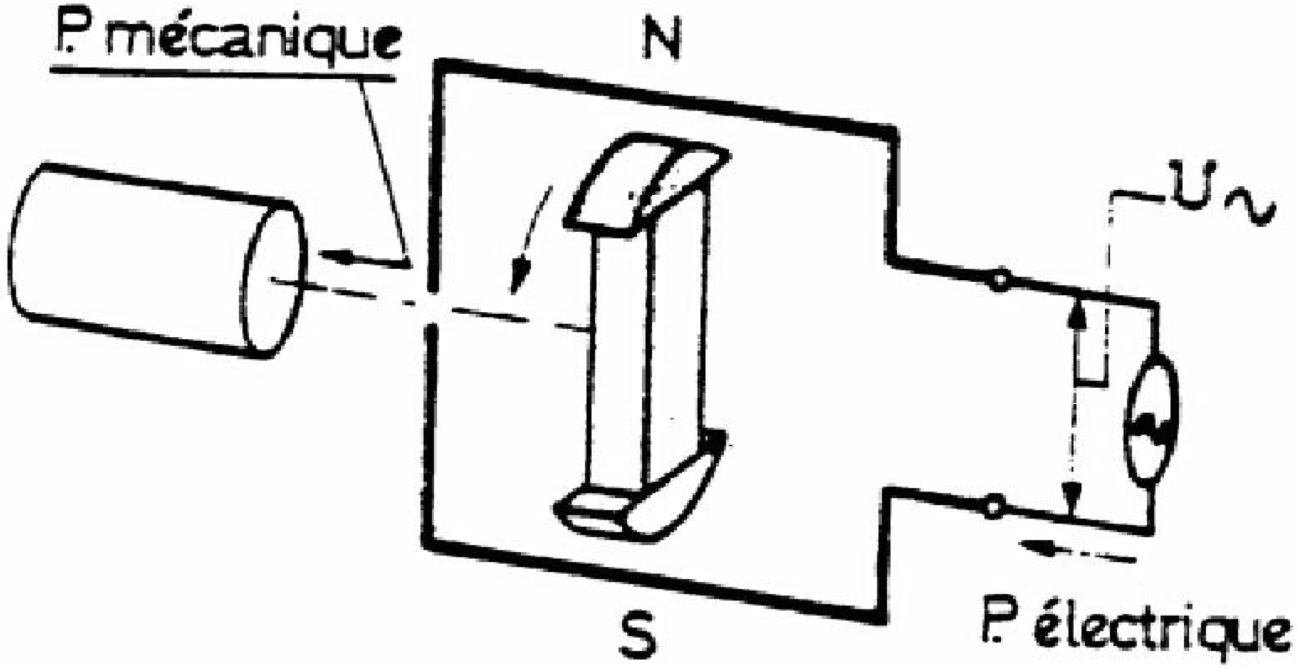
ALTERNATEUR



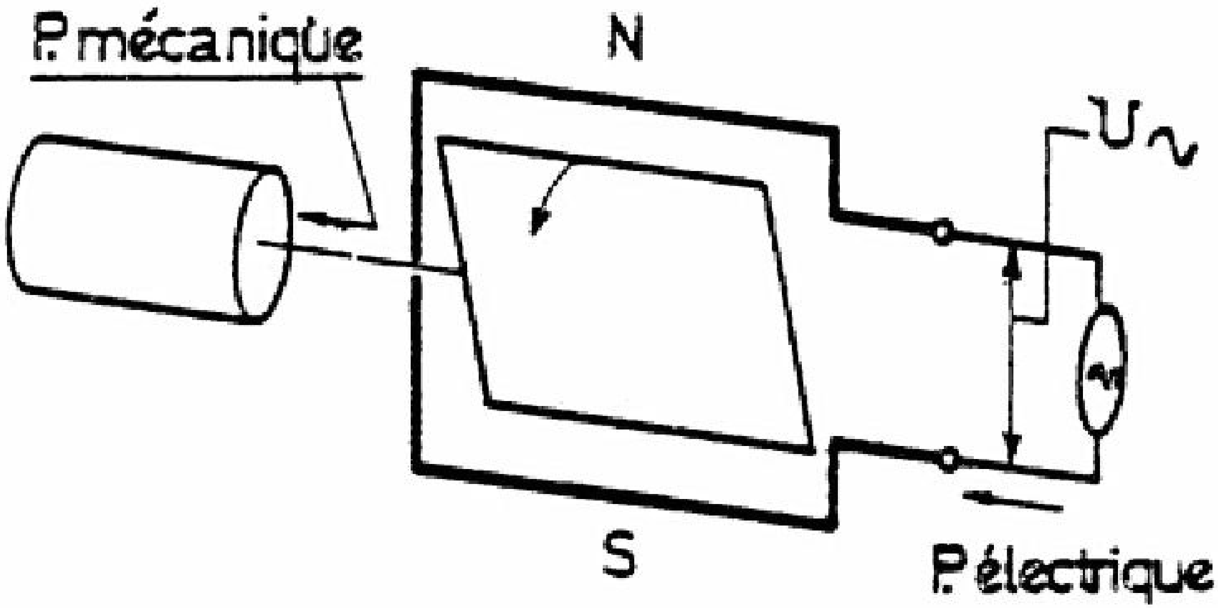
MOTEUR A COURANT CONTINU



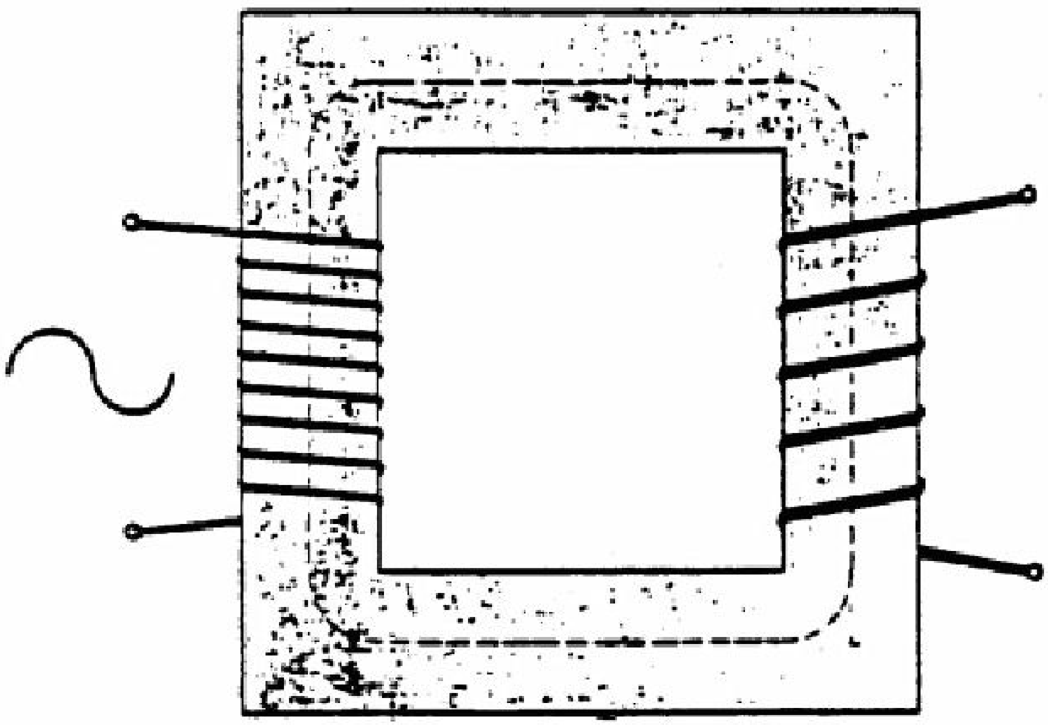
MOTEUR SYNCHRONE



MOTEUR ASYNCHRONE



Transformateur



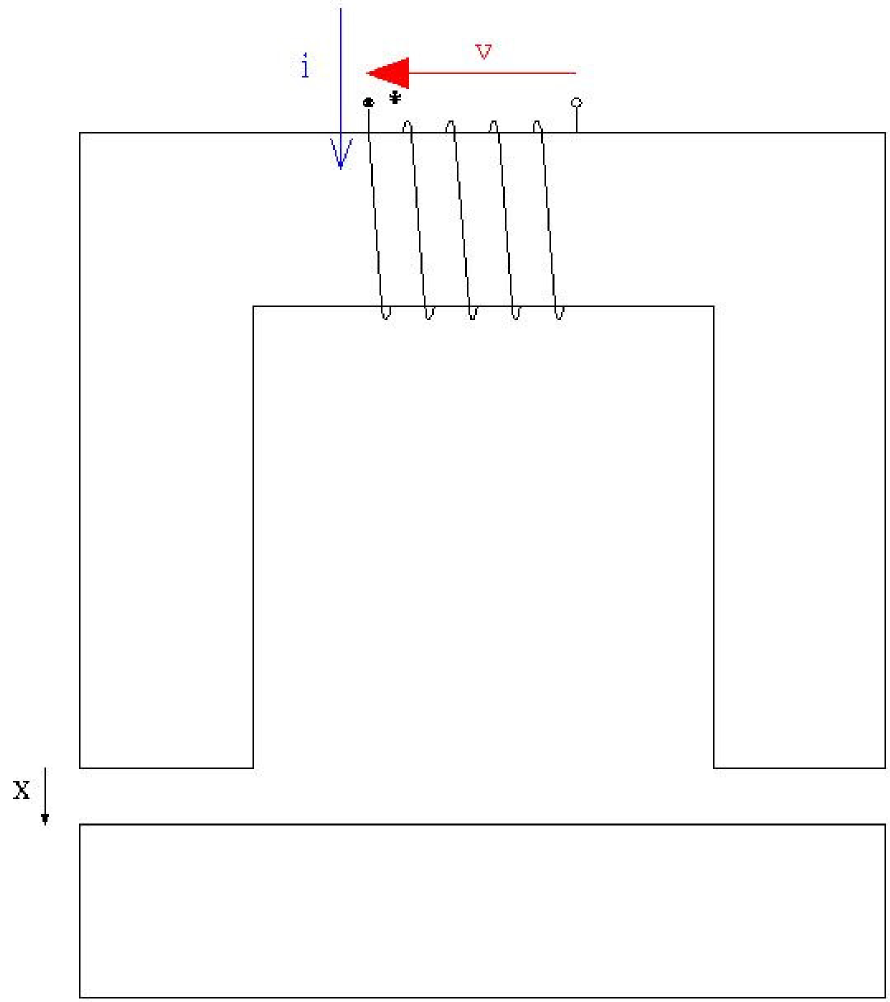
Comparaison

A) Méthode des circuits
de Kirchhoff
Optique de l'automaticien

B) Méthode des champs
de Maxwell
Optique du constructeur

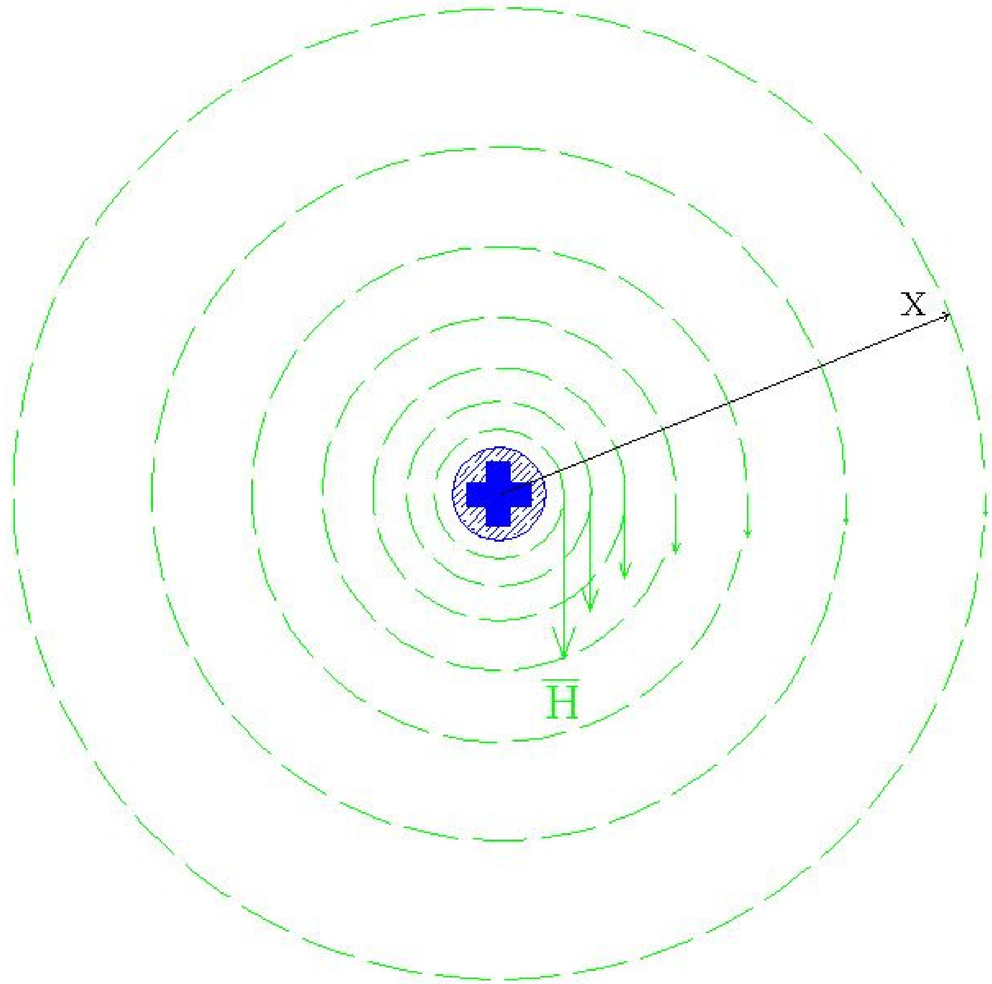
Electro-aimant

$$f_{em} = \frac{1}{2}\, i^2 \frac{dL(x)}{dx}$$



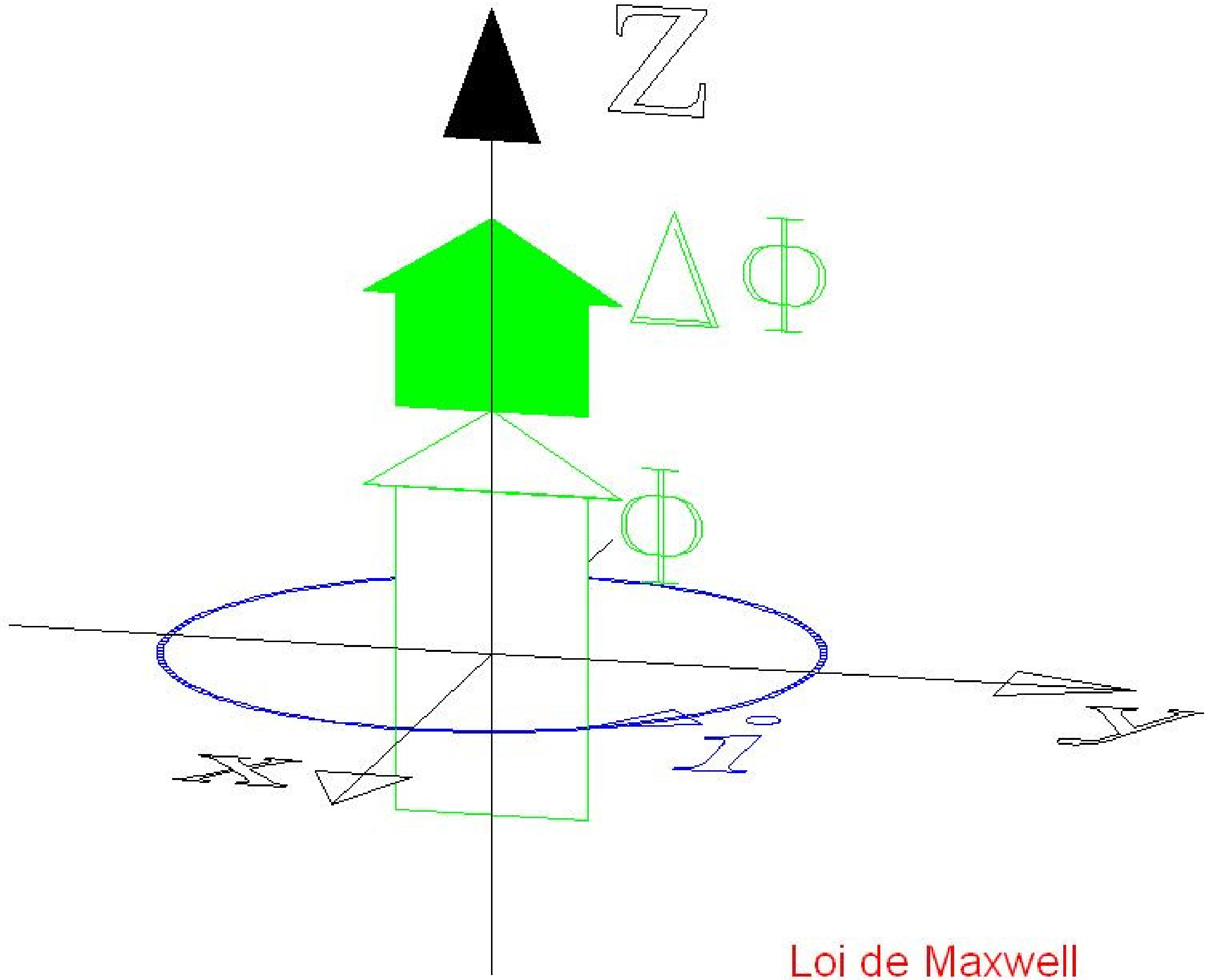
2.2.2. Choix du phénomène physique exploité

Conducteur infini



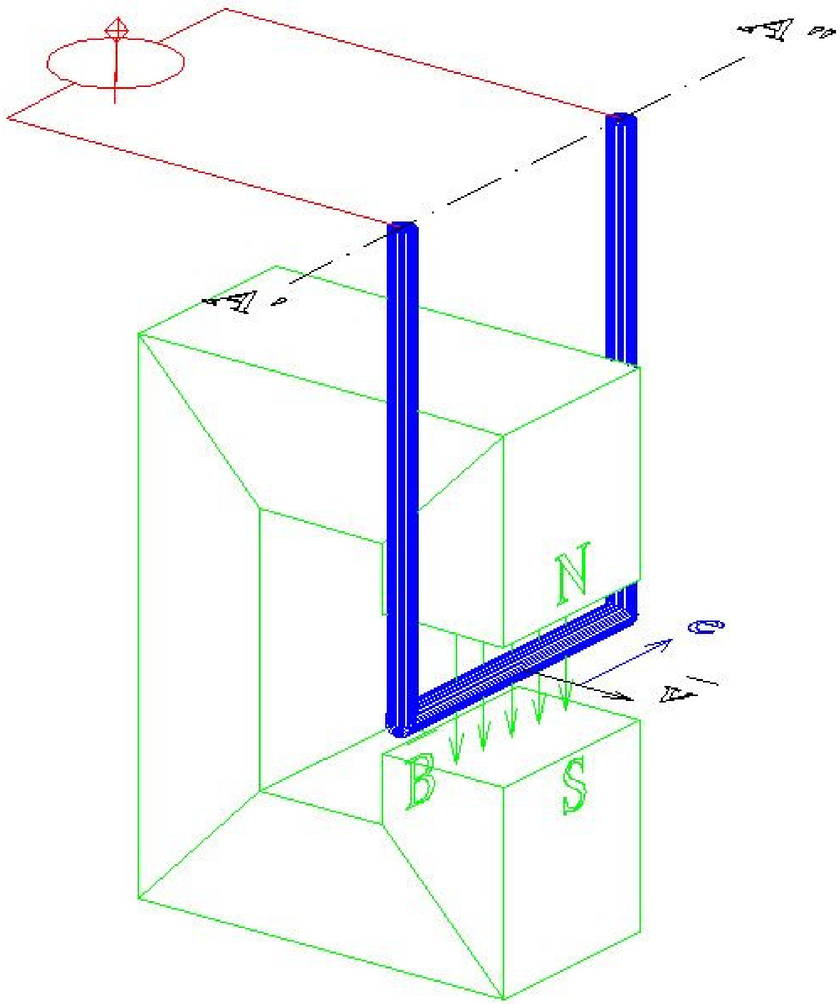
Loi de la f.m.m.

