

The protection against the distortion of the heated stainless steel plate in the process of manufacturing the stainless steel fine threads

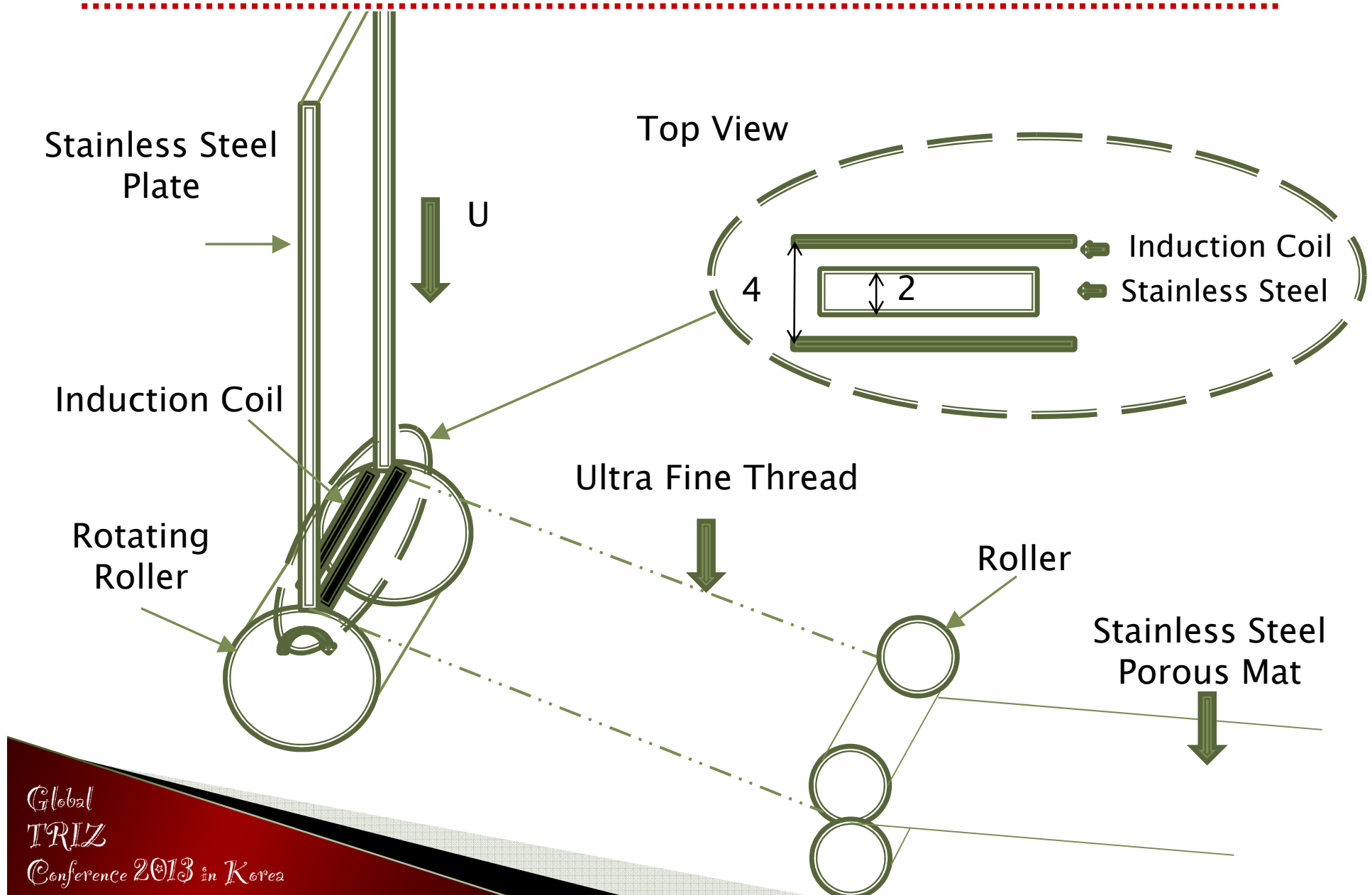
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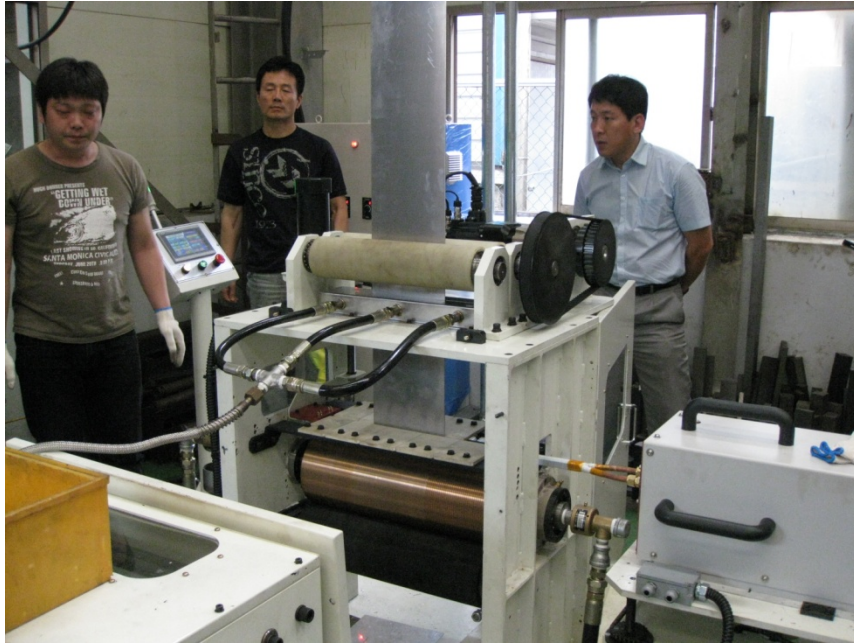
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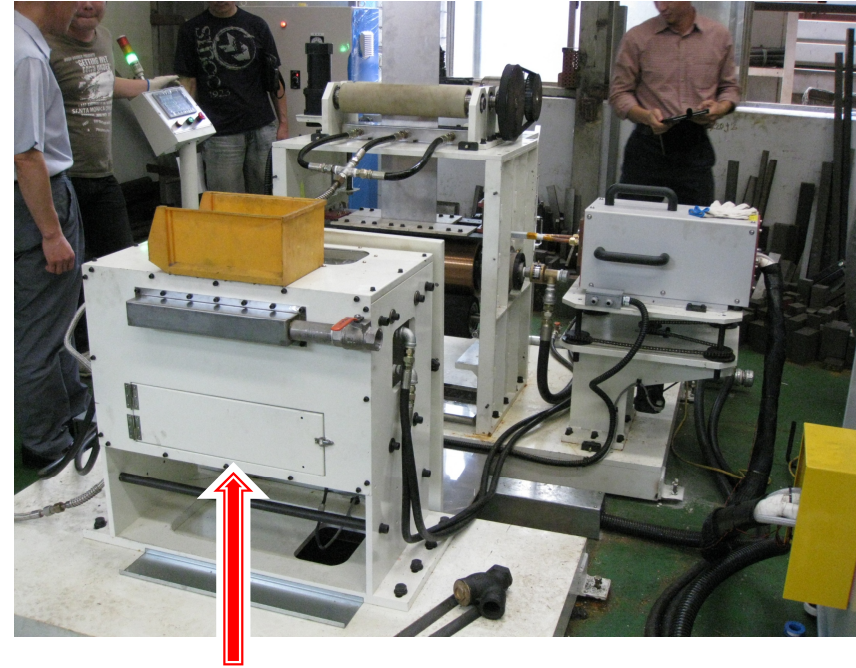
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Manufacturing Process of Ultra-Fine threads from the stainless steel plate by the induction heating





