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Paper Name: **Cost Effective Refractory Handling Manipulator for Safe & better Ergonomics**

PRESENT AFFILIATION	**TRL KROSAKI REFRACTORIES LIMITED**
AREAS OF INTEREST	**Flow control, tundish refractories & mechanisms**
Education	**B.Tech in Mechanical Engineering**
Experience	• **13 Years** • **Area – Flow control refractories & mechanisms, Tundish refractories & associated mechanisms, Refractories application systems, Supply chain management, Mechanical maintenance at plant**
Projects:	• **POKA YOKE in TRLK Slide Gate System, for ensuring SG close during Tapping operation** • **Development of Backsplash protection cover for safe operation in TRLK Slide Gate** • **Mechanization to improve the productivity by 28% of Central maintenance shop at Dalmia Bharat Refractories Ltd.**
Publication / Patent	**02-nos. patent (*Applied*)**

TRL KROSAKI

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COST EFFECTIVE REFRACTORY HANDLING MANIPULATOR FOR SAFE & BETTER ERGONOMICS

Presented By:

Suchit Kumar Mahanta

TRL Krosaki Refractories Limited

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- Background
- Concept of Manipulator
- Manipulator for Slide Gate Nozzle fixing
- Conclusion

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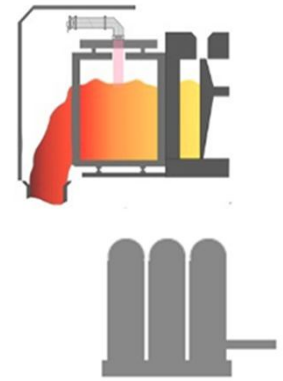
Steel Making Process Flow & Major Refractories