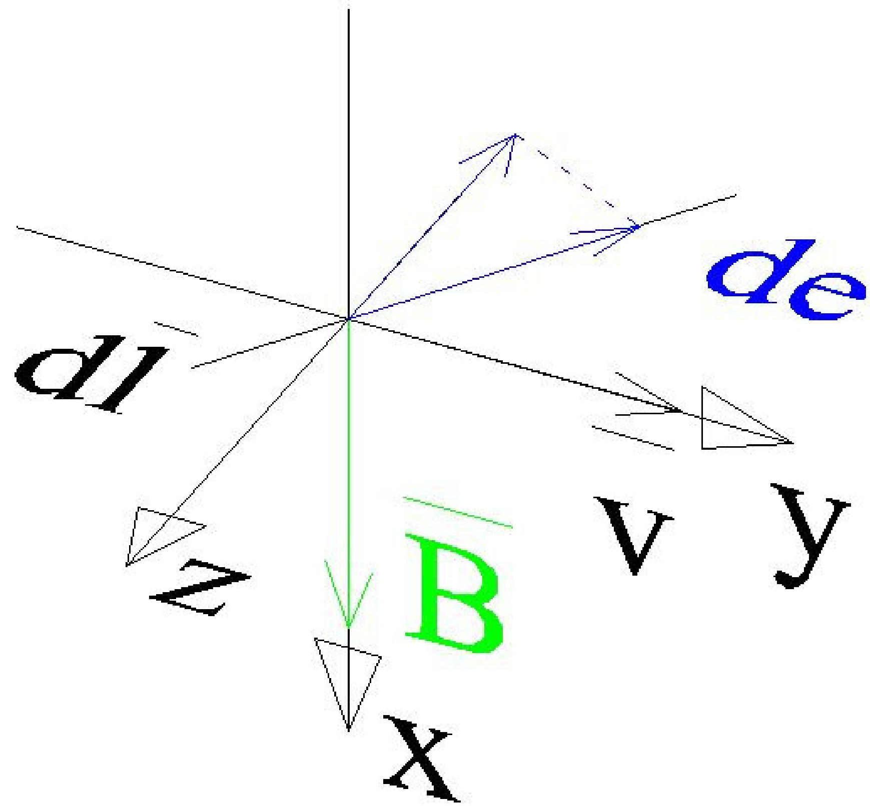
F.e.m. induite



Loi de Maxwell

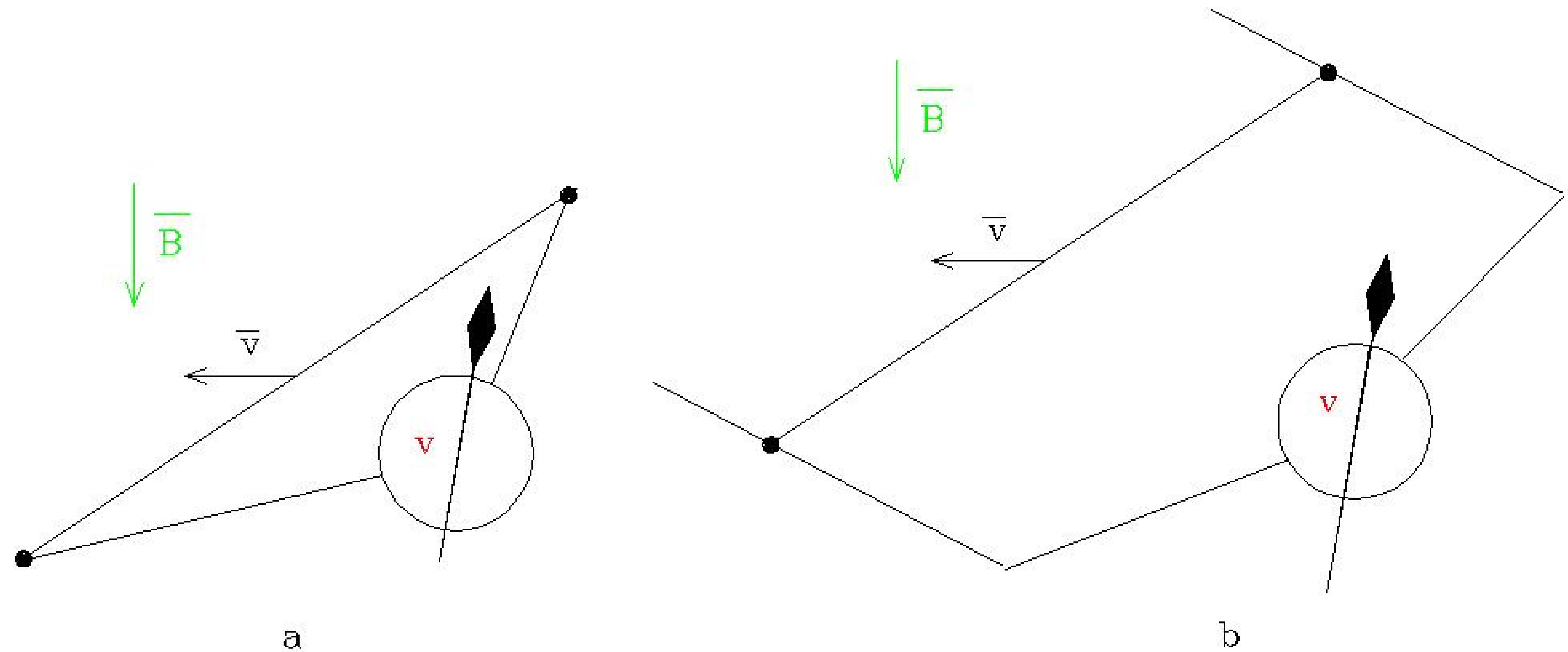
F.e.m. engendrée





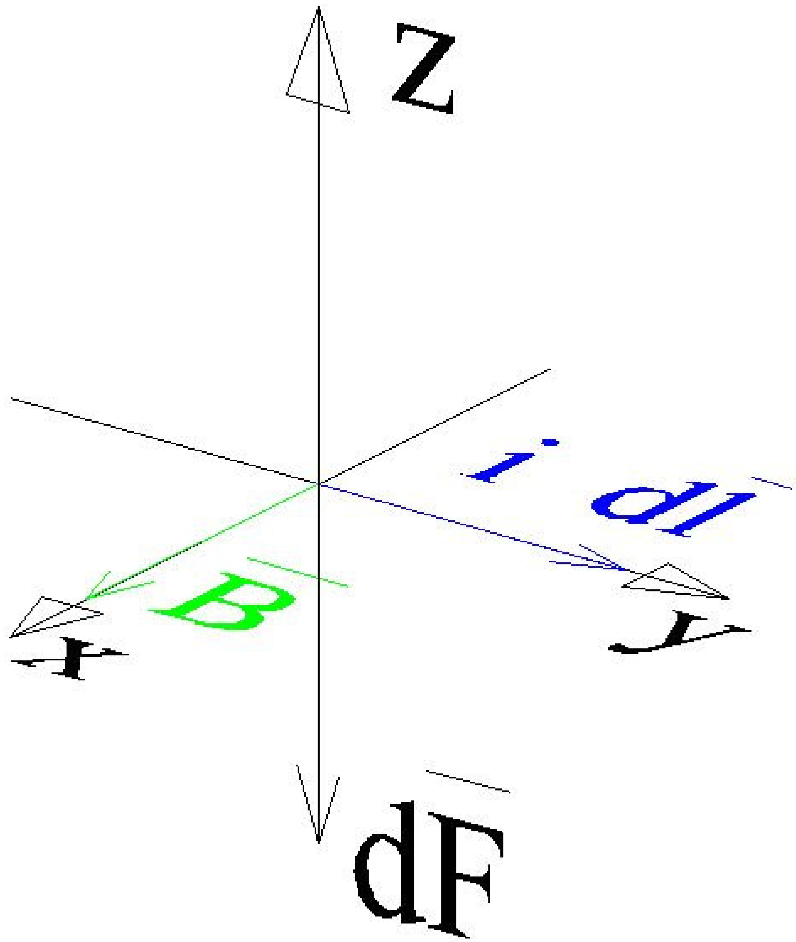
Loi de Maxwell

Laquelle des f.e.m. engendrées est nulle?