Photos of total System



Capture Drum for ultra fine Threads

Rotating Dick
cooled by the Water



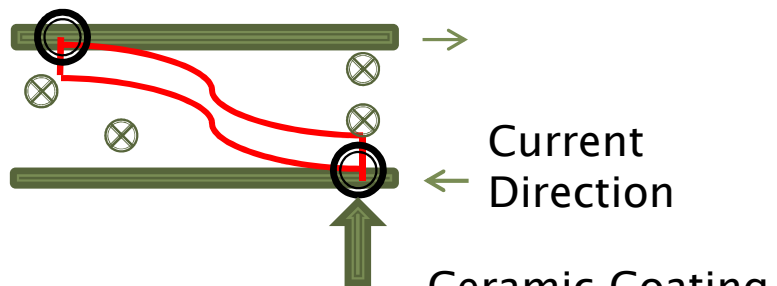
Description of the Problem

Top View

Power Off



Power On



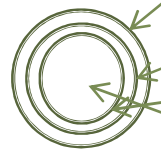
Induction Coil

Ceramic coating

Copper tube

Insulator

Cooling Water



what

electrical short occurs

when

In the process of heating

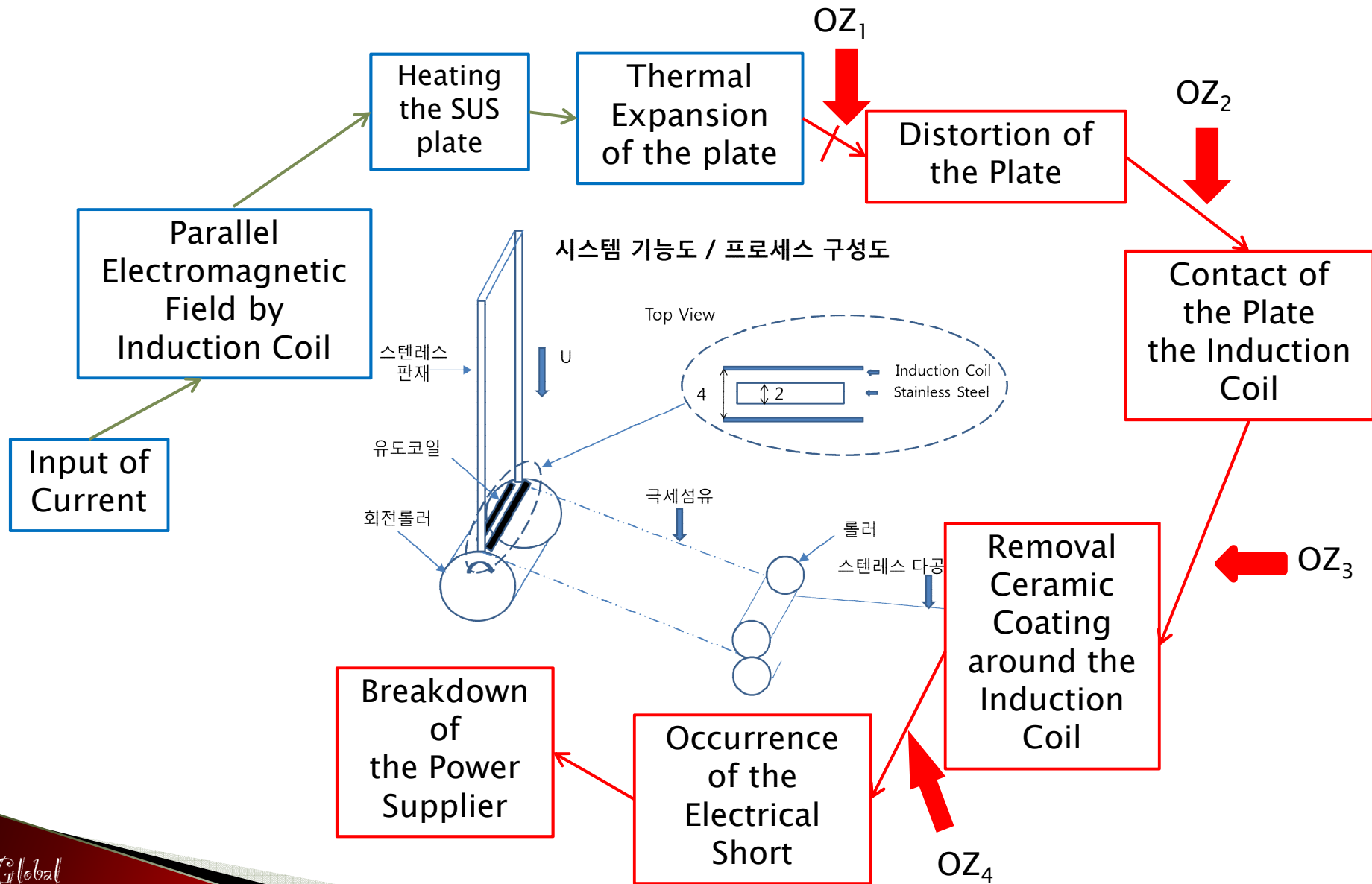
where

Induction coil contacts the stainless steel

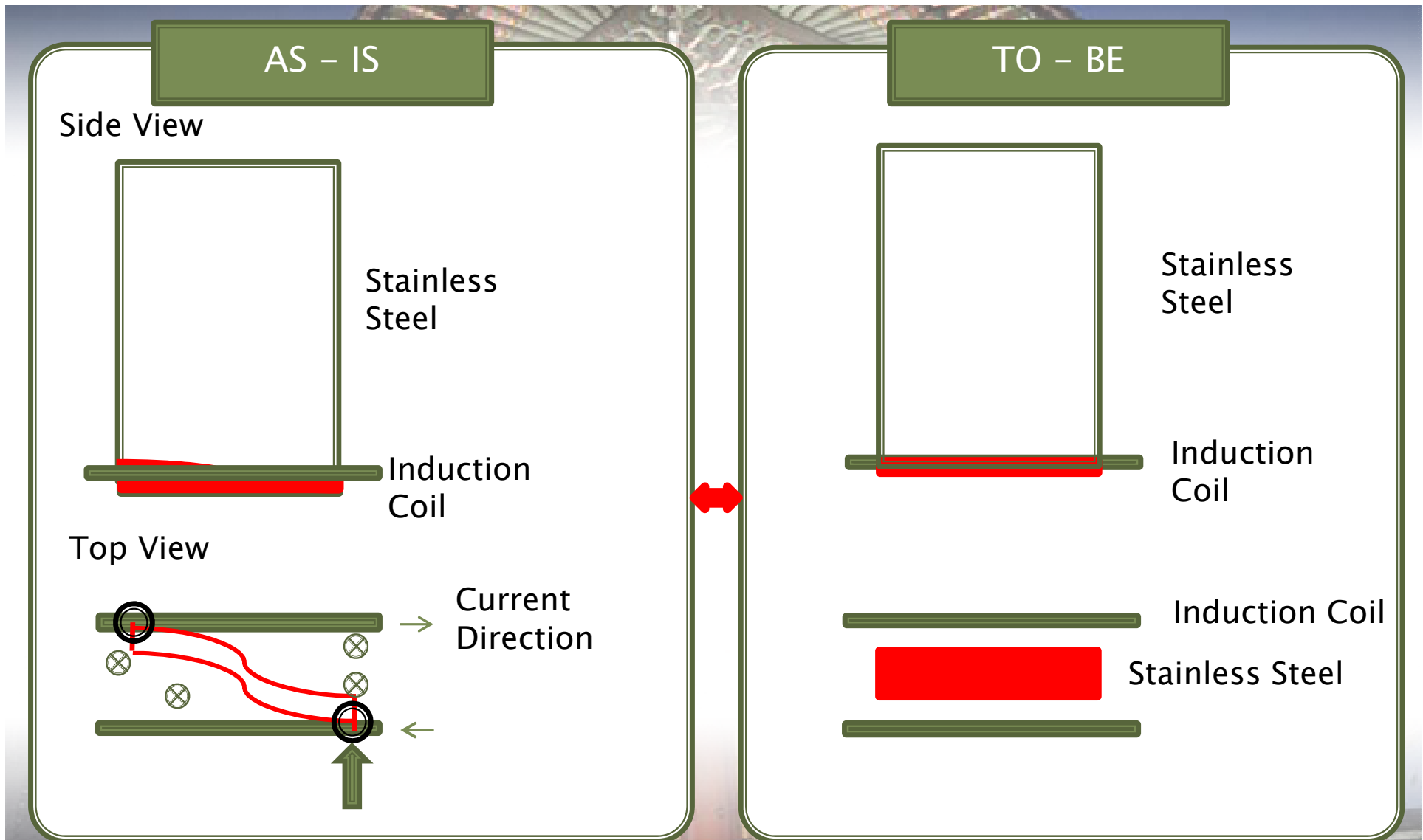
Why

No uniformities (thickness, material distribution of the stainless steel plate, eddy current heating, thermal expansion) induce the distortion of the stainless steel plate, the induction coil contacts the stainless steel plate and the coated layer of the coil is broken

Causes & Effects and Operating Zone(OZ)



Definition of the Problem(function* harm)



