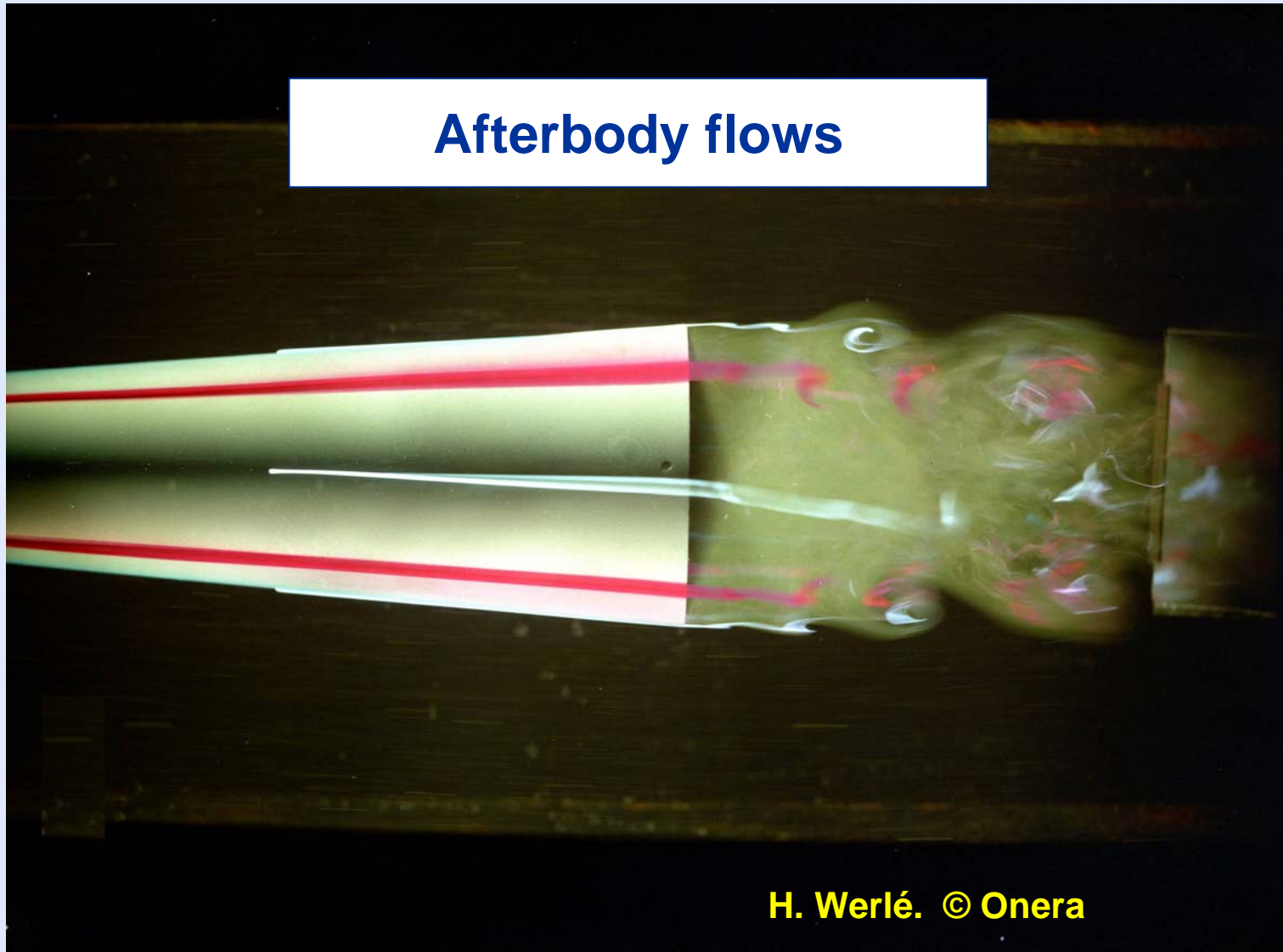


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Afterbody flows

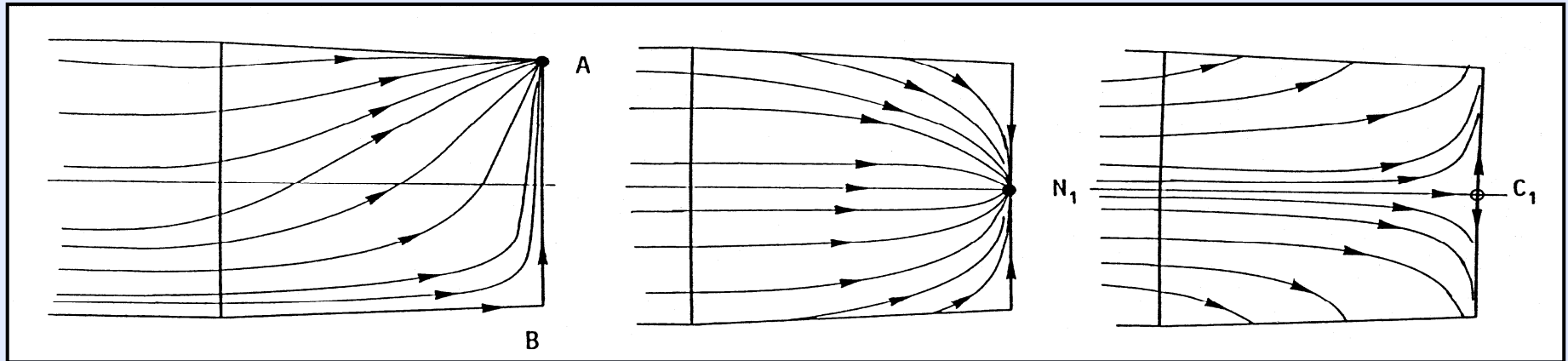


H. Werlé. © Onera

Afterbody flows

- 1. Non-propelled afterbody**
- 2. Propelled afterbody without base**
- 3. Propelled afterbody with base**
- 4. Rectangular section afterbody**
- 5. Two-nozzle afterbody**
- 6. Flow past an automobile**

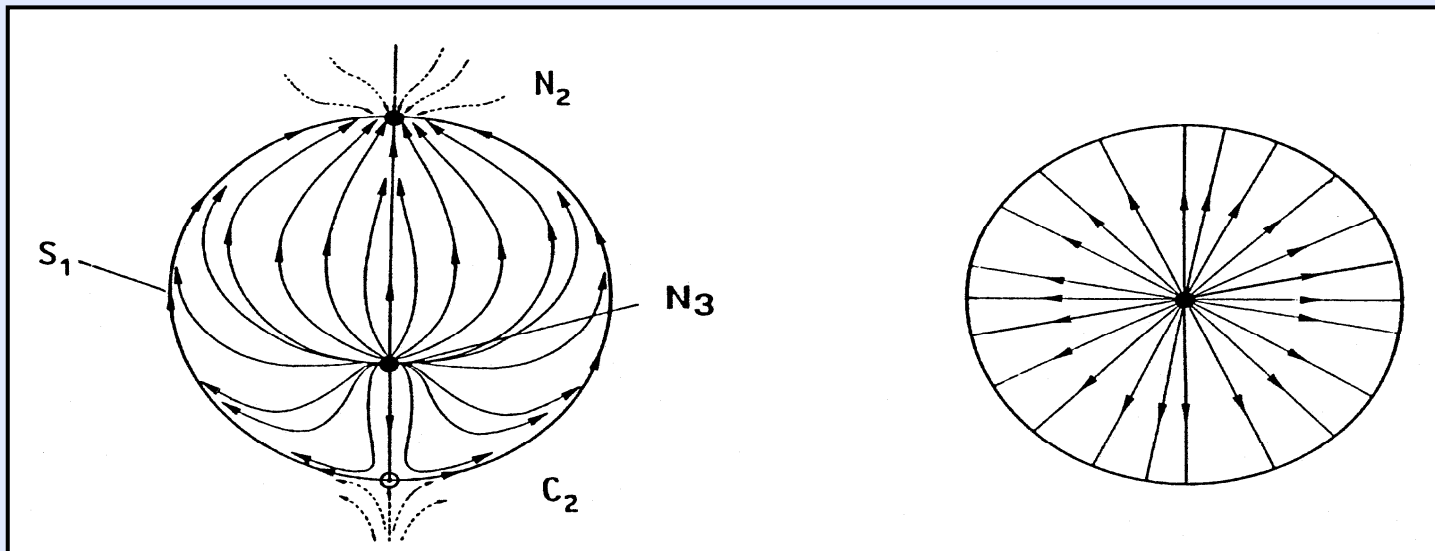
Non-propelled axisymmetric afterbody at incidence Skin friction line pattern



Body, side view

Seen from above

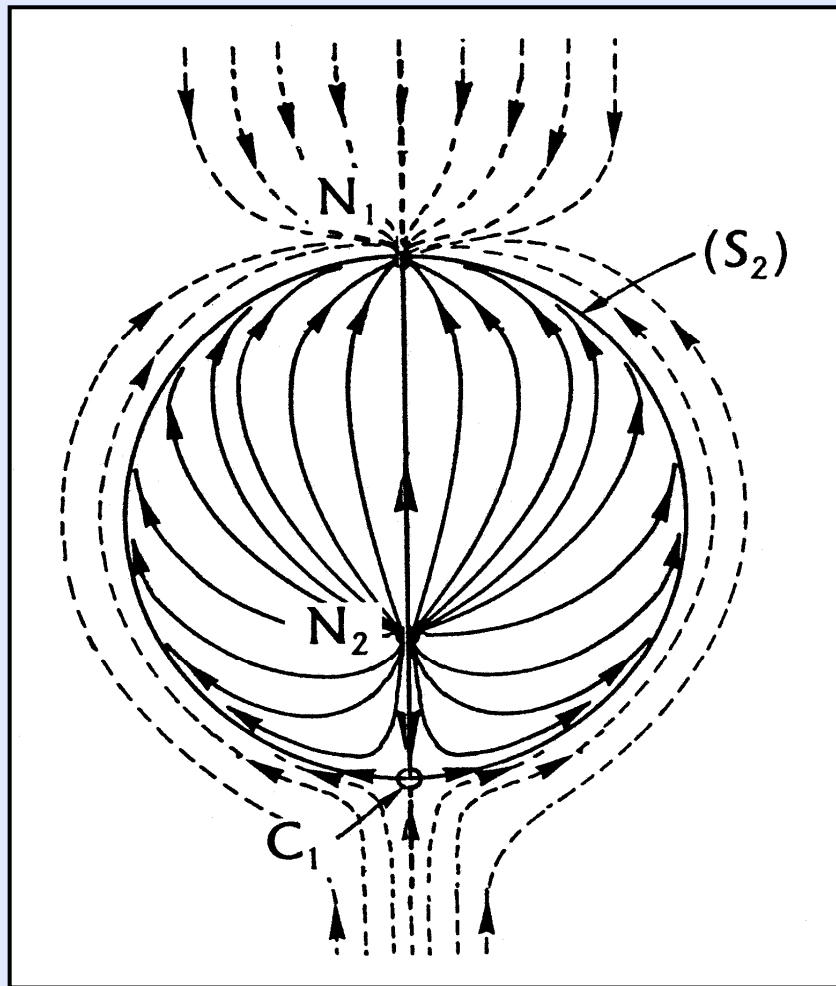
Seen from below



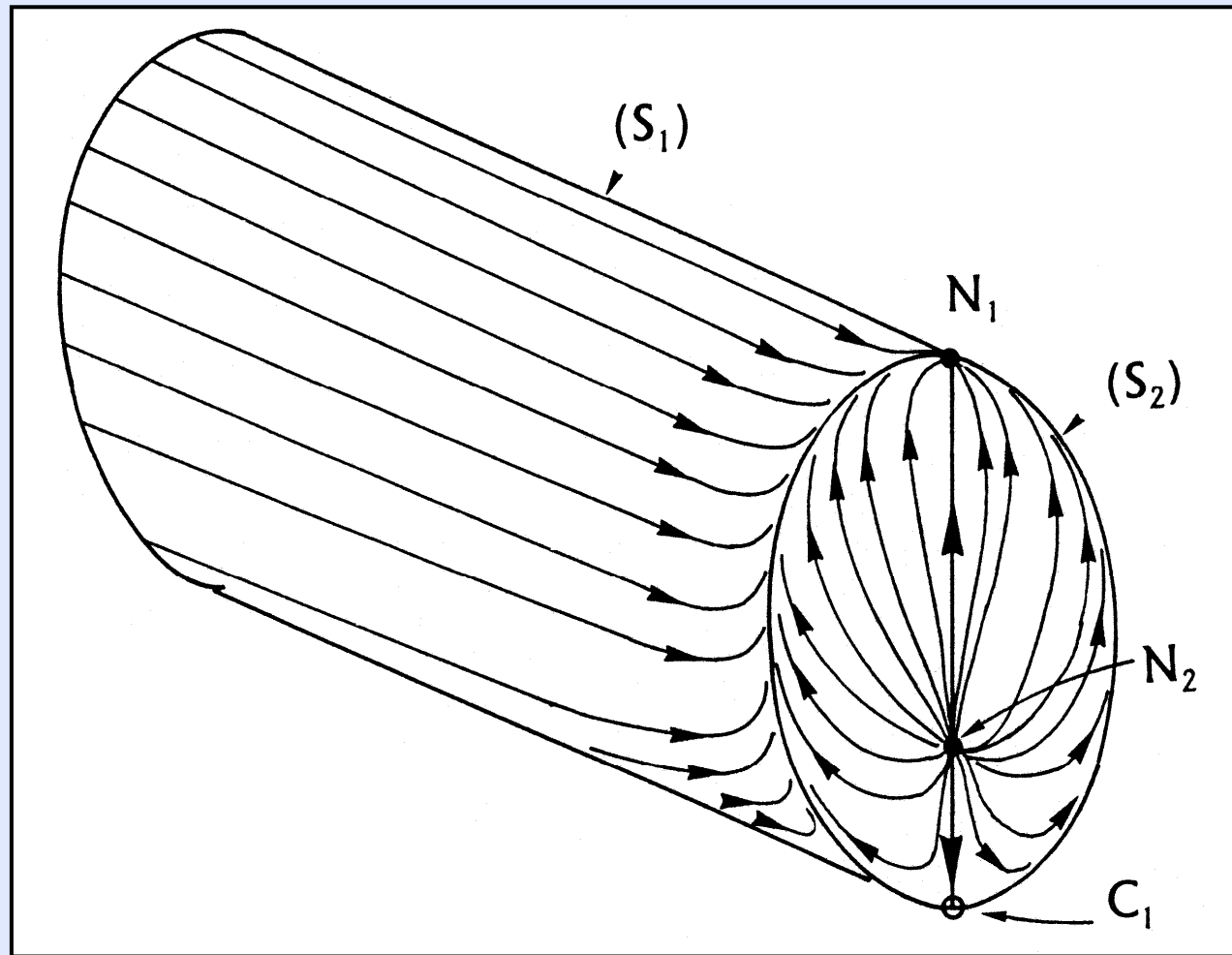
Base

Base at zero incidence

**Non-propelled axisymmetric afterbody at incidence
Skin friction line pattern**

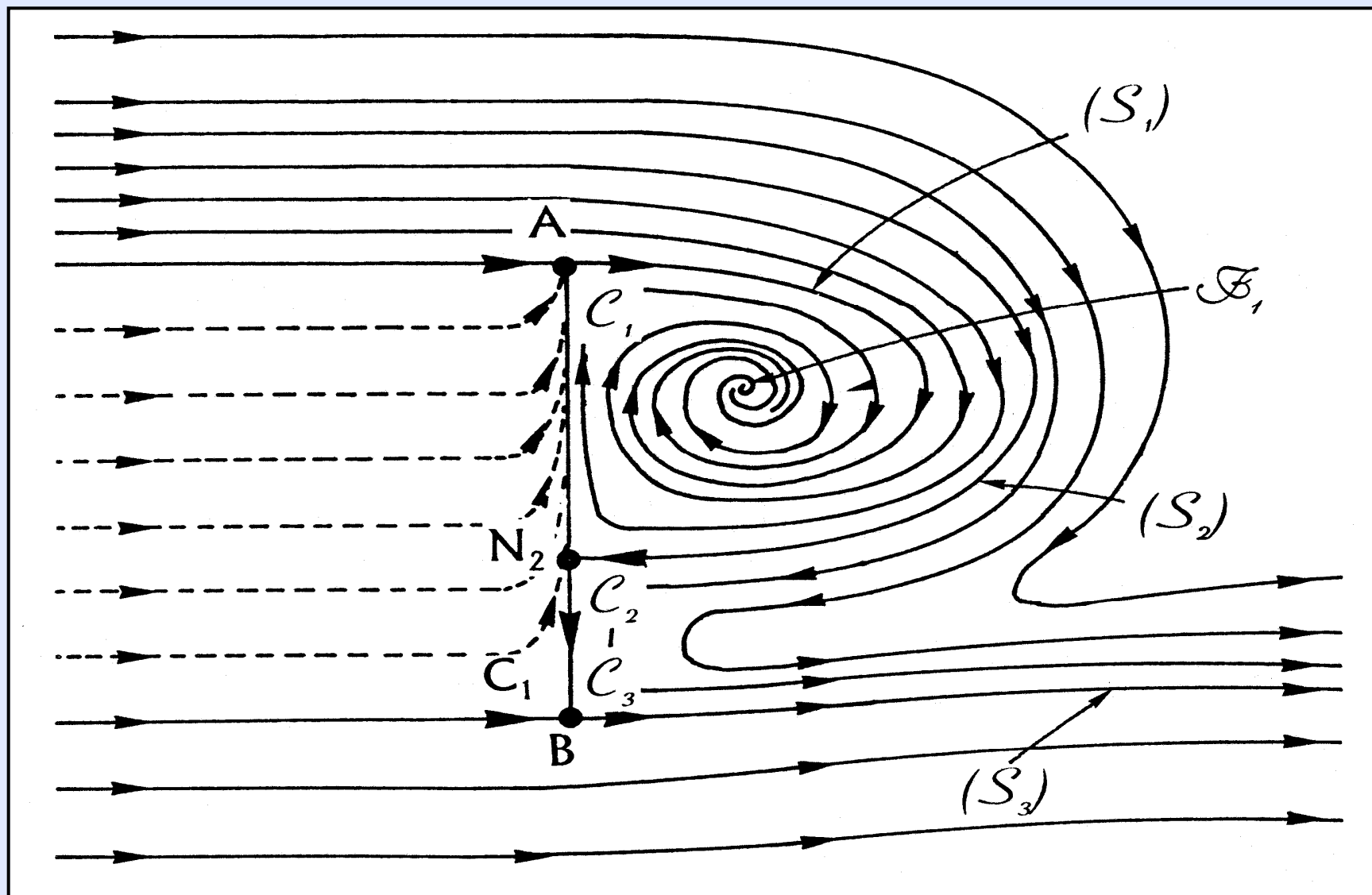


On the base

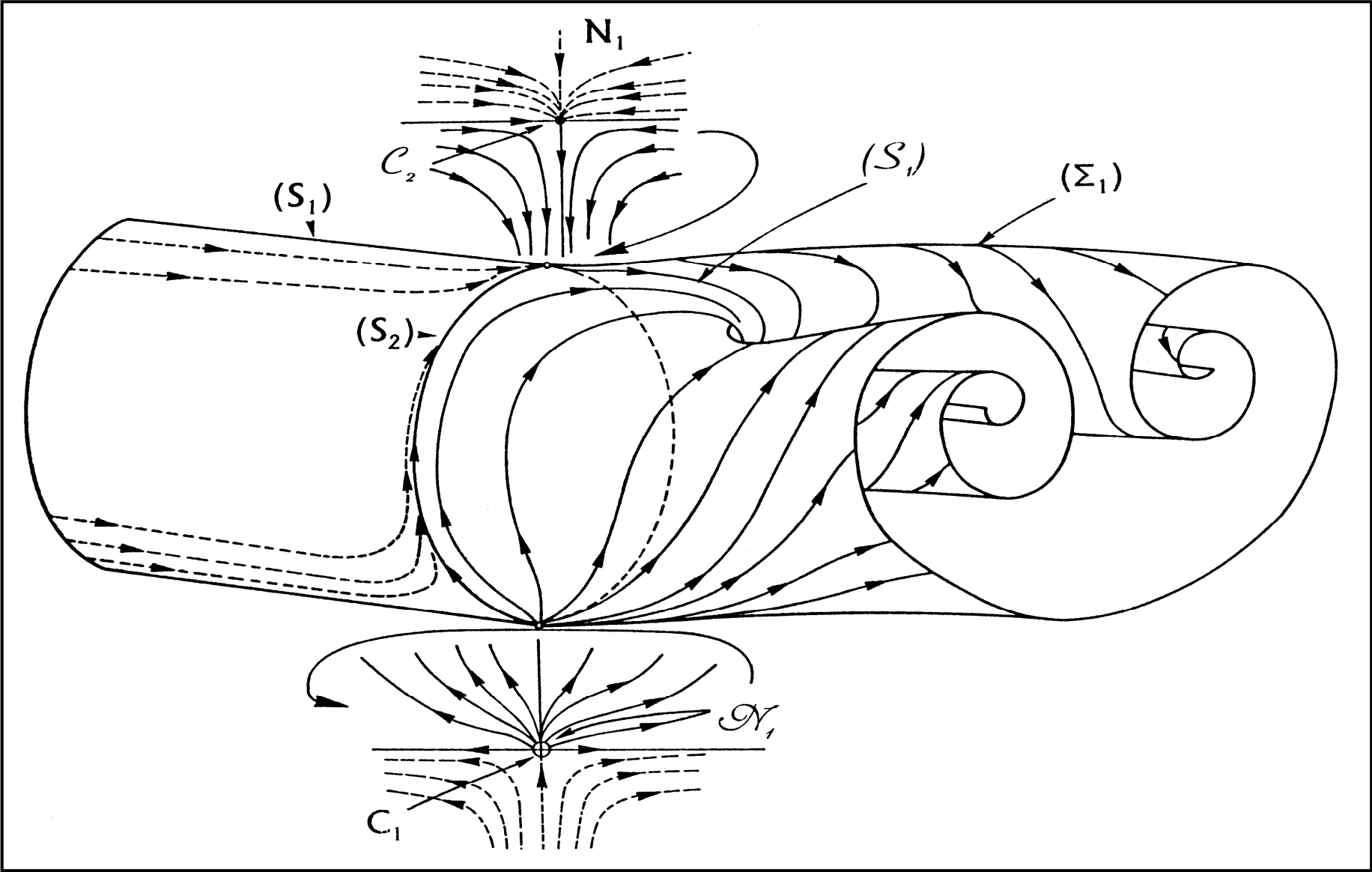


On the afterbody

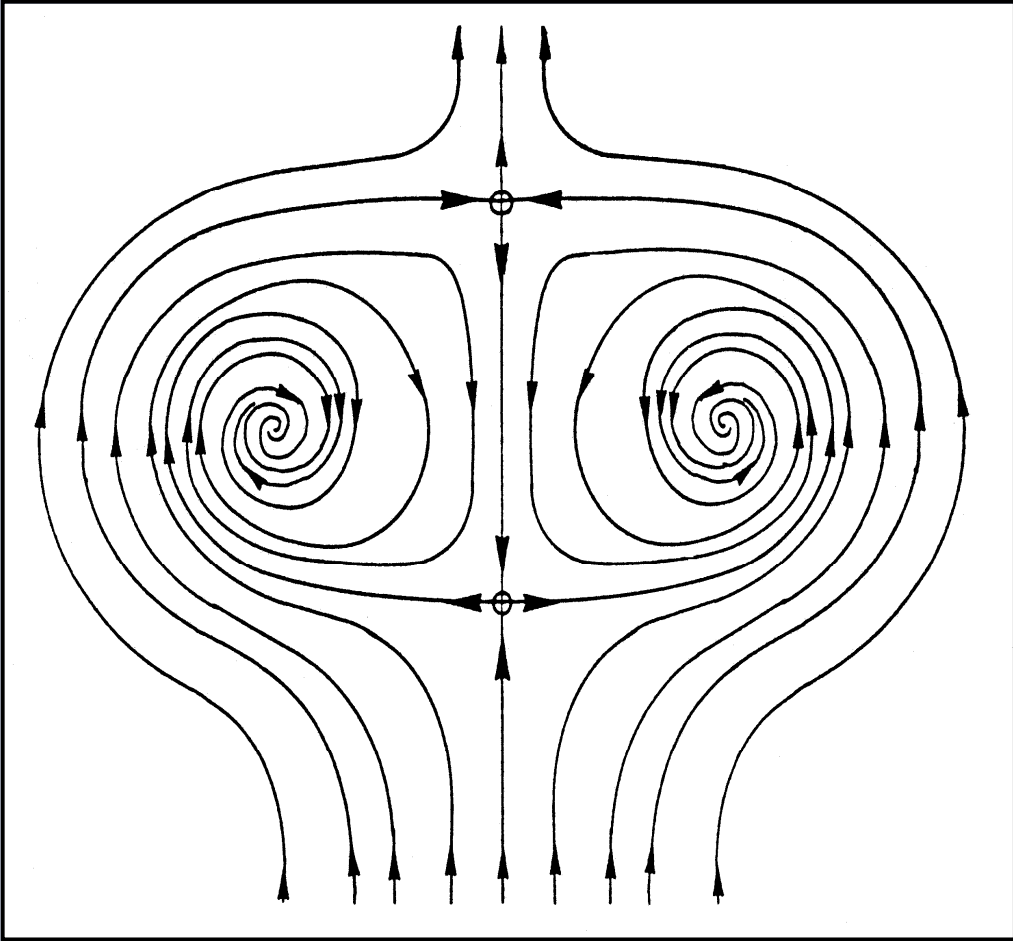
Non-propelled axisymmetric afterbody at incidence
Flow in the vertical symmetry plane