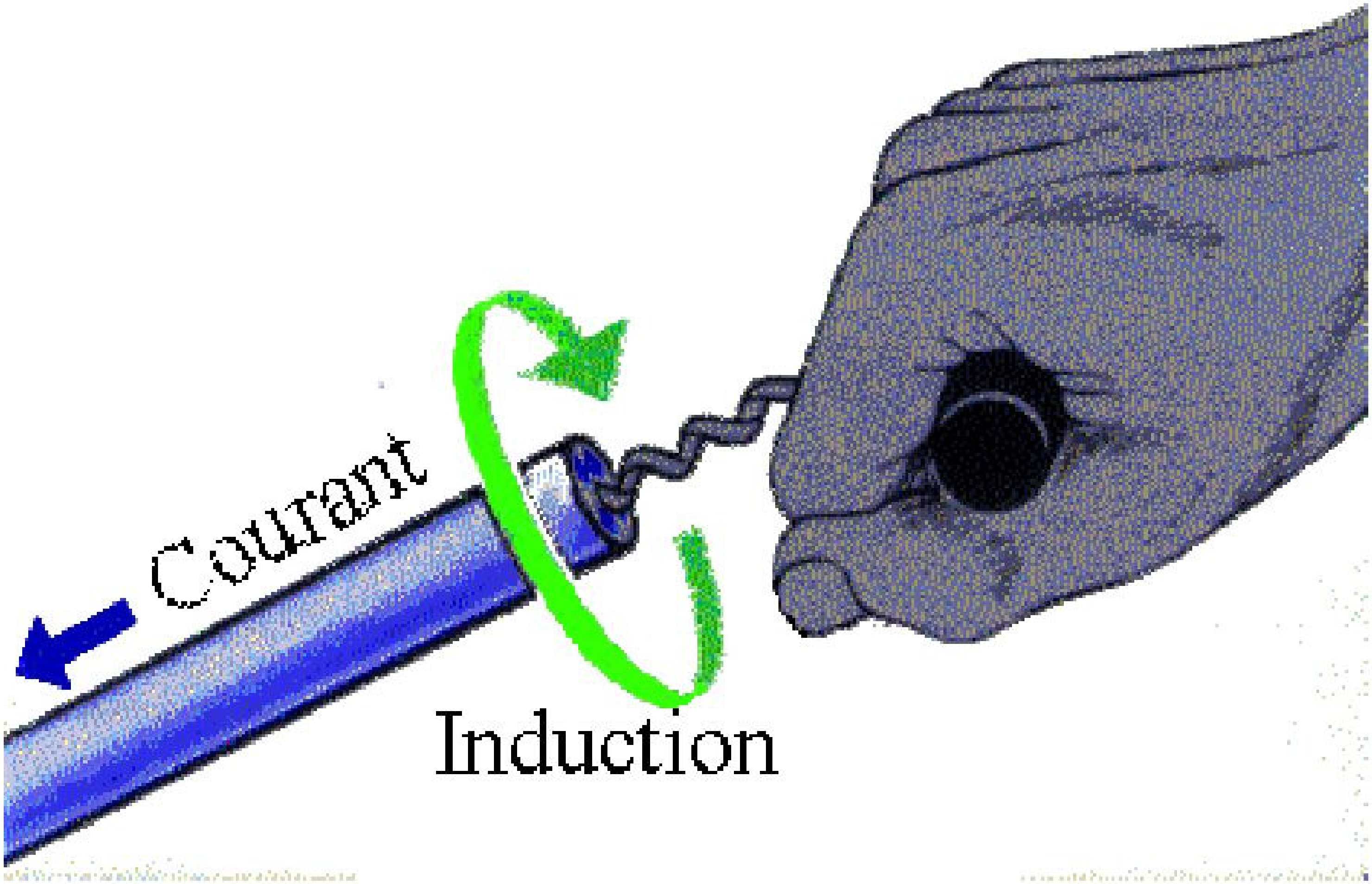
Loi de Maxwell

Loi de Laplace



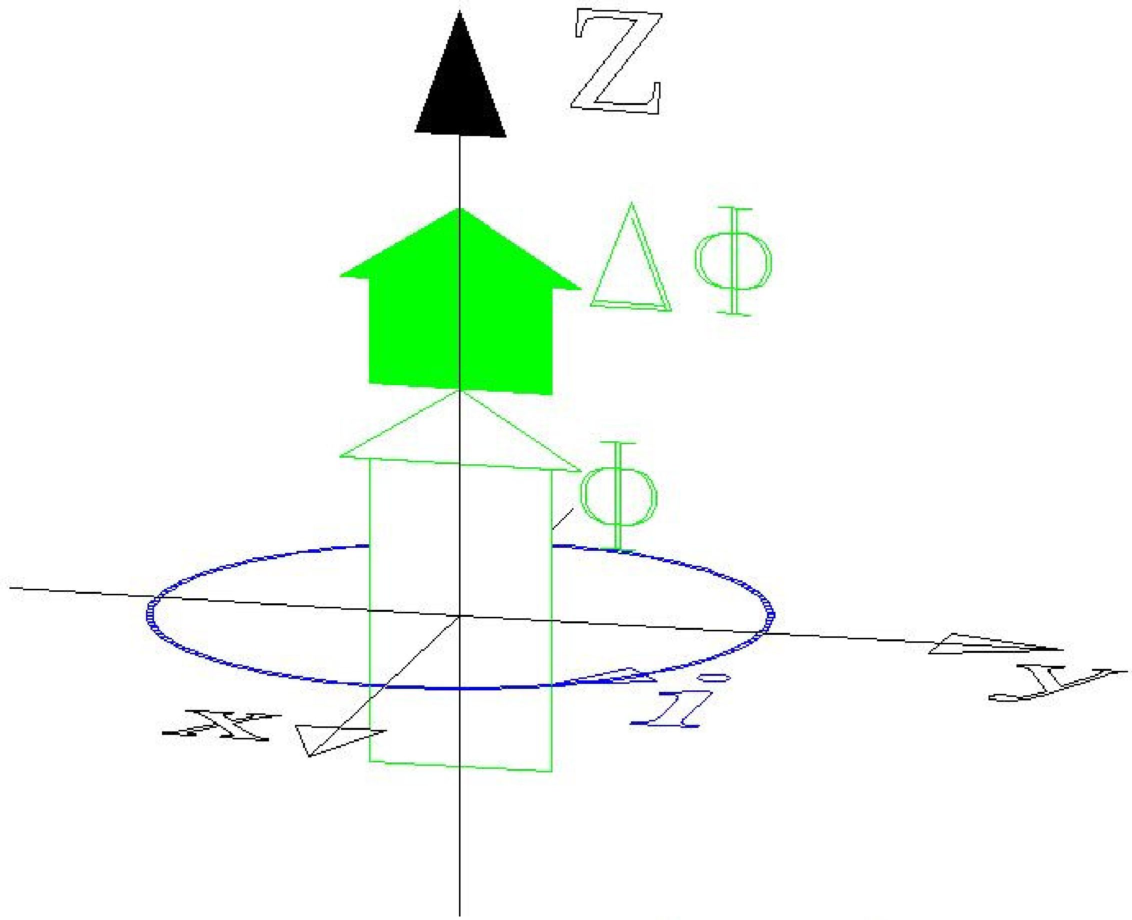
Loi de Laplace

Règle du tire-bouchon



Règles mnémotechniques

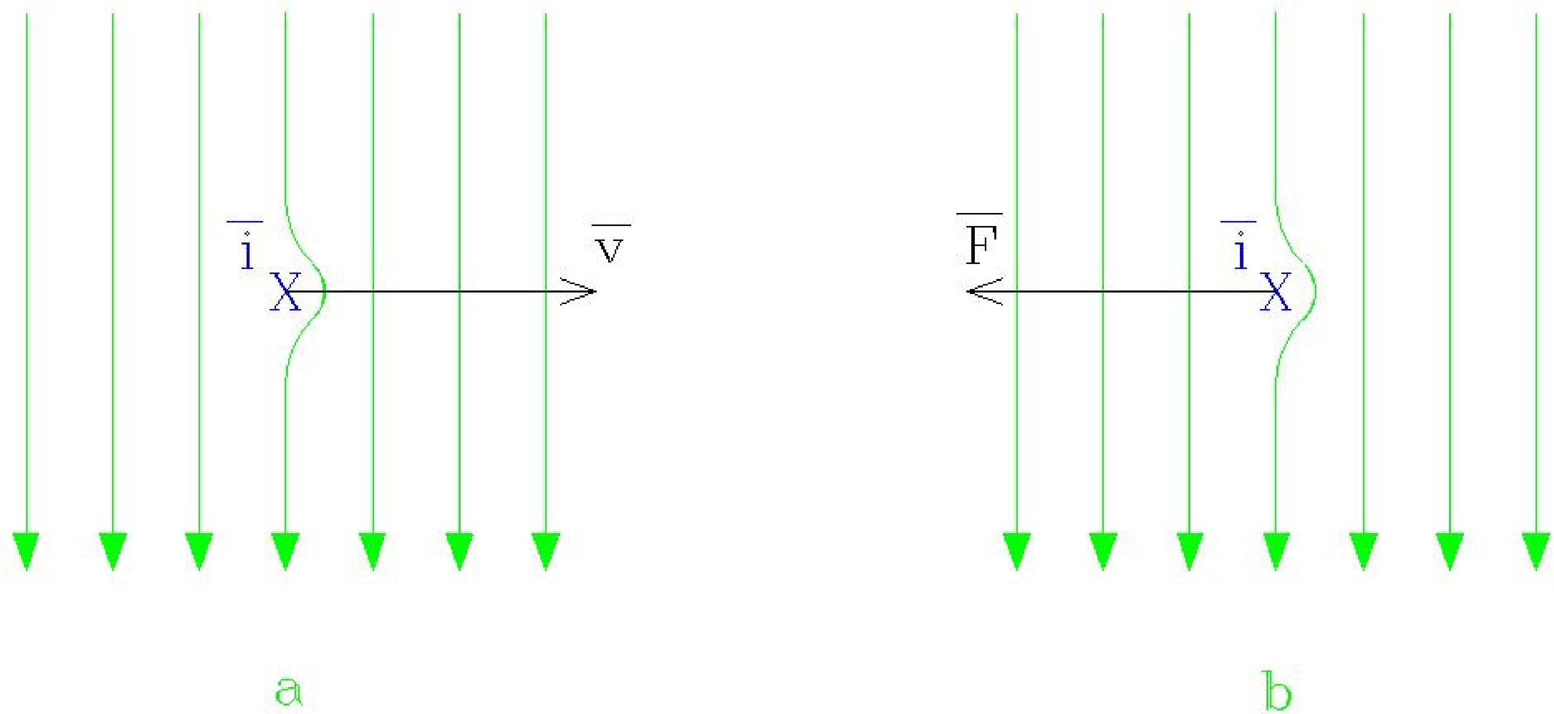
Loi de Lenz



Règles mnémotechniques

Règles de Cruciani

Règles de Cruciani



Règles mnémotechniques

Alternateur à axe vertical

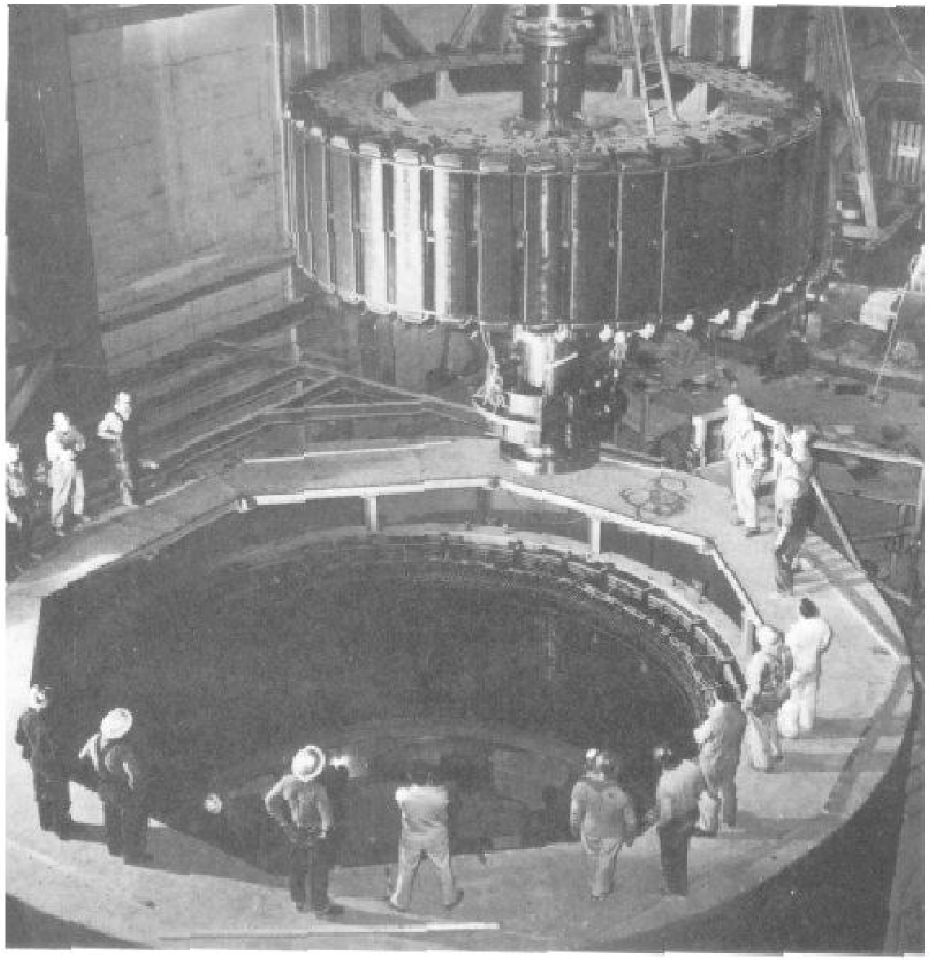
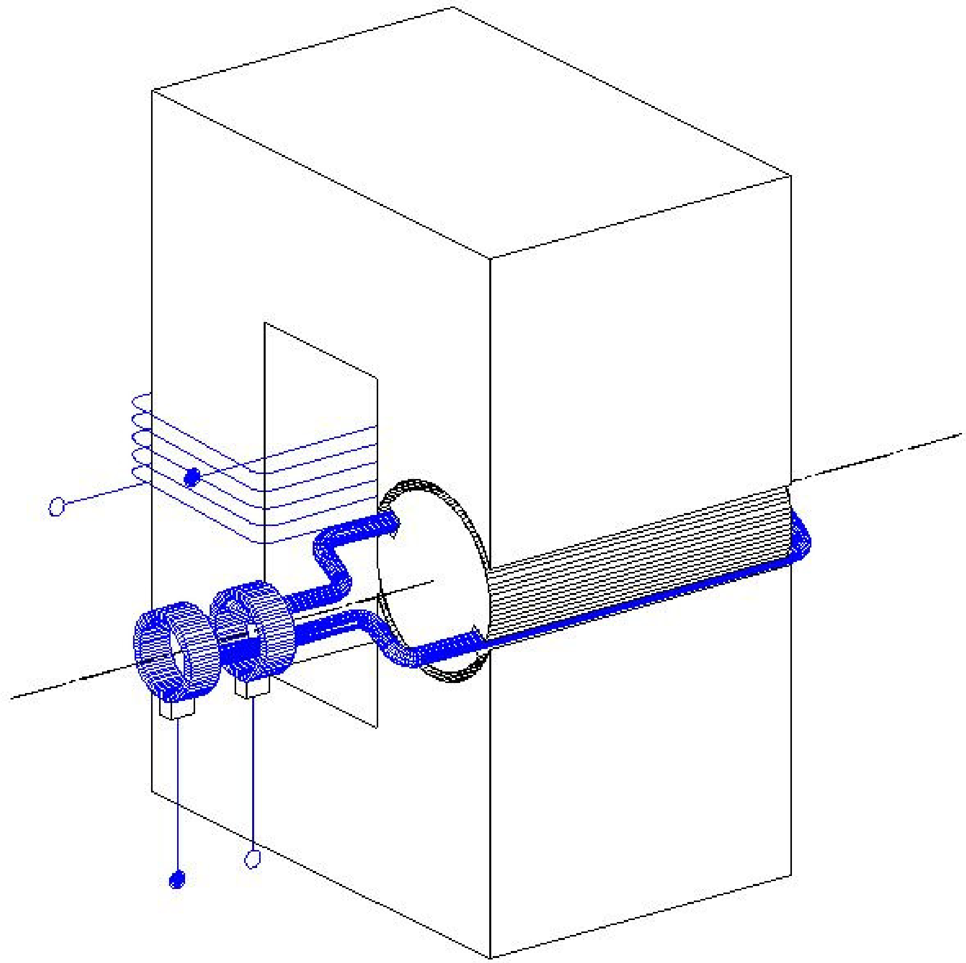


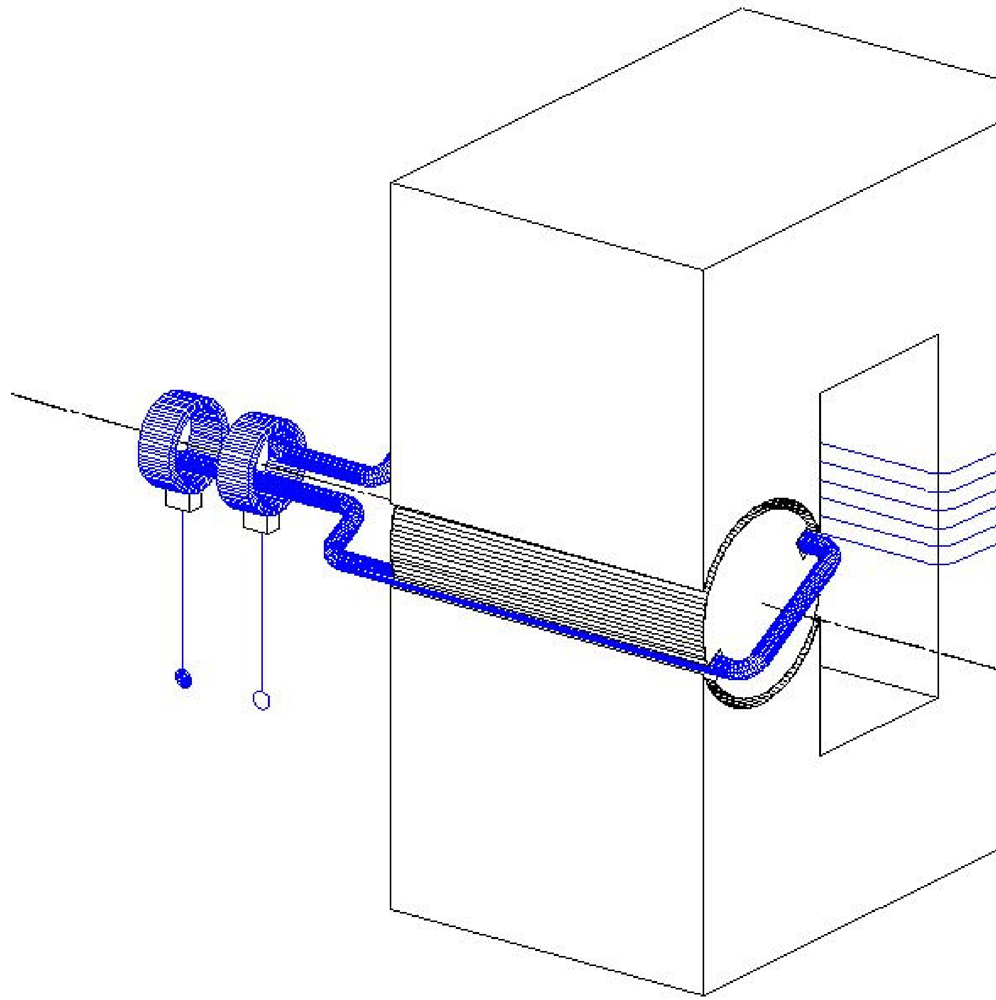
Fig. 5-3. Salient-pole rotor being lowered into the stator of a hydrogenerator. (Courtesy General Electric Company.)

Eléments constitutifs

Principes de fonctionnement



Principes de fonctionnement



Disques conducteurs et balais

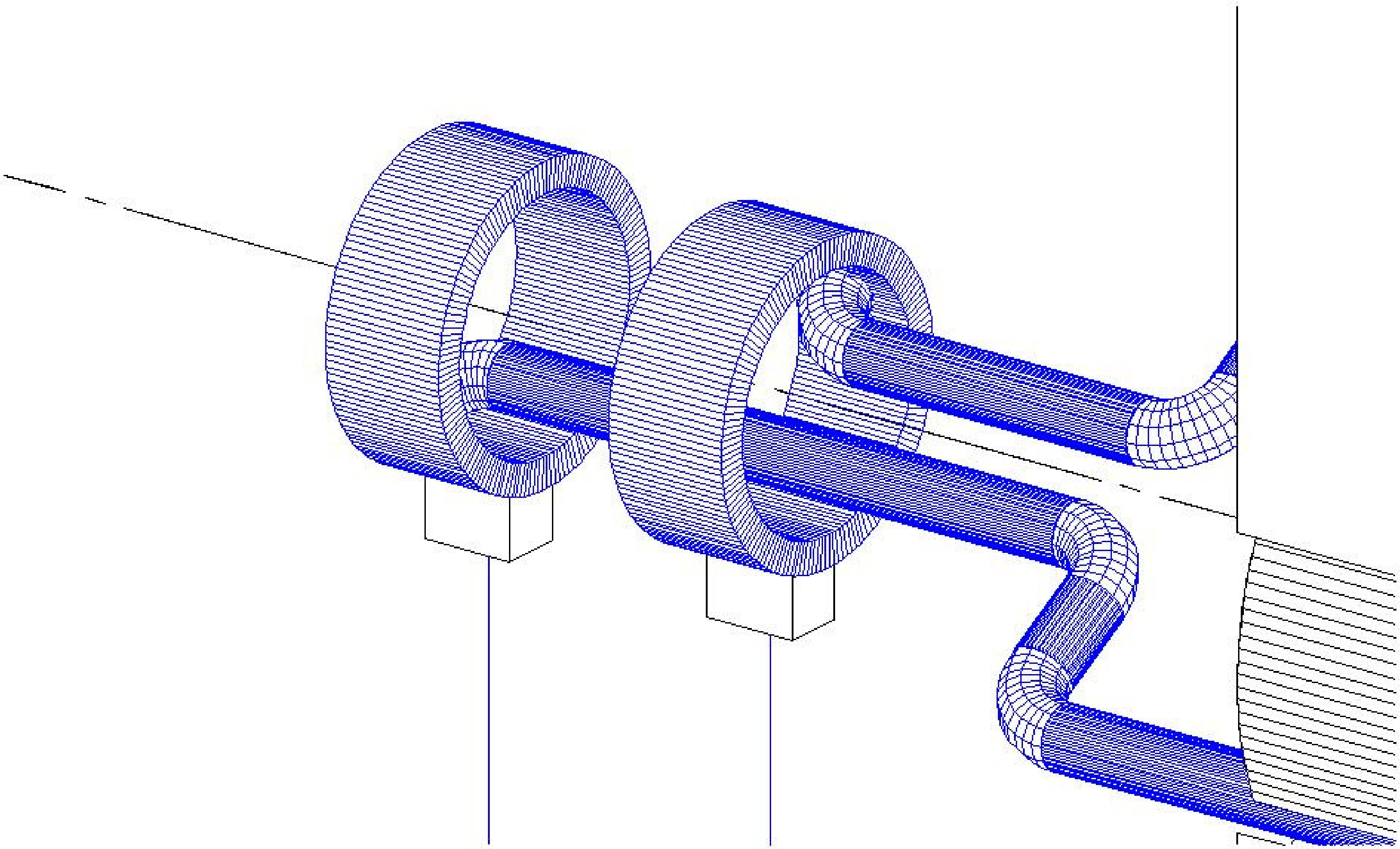
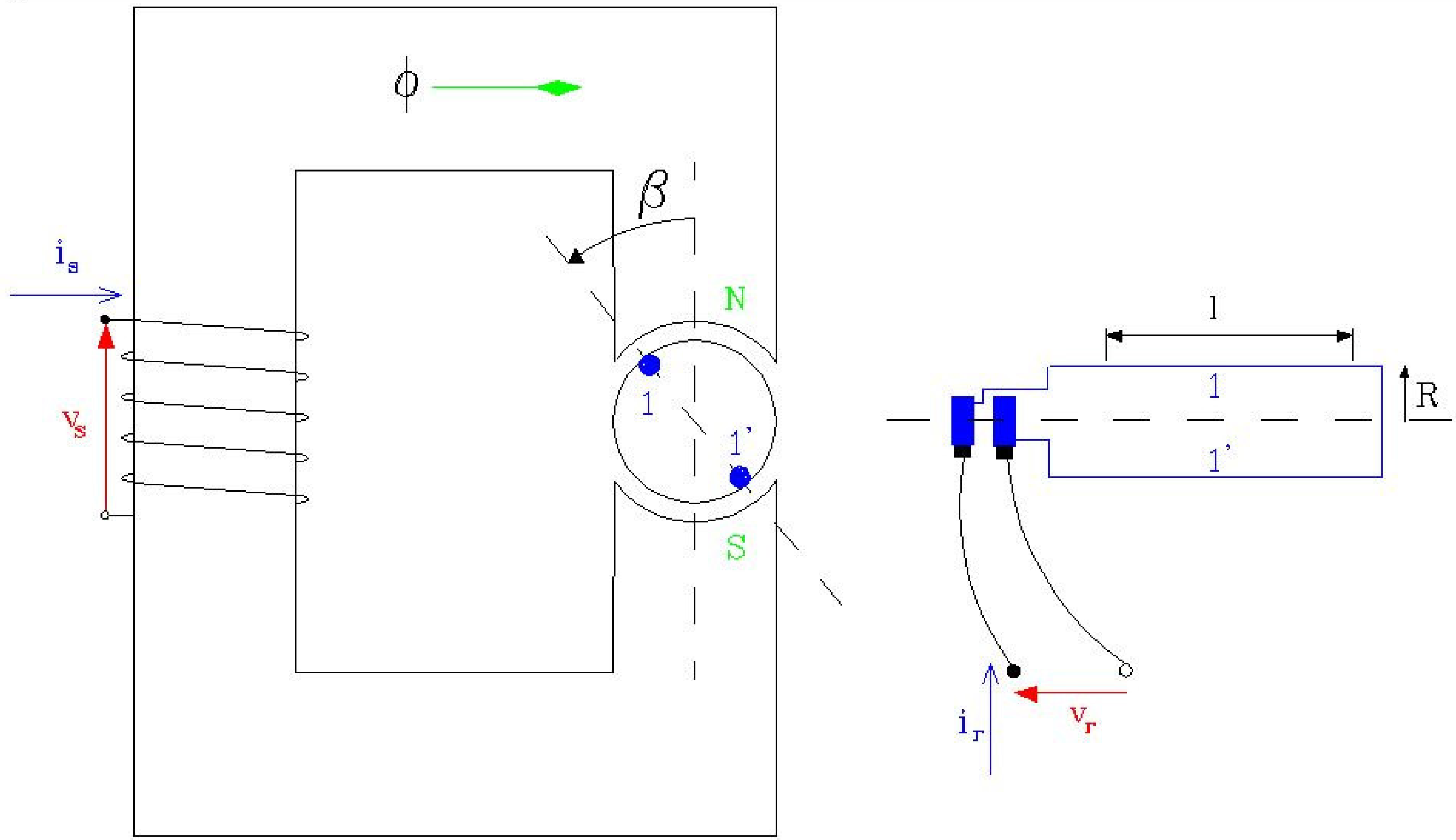
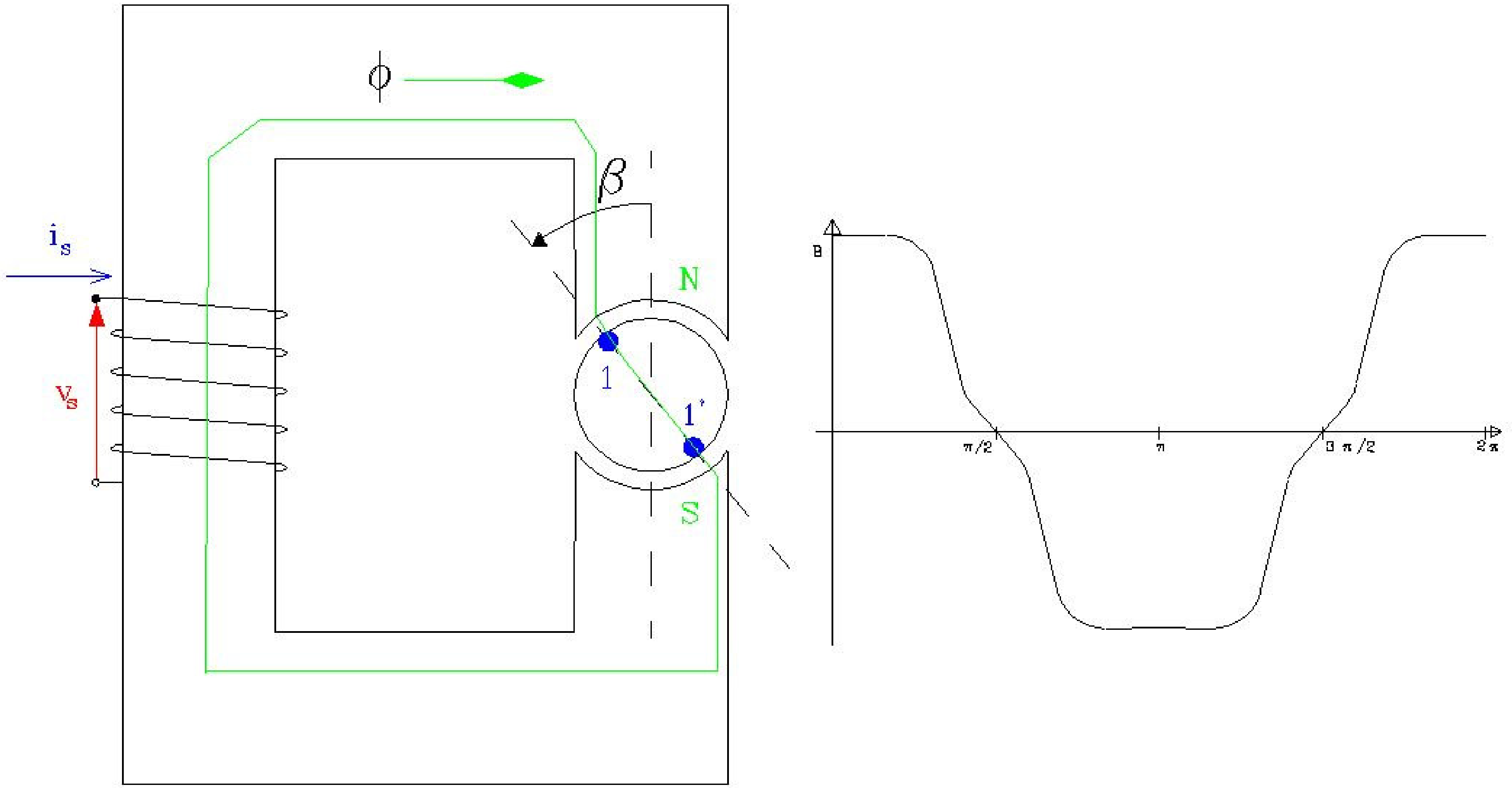