Resources and Evaluation

When : The stainless steel plate is heating by the induction coil

Where : within the induction coils

Field : thermal, magnetic, mechanical, chemical, electrical

Material : stainless steel thin plate, induction coil, nitrogen, water, electricity, rotating disk

location	Material	cost (high/low)	usefulness
system(OZ)	stainless steel plate	low	neutral
	induction coil	high	neutral
	nitrogen	low	useful
	water	low	harmful
	Electricity	high	neutral
	Rotating disk	high	neutral
Environment	Heat	low	harmful
	Magnetic	high	Neutral
Upper system	Nitrogen	low	useful
	Gravity	low	neutral
	Temperature of environment	high	neutral
	Gap between the thin plate and the induction coil	low	harmful

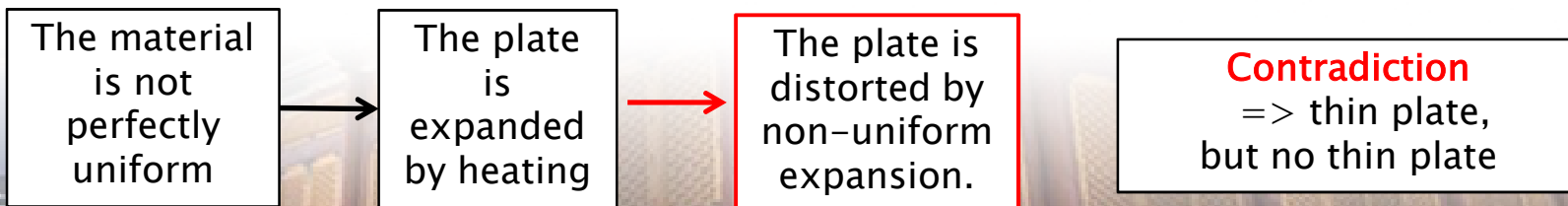
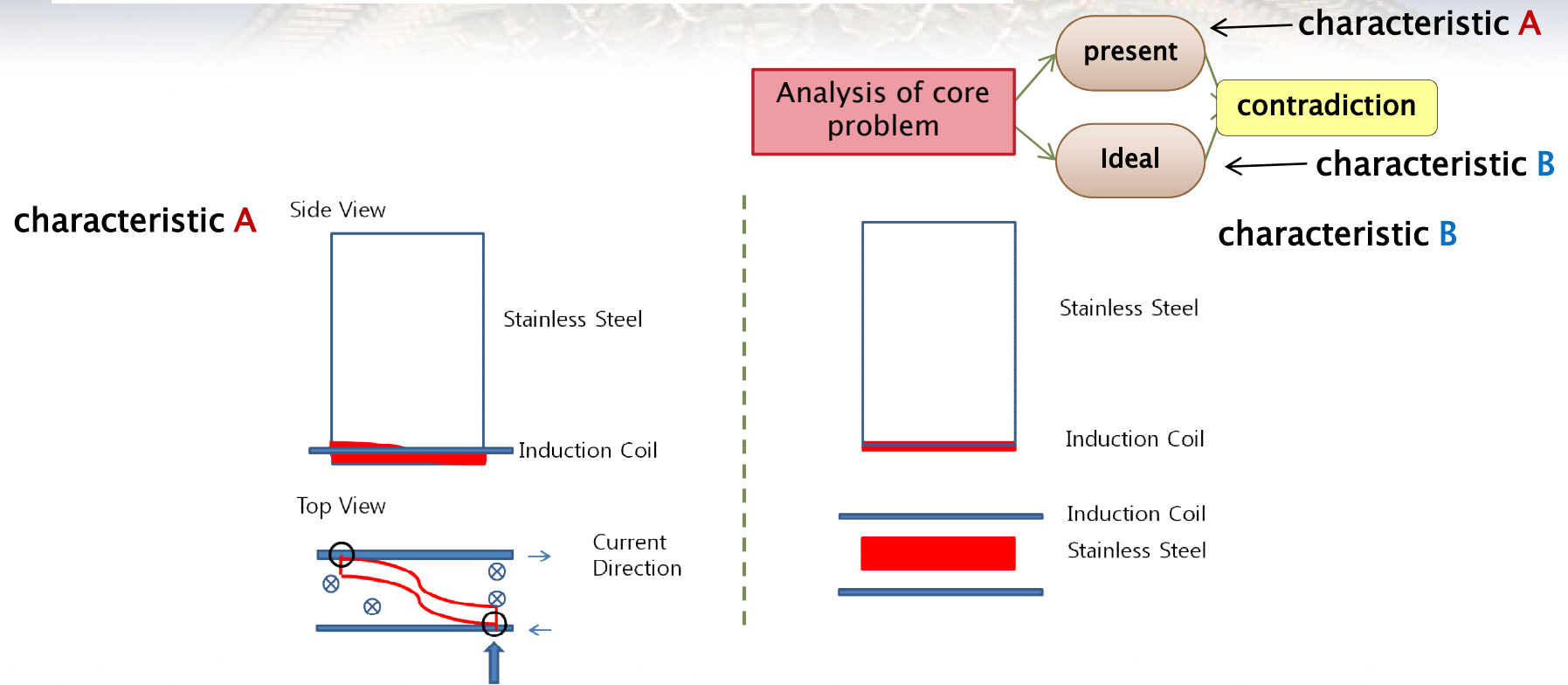
Plan of the ideal solution

Using the X-resources ____ characteristics at the OZ, OT, **harmful effects(unwanted situations)** ____ does not occurred spontaneously!
(wanted situation is obtained)

Resources / characteristics	Ideal solution (IFR) / contraction
stainless steel plate / thermal expansion due to heat input	The stainless steel plate is expanded by heating, but does not distort.
Induction coil / Induction heating	The induction coil heats the stainless steel plate by induction, but the coil heats the plate narrowly and uniformly.
heated plate / being cooled.	The heated plate is not cooled, and the temperature is remained at a constant temperature.
rotating disk / inducing the wind.	The wind which the rotating disk induces does not contribute the cooling.