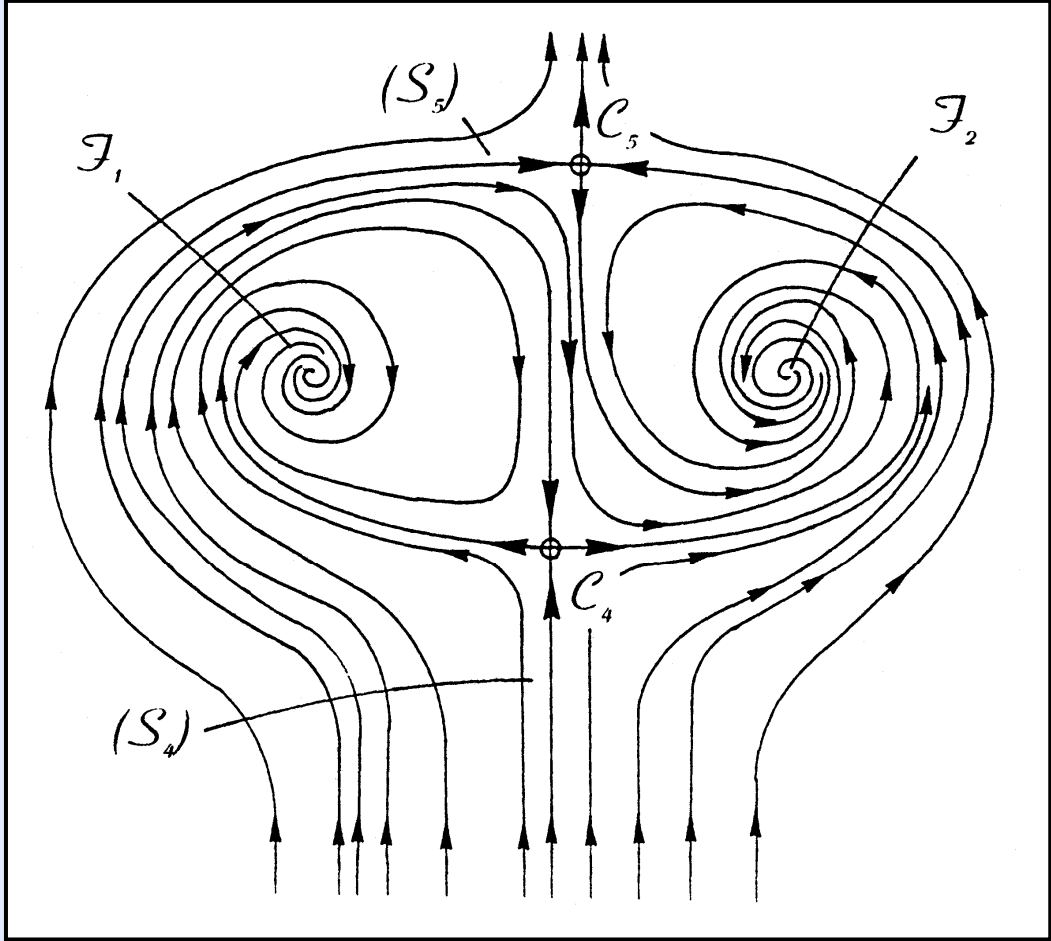
**Non-propelled axisymmetric afterbody at incidence
Detachment surface**



**Non-propelled axisymmetric afterbody at incidence
Flow projected in a vertical downstream plane**

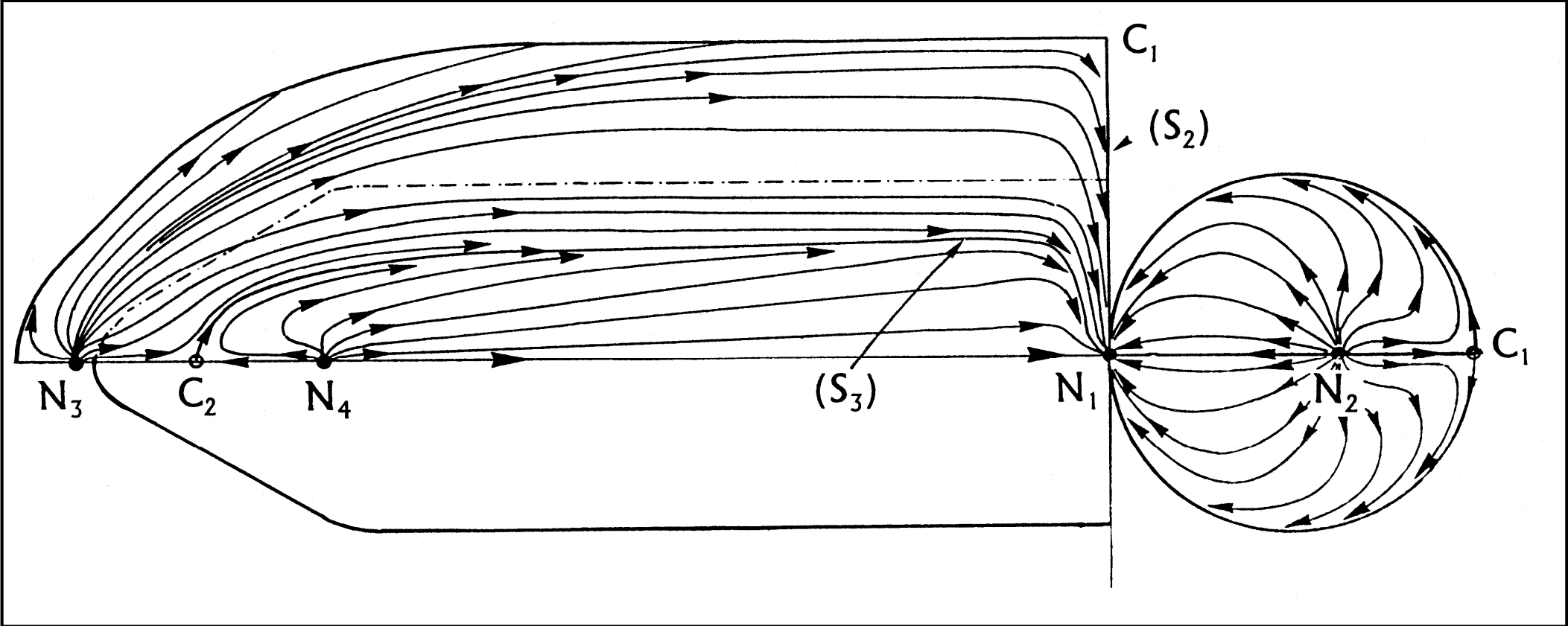


Improbable symmetric organisation

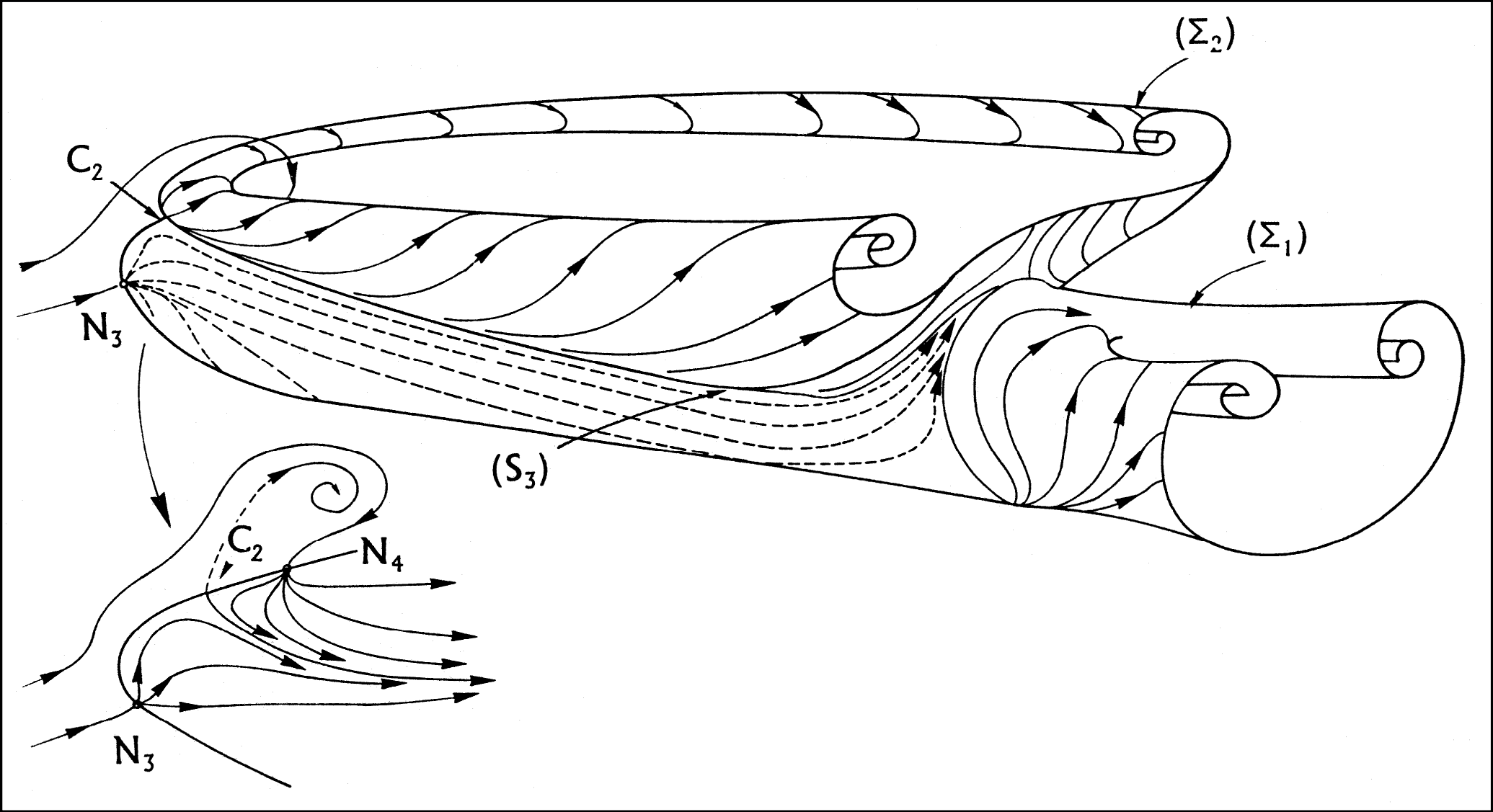


More probable asymmetric organisation

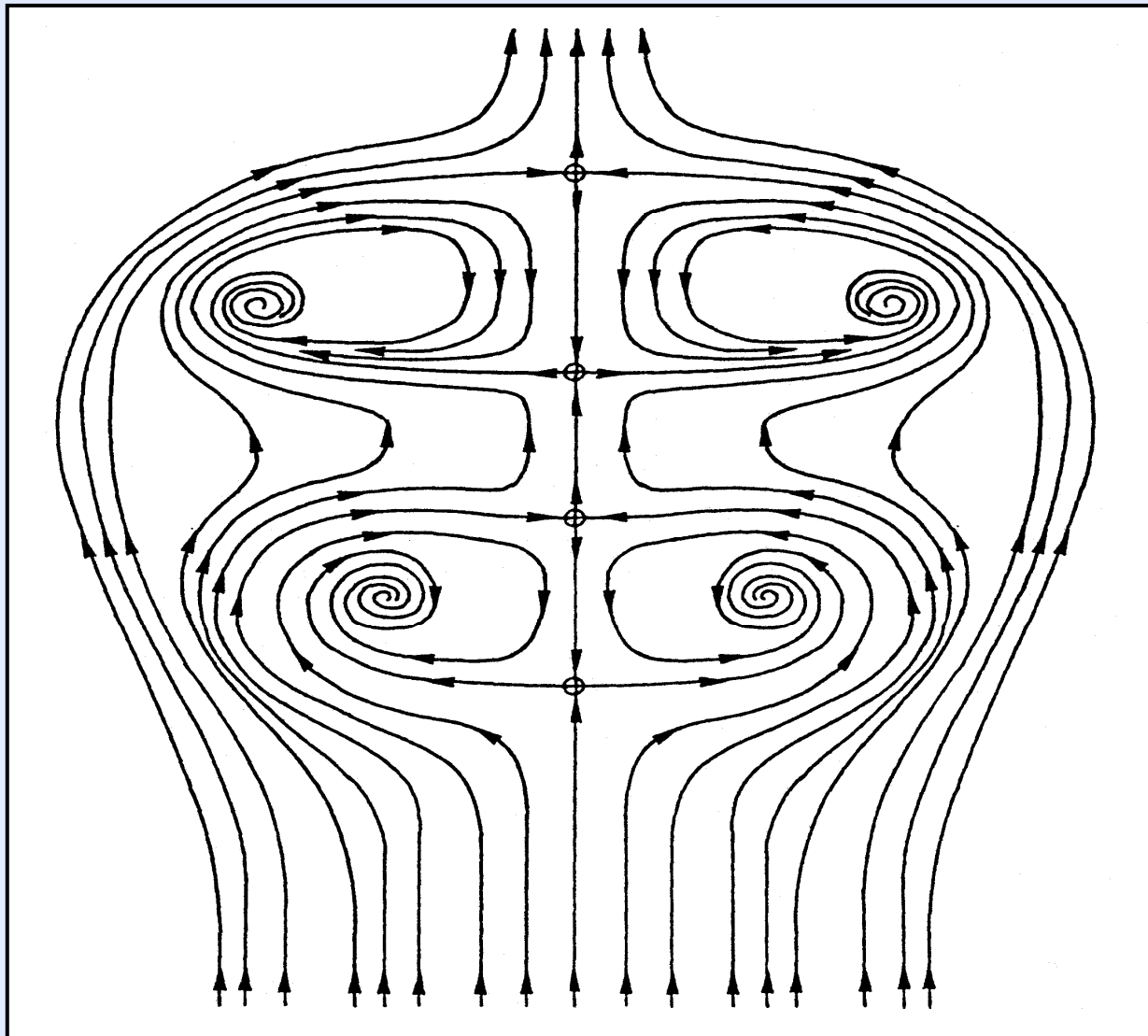
**Non-propelled axisymmetric afterbody at incidence
Skin friction line pattern (upstream part developed)**



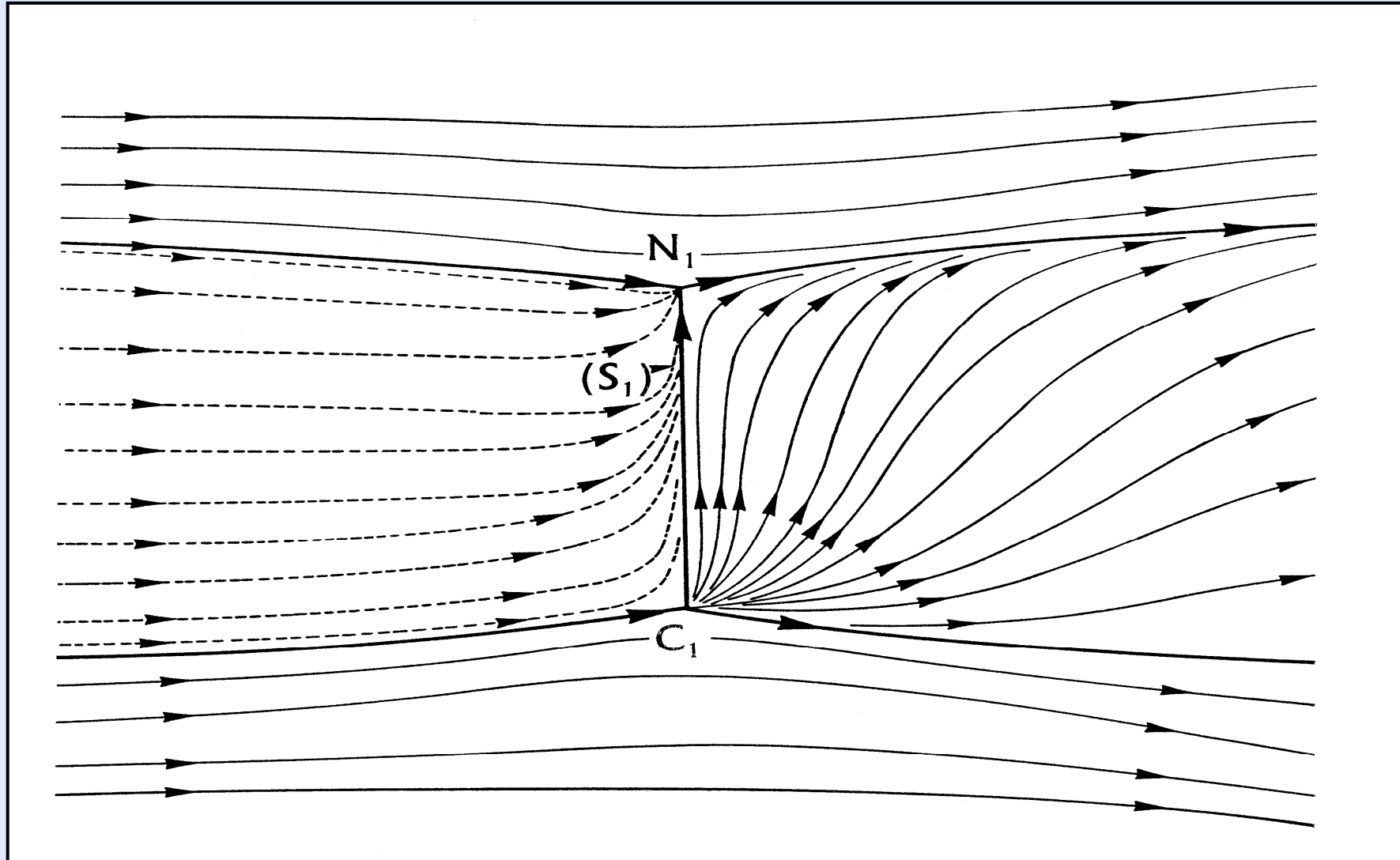
Non-propelled axisymmetric afterbody at incidence
Main detachment surfaces



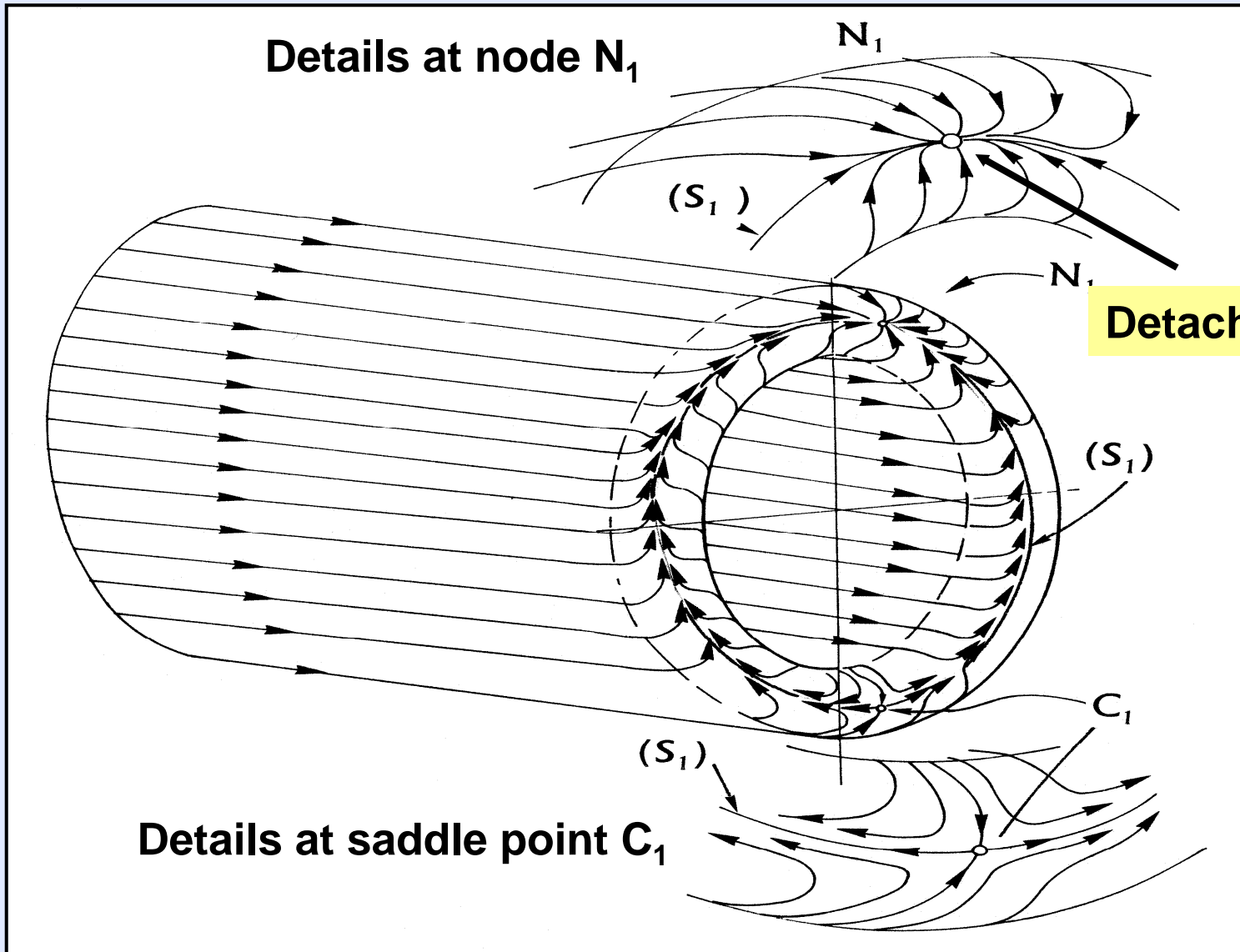
Non-propelled axisymmetric afterbody at incidence
Flow projected in a vertical downstream plane or wake structure