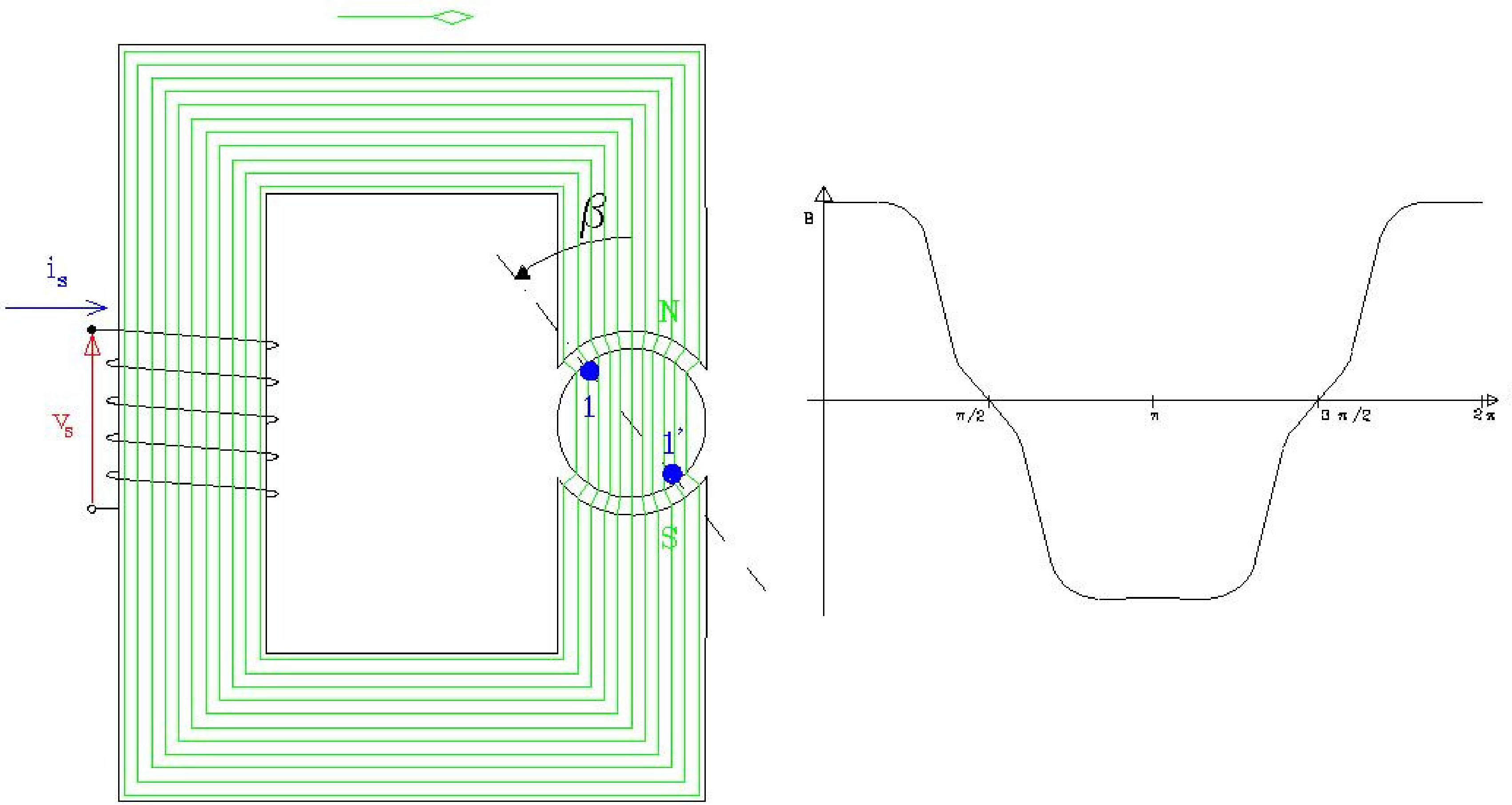
Schéma de principe



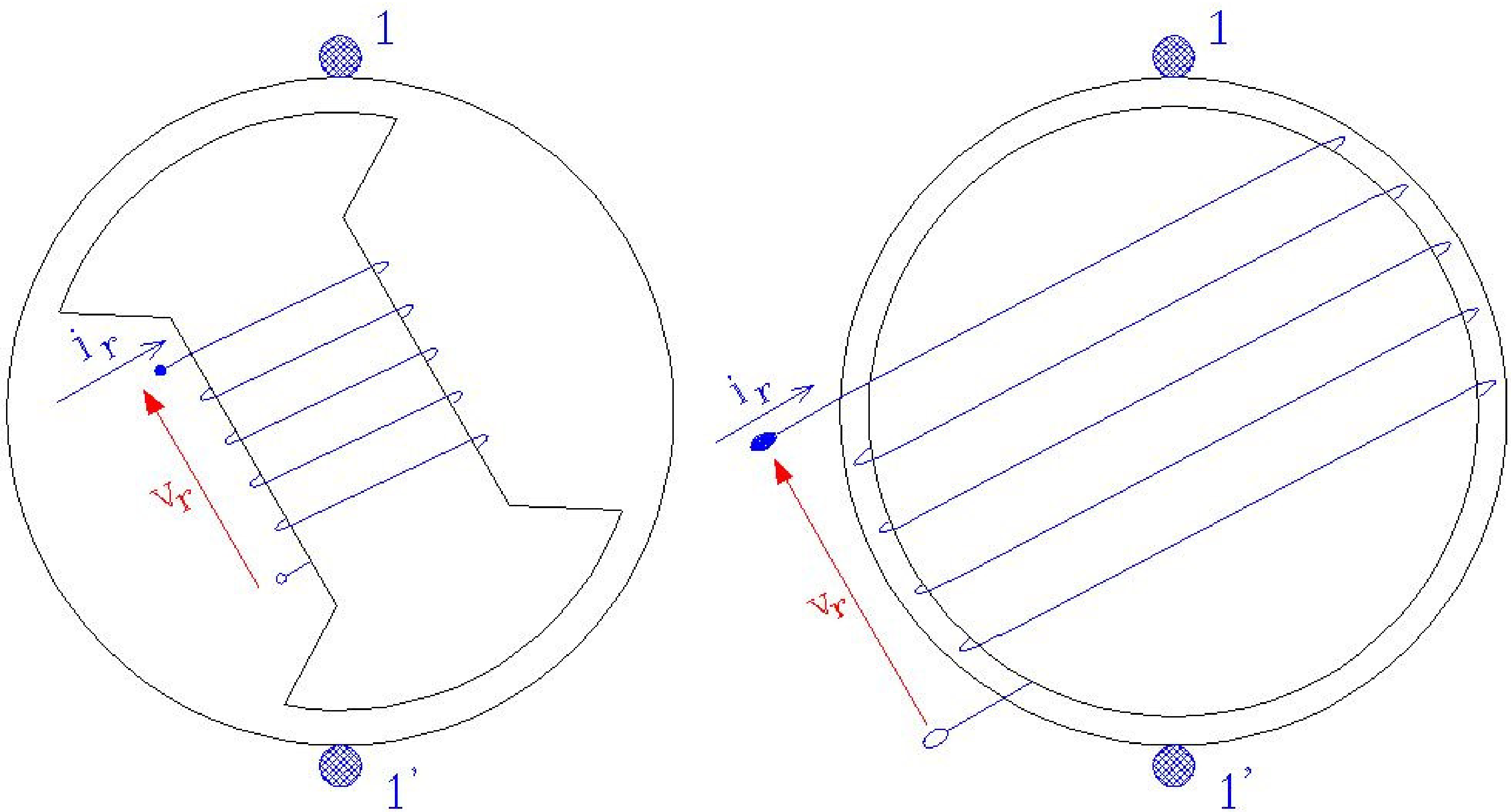
Méthode des champs



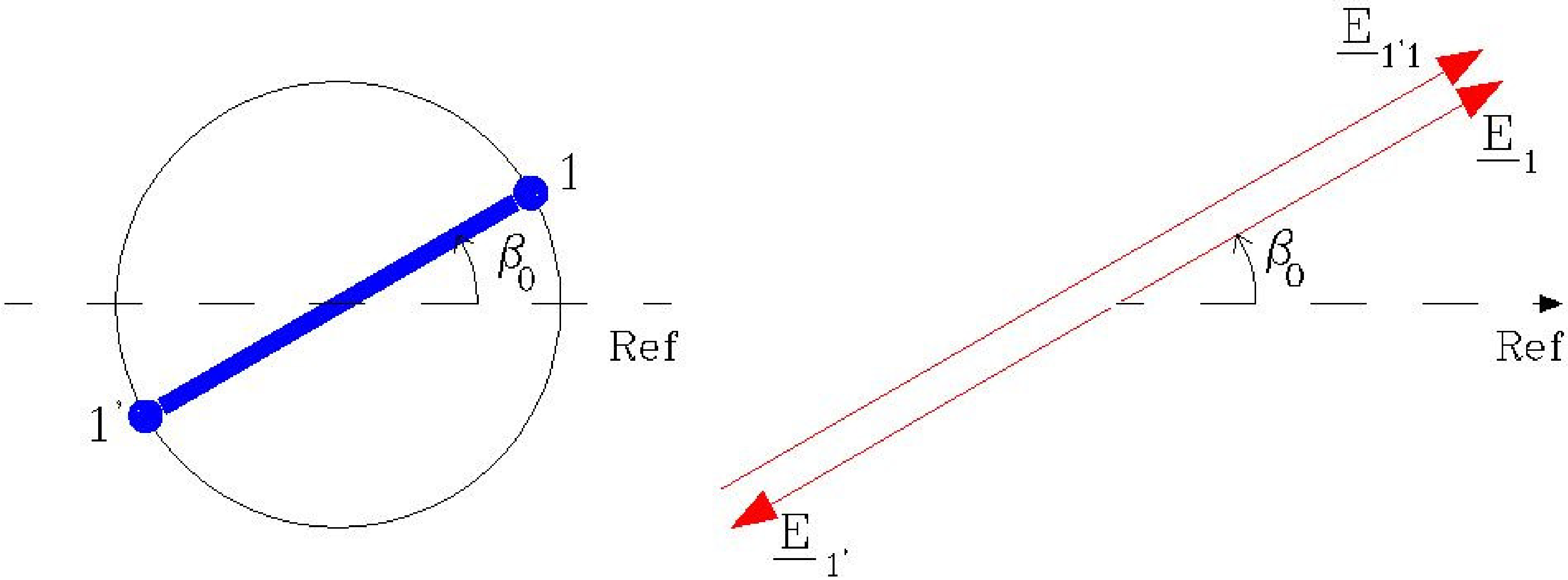
Méthode des champs



Induit au stator

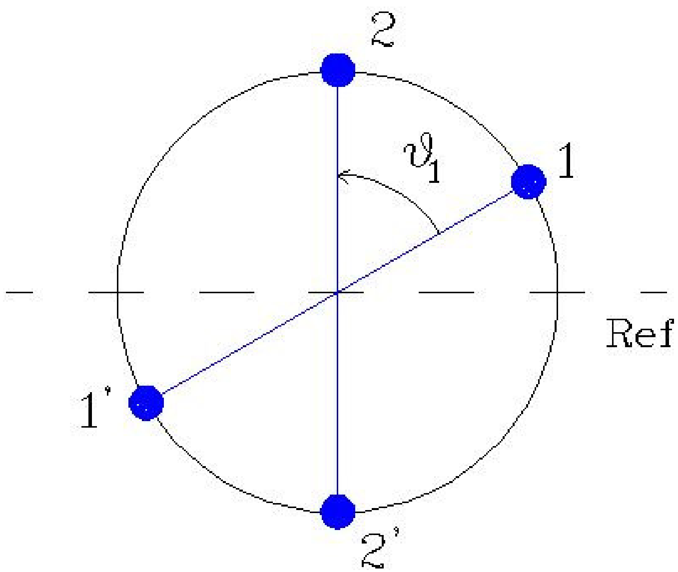


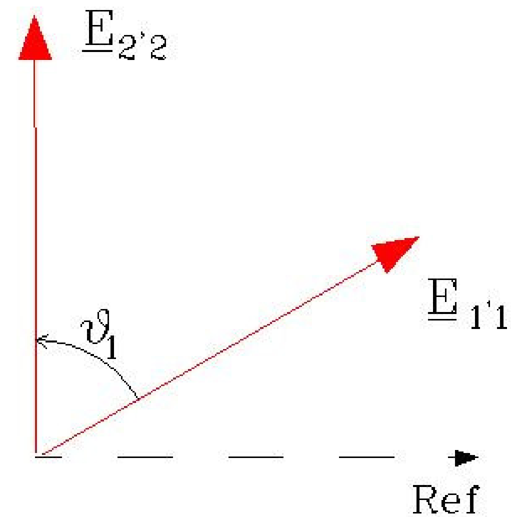
Induction sinusoïdale - Spire diamétrale