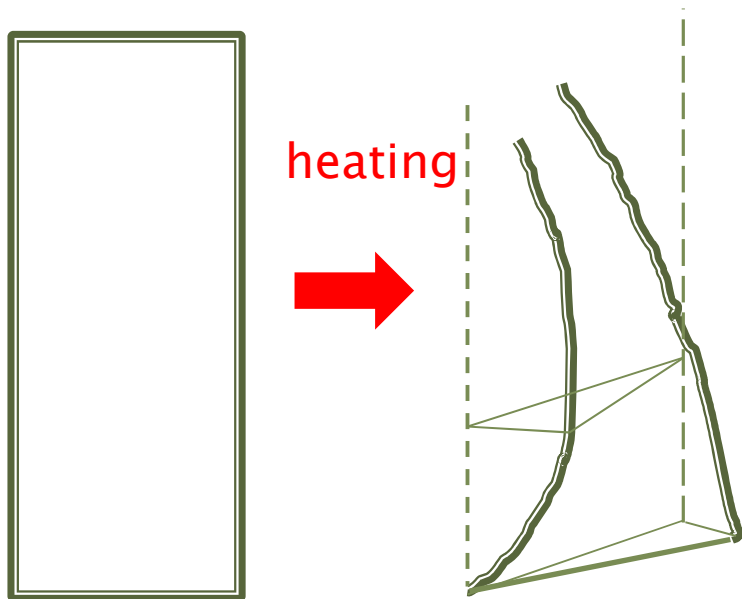
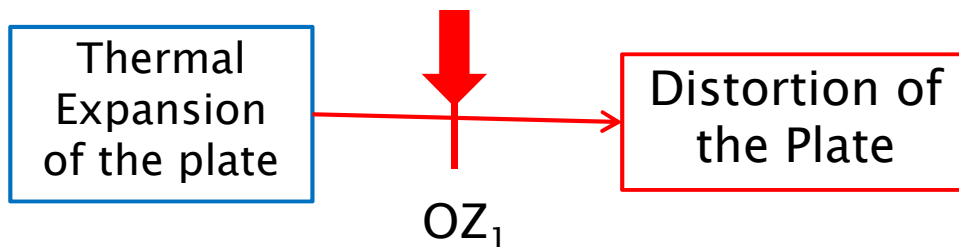
Description of Contradiction

Derivation of the physical contradiction

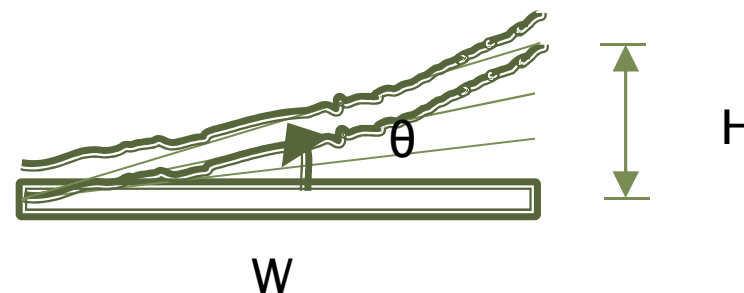


Solving the solution

Operating Zone 1:



Using small persons model



Width 0

Force 0

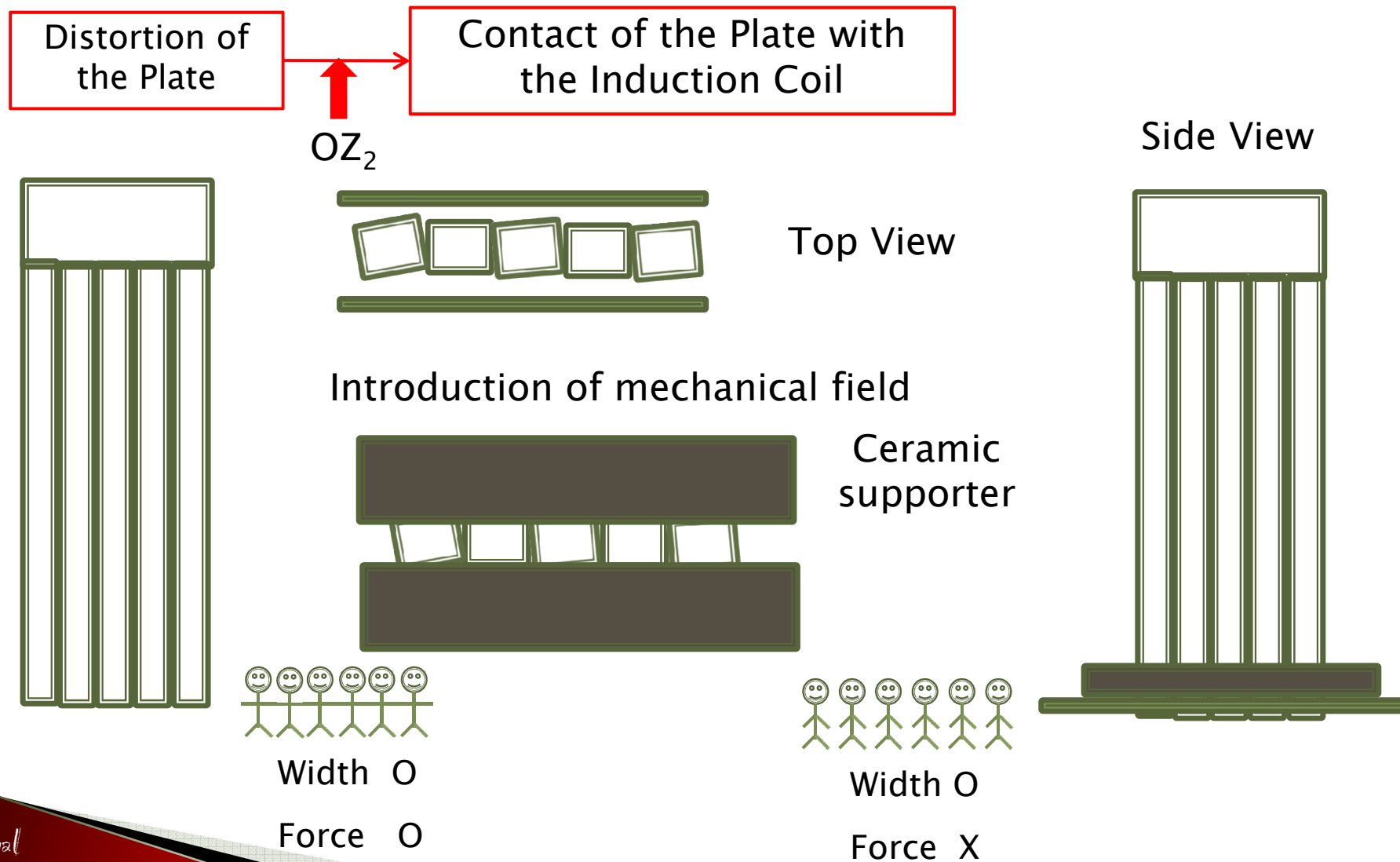
$$W \times \tan \theta = H$$

H : to decrease

W : as small as possible

θ : as small as possible

Solving the solution