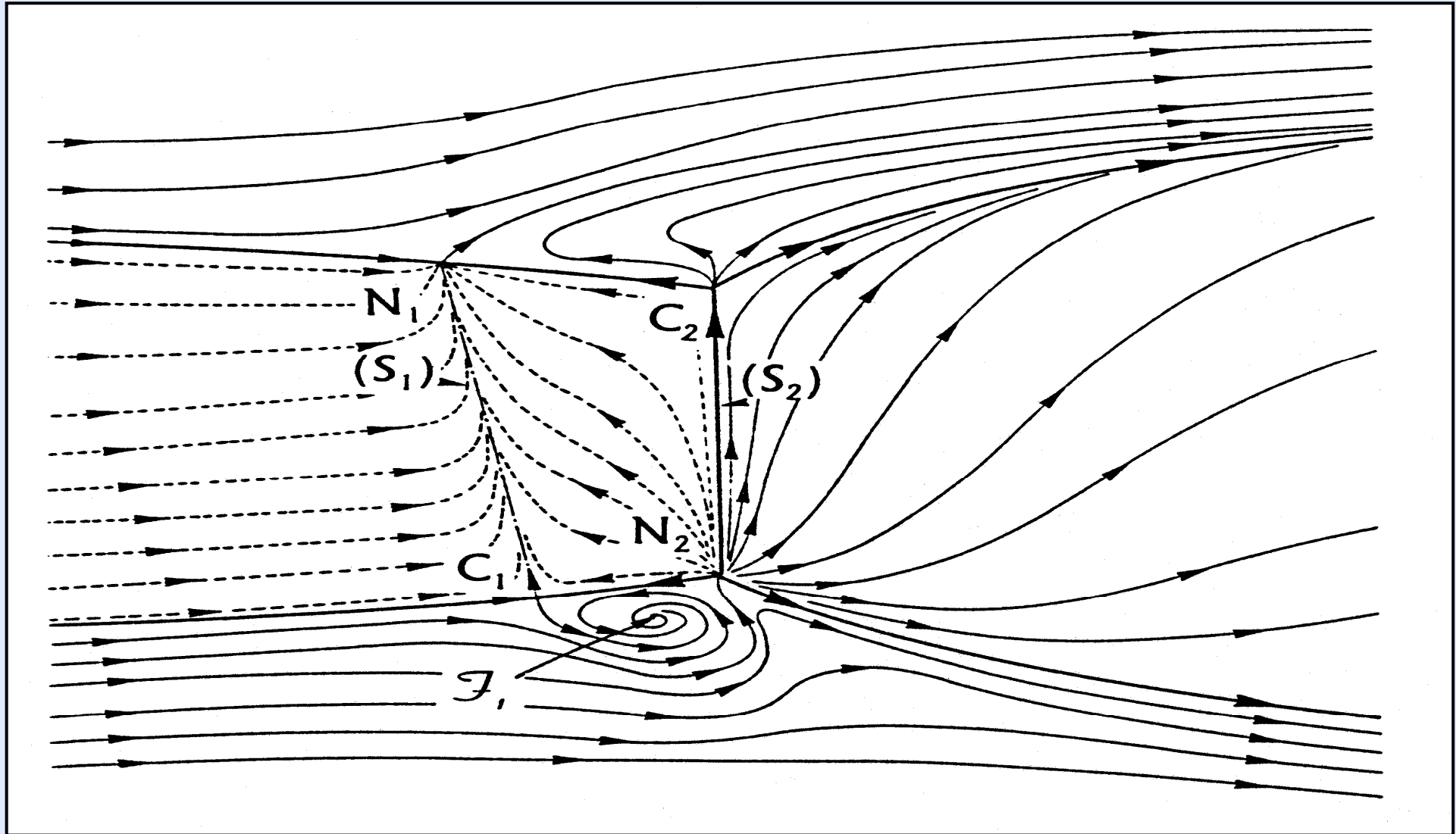
Propelled afterbody without base at incidence
Skin friction line pattern and separation surface



Propelled afterbody without base at incidence
Skin friction line pattern at nozzle exit

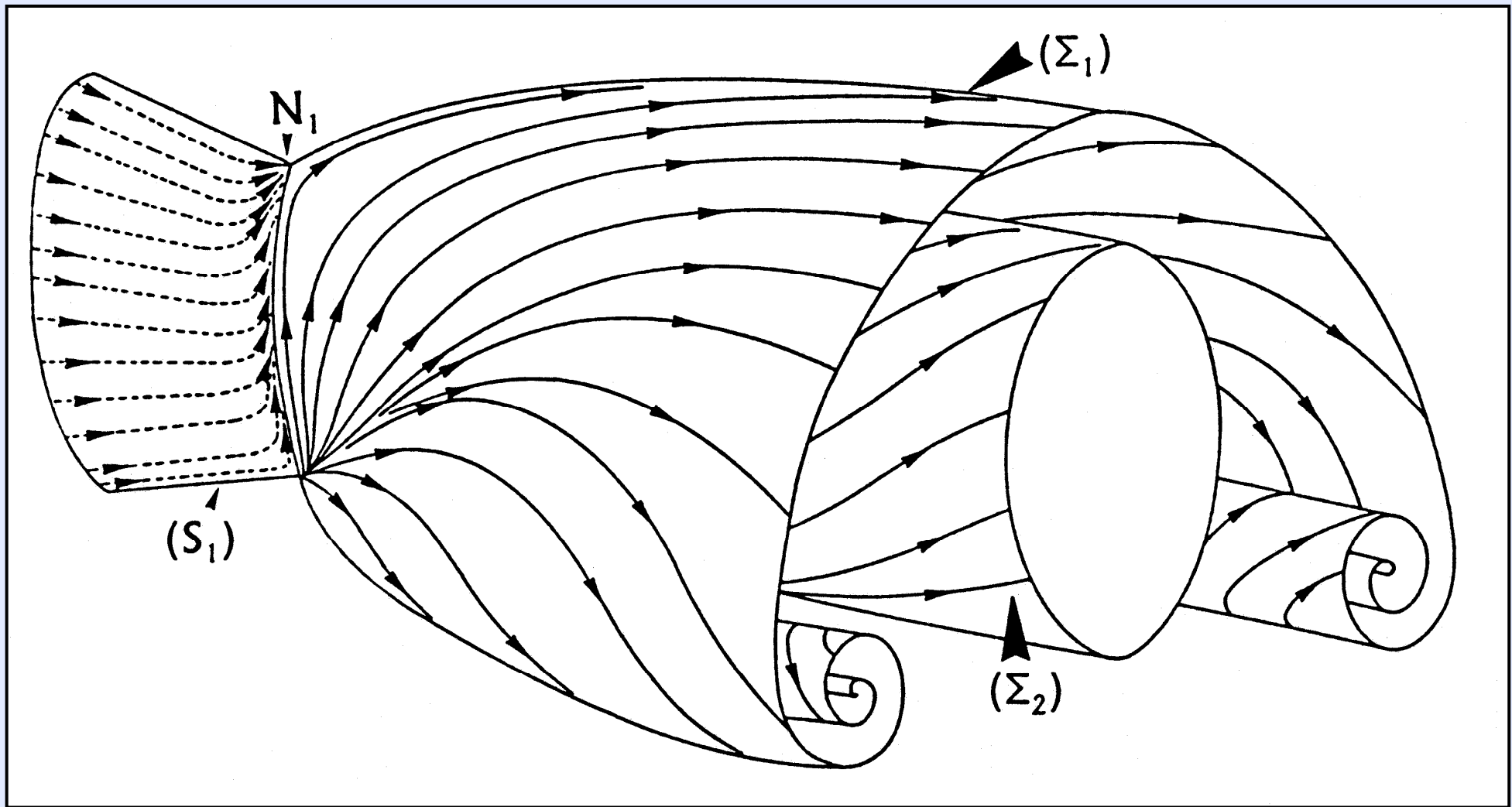


Propelled afterbody without base at incidence with jet pluming
Skin friction line pattern on the fuselage and jet surface

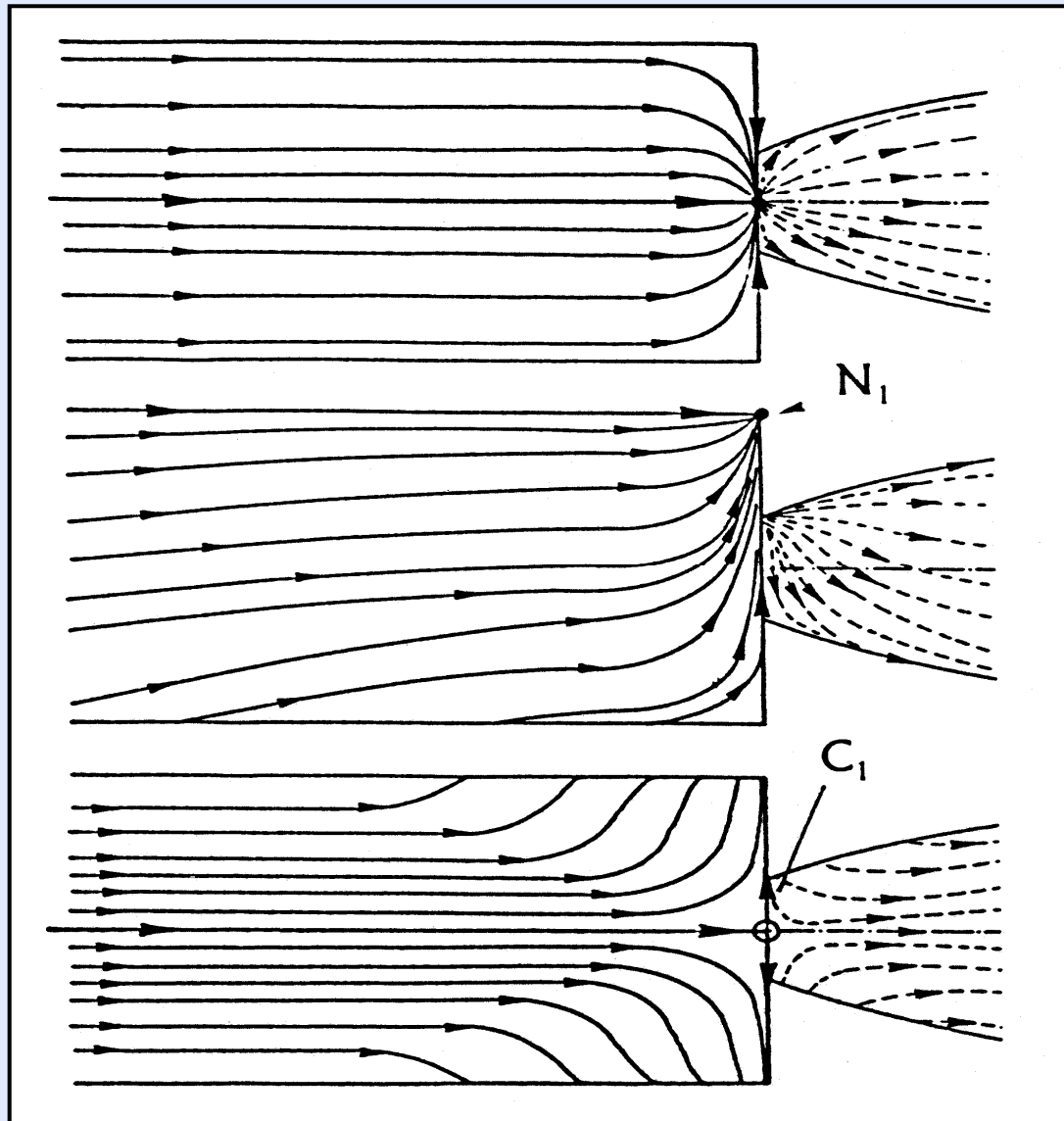


Symmetry plane and jet separation surface

Propelled afterbody without base and jet pluming
Main detachment surfaces



Propelled afterbody with base at incidence
Skin friction line pattern on the fuselage

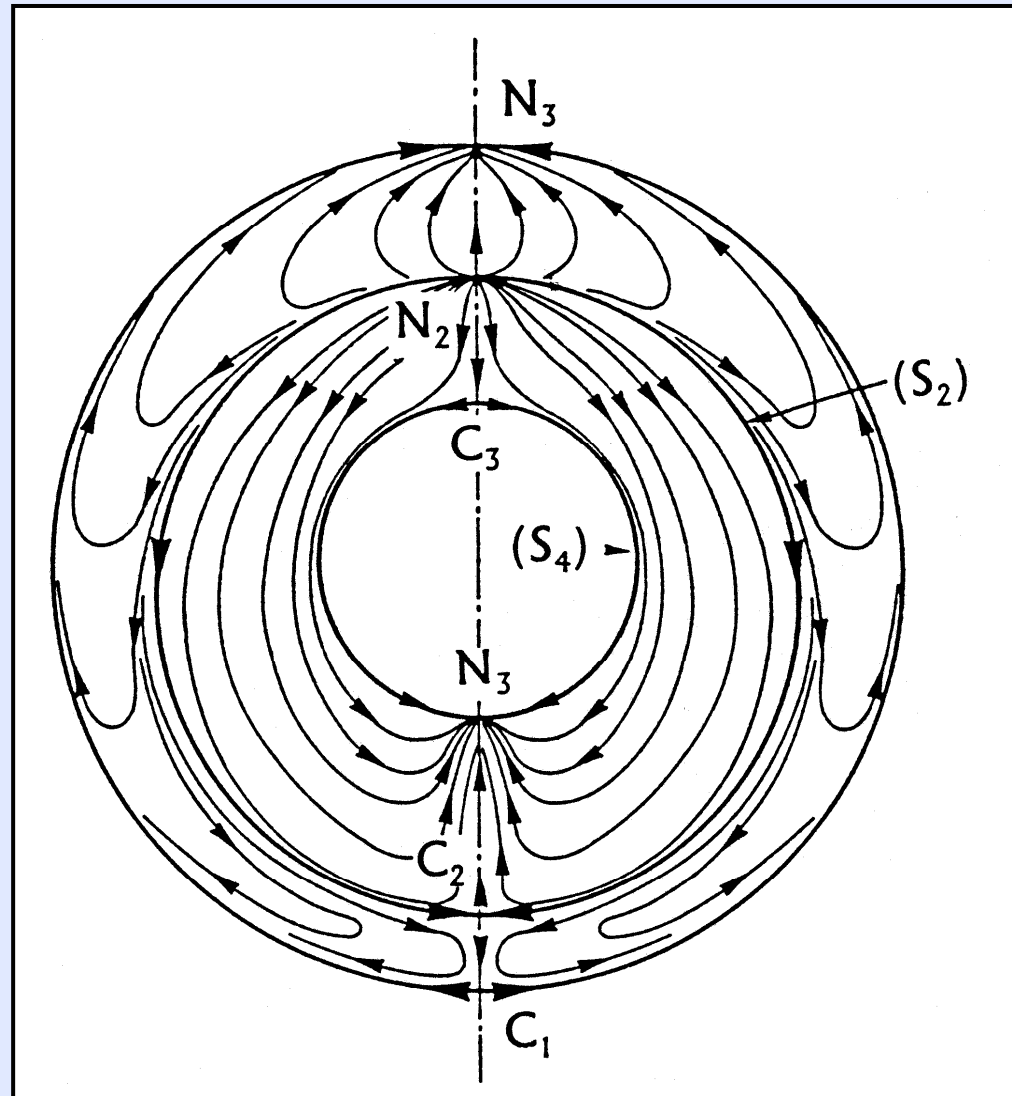


Seen from above
Leeside

Side view

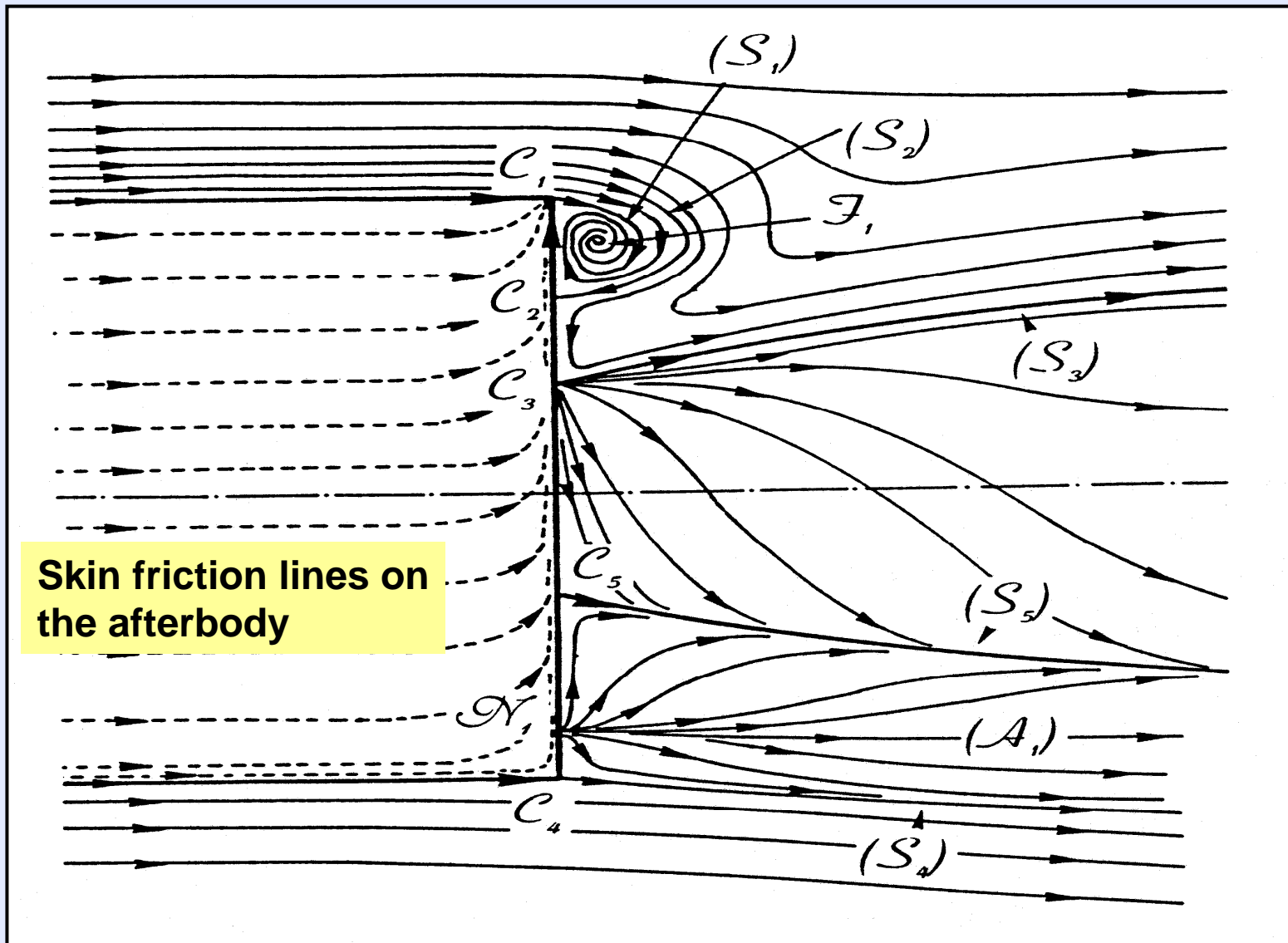
Seen from below
Windward side

Propelled afterbody with a base



Skin friction line pattern on the base

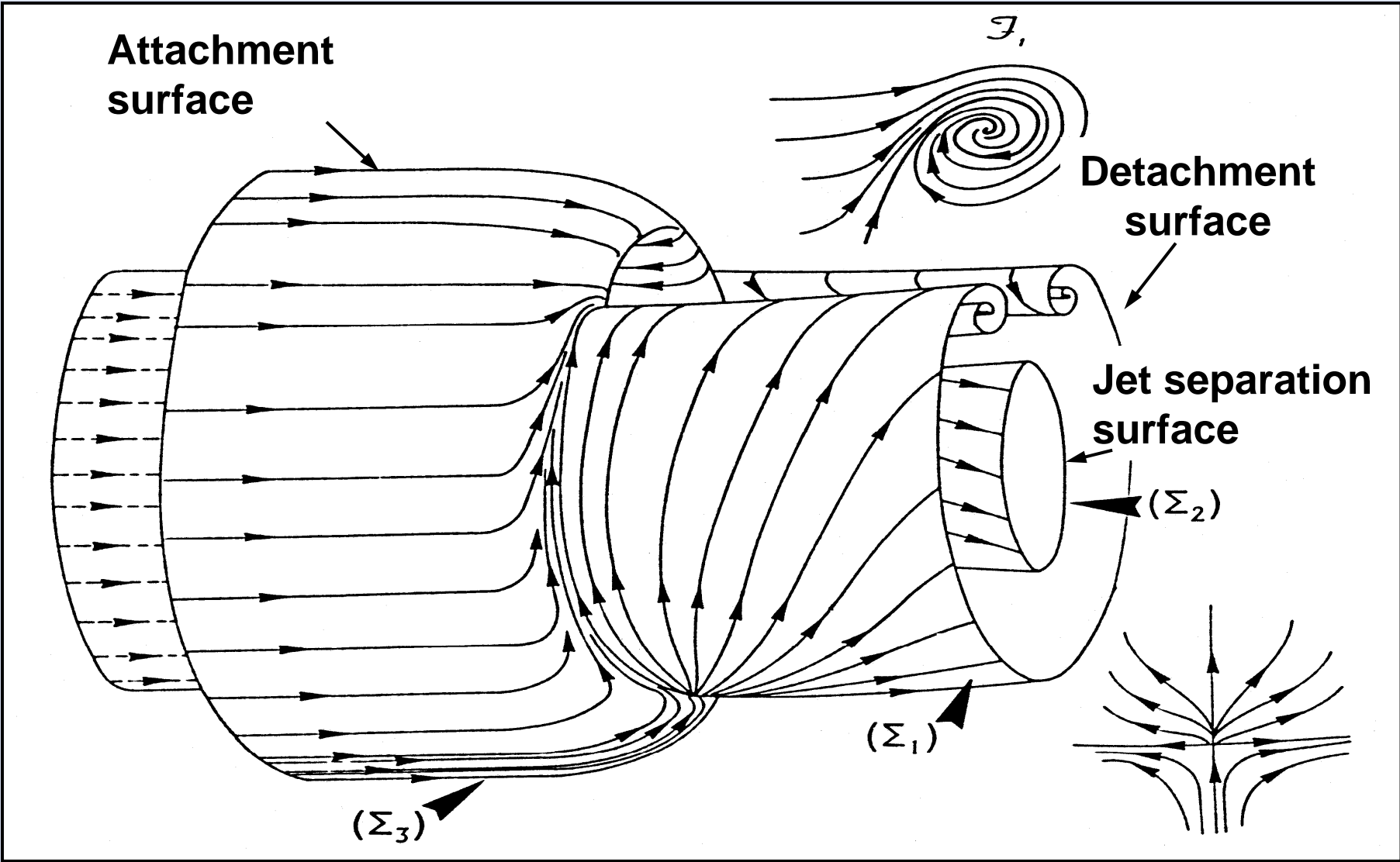
Propelled afterbody with base at incidence