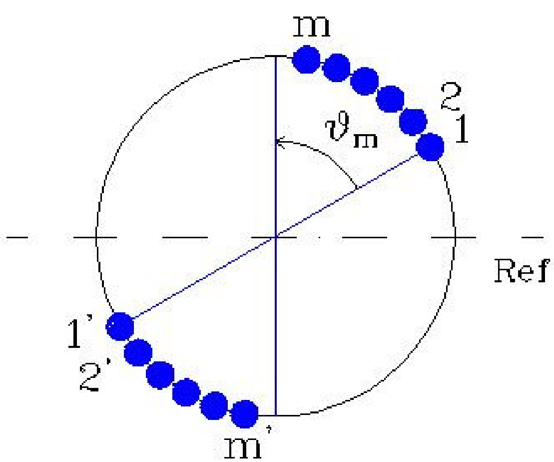
1.4.3. Machines hétéropolaires

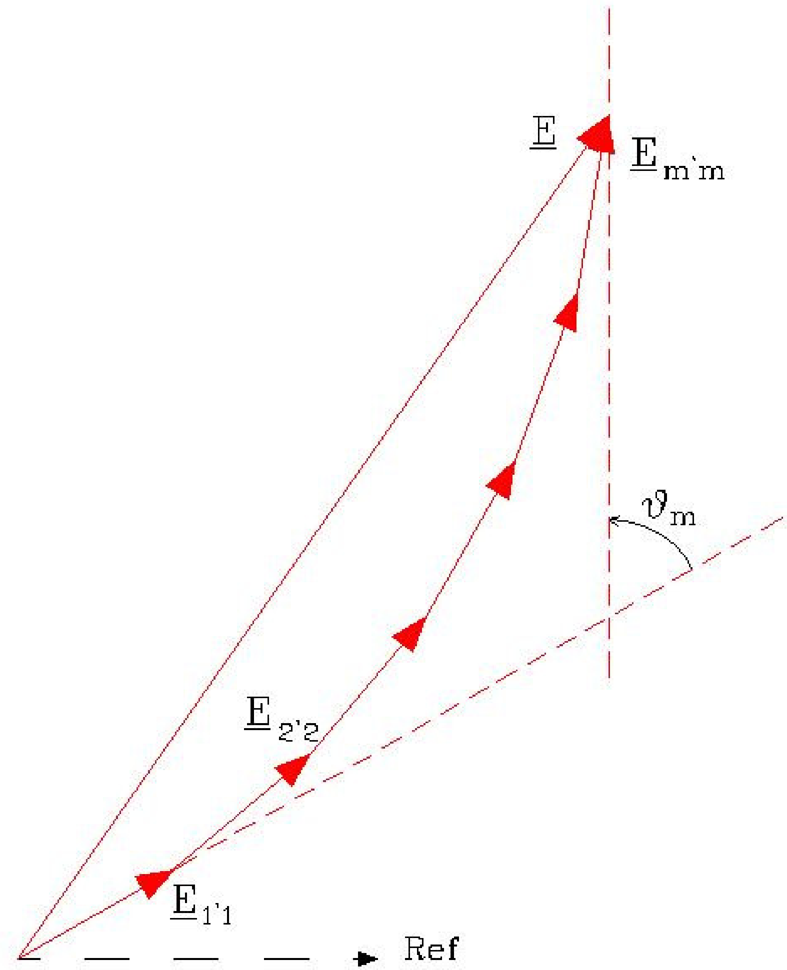
Induction sinusoïdale - Spires décalées



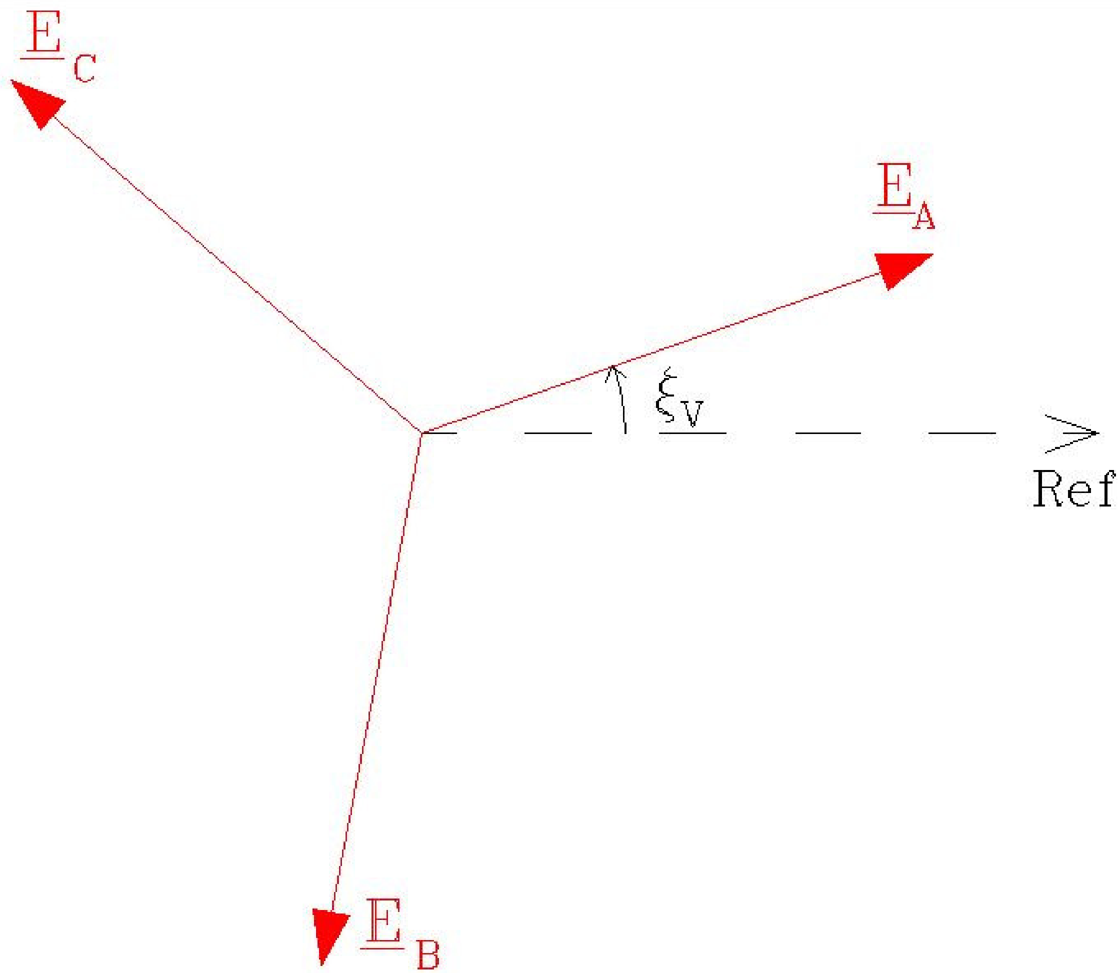


Induction sinusoïdale - Enroulement



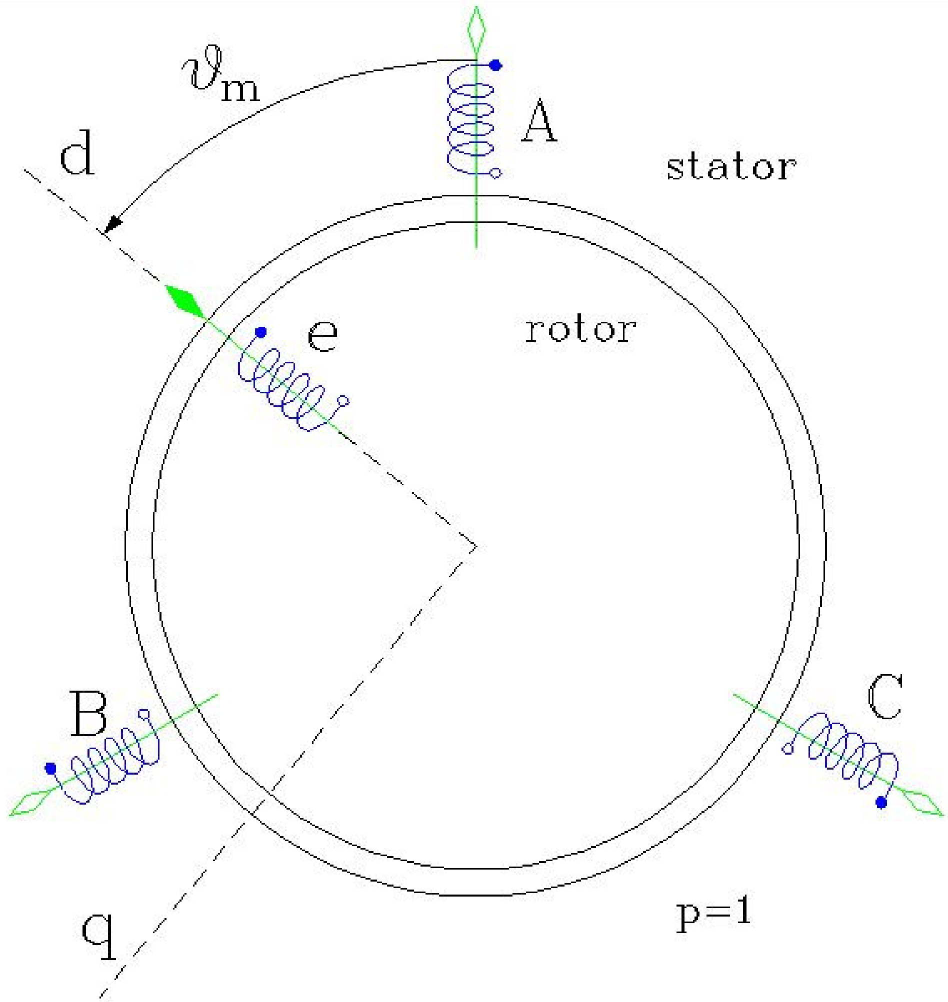


Le triphasé



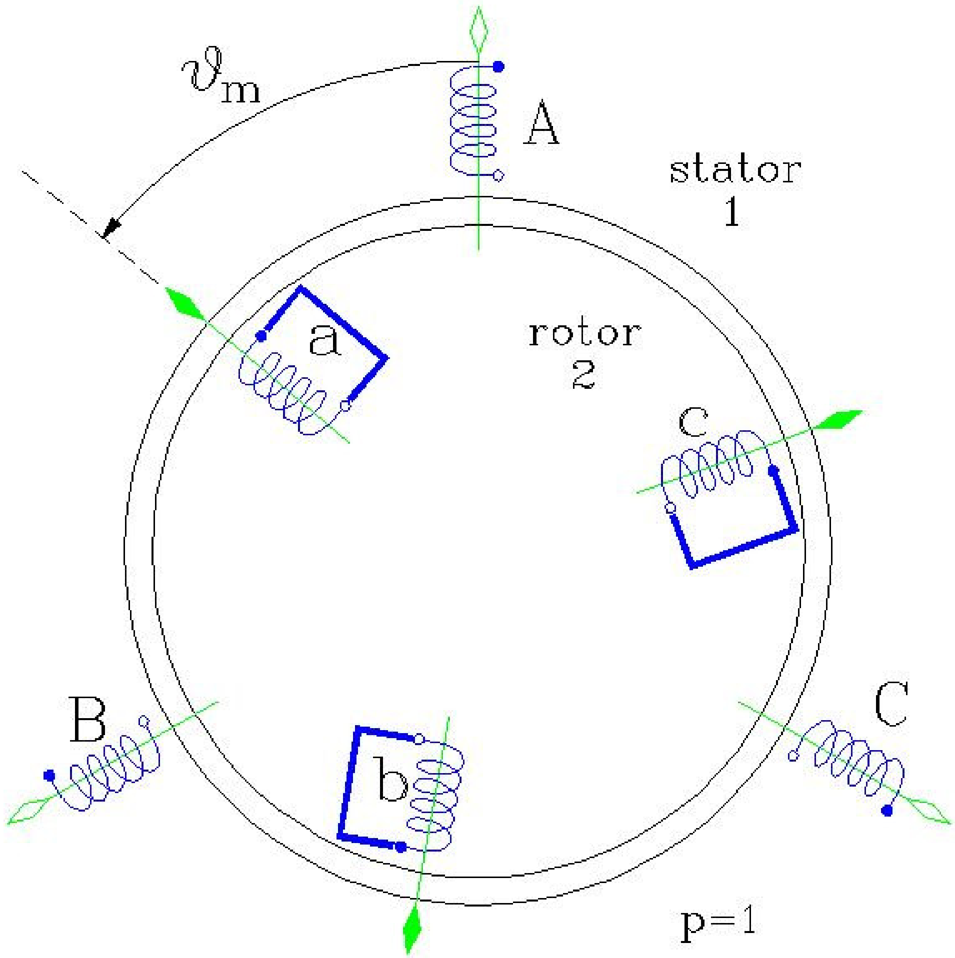
1.4.3. Machines hétéropolaires

Machine synchrone à rotor lisse



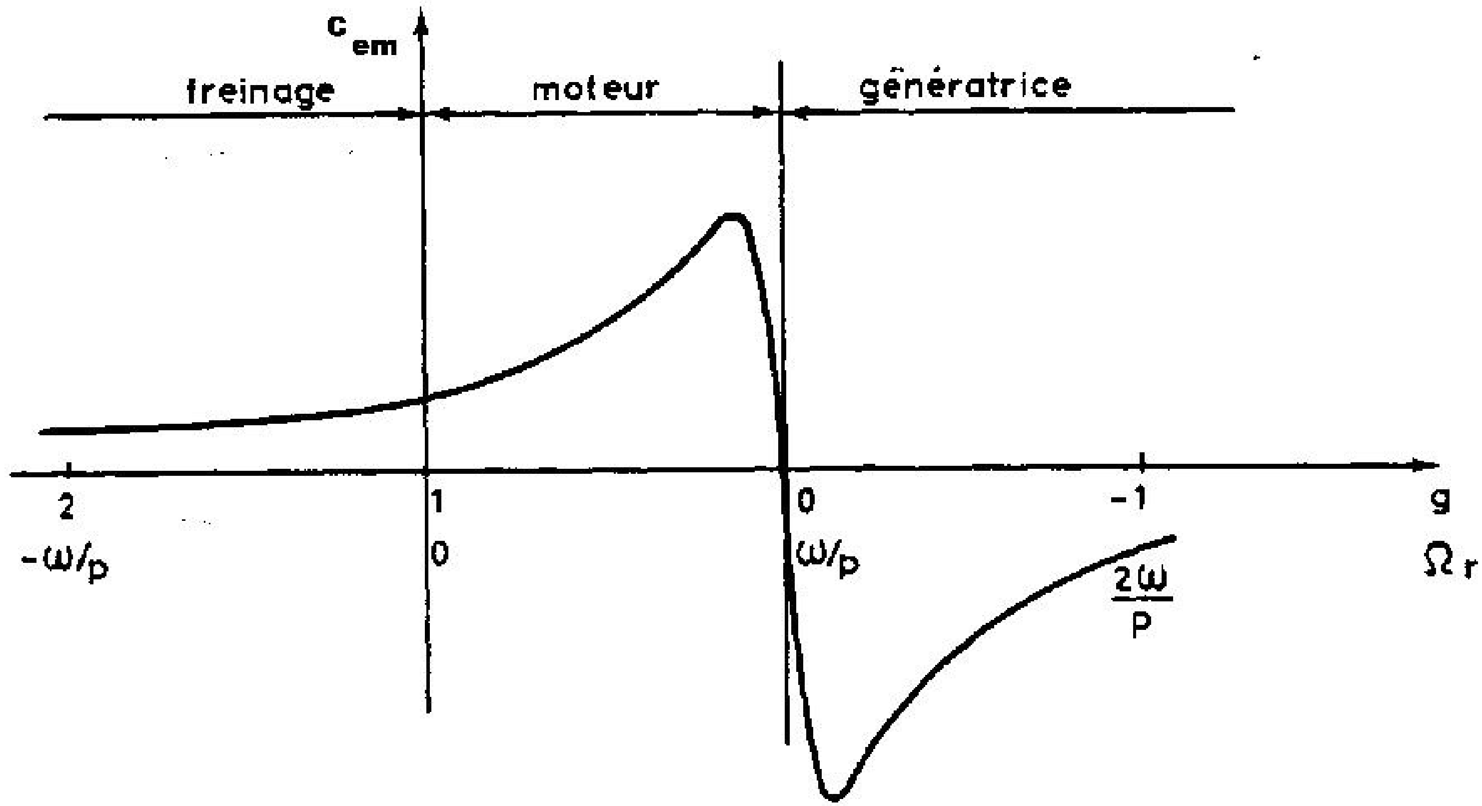
1.4.3. Machines hétéropolaires

Machine asynchrone



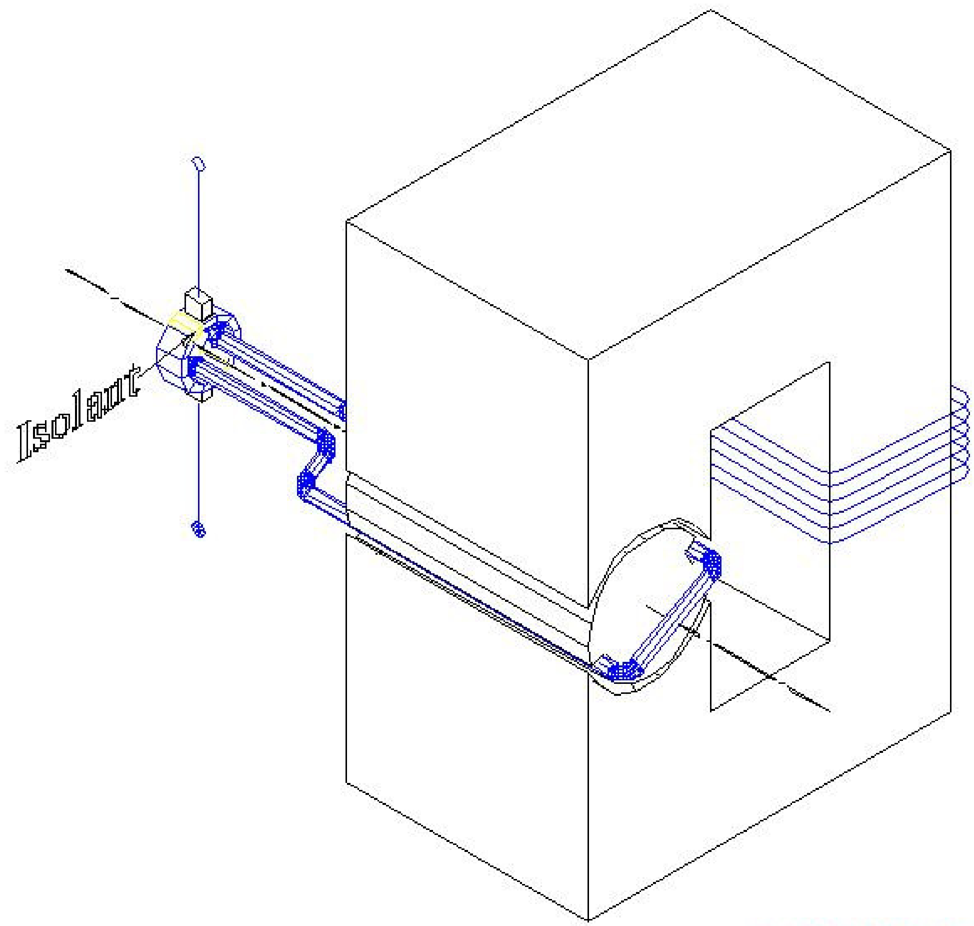
1.4.3. Machines hétéropolaires

Caractéristique mécanique de la machine asynchrone



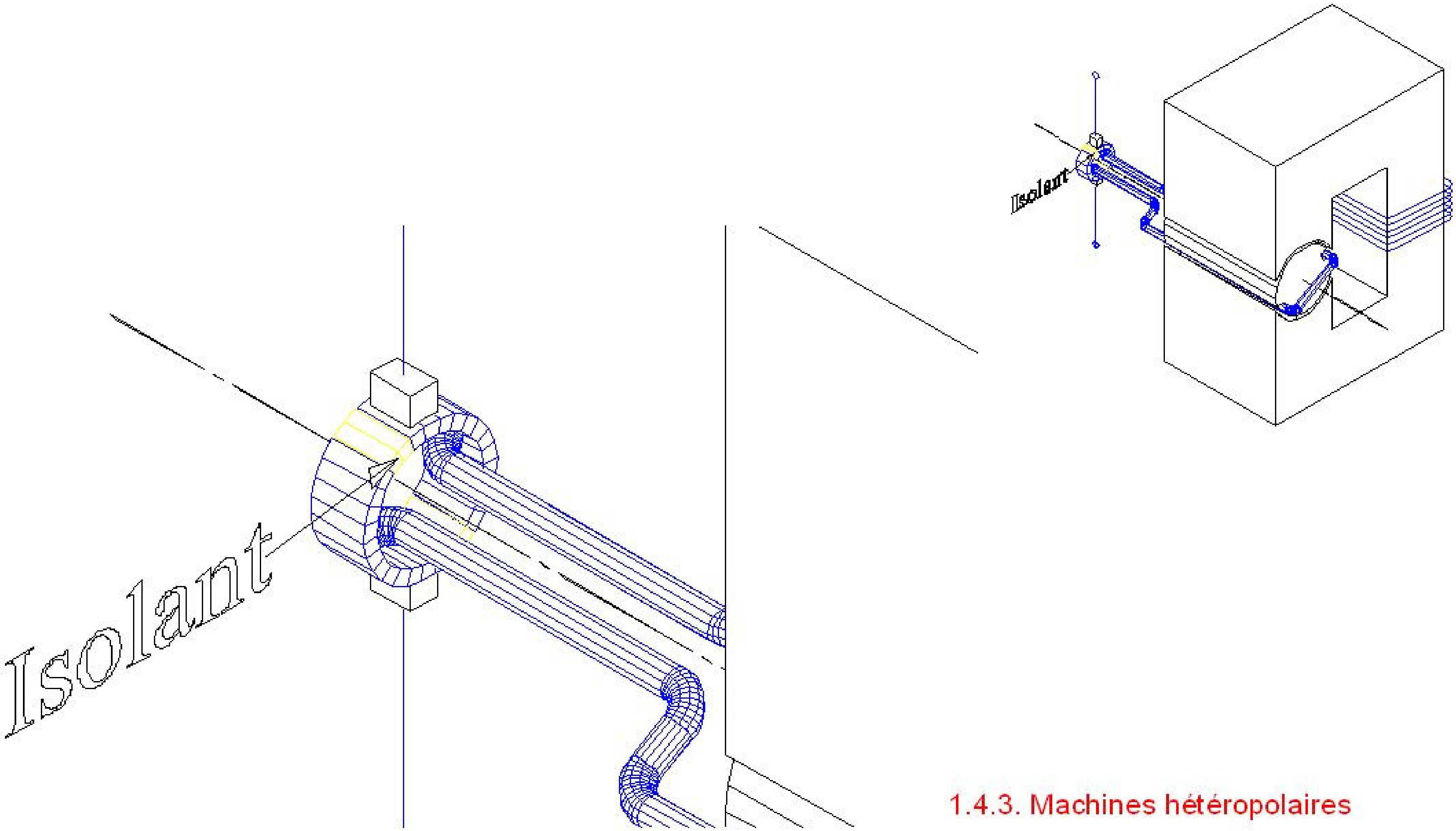
1.4.3. Machines hétéropolaires

Machine à courant continu



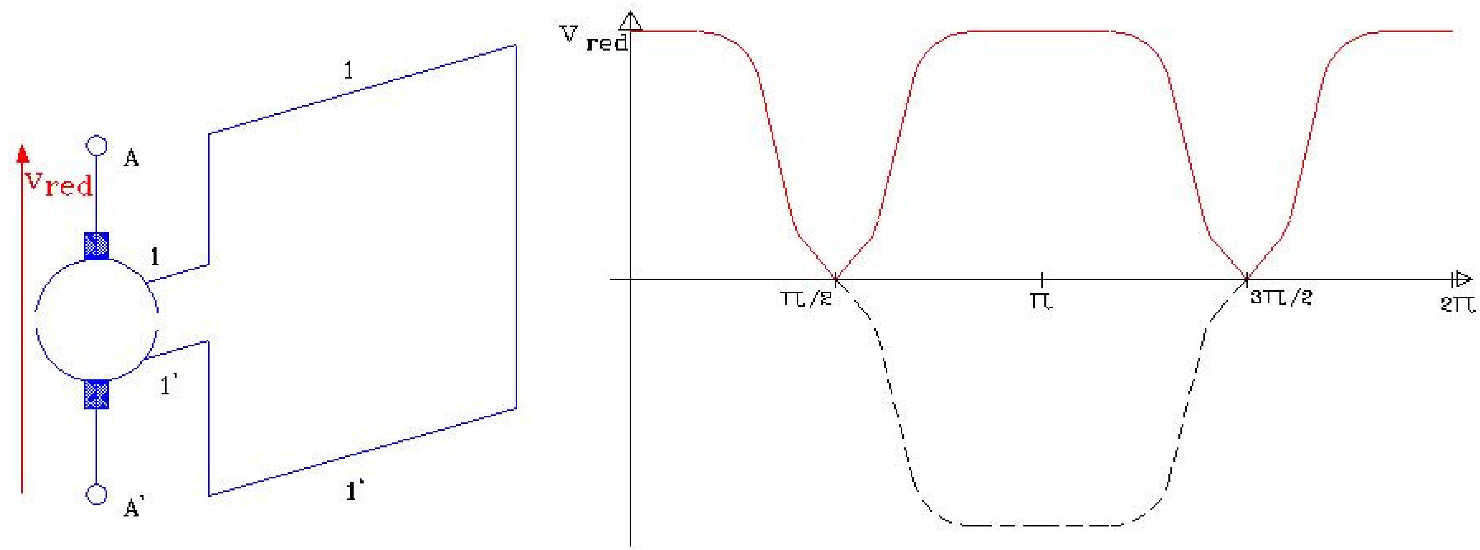
1.4.3. Machines hétéropolaires

Système balais-collecteur