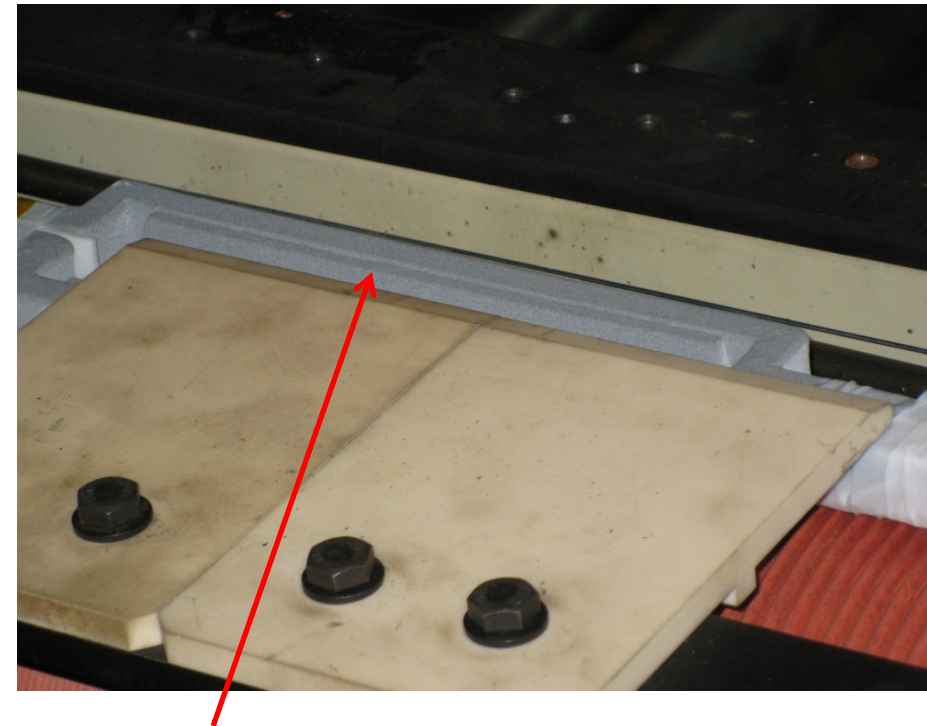
Solving the solution

Contact of the Plate
with
the Induction Coil



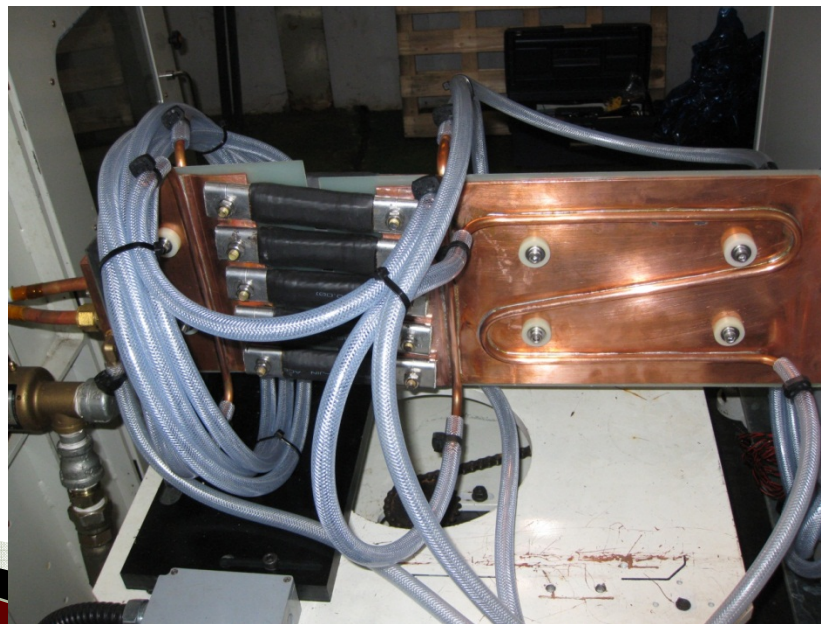
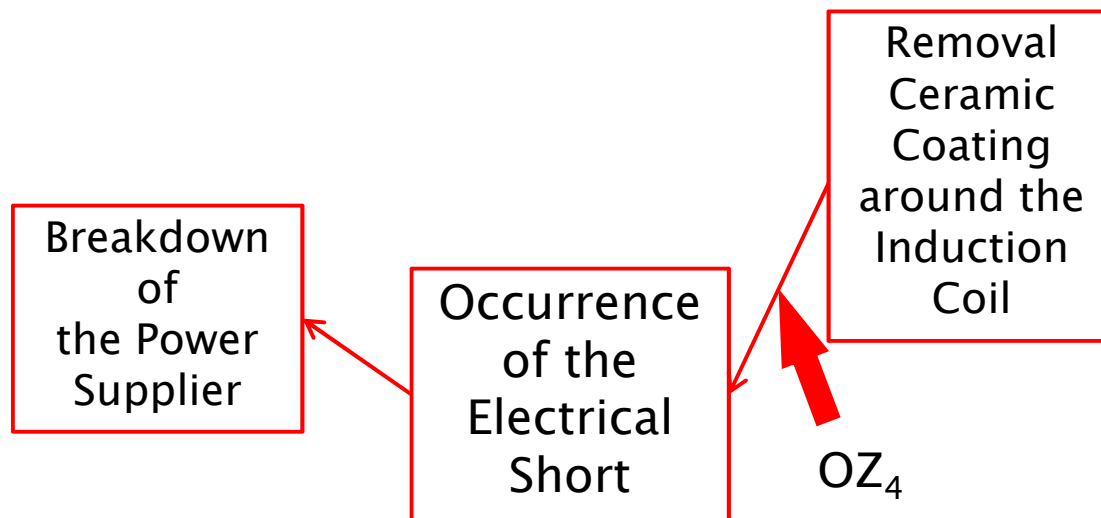
OZ₃