Skin friction lines on the afterbody

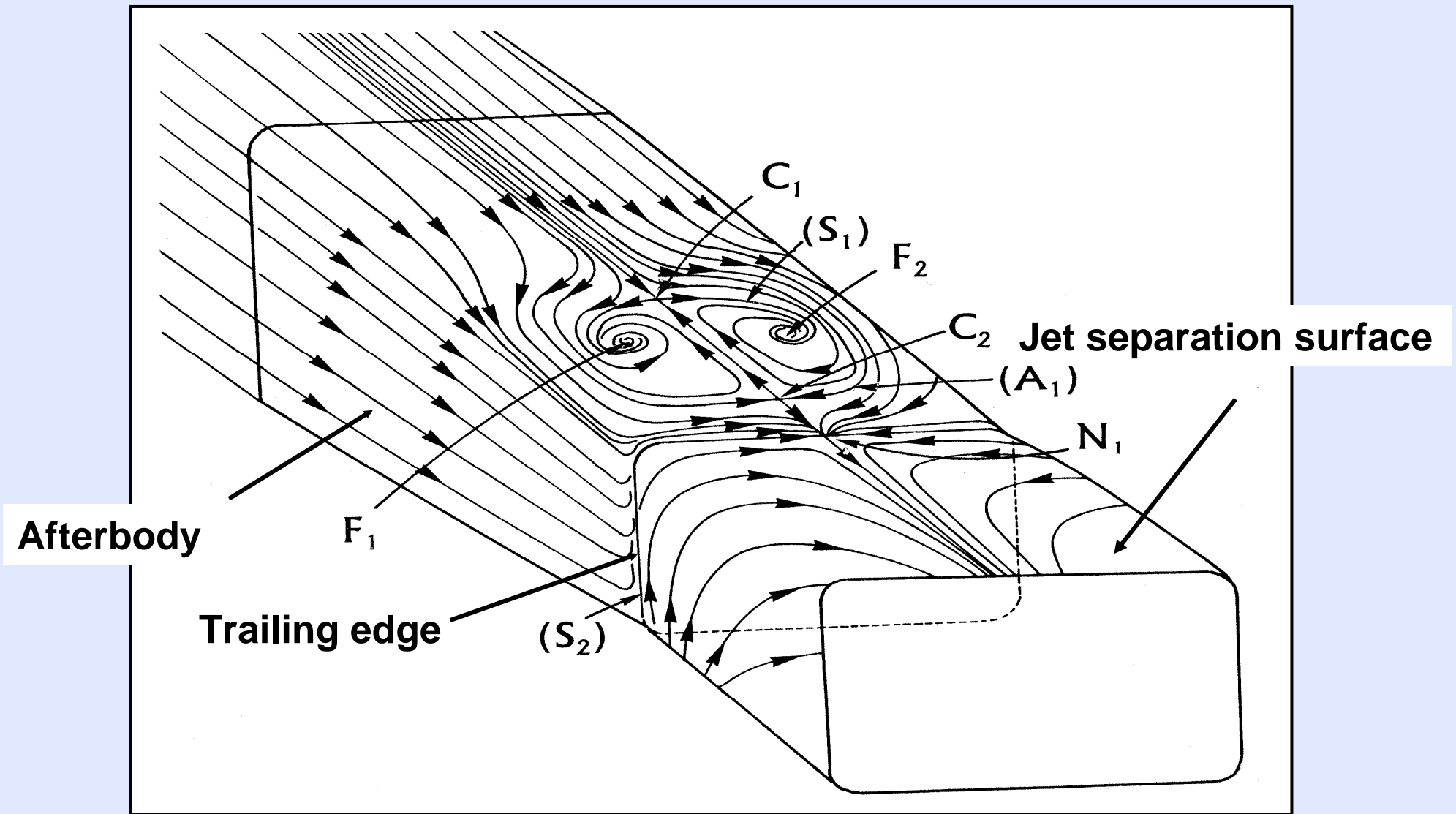
Streamlines in the symmetry plane and on the jet separation surface

Propelled afterbody with base at incidence



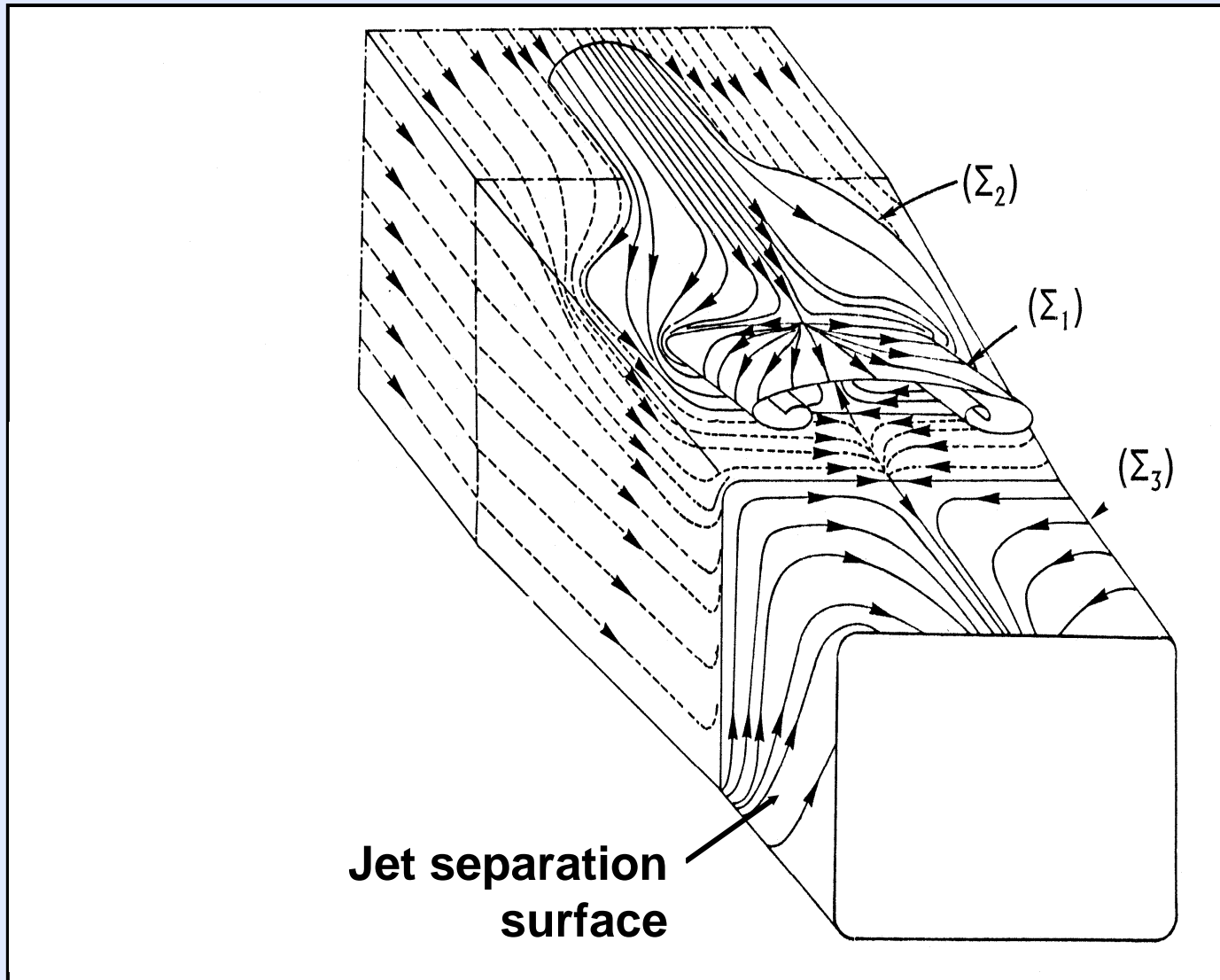
Main separation surfaces

Afterbody with rectangular cross section



Skin friction line pattern on the suction side

Afterbody with rectangular cross section



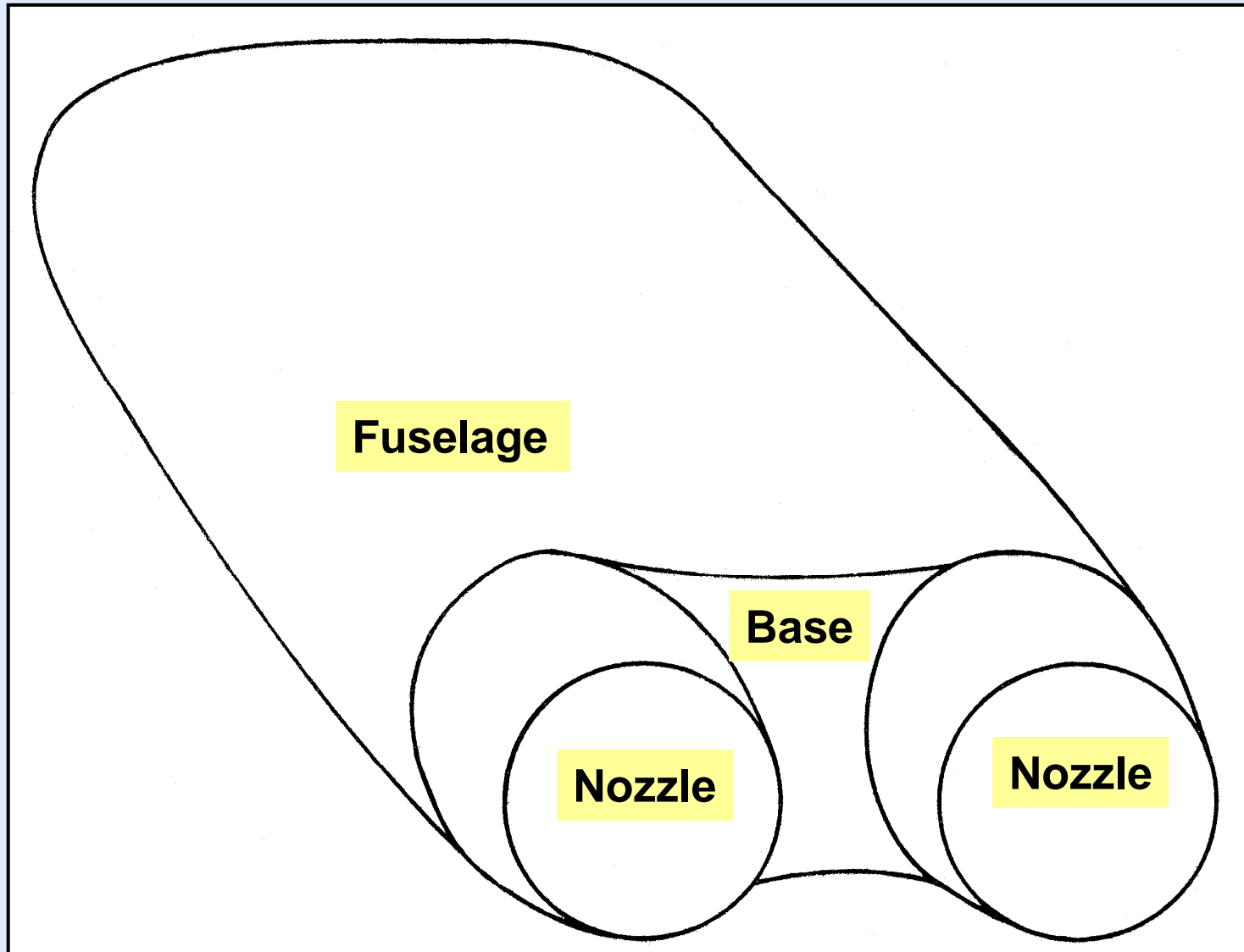
Main separation surfaces

Afterbody of a twin-nozzle fighter aircraft

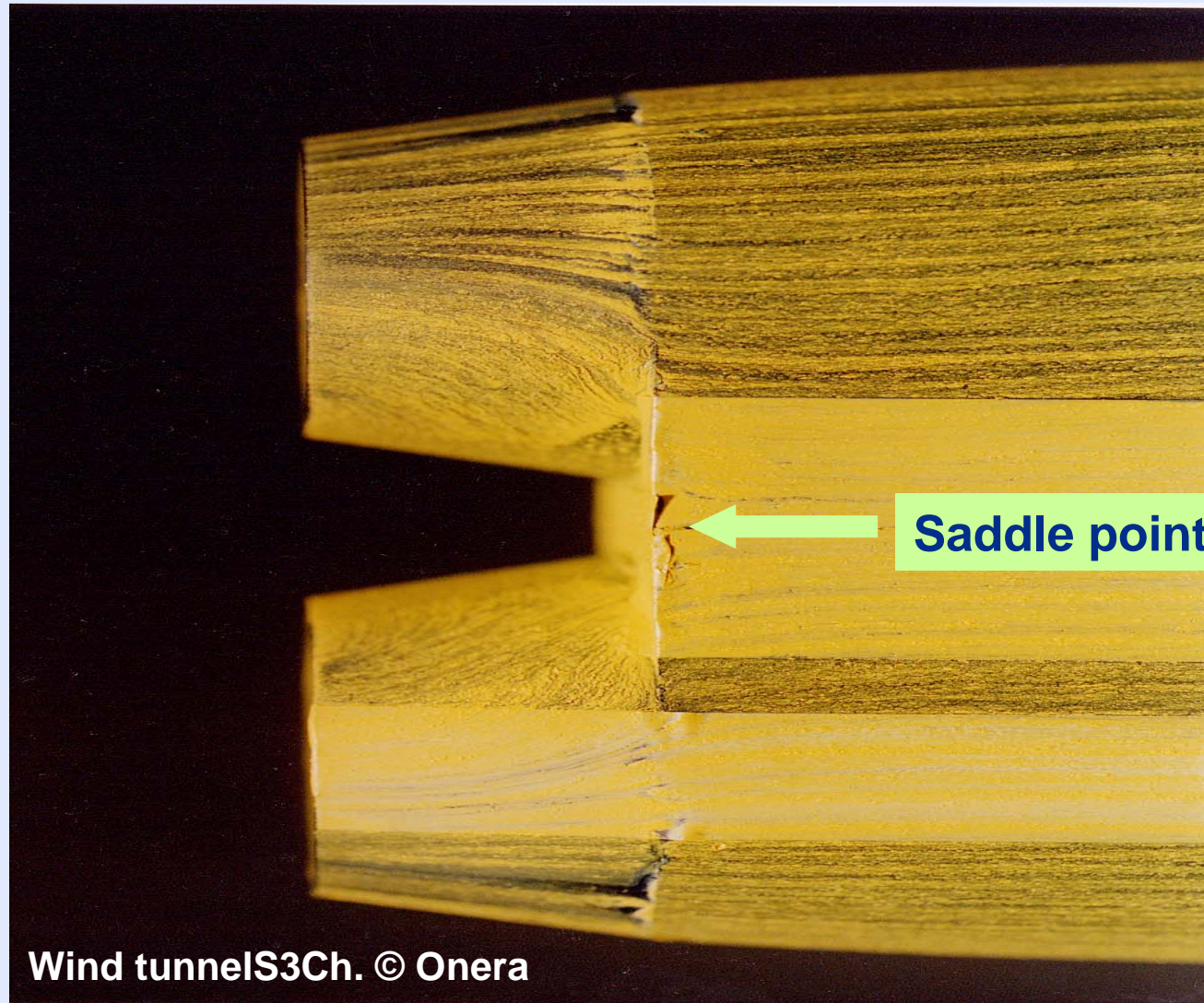


Dassault Aviation *Jaguar* fighter aircraft

Afterbody of a twin-nozzle fighter aircraft
Simplified afterbody geometry

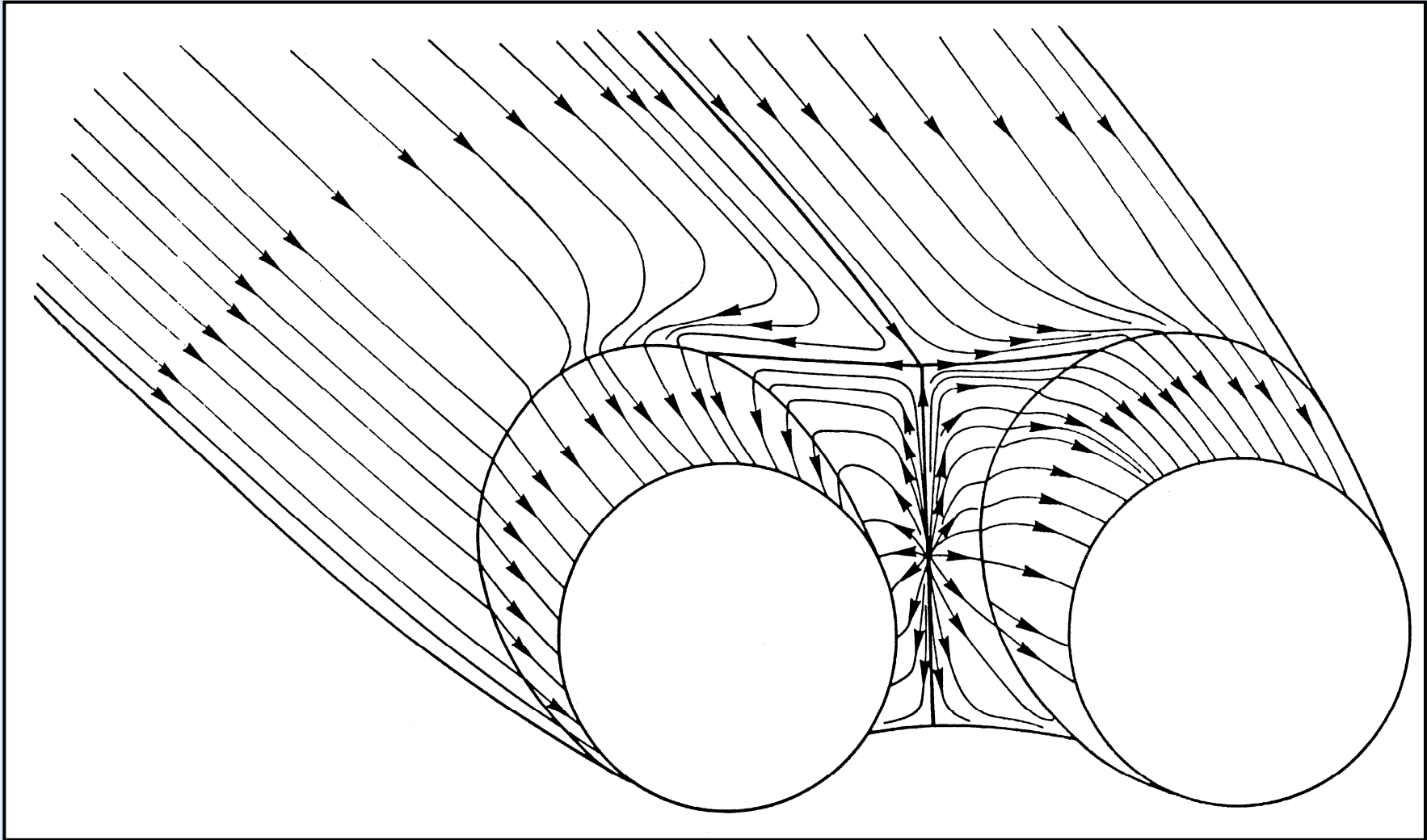


Afterbody of a twin-nozzle fighter aircraft



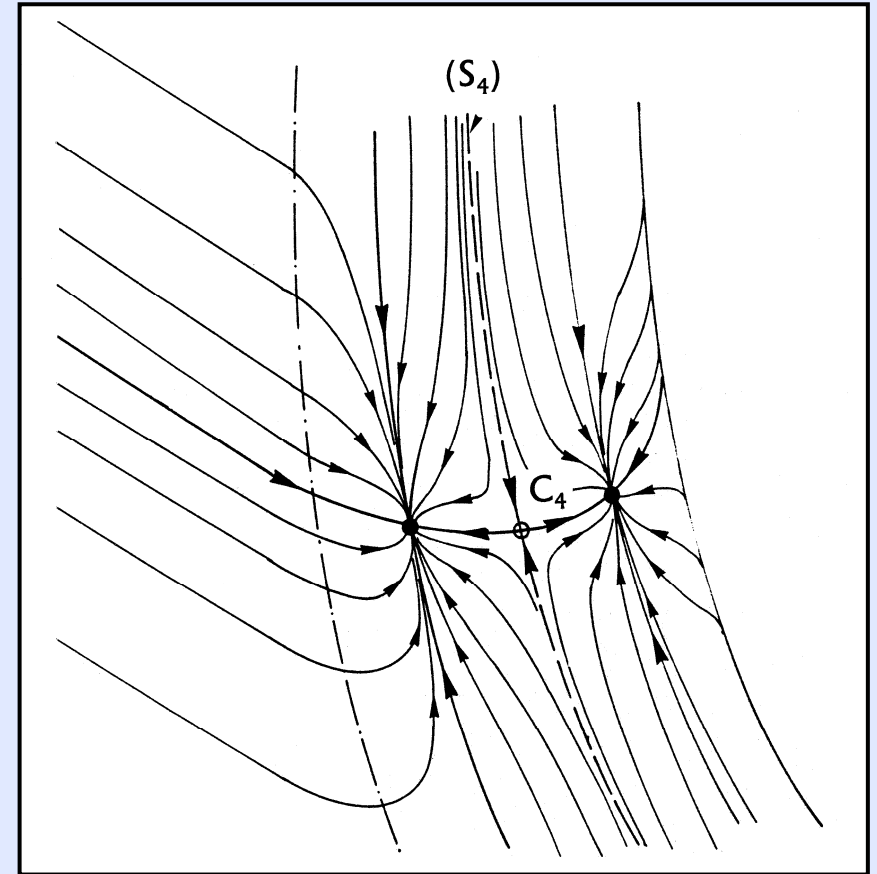
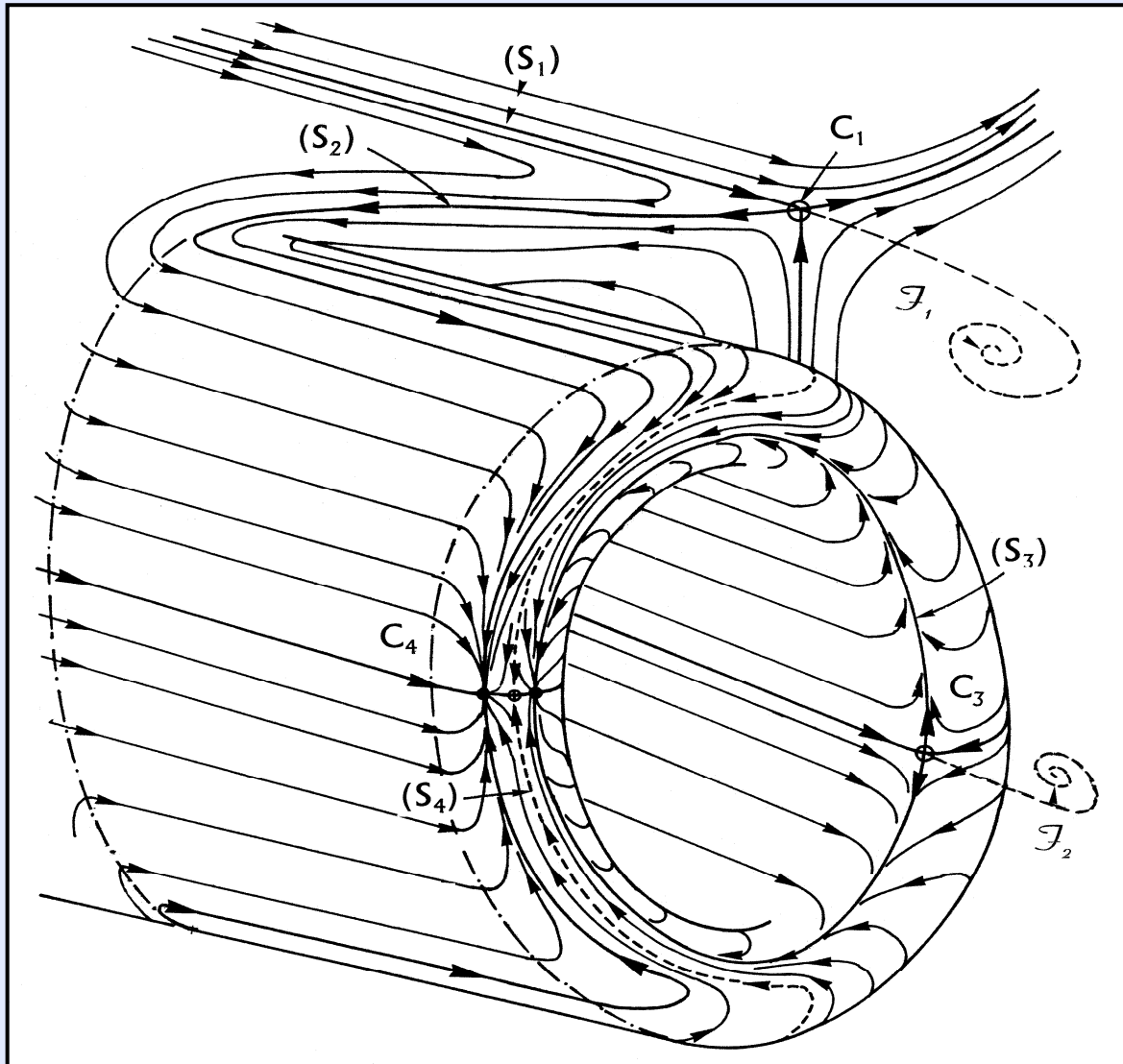
Surface flow visualization