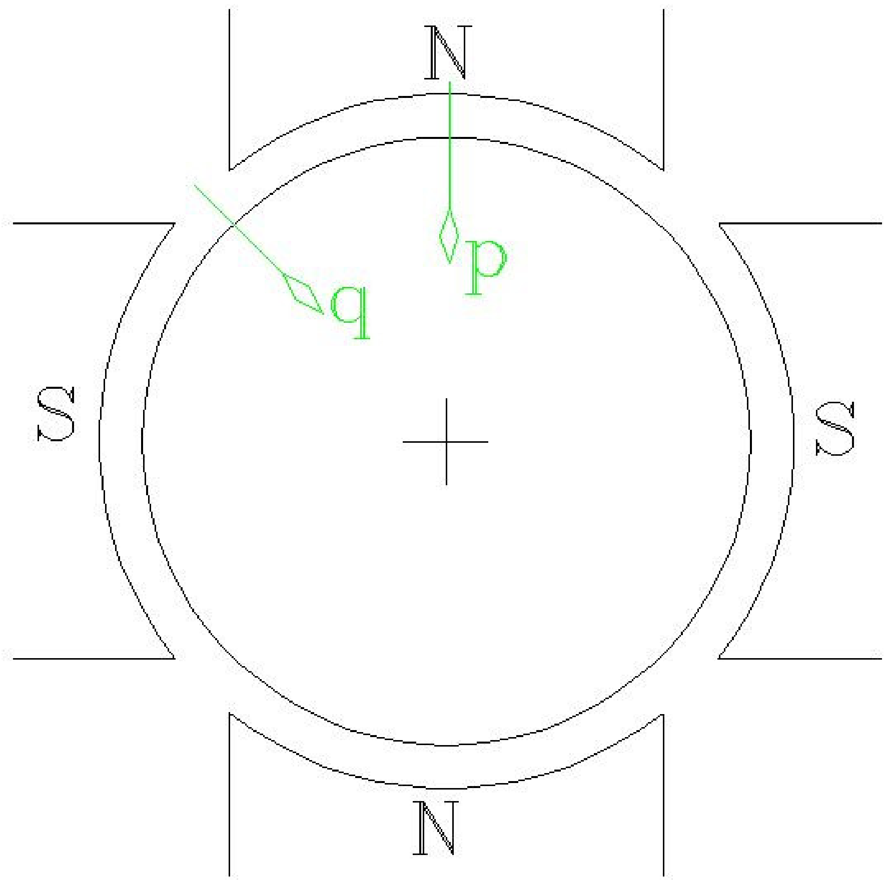
1.4.3. Machines hétéropolaires

Effet redresseur du collecteur



1.4.3. Machines hétéropolaires

Machine à plusieurs paires de pôles



Méthode des éléments finis

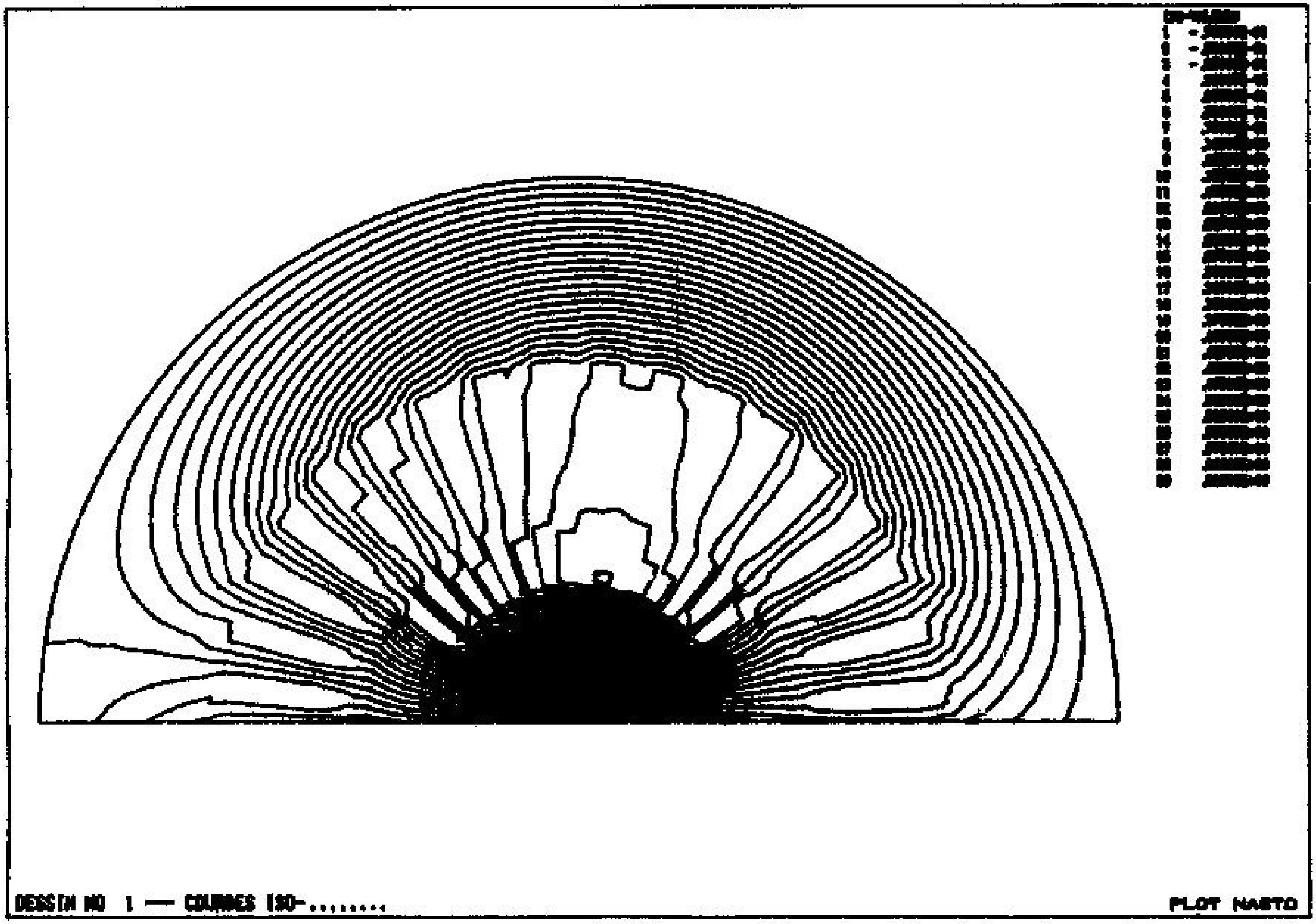
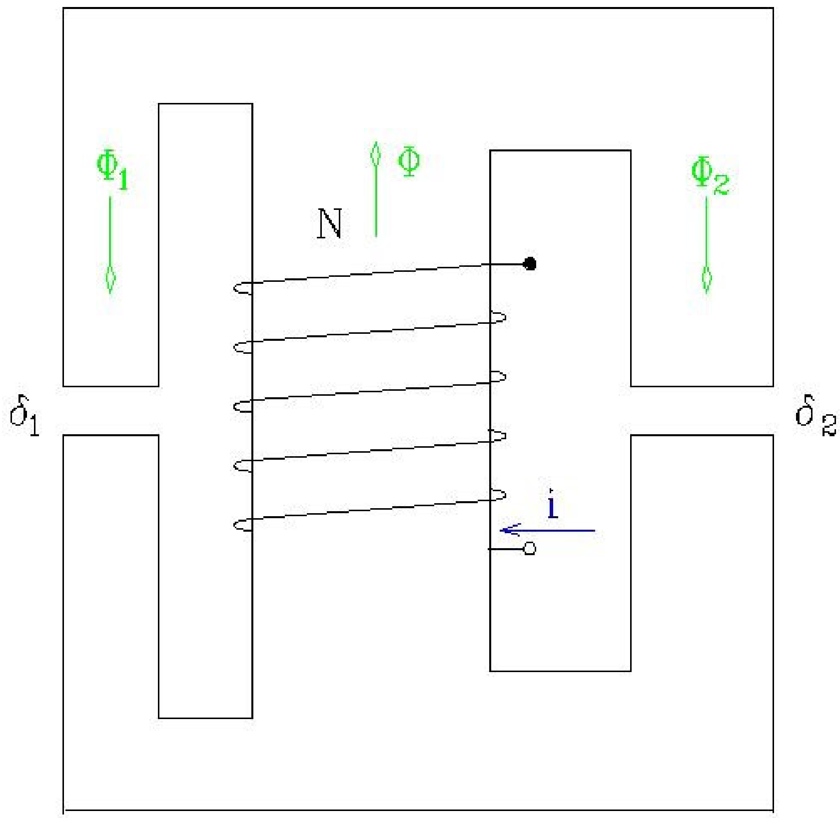
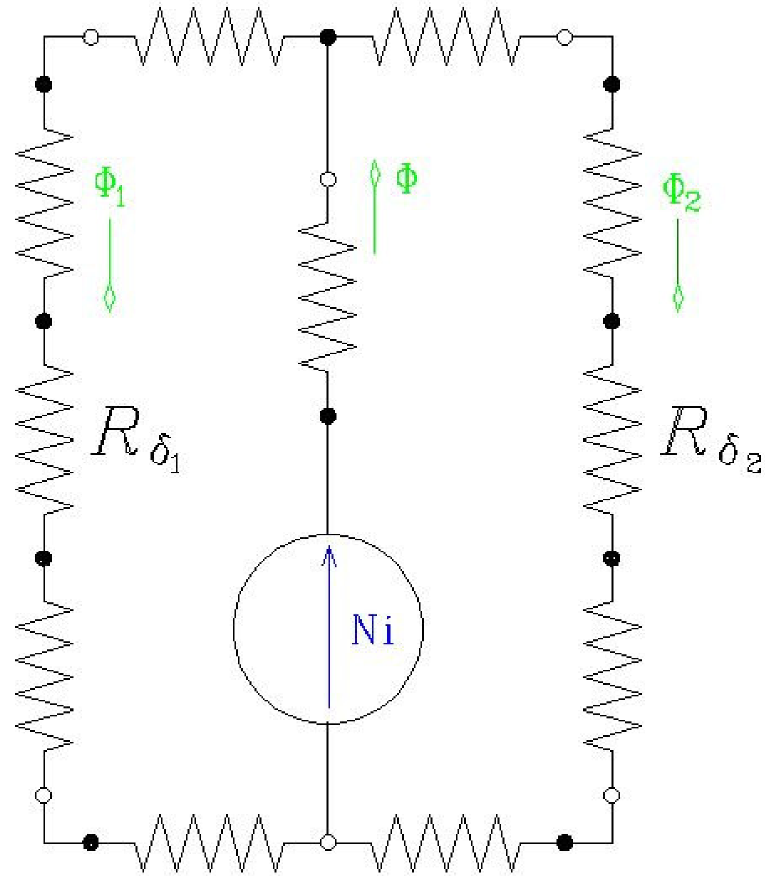


Tableau des analogies

I : *courant*	ϕ : *flux*
J : *densité de courant*	B : *induction*
V : *potentiel électrique*	$\mathcal{V}$: *potentiel magnétique*
E : *f. électromotrice*	$\mathcal{F}$: *f. magnétomotrice*
$\Delta V = R\, I$	$\Delta \mathcal{V} = \Re\, \phi$
R : *résistance*	$\Re$: *réluctance*
$= \int_0^l \rho \, \frac{dl}{S}$	$= \int_0^l \frac{1}{\mu} \frac{dl}{S}$
G : *conductance*	$\mathcal{P}$: *perméance*
$= \iint_S \frac{1}{\rho} \frac{dS}{l}$	$= \iint_S \mu \frac{dS}{l}$