Removal Ceramic
Coating around the
Induction Coil



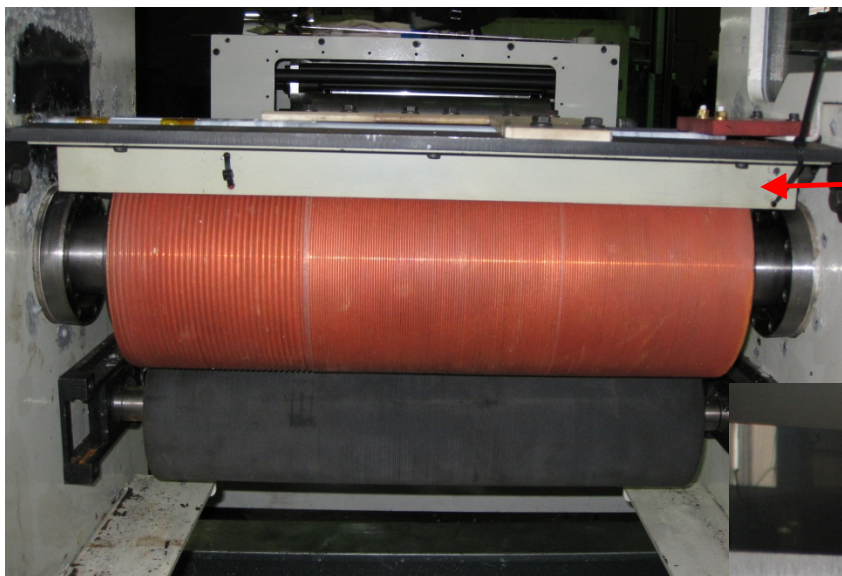
3. Ceramic coated Induction Coil for
the 200 mm width Plate