Afterbody of a twin-nozzle fighter aircraft



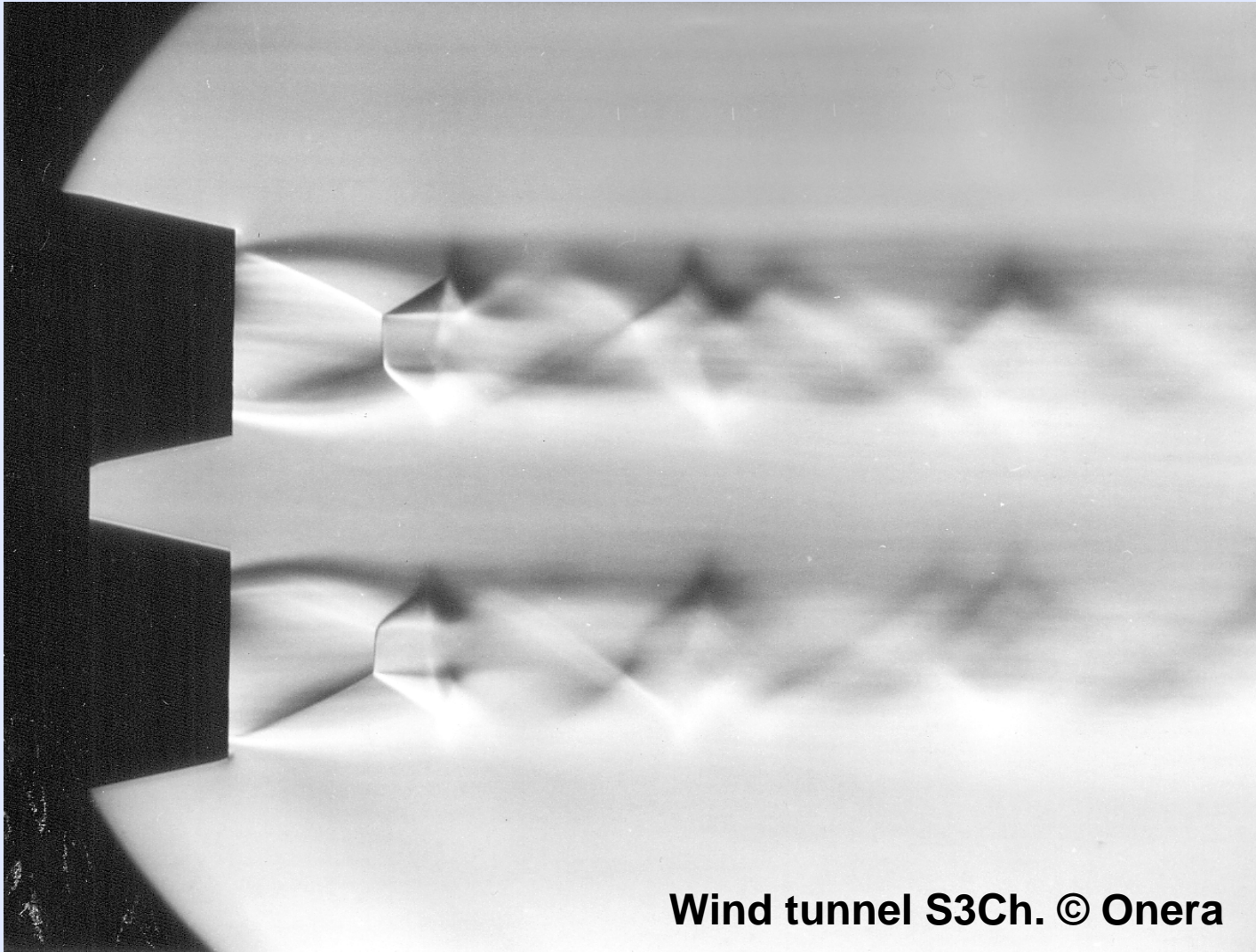
Skin friction line pattern

Afterbody of a twin-nozzle fighter aircraft
Skin friction line pattern. Details at the nozzle lip



**Details in the vicinity of
saddle point C_4**

Afterbody of a twin-nozzle fighter aircraft

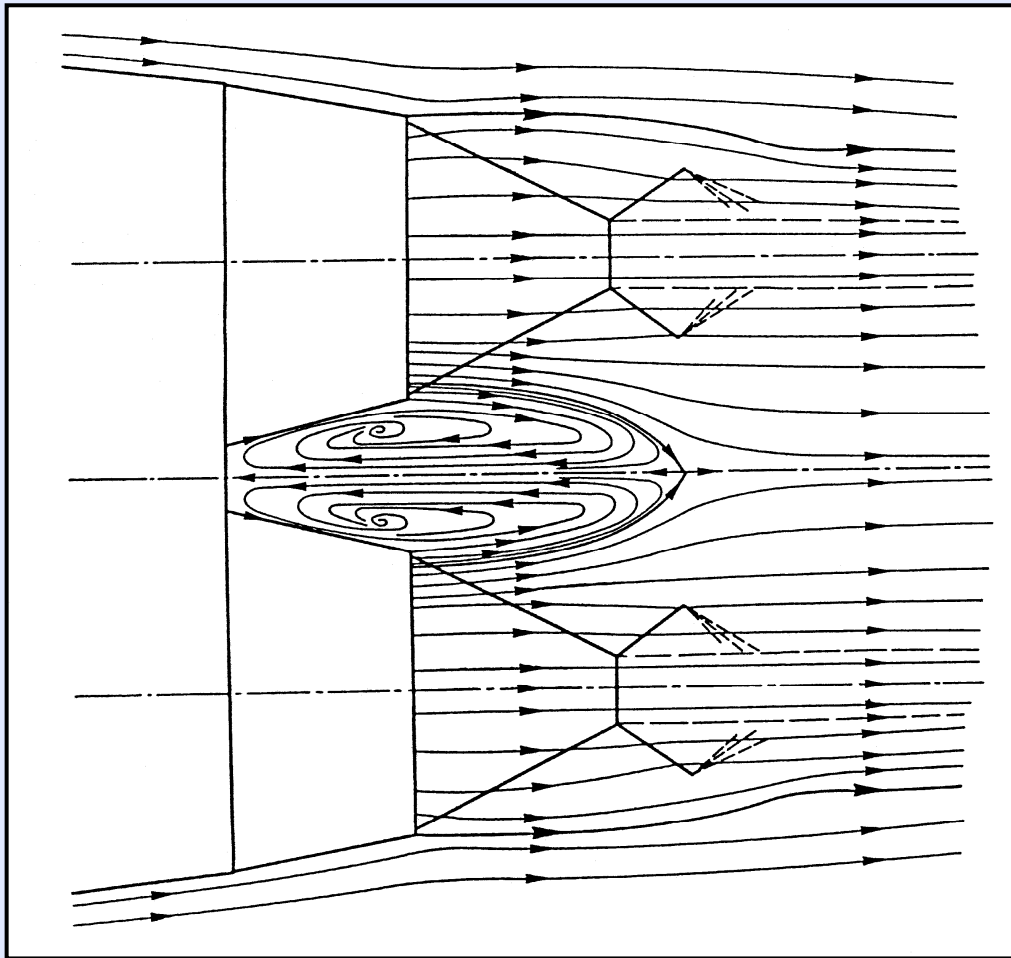


Wind tunnel S3Ch. © Onera

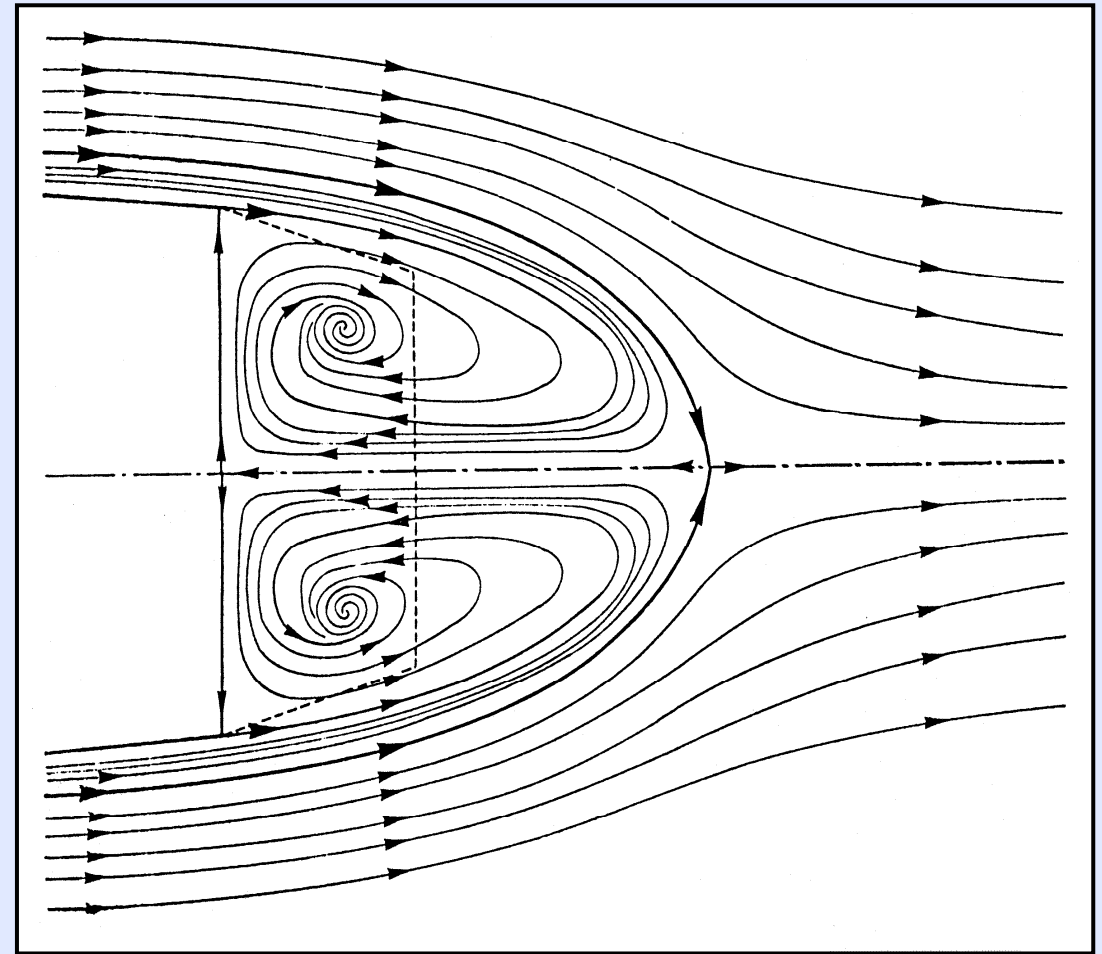
Schlieren visualisation of the jets

Afterbody of a twin-nozzle fighter aircraft

Flow in the symmetry planes

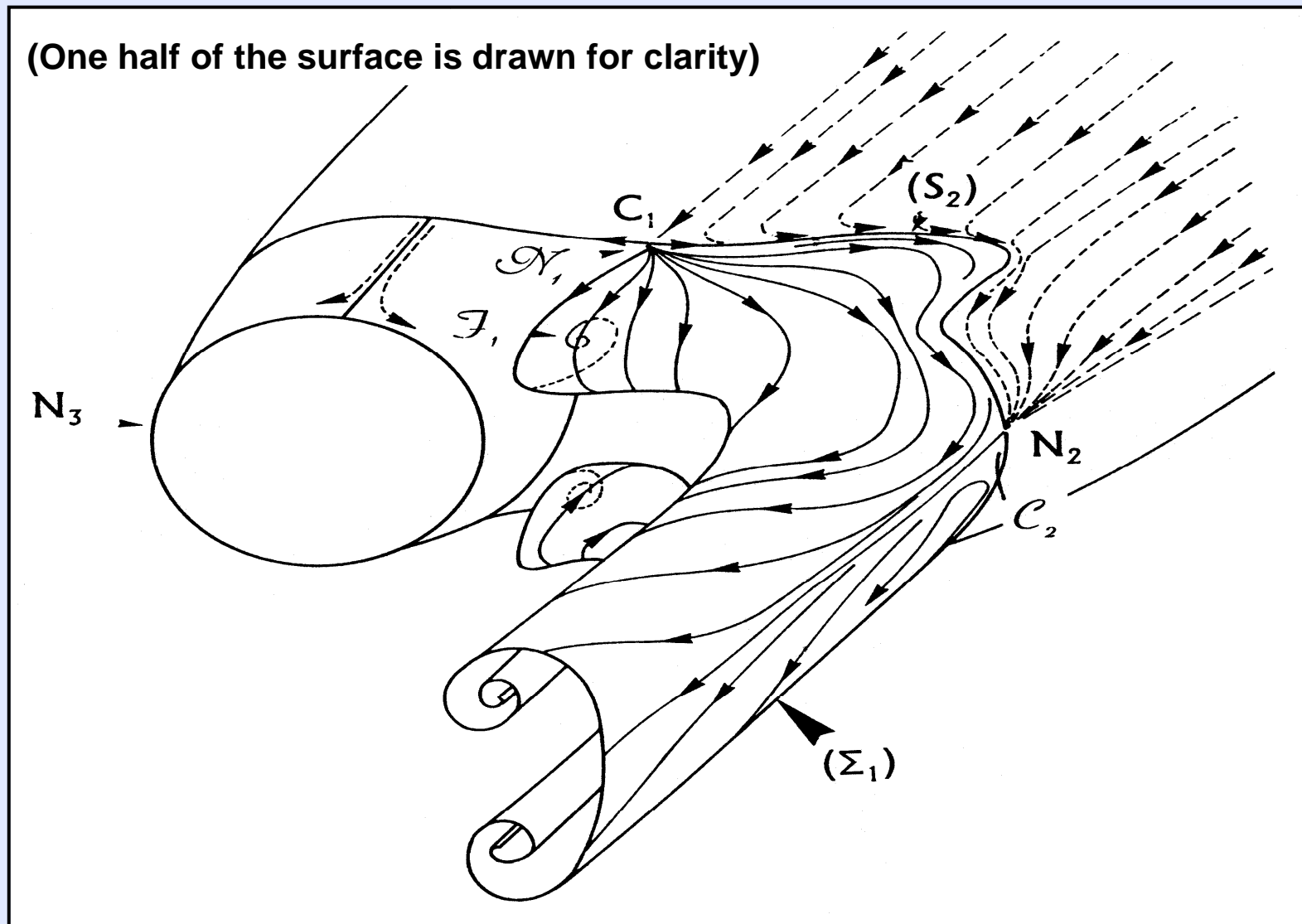


Plane containing the nozzle axes



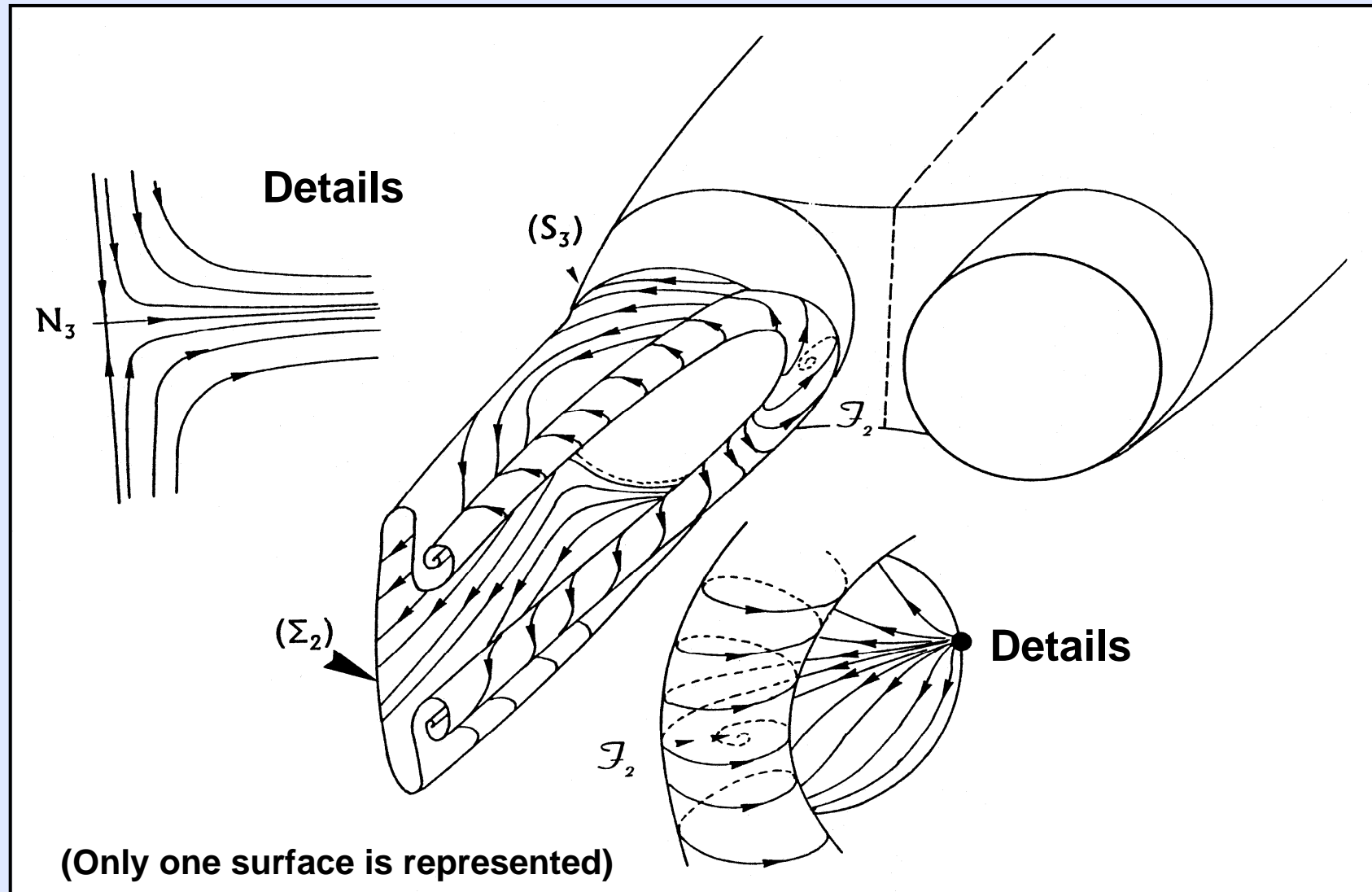
Perpendicular plane

Afterbody of a twin-nozzle fighter aircraft



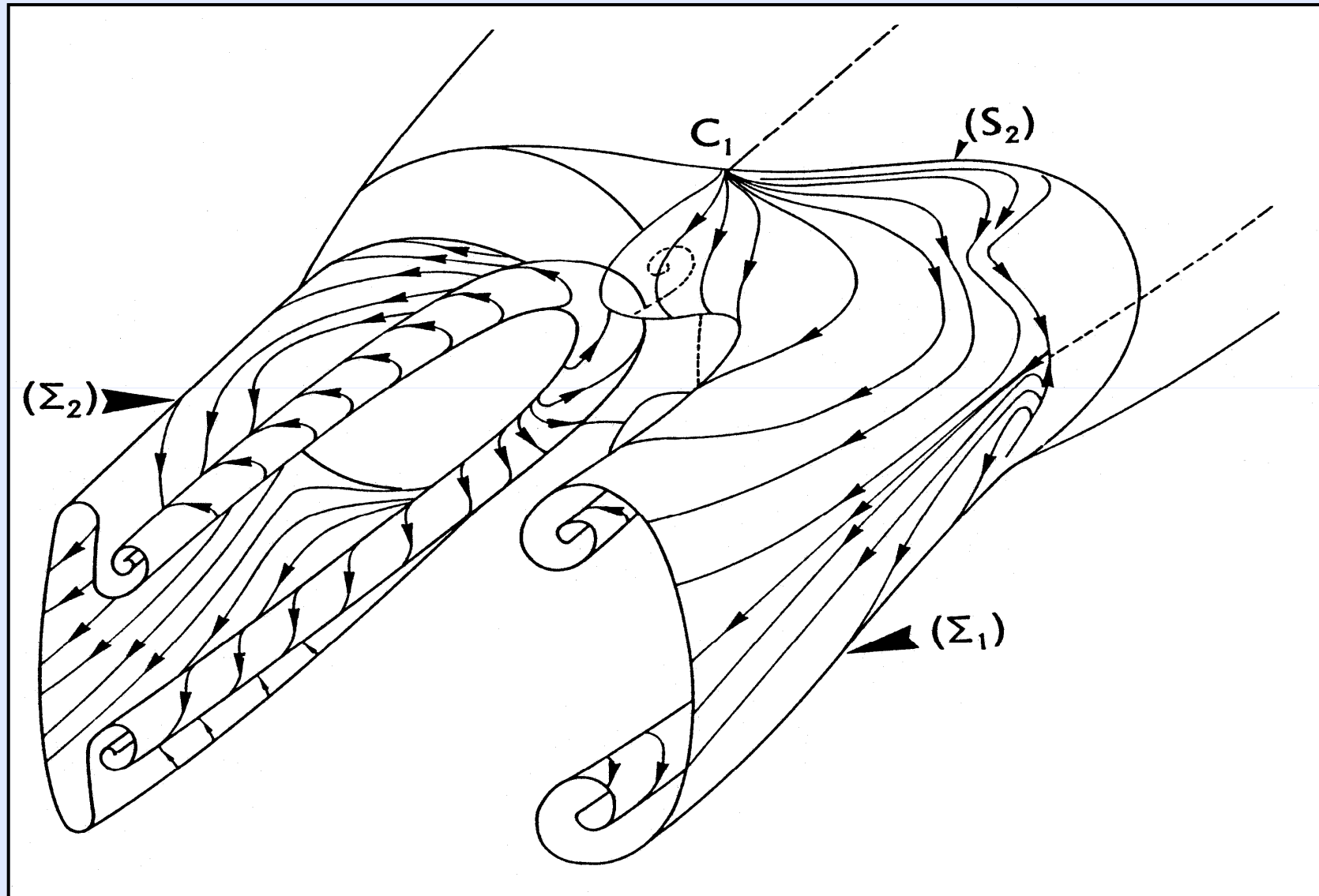
Detachment surface attached to the afterbody extremity