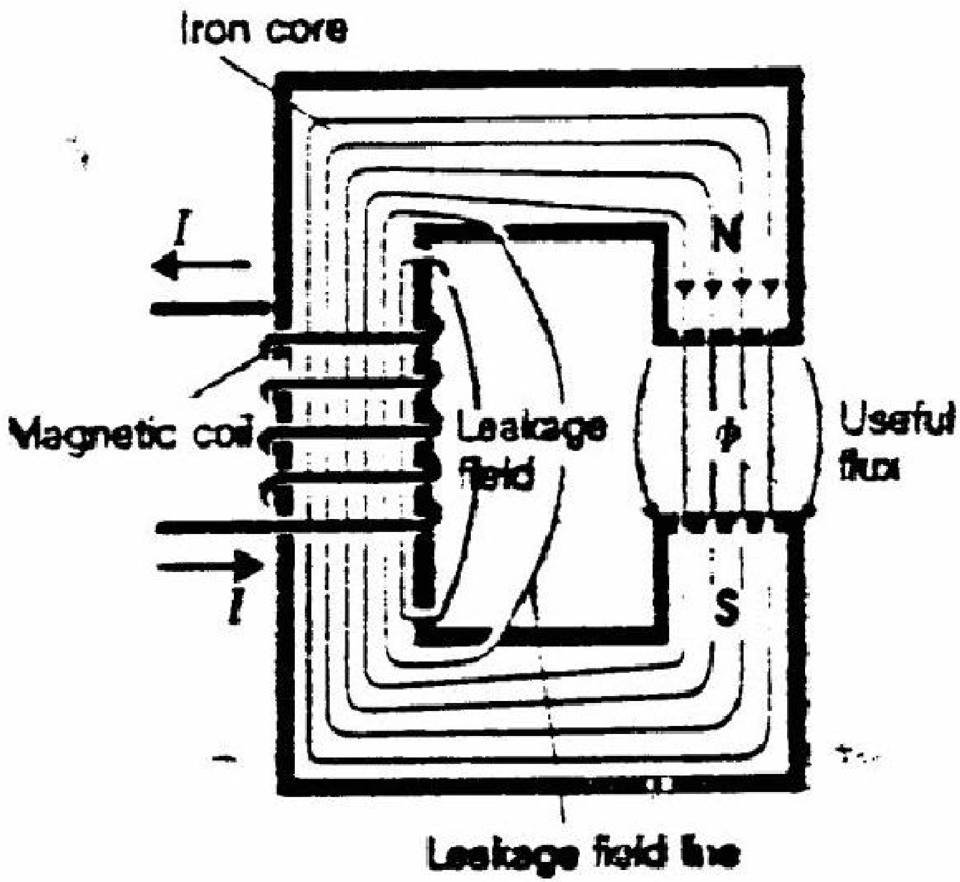
Schéma équivalent



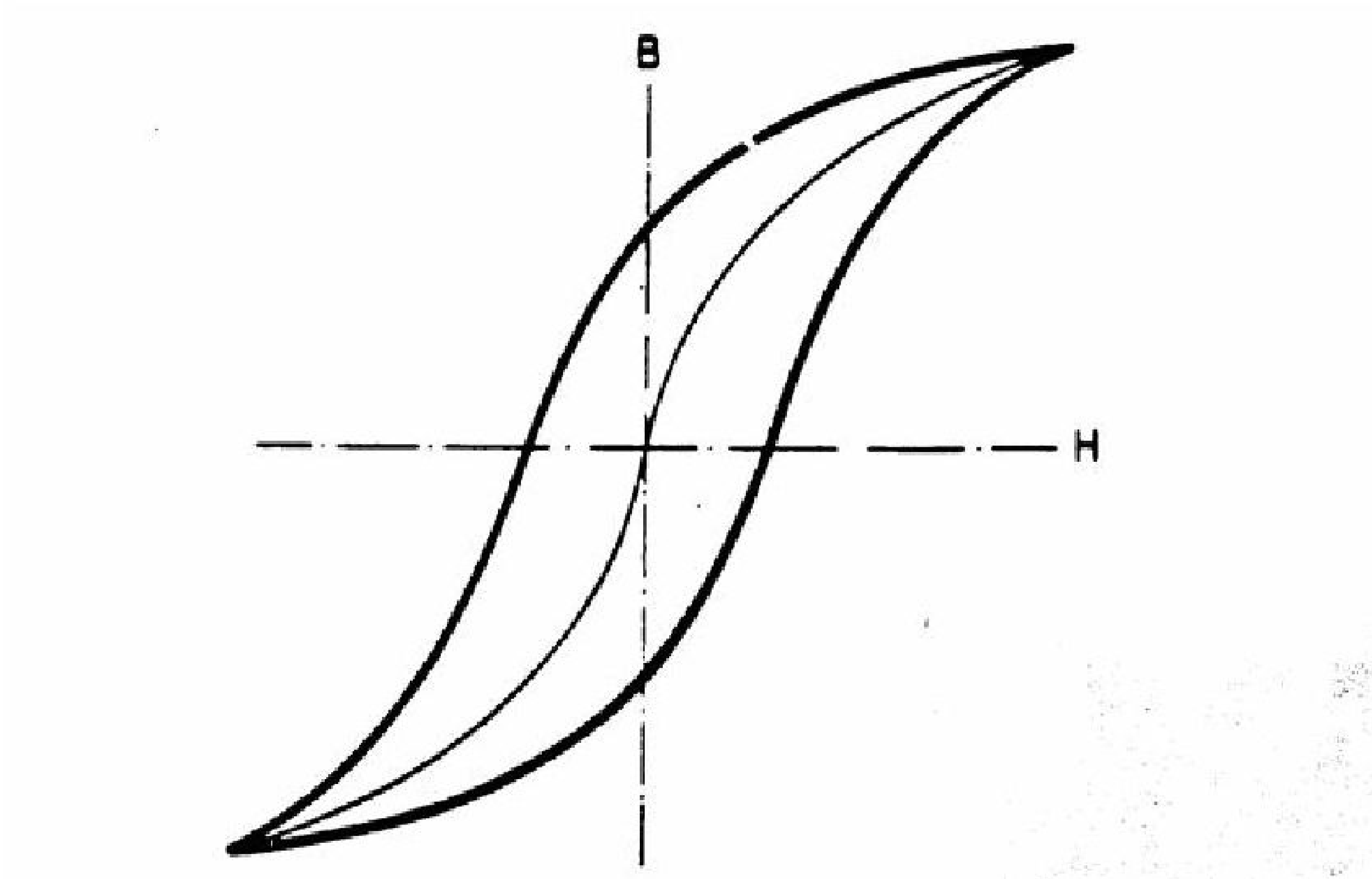


2.1.2. Analogie entre grandeurs électriques et magnétiques

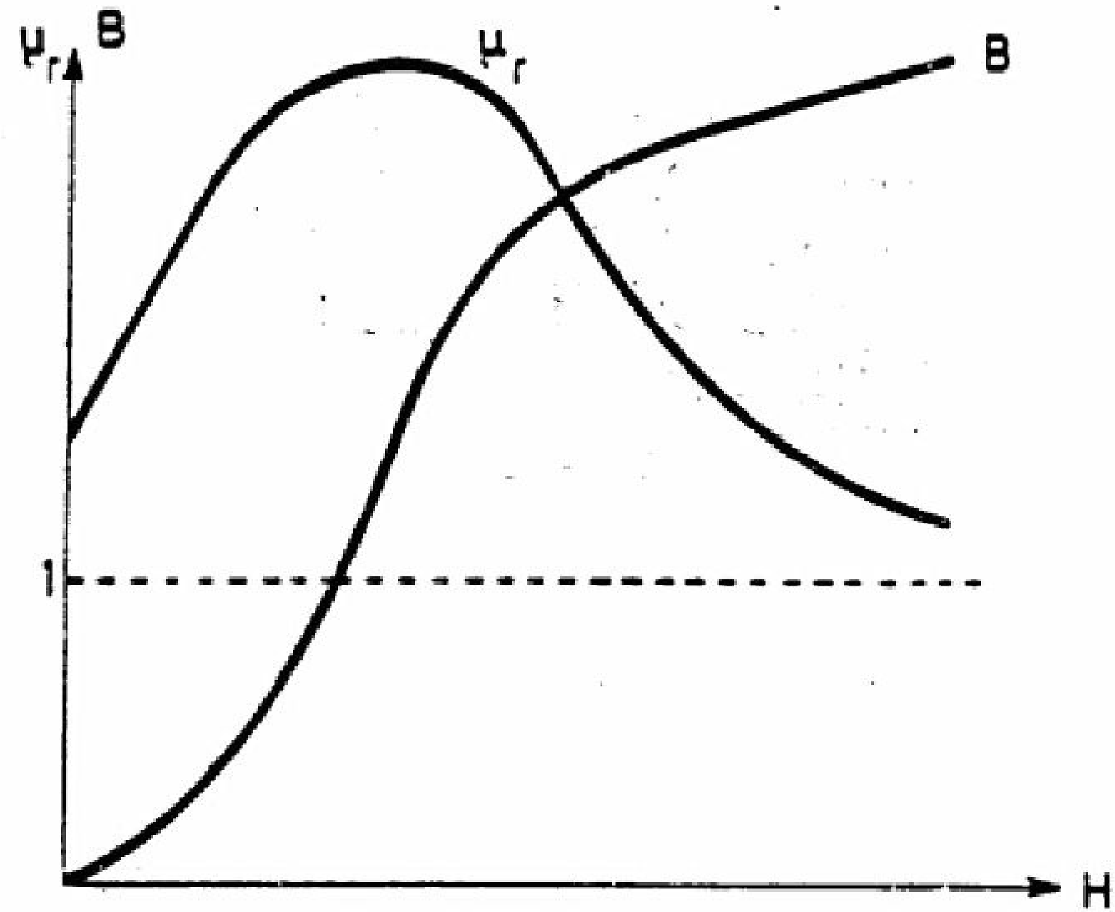
Flux de dispersion magnétique



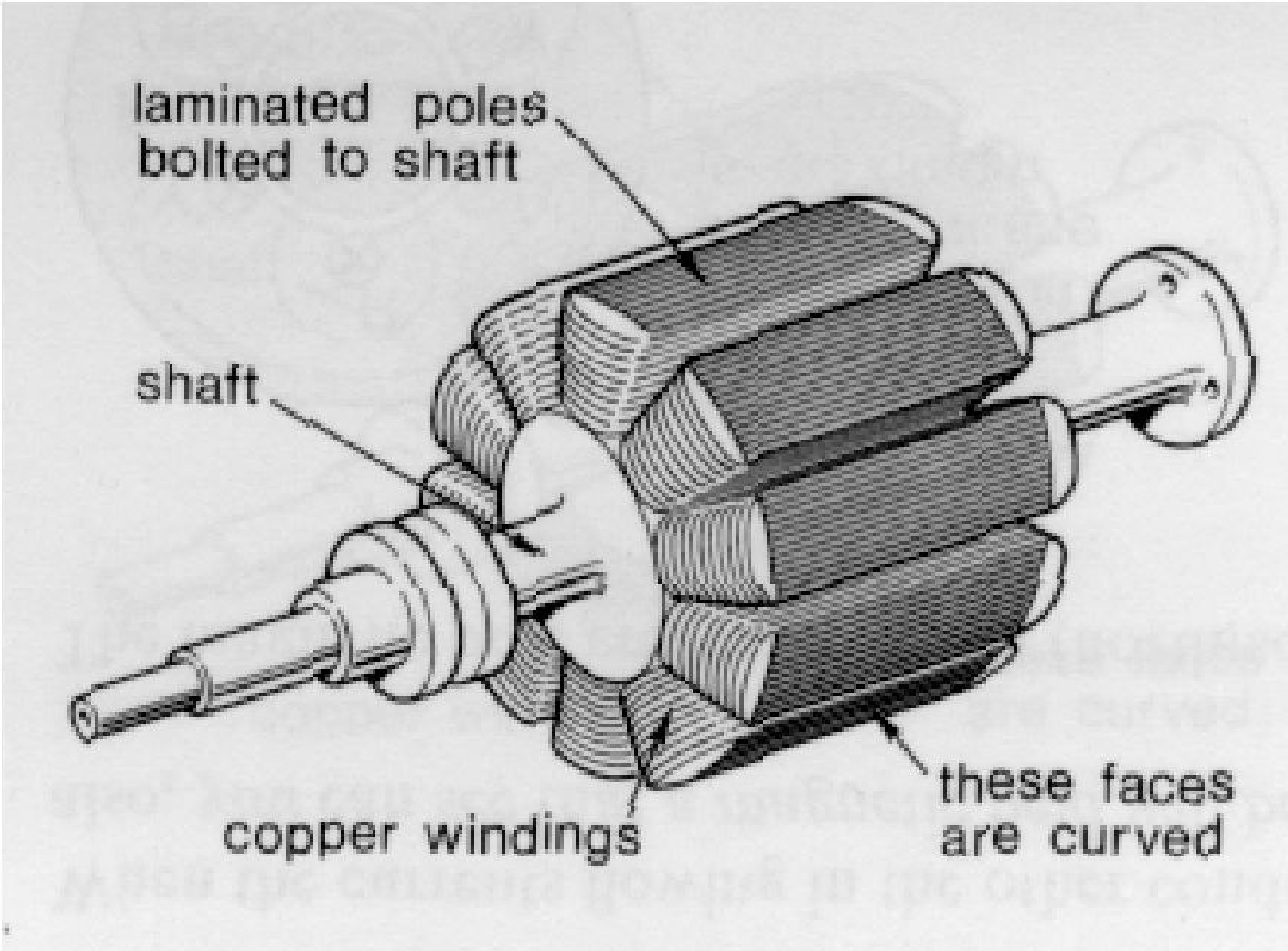
Courbe d'aimantation Avec hystérèse



Perméabilité et magnétisation



Inducteur à pôles saillants



Inducteur à pôles lisses

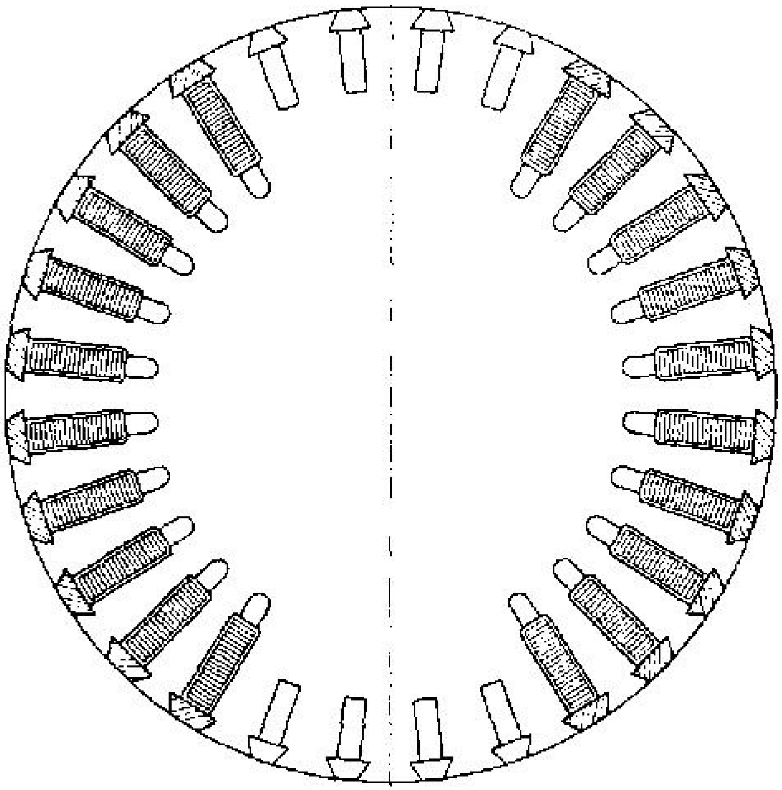


Abb. 102 a. Induktor mit schmäleren und niedrigeren Nuten im unbewickelten Teil.

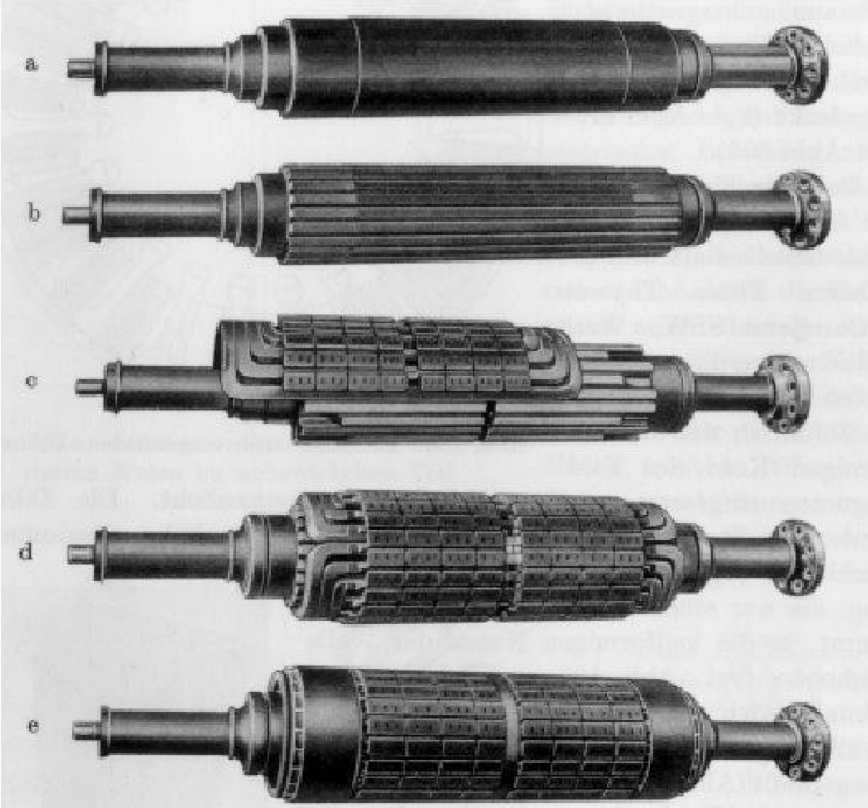
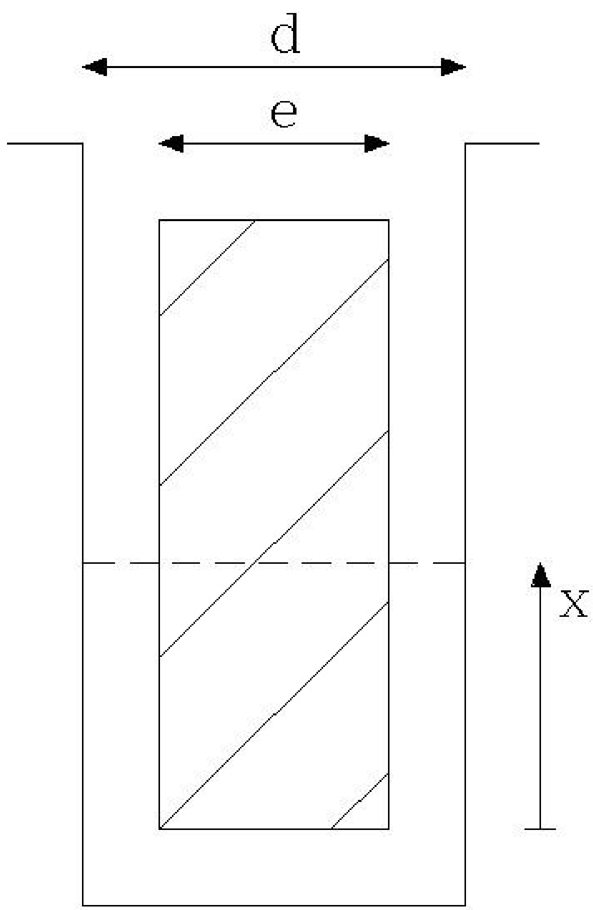


Abb. 106 a bis e. Zweipoliger Induktor in verschiedenen Zeitabschnitten der Herstellung. AEG.

3.1.1. Disposition des enroulements

Densité de courant dans un conducteur d'encoche



$$H(x)\ d + 0 = \int_0^x J\ e\ dx \quad \text{donc}$$

$$H(x) = \frac{J\ e}{d}\ x$$

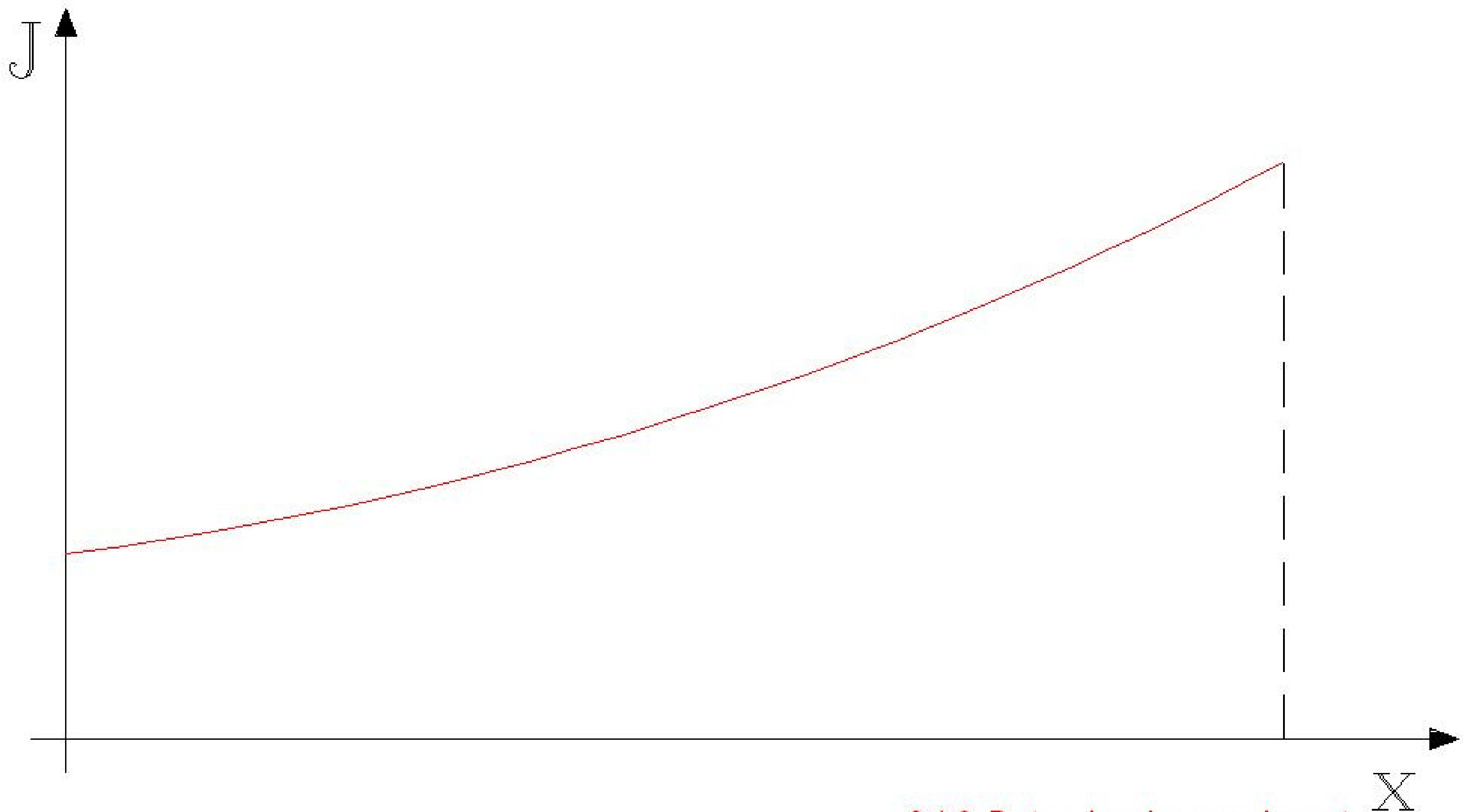
$$\frac{\Delta\ \varphi(x)}{\Delta\ l} = \text{constante} - \int_0^x B(x)\ dx$$

$$= \text{constante} - \mu_0 \int_0^x H(x)\ dx$$

$$= \text{constante} - \frac{\mu_0\ J\ e}{d}\ \frac{x^2}{2}$$

3.1.9. Pertes dans les enroulements

Densité de courant dans un conducteur d'encoche



3.1.9. Pertes dans les enroulements

Barre Roebel

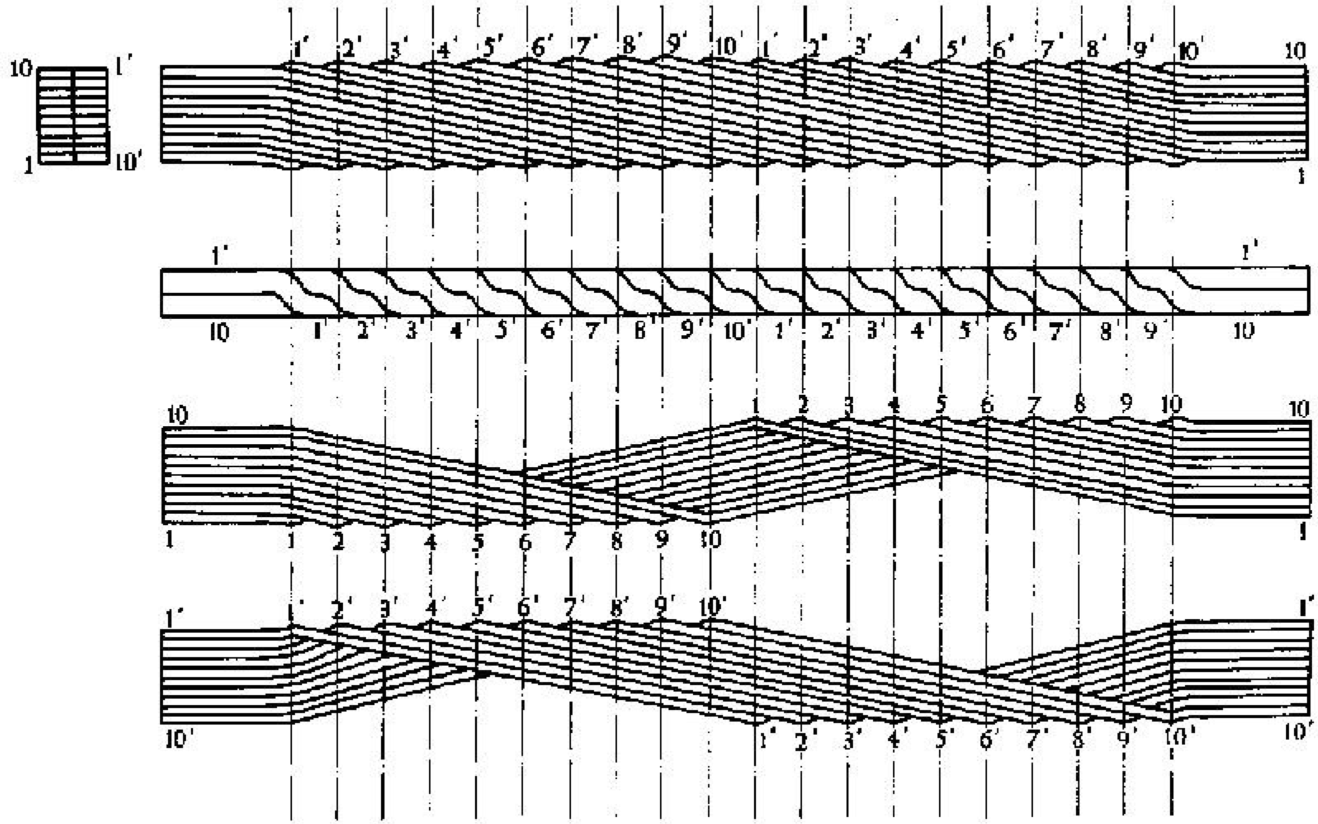
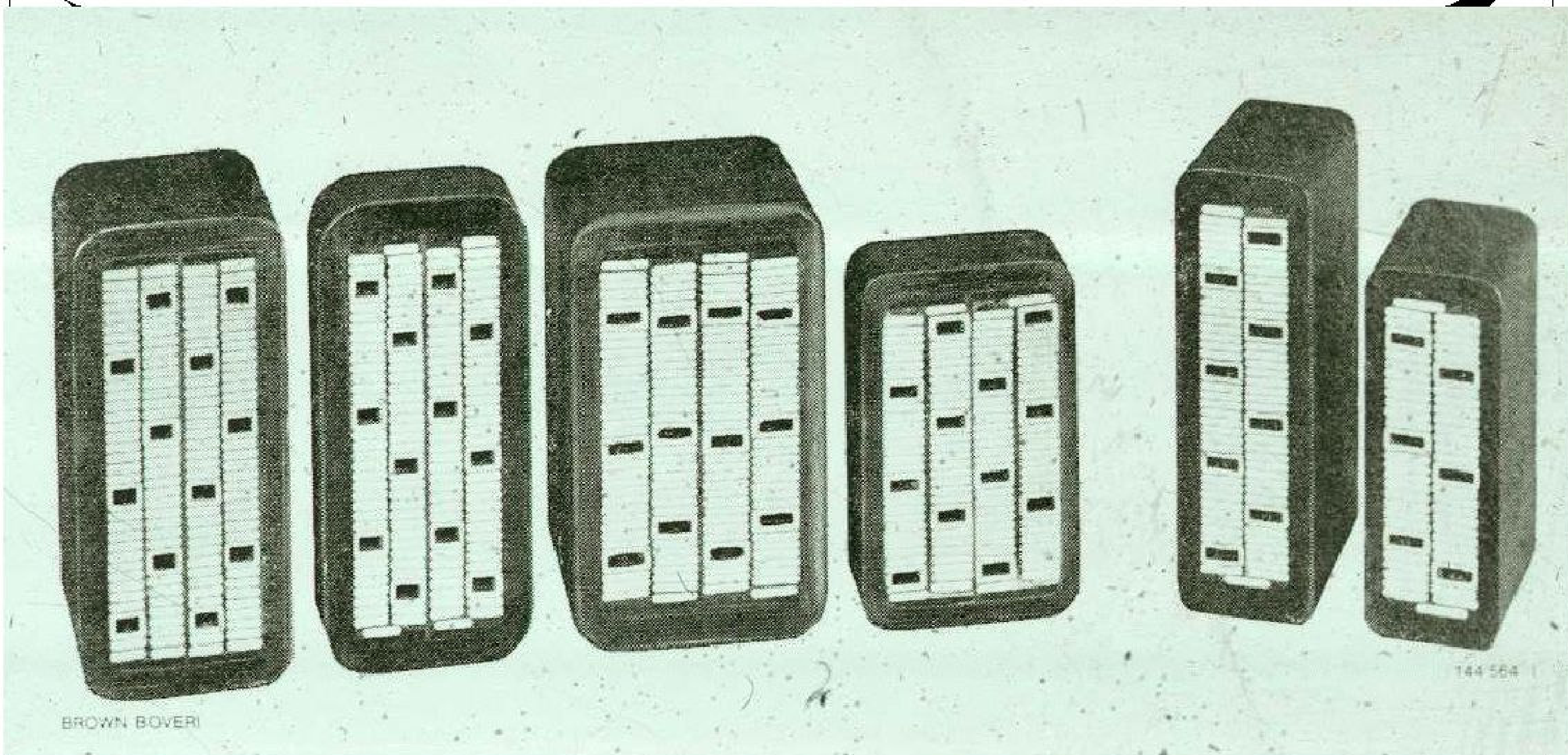


Abb. 2.27. Aufbau eines Roebelstabes

Barre Roebel (avec refroidissement direct)