Solving the solution



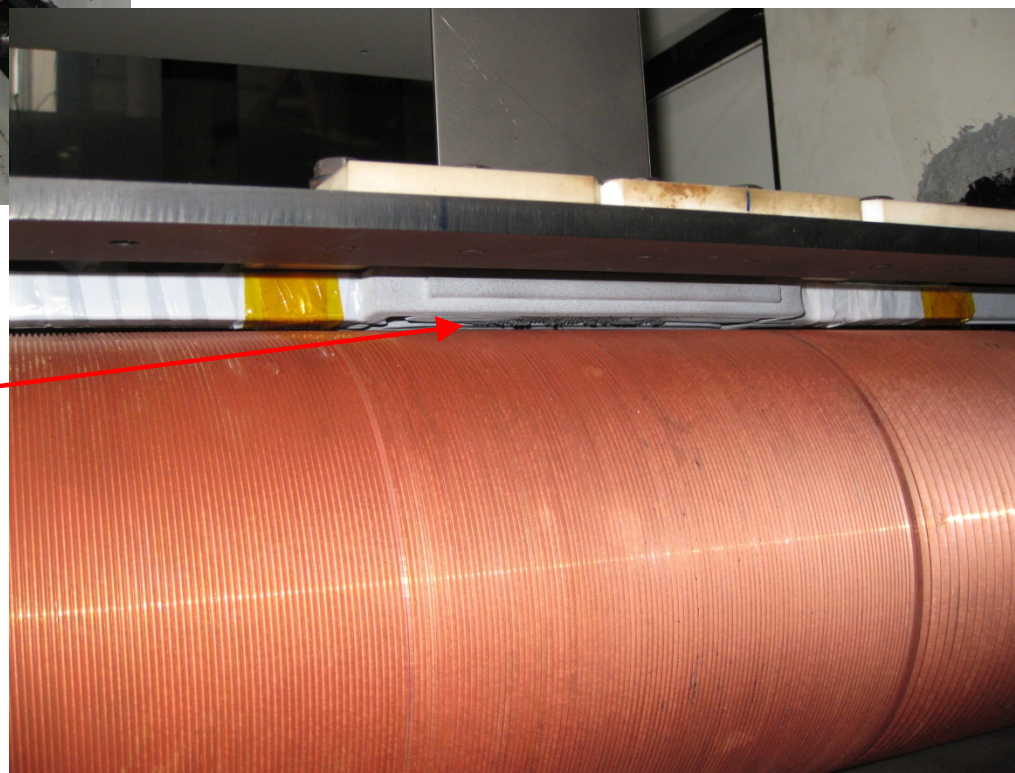
4. Power Supply supplementation

Solving the solution

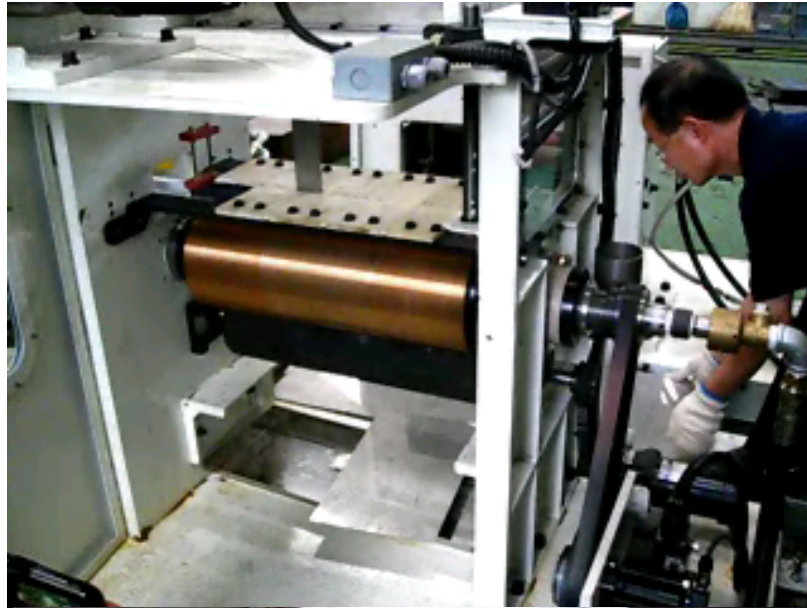


Shielding plate
against the
wind

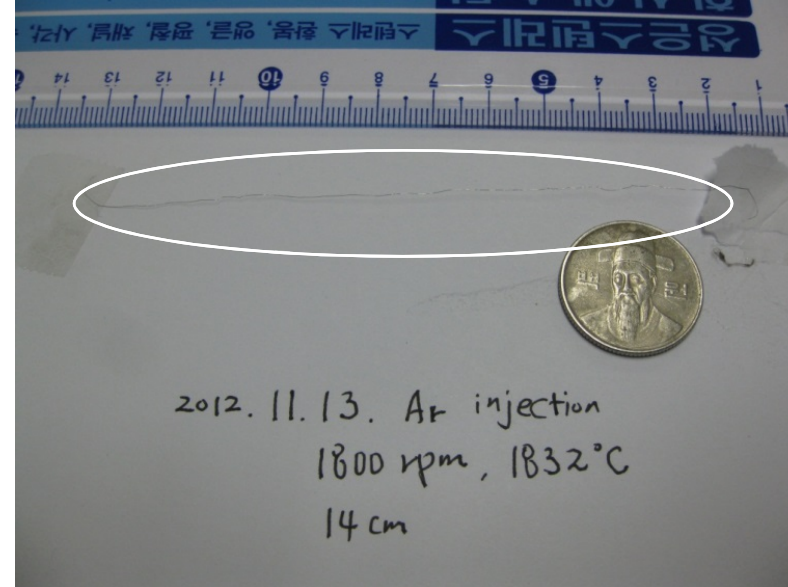
Gap between the rotating
drum and the stainless
steel plate



Obtaining of the Real Solution

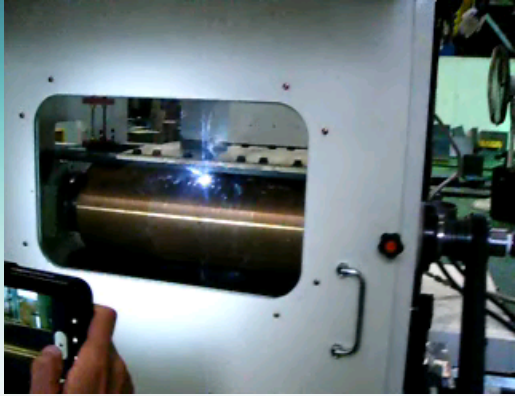


인덕션 코일로 박판 가열 장면



2012. 11. 13. Ar injection
1800 rpm, 1832°C
14 cm

Concluding Remarks



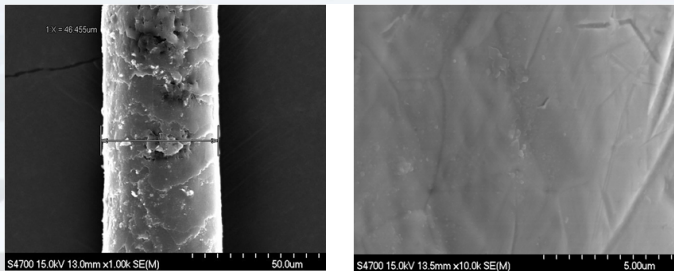
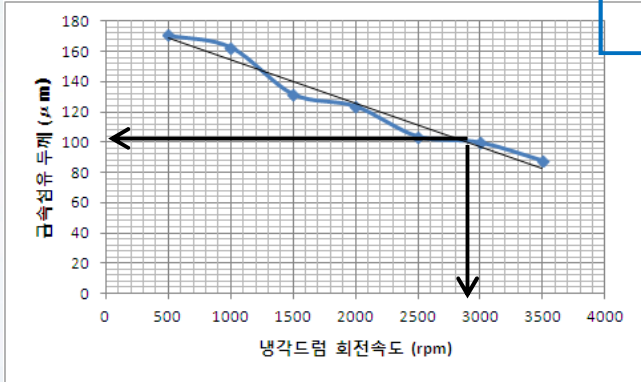
By protecting the distortion of the stainless steel plate through TRIZ



Production of ultra fine stainless steel thread



Fabrication of sintered mat



Diameter 100 μ @ 3000 rpm