Afterbody of a twin-nozzle fighter aircraft



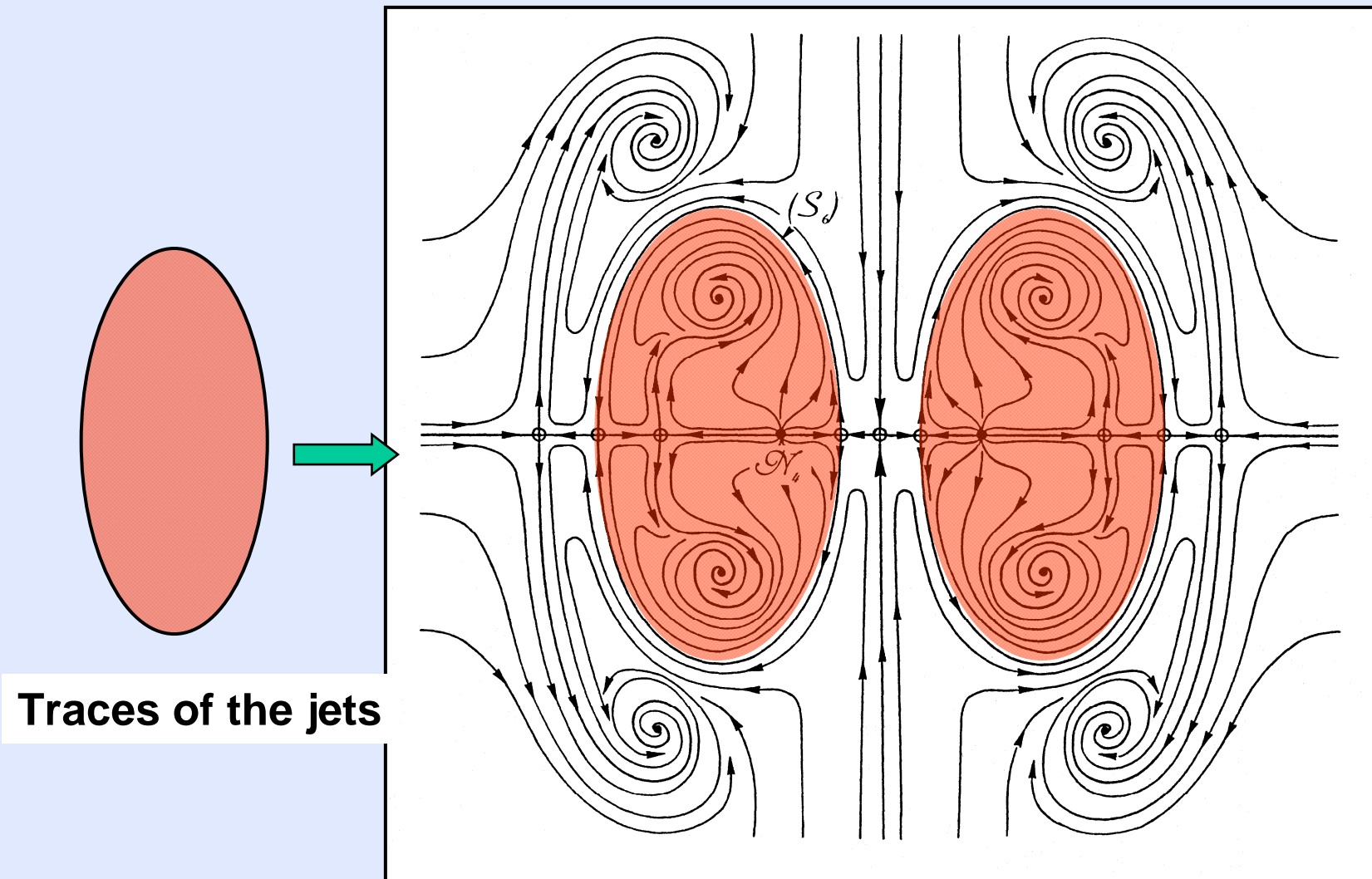
Detachment surface attached to the nozzle lip

Afterbody of a twin-nozzle fighter aircraft



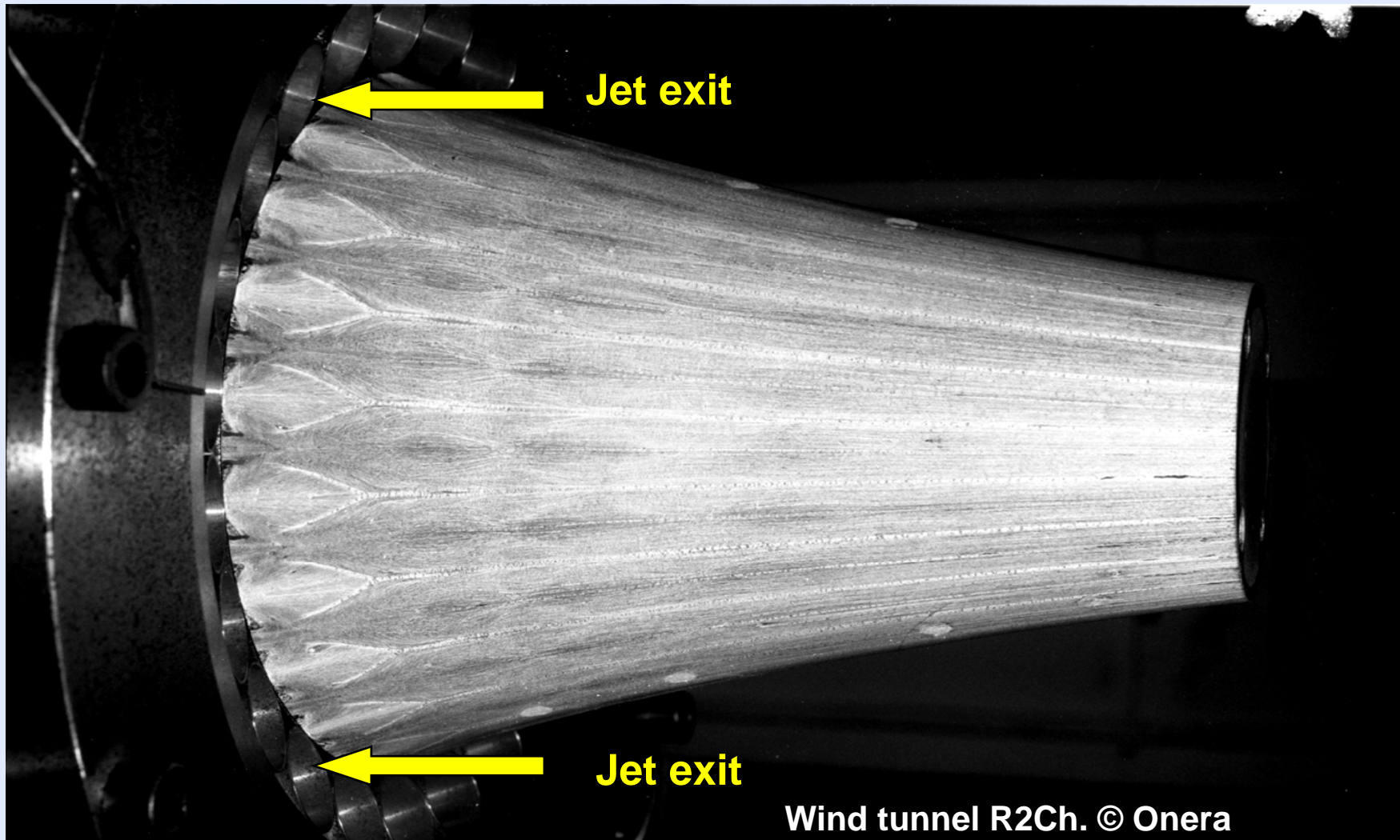
Representation of the main separation surfaces

Afterbody of a twin-nozzle fighter aircraft



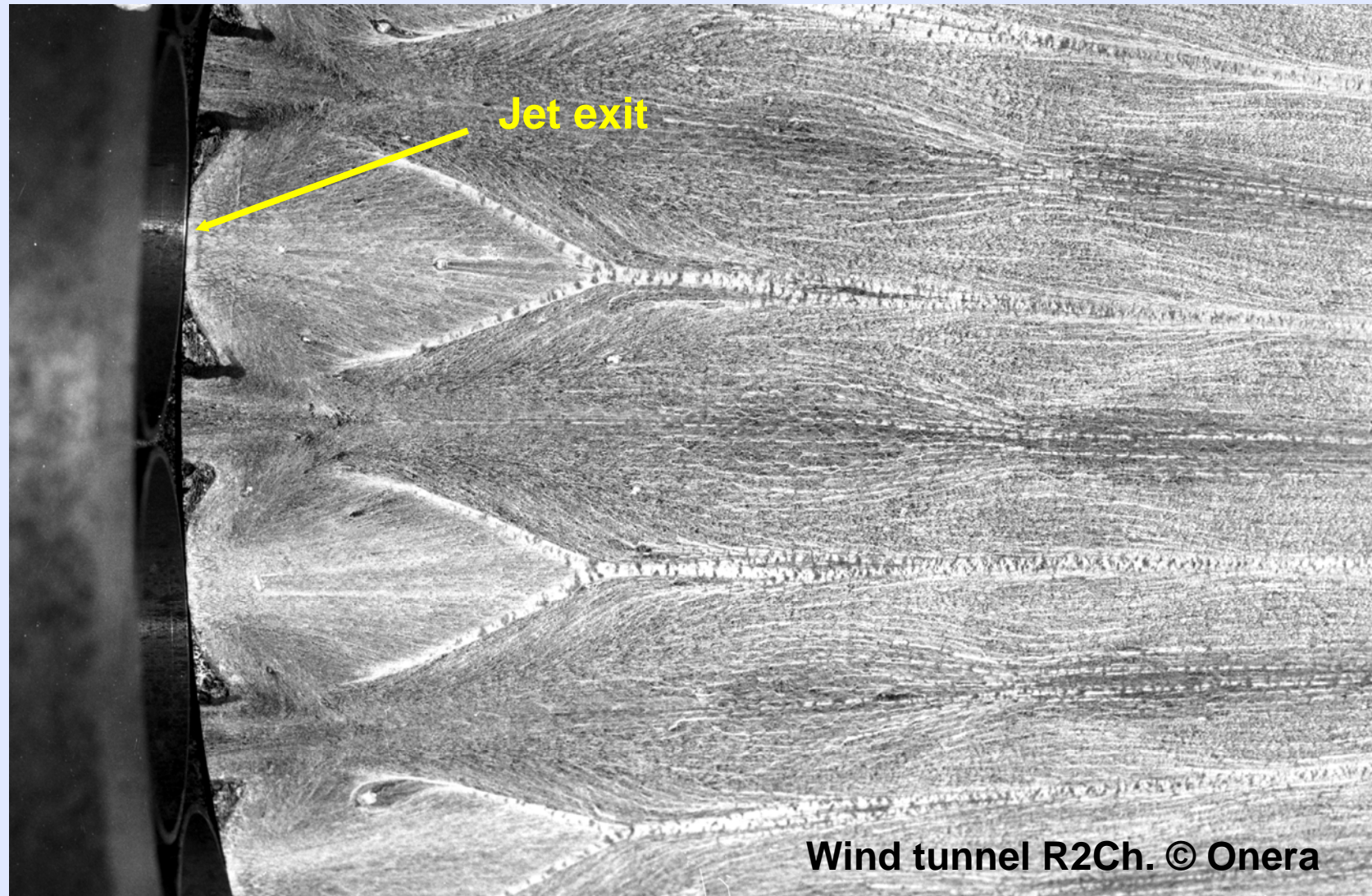
Flow projected in a normal downstream plane

Aerospike type nozzle with 24 peripheral jets



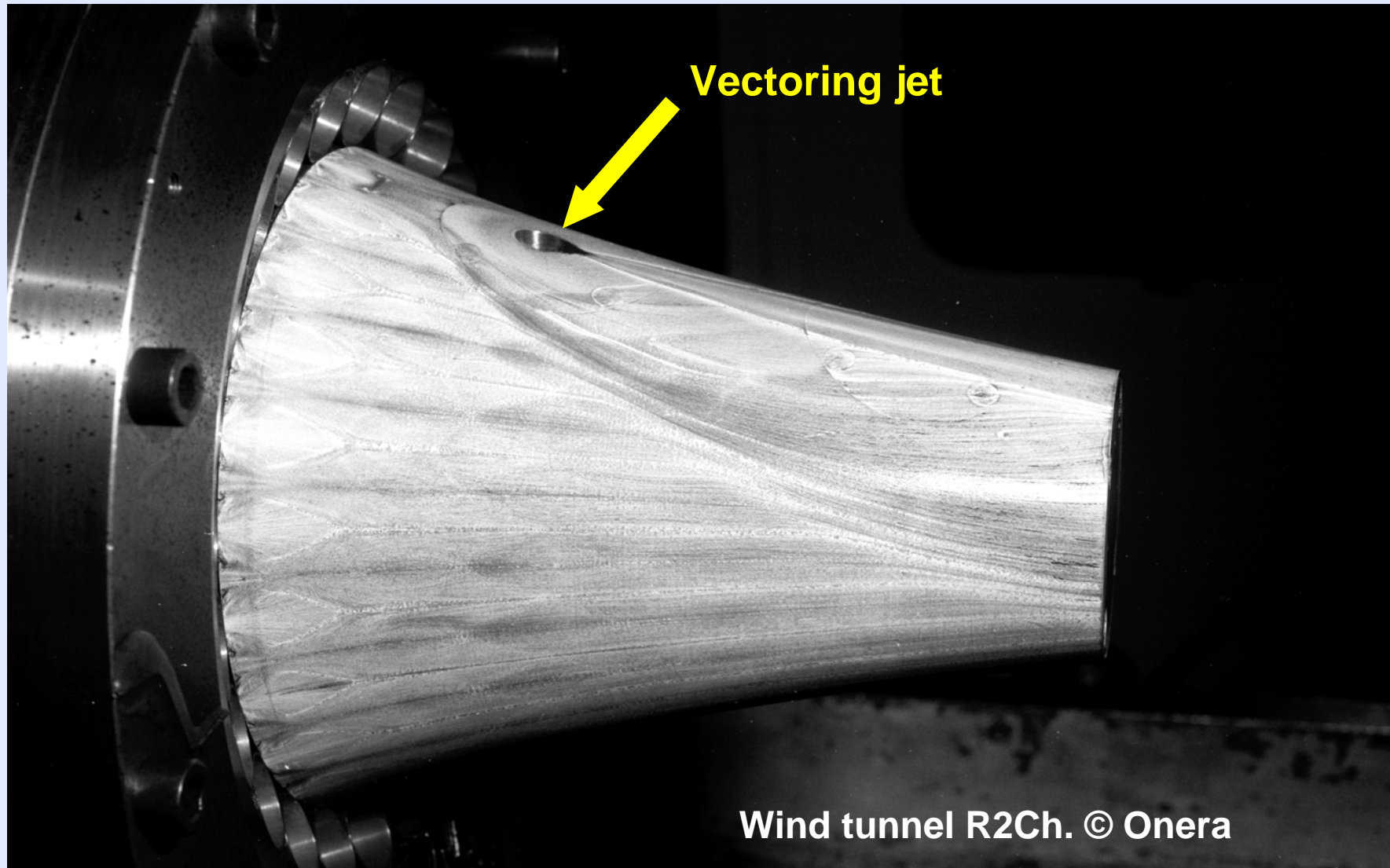
Surface flow visualisation

Aerospike type nozzle with 24 peripheral jets



Surface flow visualisation. Close up of the jet exit region

**Aerospike type nozzle with vectoring lateral jet
Surface flow visualisation**



Wind tunnel R2Ch. © Onera

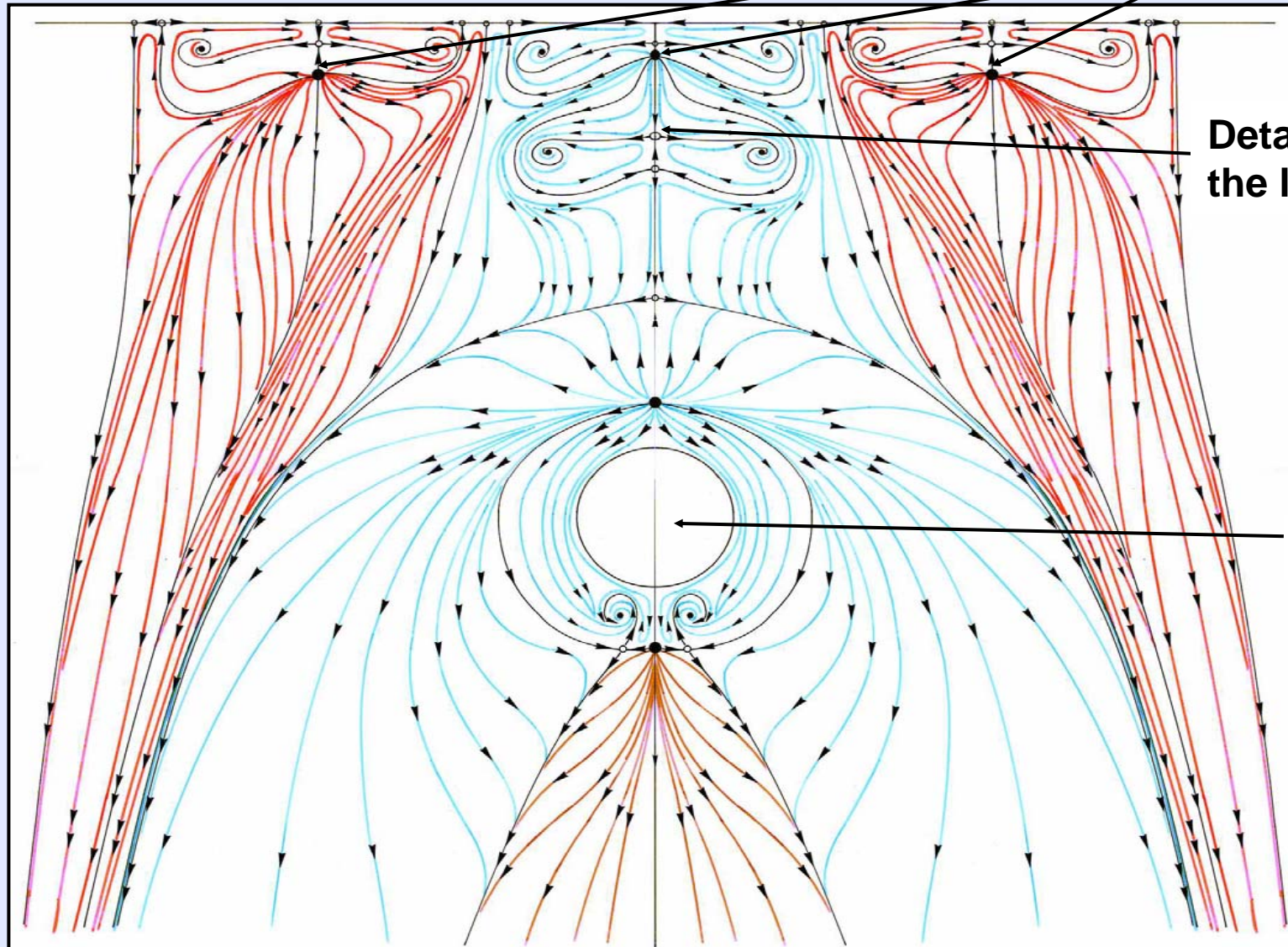
Aerospike type nozzle with vectoring lateral jet