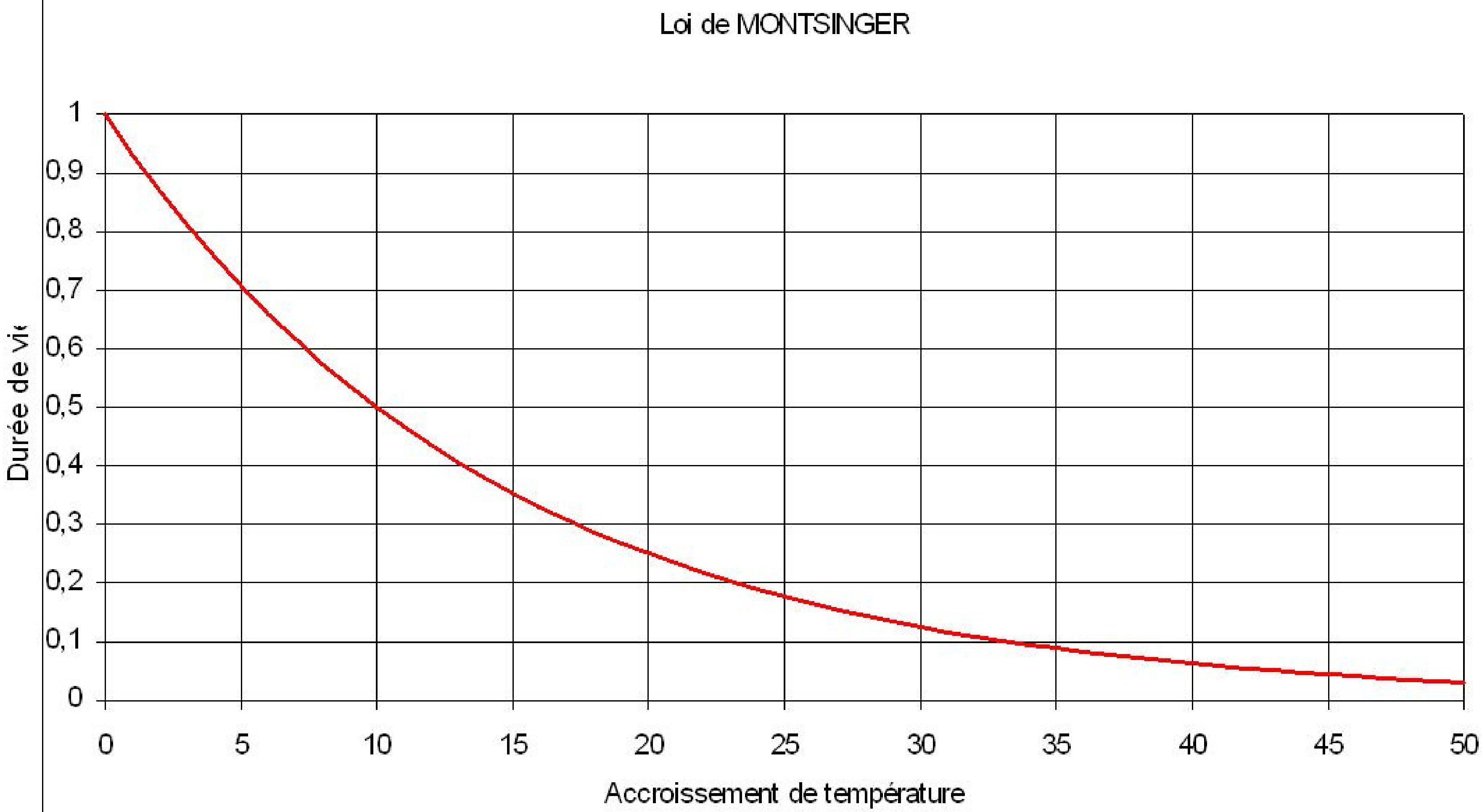
Matériaux conducteurs

Matériaux conducteurs

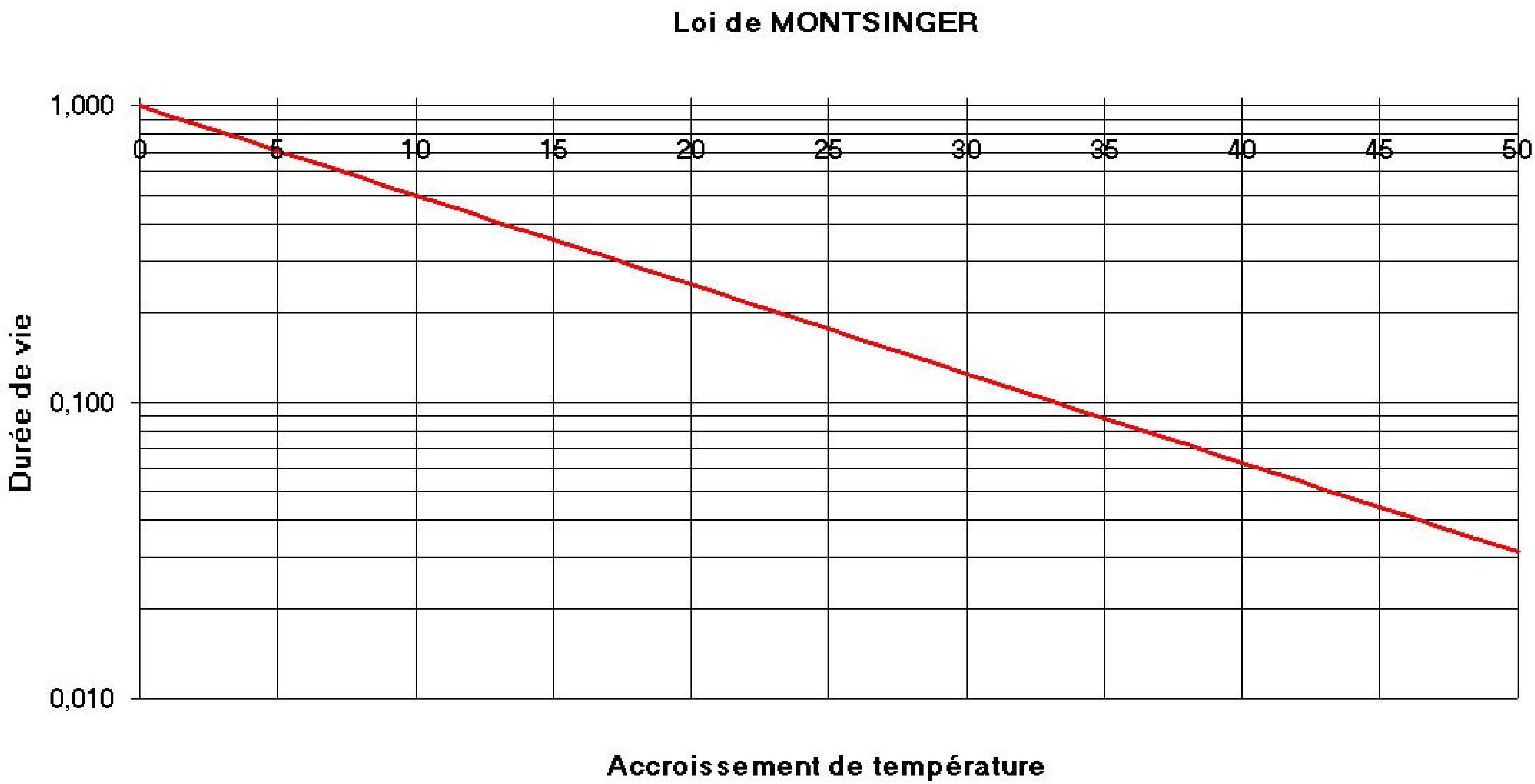
	Cu	Al	unités	rapp. Cu/Al
$\rho_{20°}$	0,017 8	0,029 0	Ω mm²/m	0,6
α	3,92 10^{-3}	4,0 10^{-3}	1/K	~
masse volumique	8,9	2,7	kg/dm³	3,3
$R_{traction}$	30	12	kg'/mm²	2,5
$T°_{fusion}$	1080	650	°C	

3.1.10. Matériaux utilisés

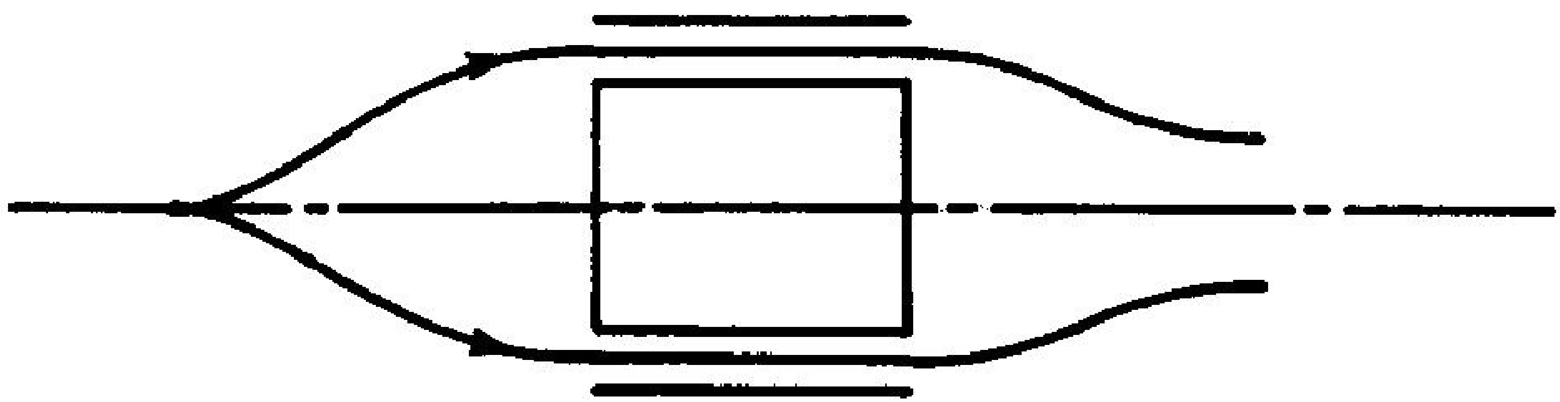
Loi de Montsinger



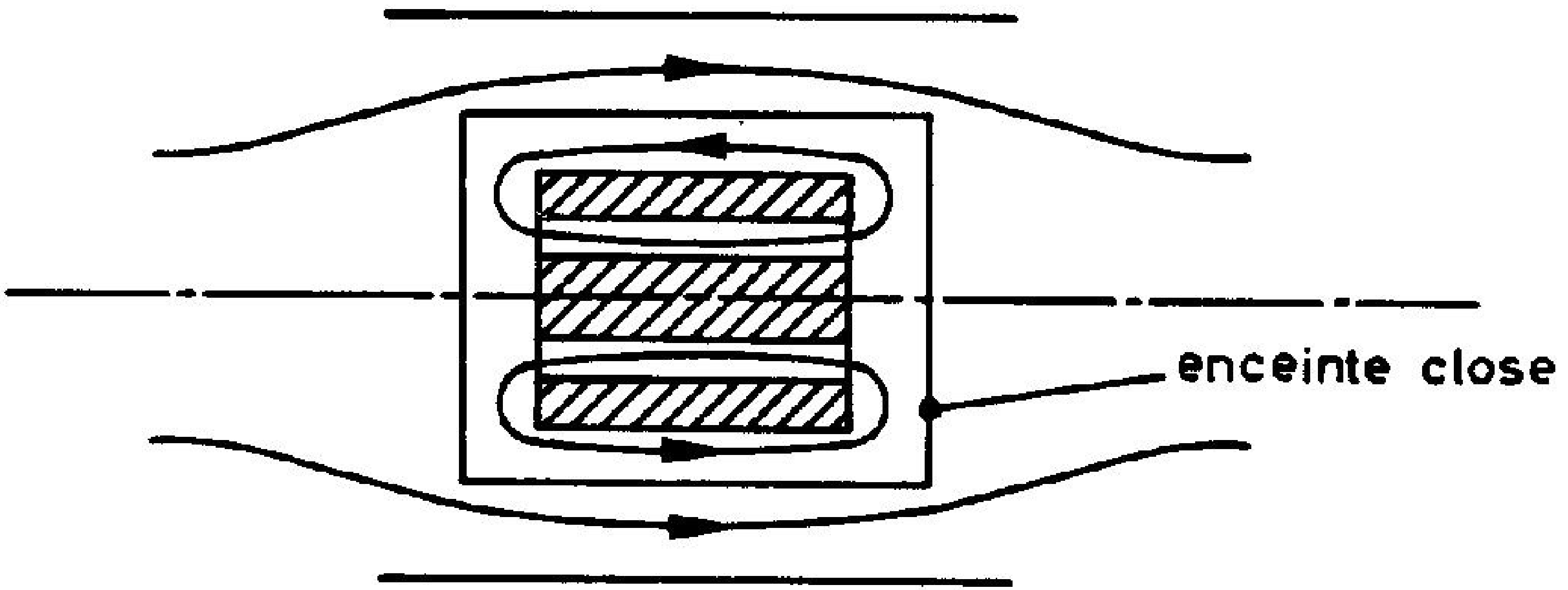
Loi de Montsinger



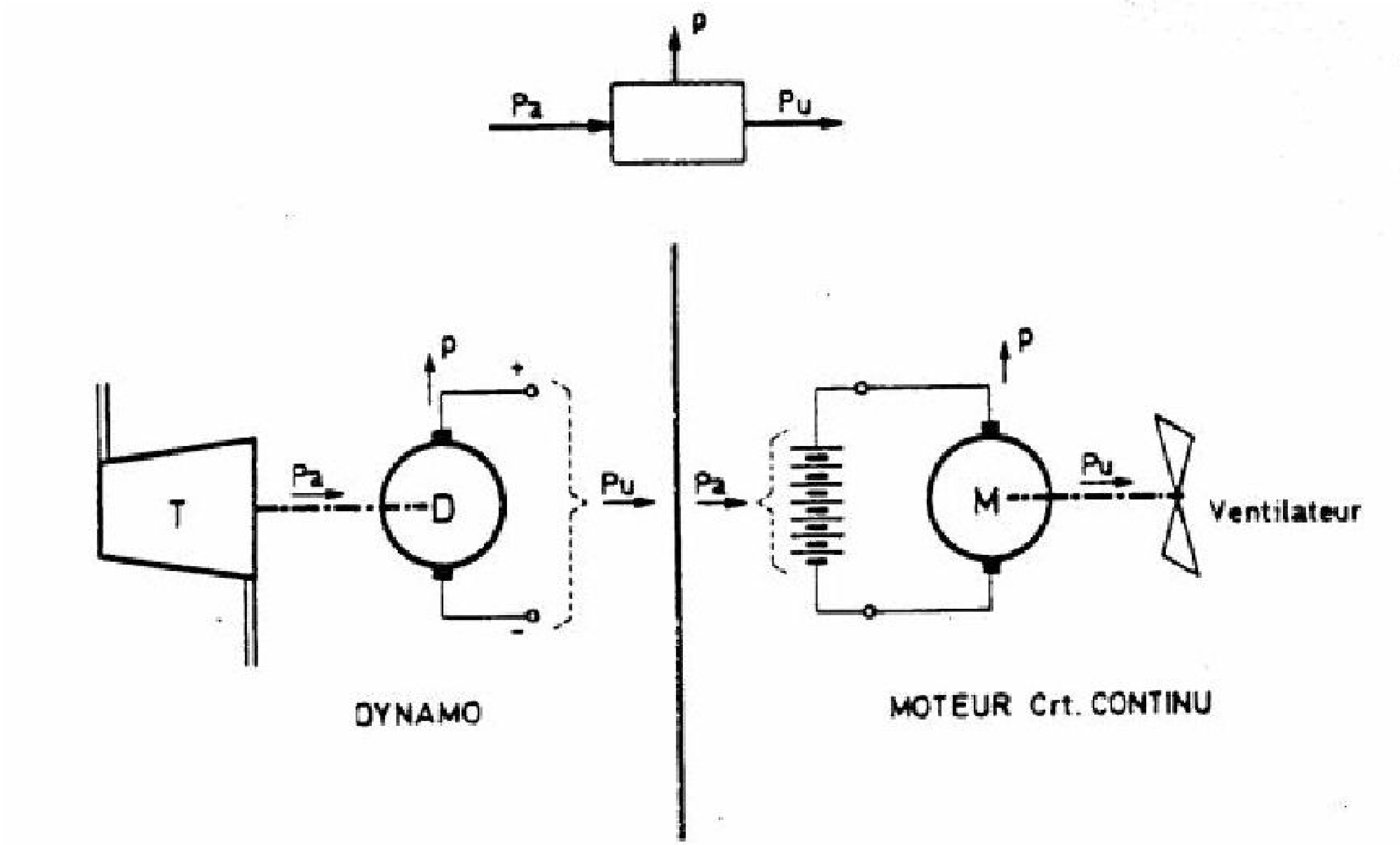
Ventilation à circuit ouvert



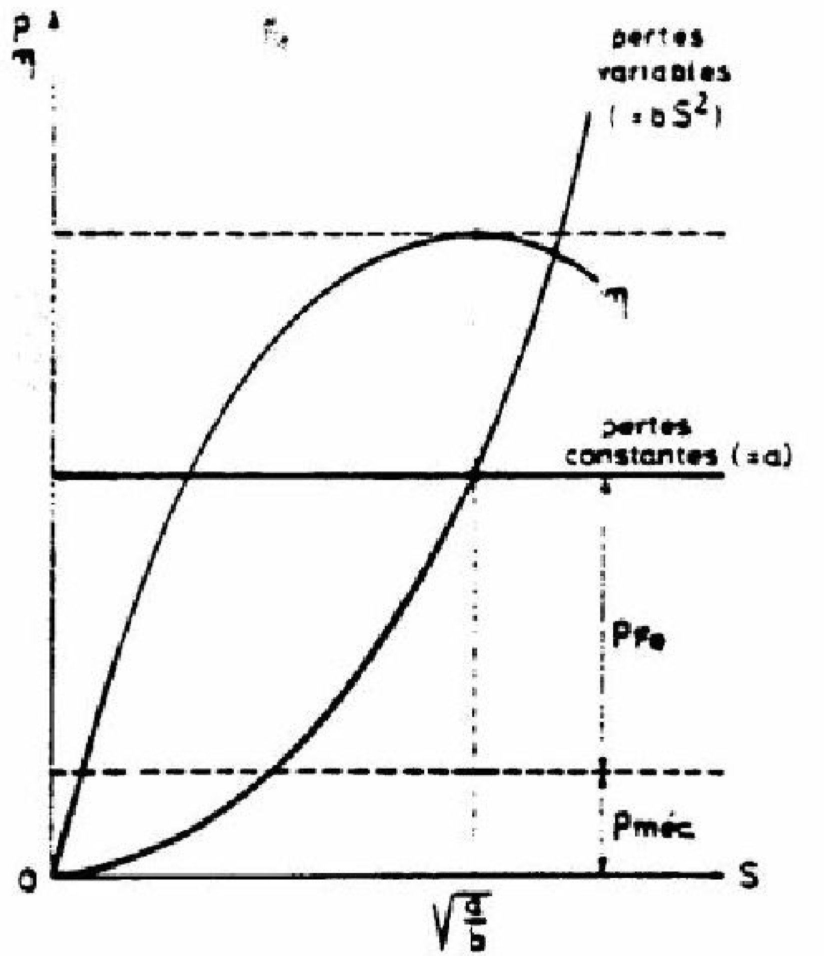
Ventilation à circuit fermé



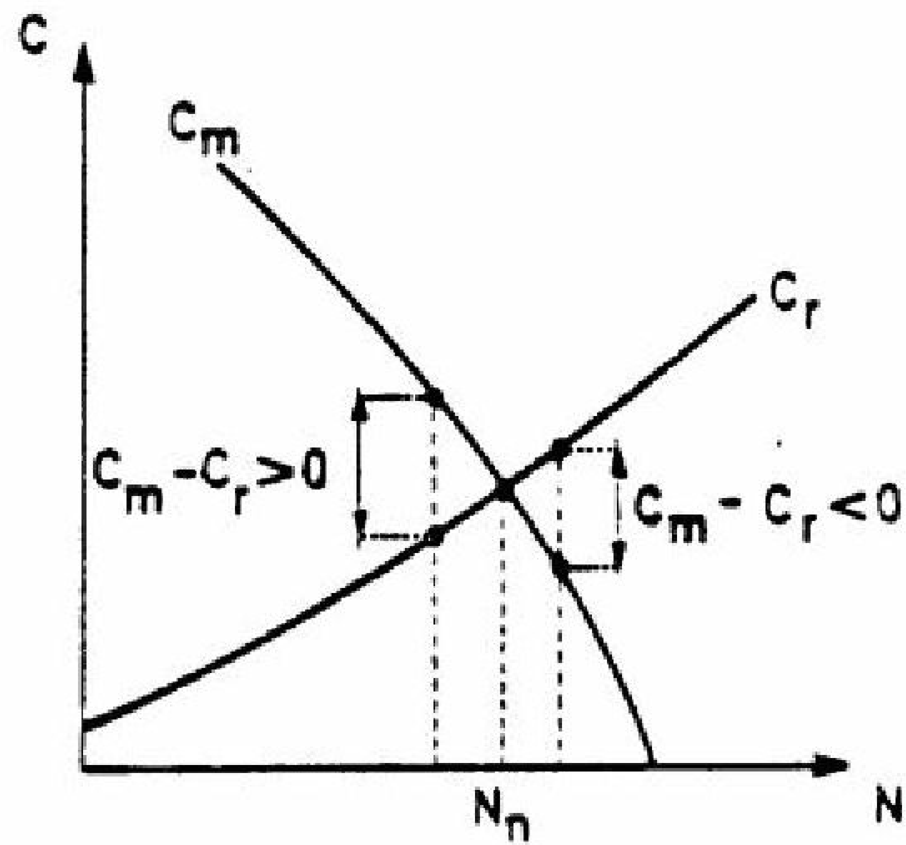
Rendement des machines électriques



Rendement des machines électriques



Couples moteur et résistant en régime



Regime stable

Stabilité d'une génératrice