Surface flow visualisation. Lateral jet exit region

Aerospike type nozzle with lateral jet

Skin friction line pattern



Nozzle jet impacts

Detachment induced by the lateral jet

Lateral jet

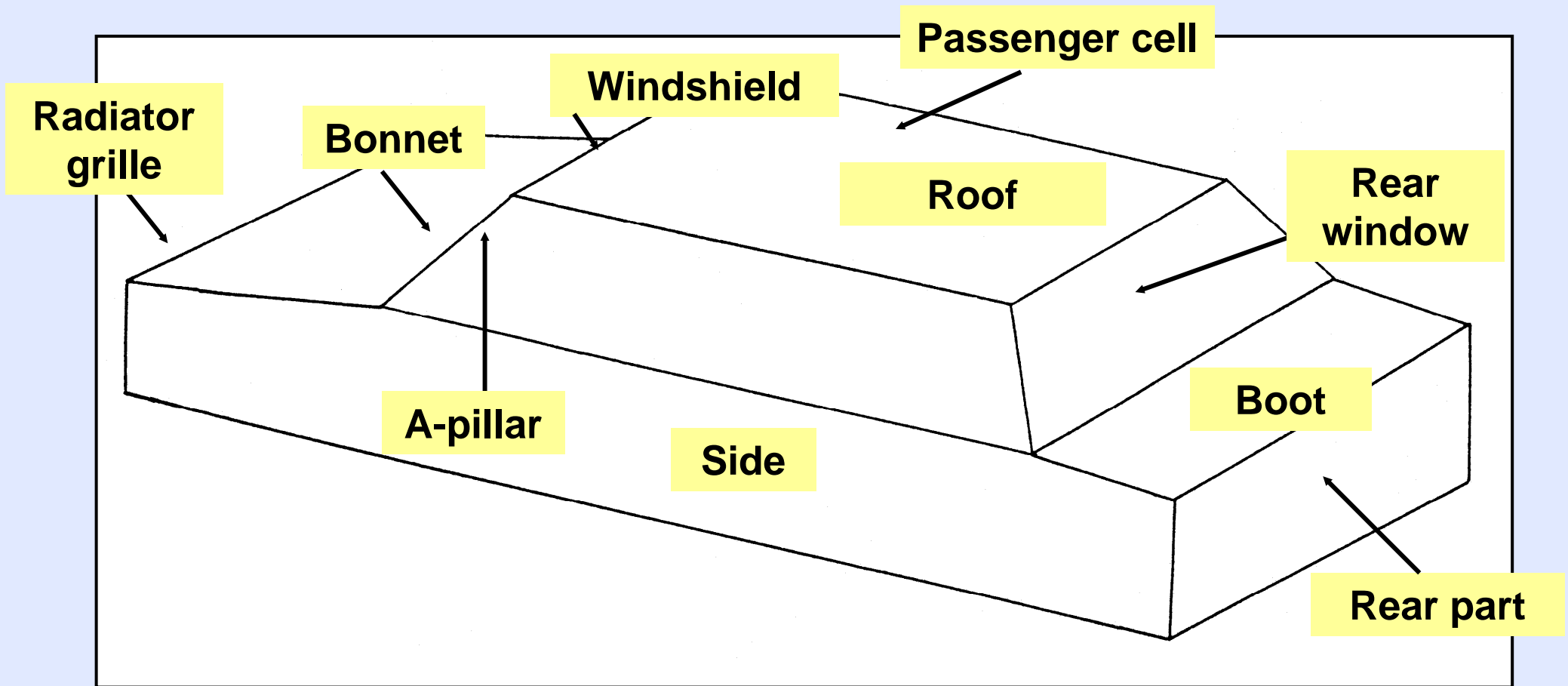
Automobile

H. Werlé. © Onera



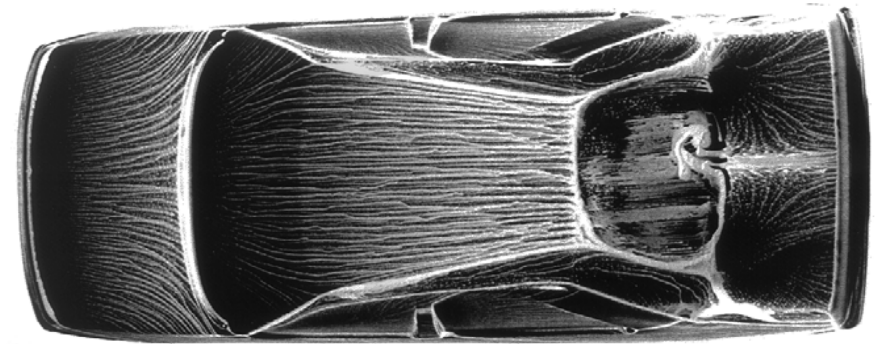
Water tunnel visualisation of the flow past the Citroën DS21 car

Sedan type or three-box automobile

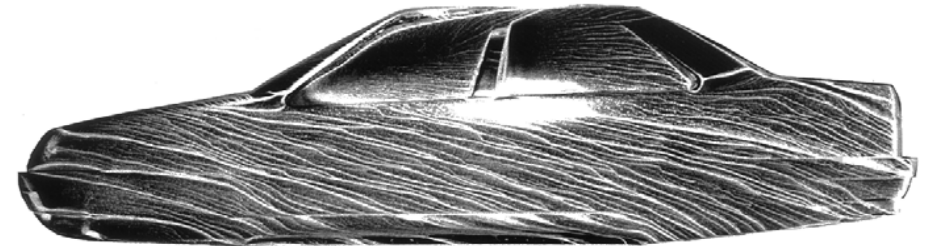


Sedan type or three-box automobile

Seen from above



Side view



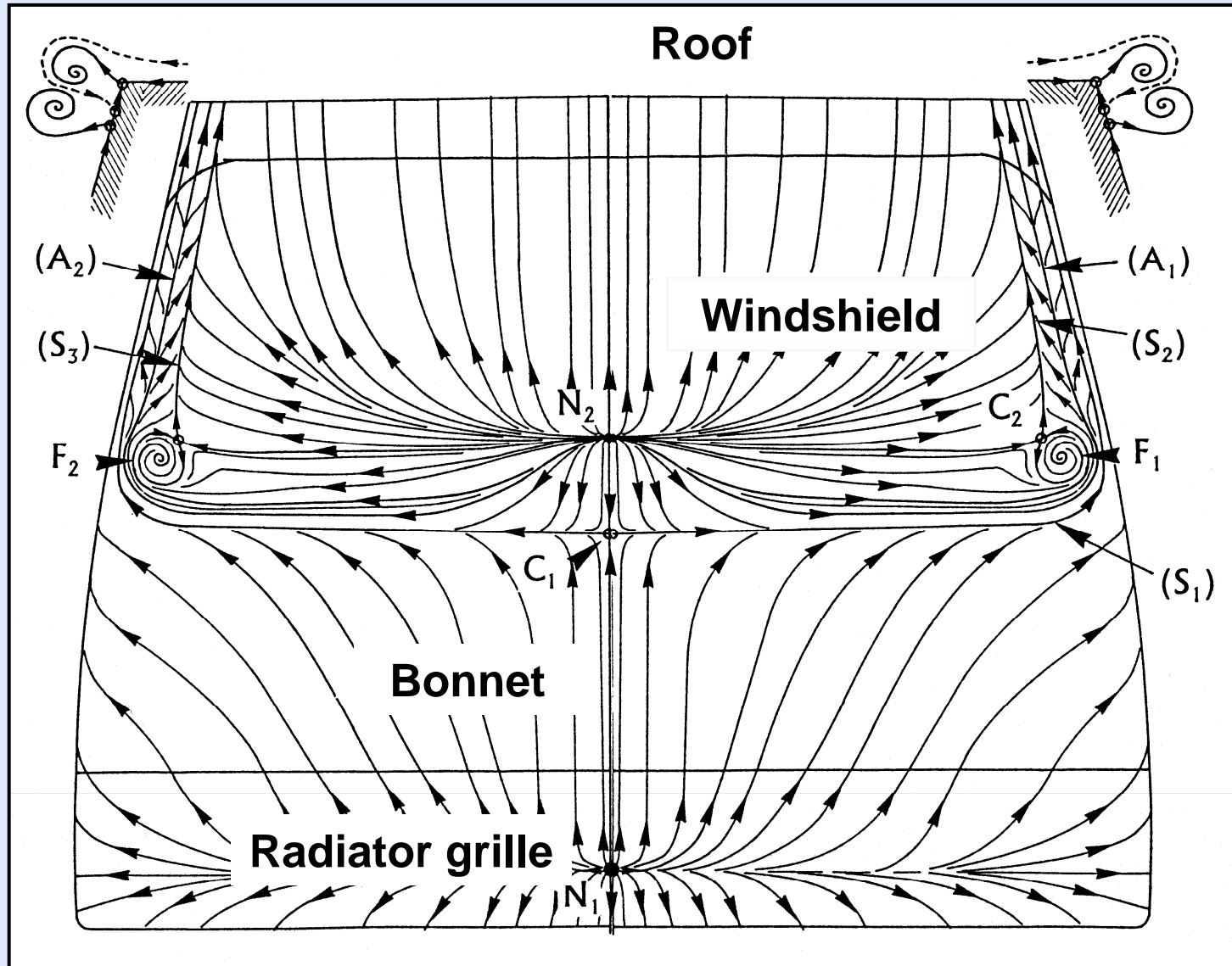
Front view



Surface flow visualizations with viscous film

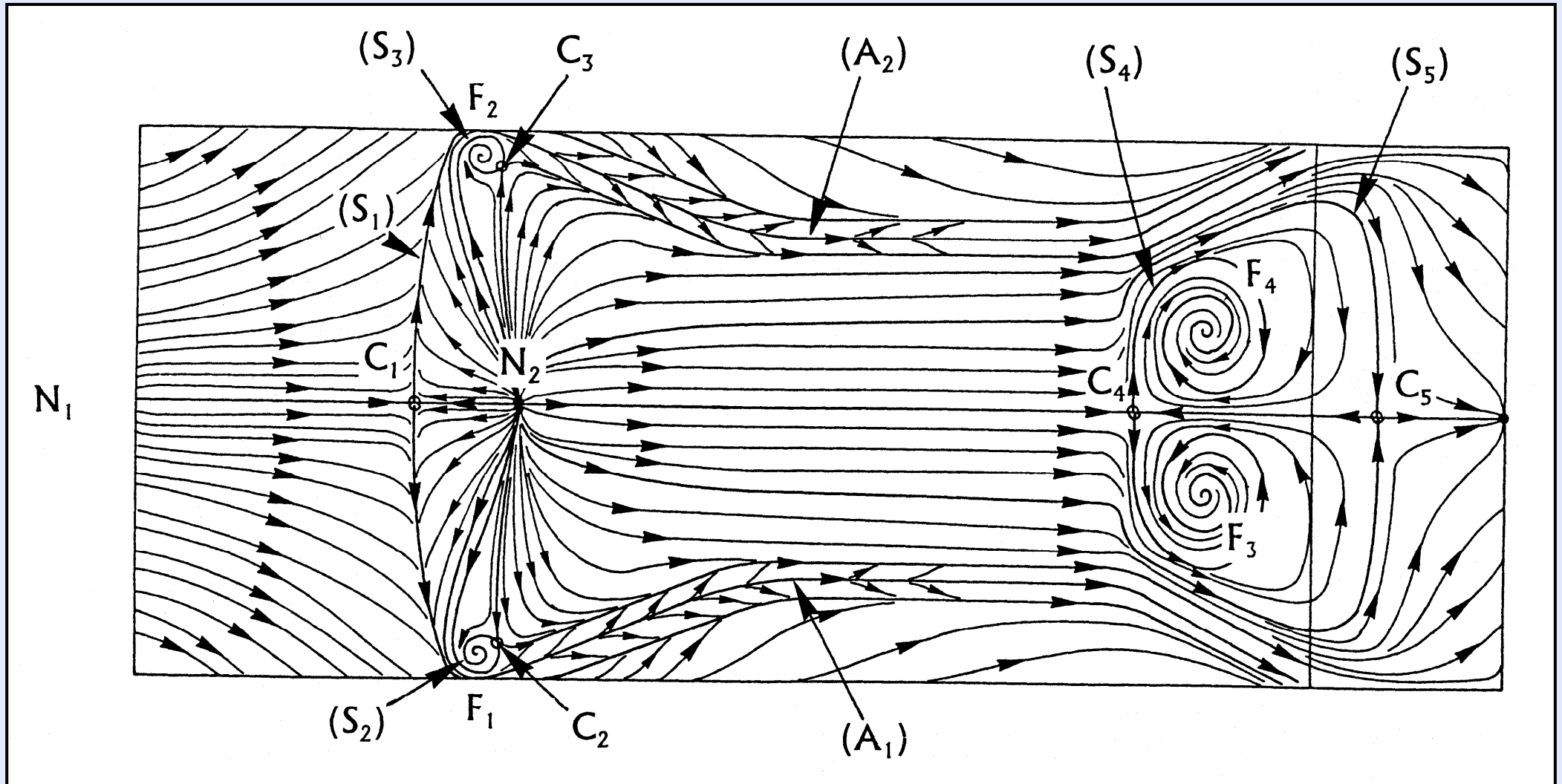
Wind tunnel S2Ch. Document Onera- PSA Peugeot-Citroën

Sedan type or three-box automobile



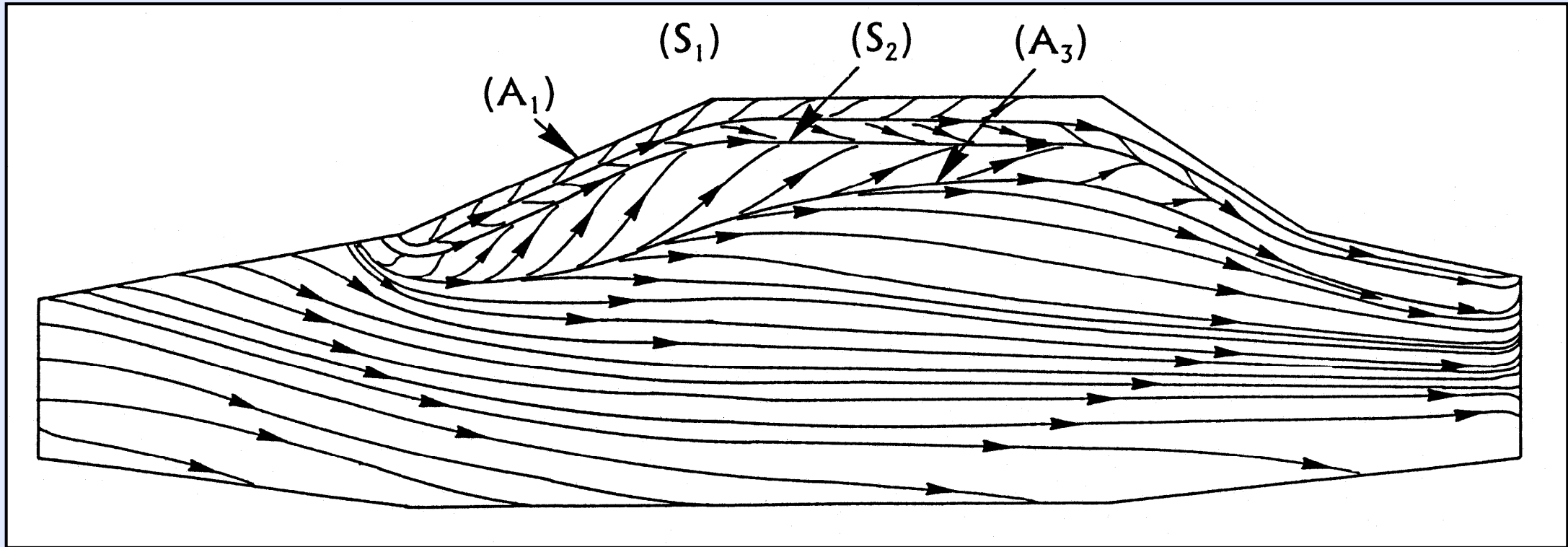
Skin friction line pattern. Front part

Sedan type or three-box automobile



Skin friction line pattern. View from above

Sedan type of three-body automobile

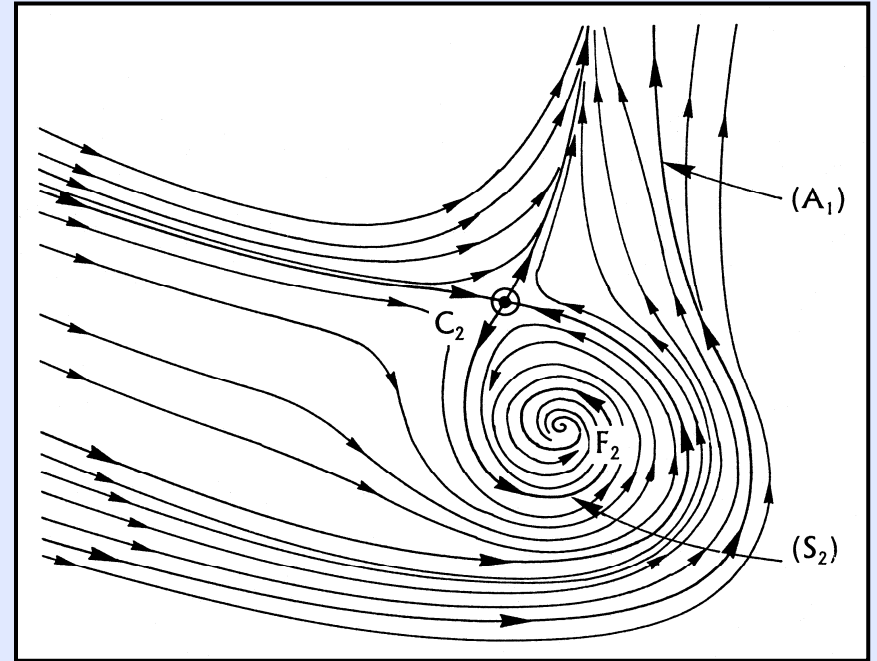
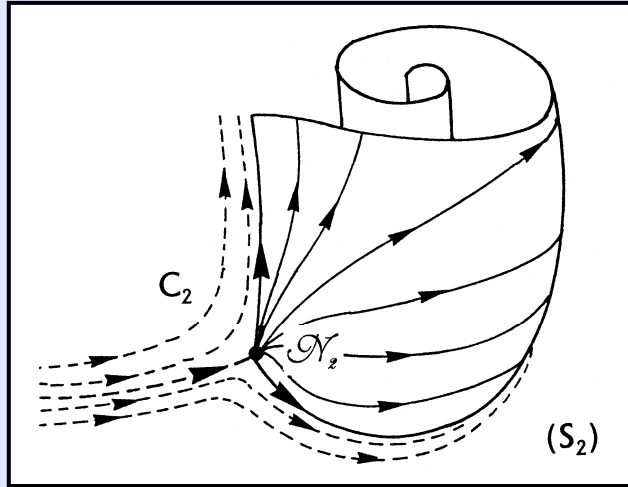


Skin friction line pattern. Side view

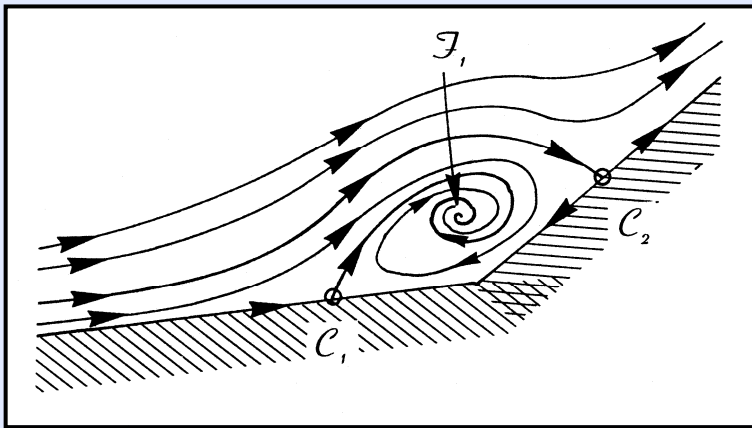
Sedan type automobile

Formation of windshield and A-pillar vortices

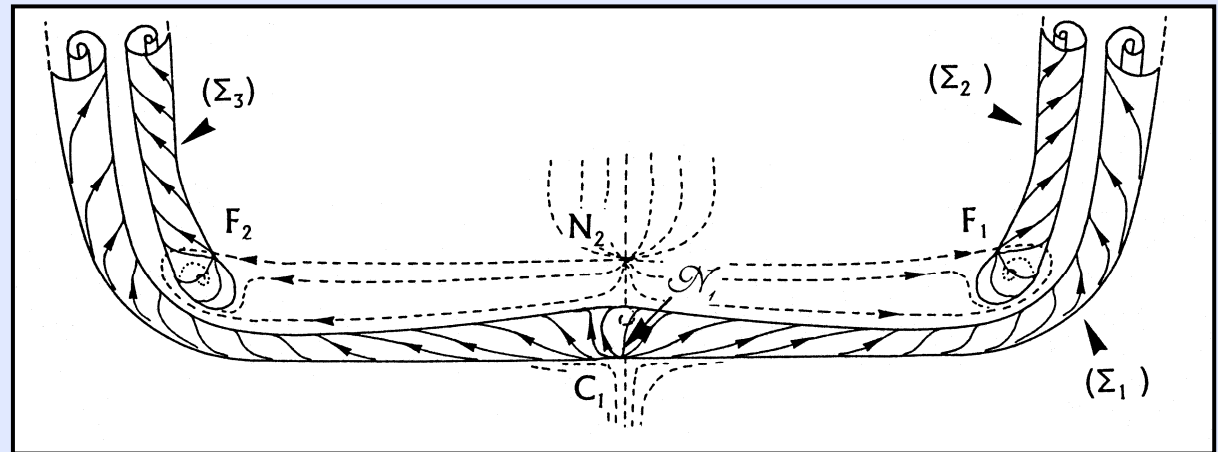
Start of the A-pillar vortex



Skin friction line pattern in the vicinity of focus F_2

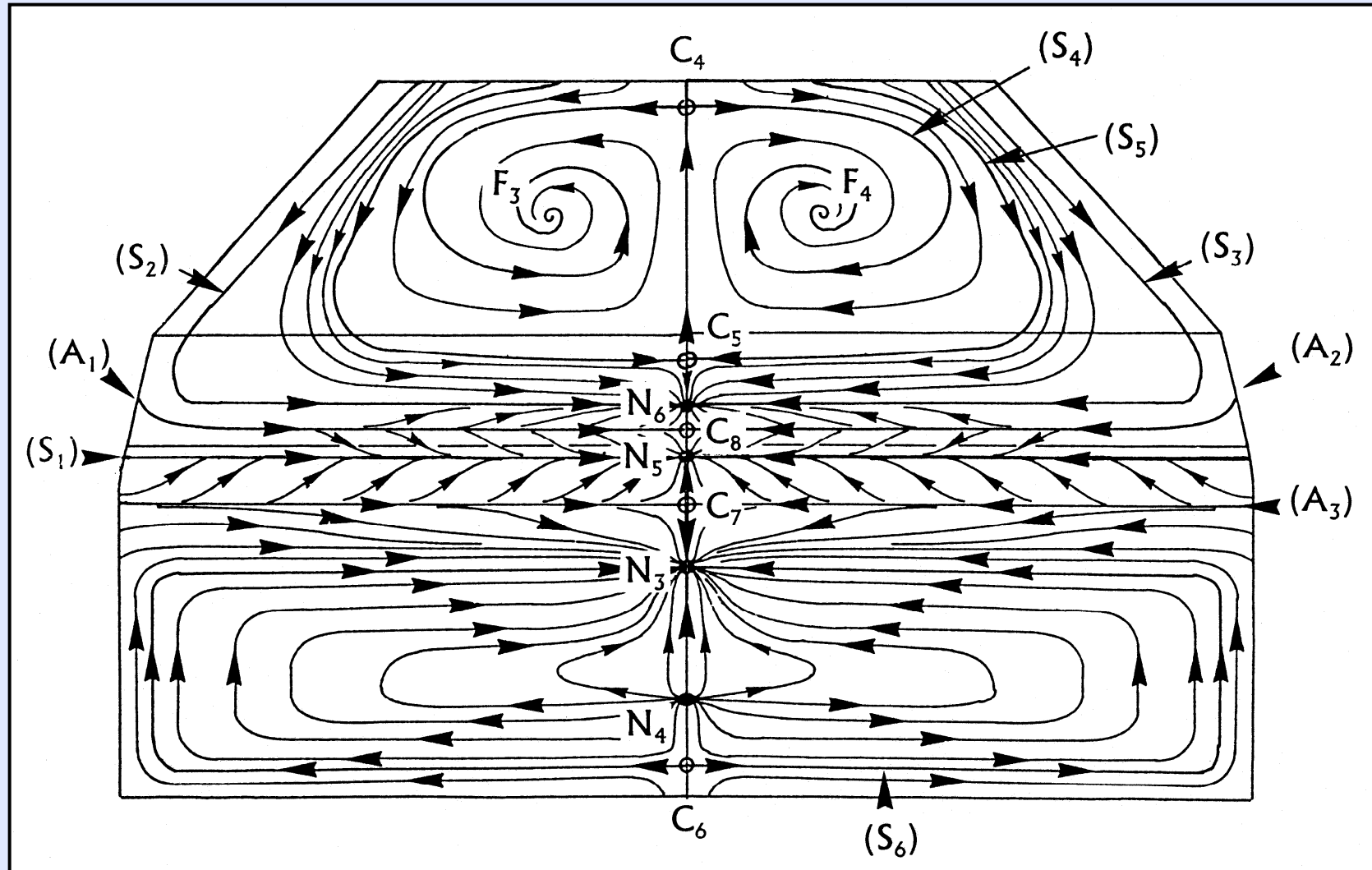


Windshield detachment



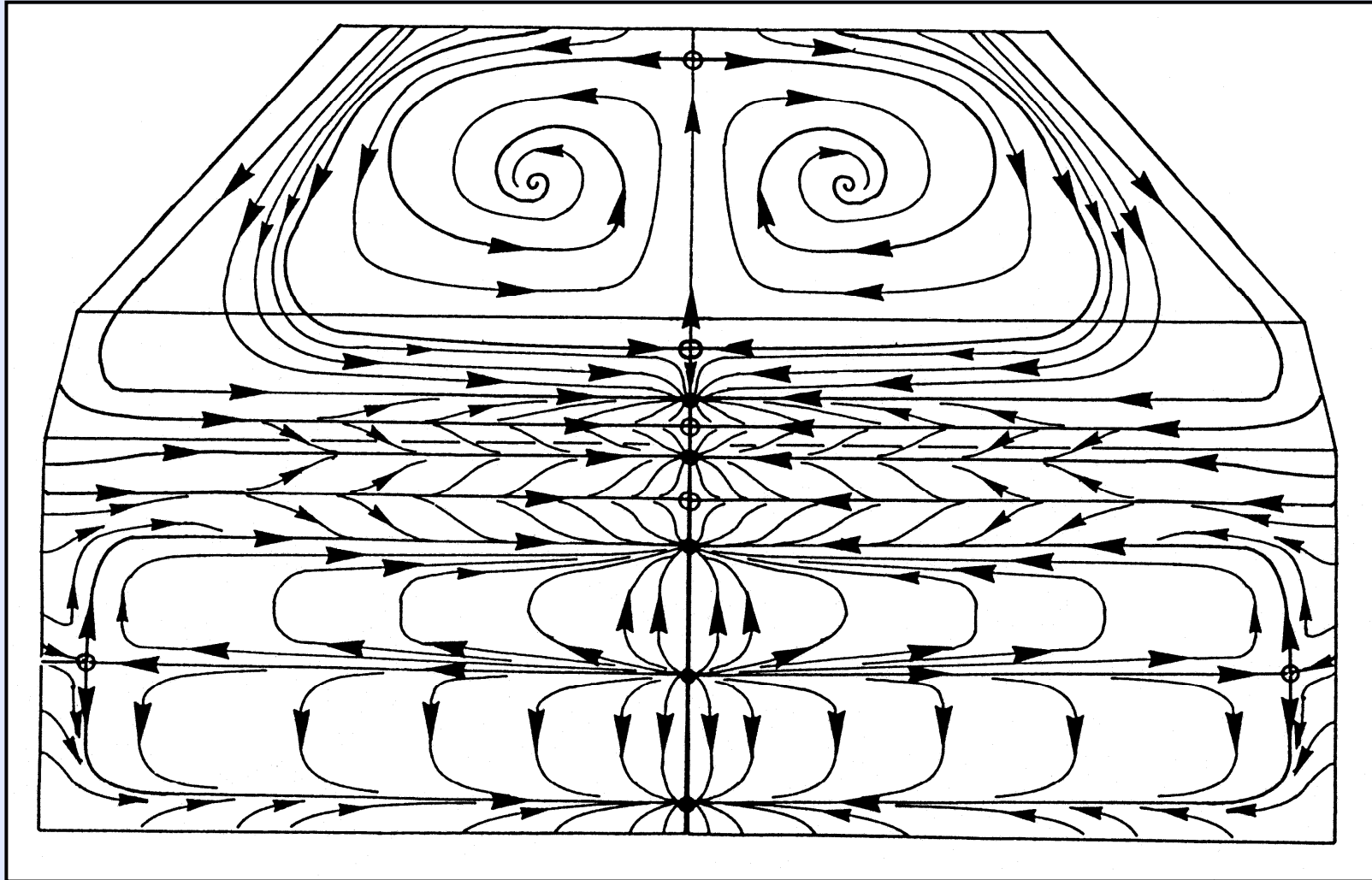
Starting of the detachment surfaces

**Sedan type automobile
Skin friction line pattern. Rear part**



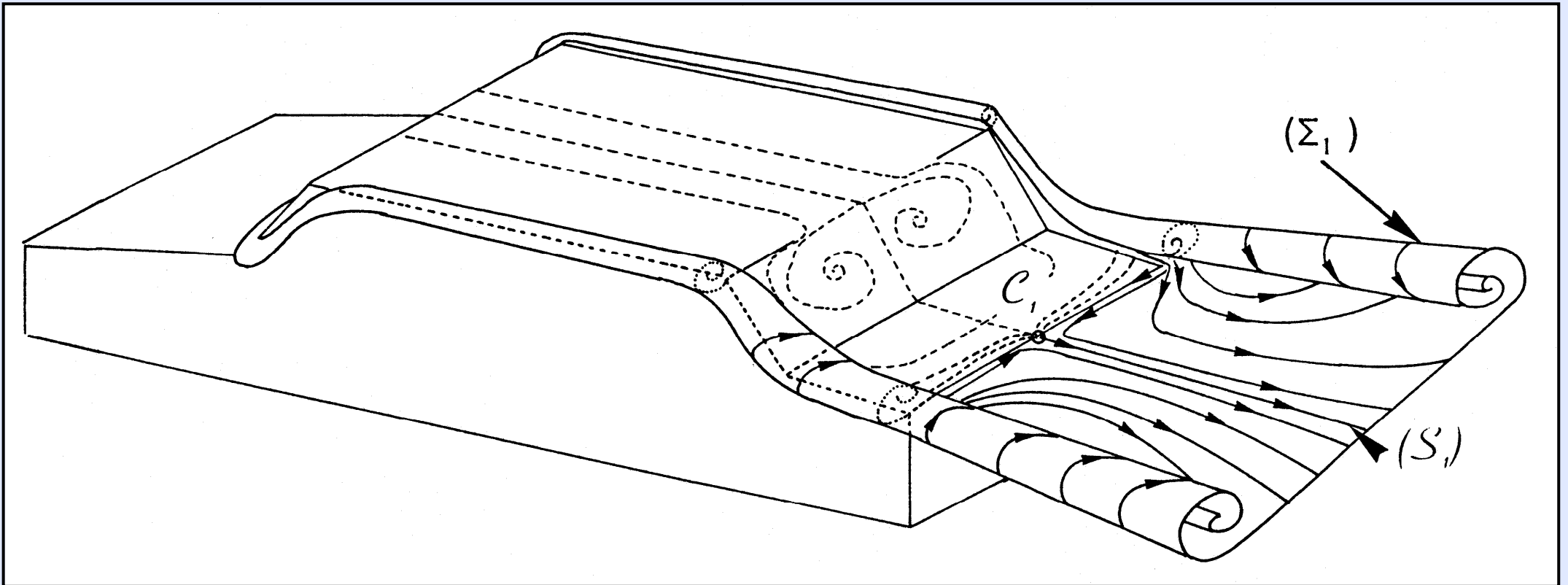
First interpretation: One boot vortex

**Sedan type automobile
Skin friction line pattern. Rear part**

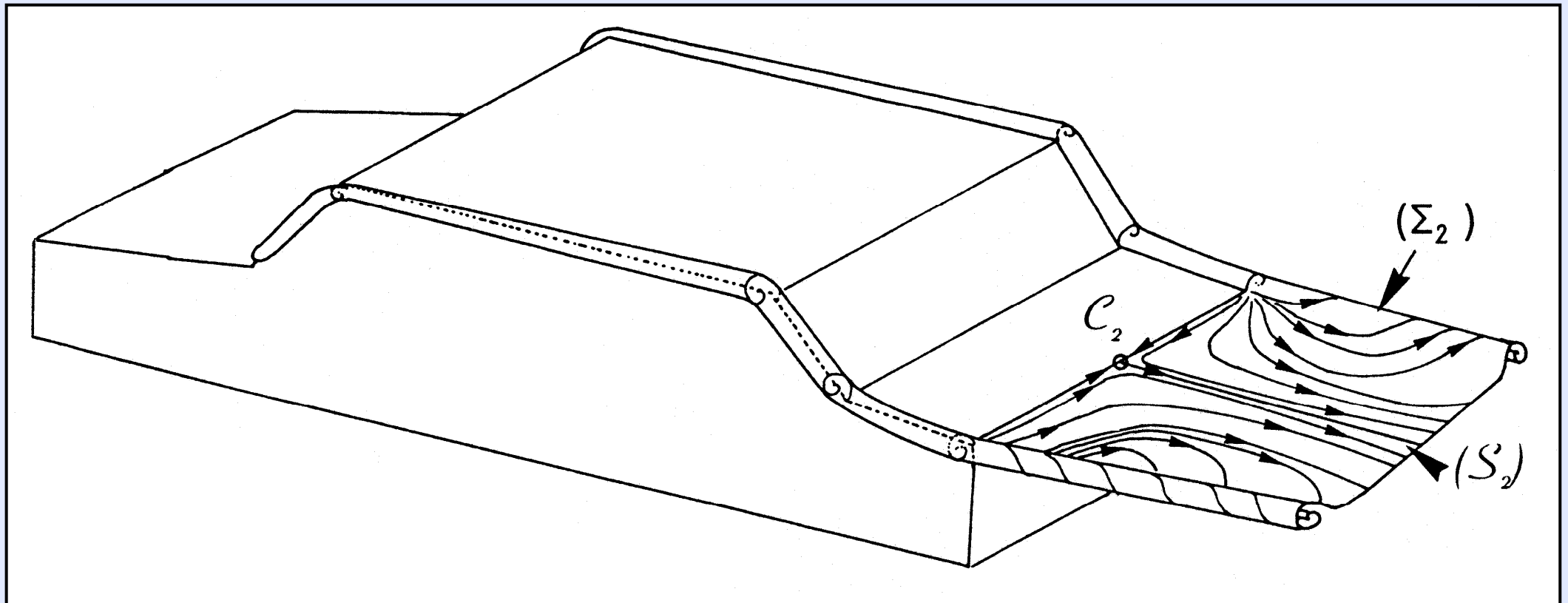


Second interpretation: Two boot vortices

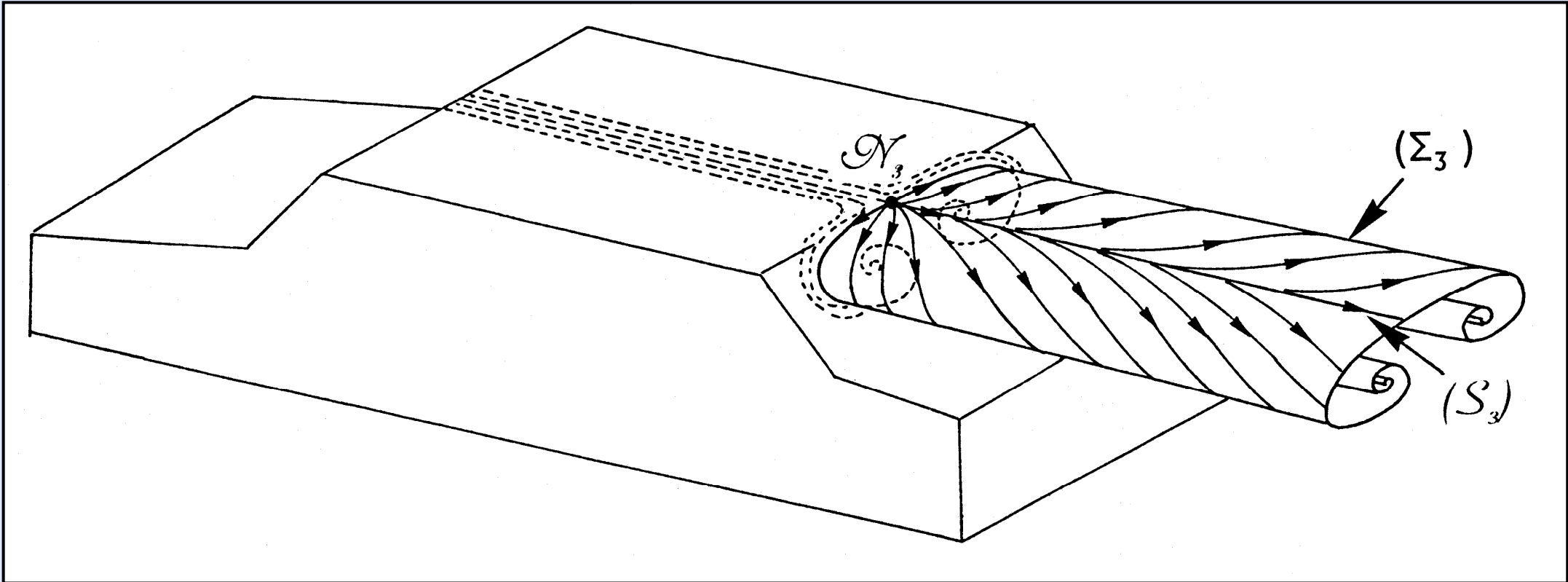
**Sedan type or three-box automobile
Separation surfaces. Windshield detachment**



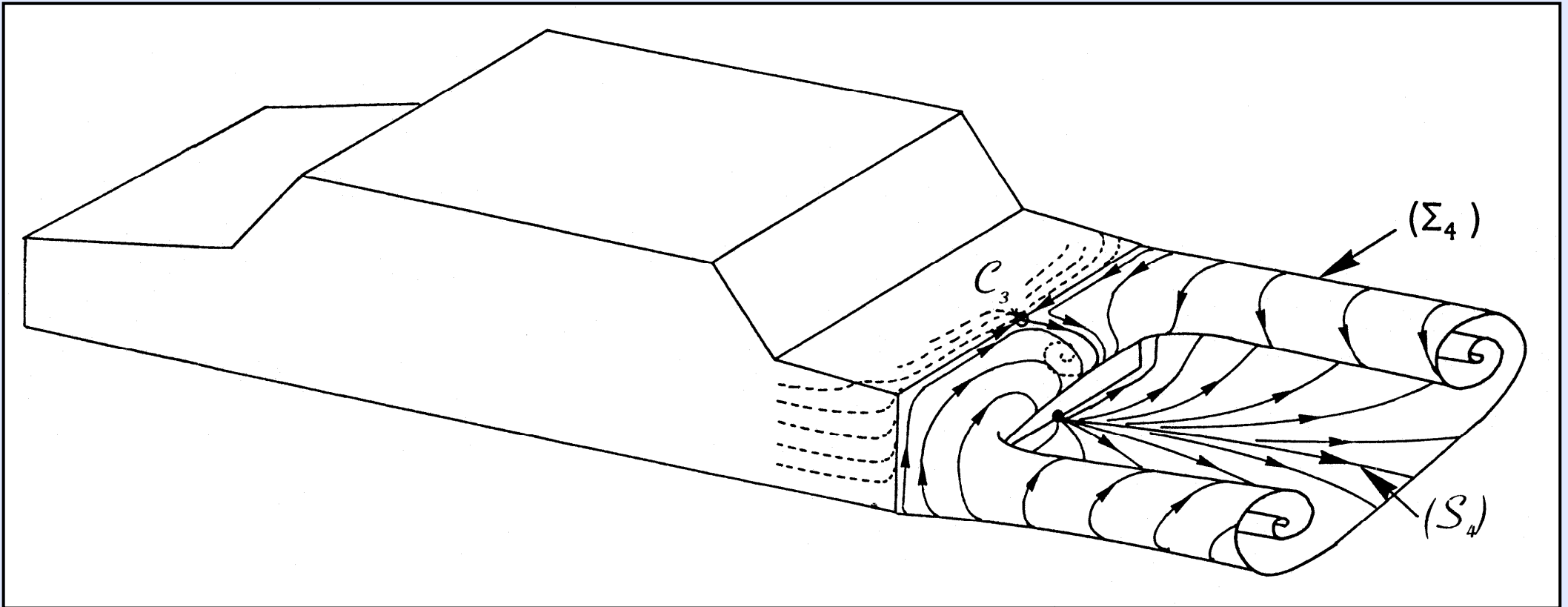
**Sedan type or three-box automobile
Separation surfaces. A-pillar detachment**



**Sedan type or three-box automobile
Separation surfaces. Rear window detachment**

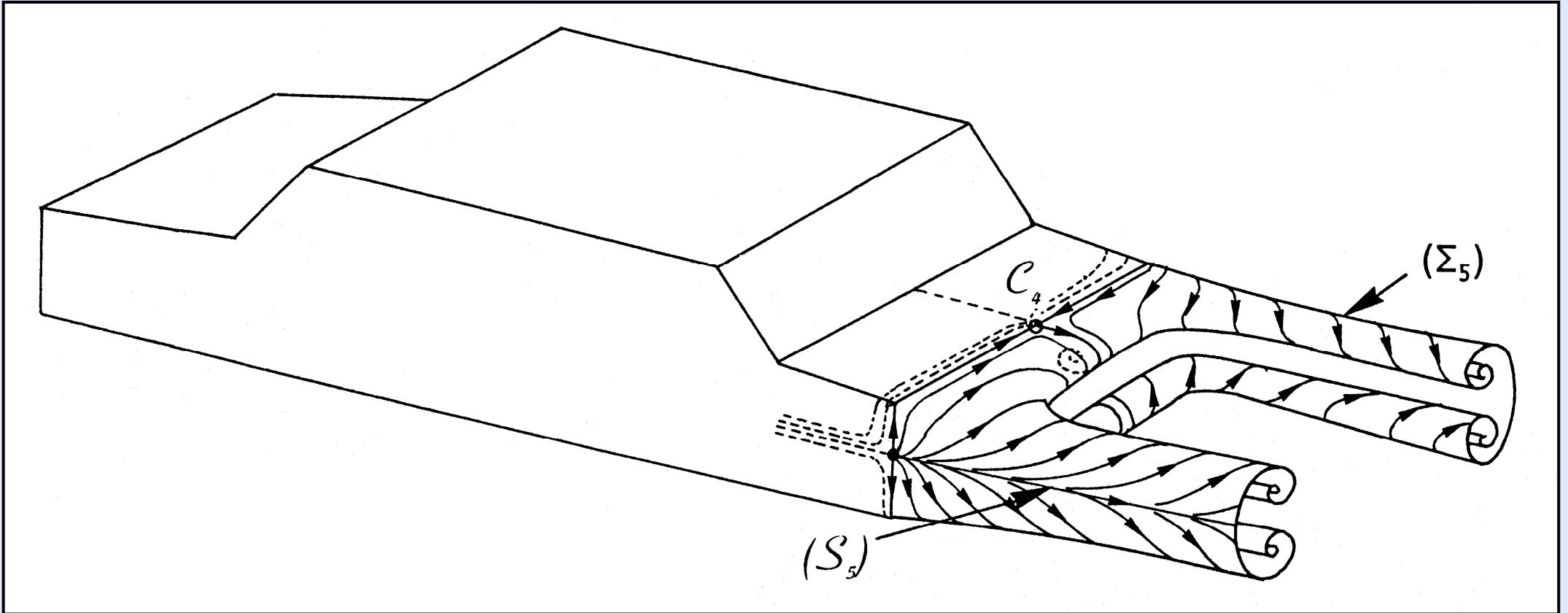


**Sedan type or three-box automobile
Separation surfaces. Trunk detachment**



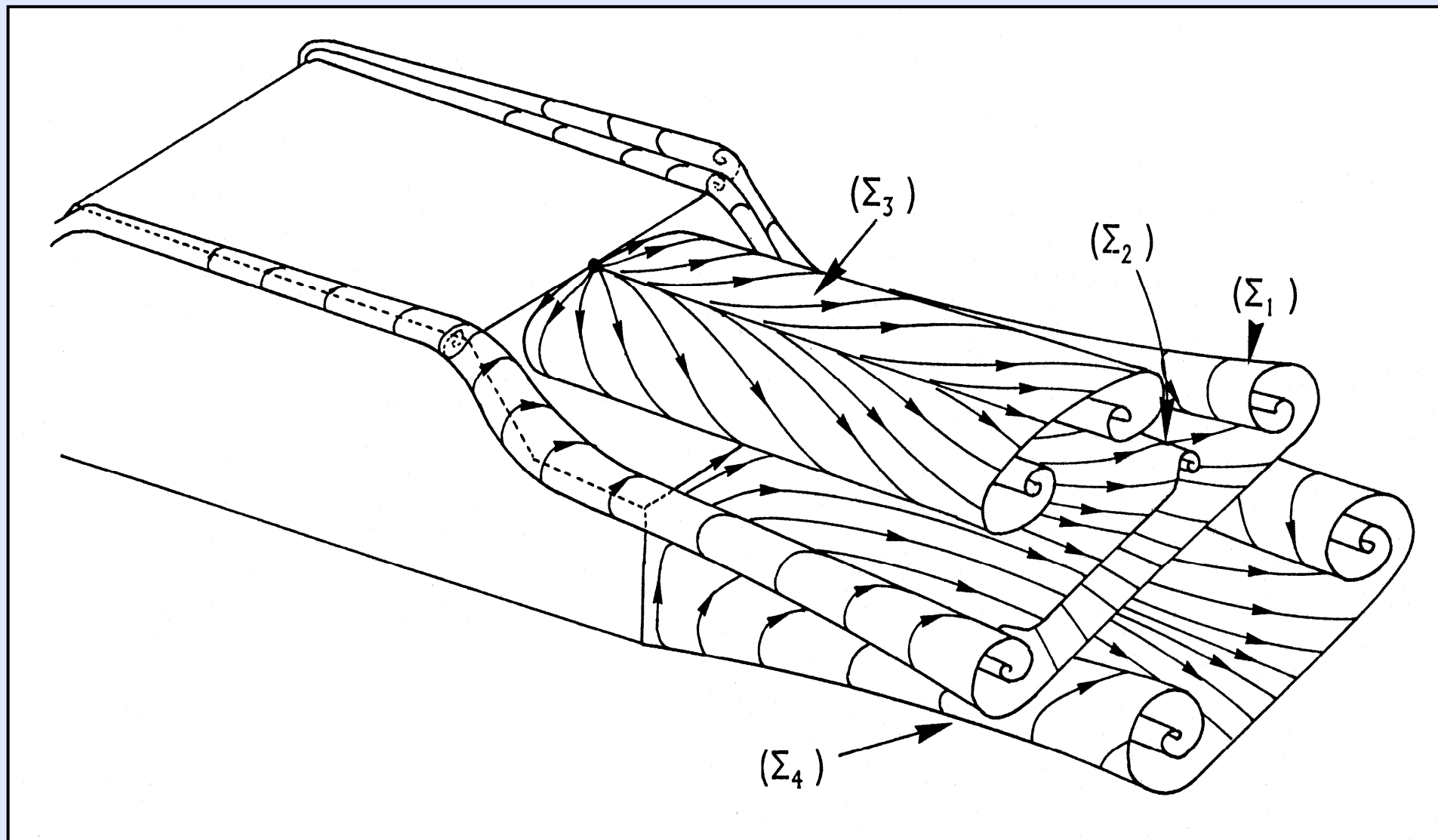
First possibility: One horseshoe vortex

**Sedan type or three-box automobile
Separation surfaces. Trunk detachment**



Second possibility: Two horseshoe vortices

**Sedan type or three-box automobile
Main detachment surfaces**



**Sedan type or three-box automobile
Field projected in a vertical downstream plane**