Iron Making

Coke Oven/ Hot Stove

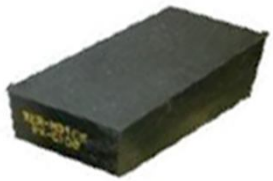


Coke oven refractories

Blast Furnace

High Alumina refractories

Torpedo Ladle



Al2O3-SiC-C refractories

Steel Making

Oxygen Converter

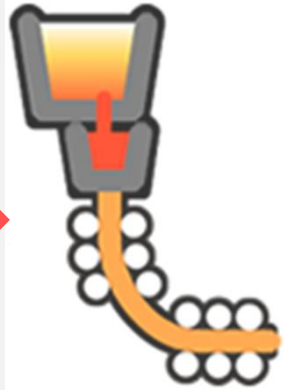
MgO-C refractories

Secondary Refining Furnace

Magnesia-Chrome refractories

Steel Casting

Steel Ladle/ Continuous Casting



Slide gate plate

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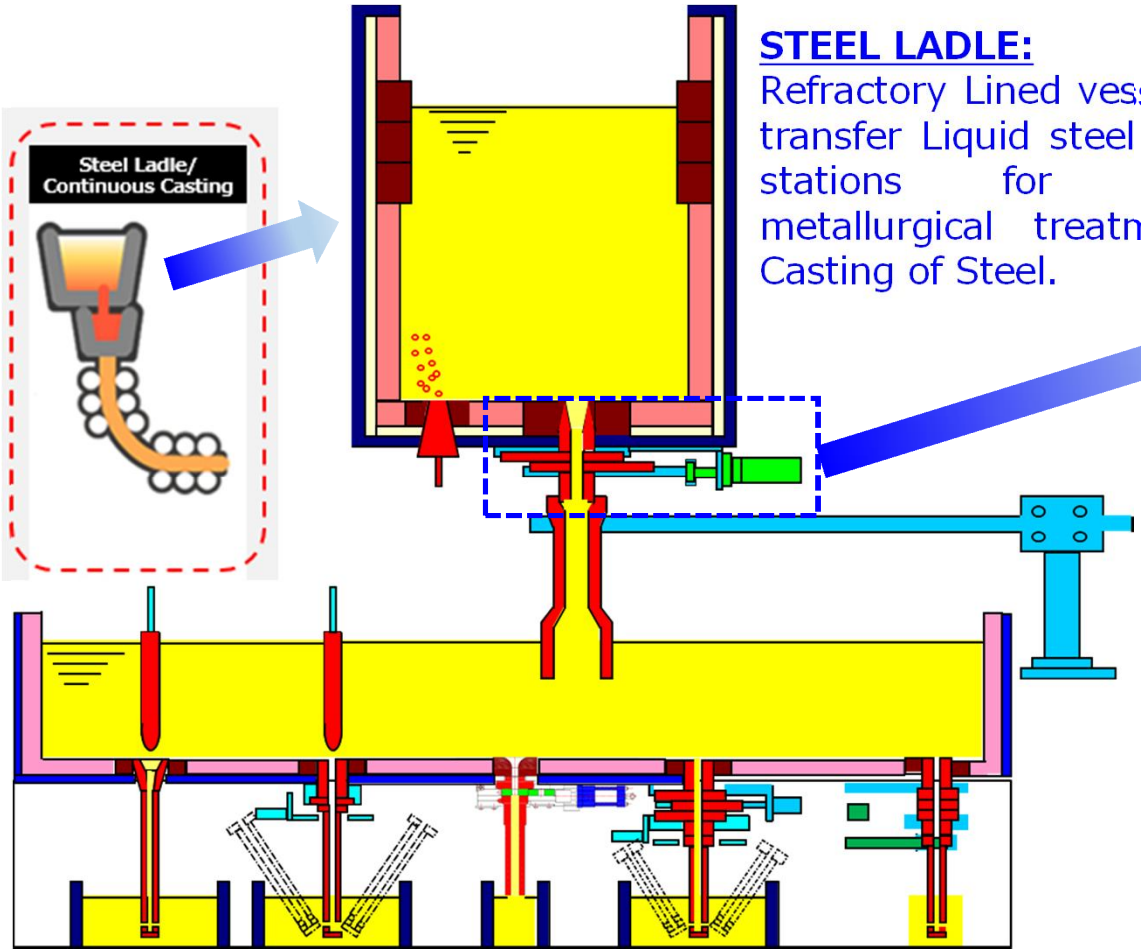
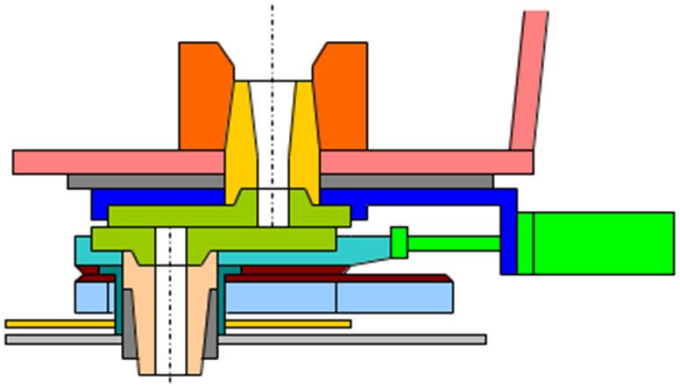
Ladle and Slide Gate



STEEL LADLE:

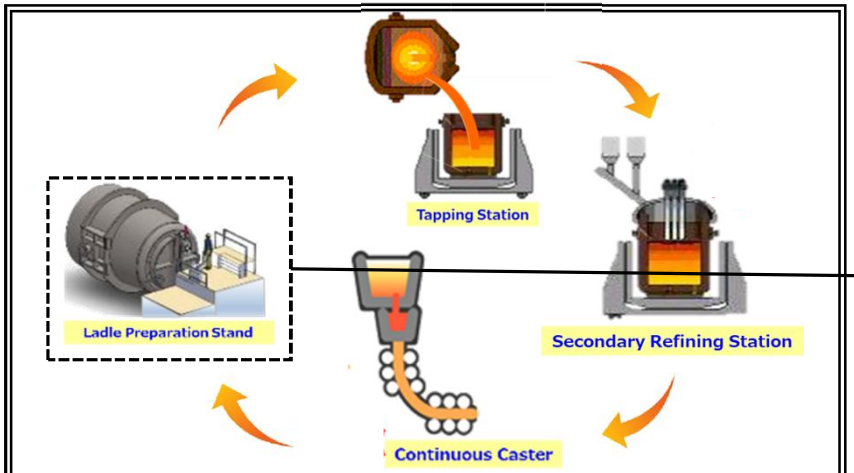
Refractory Lined vessel used to transfer Liquid steel to various stations for Secondary metallurgical treatments and Casting of Steel.



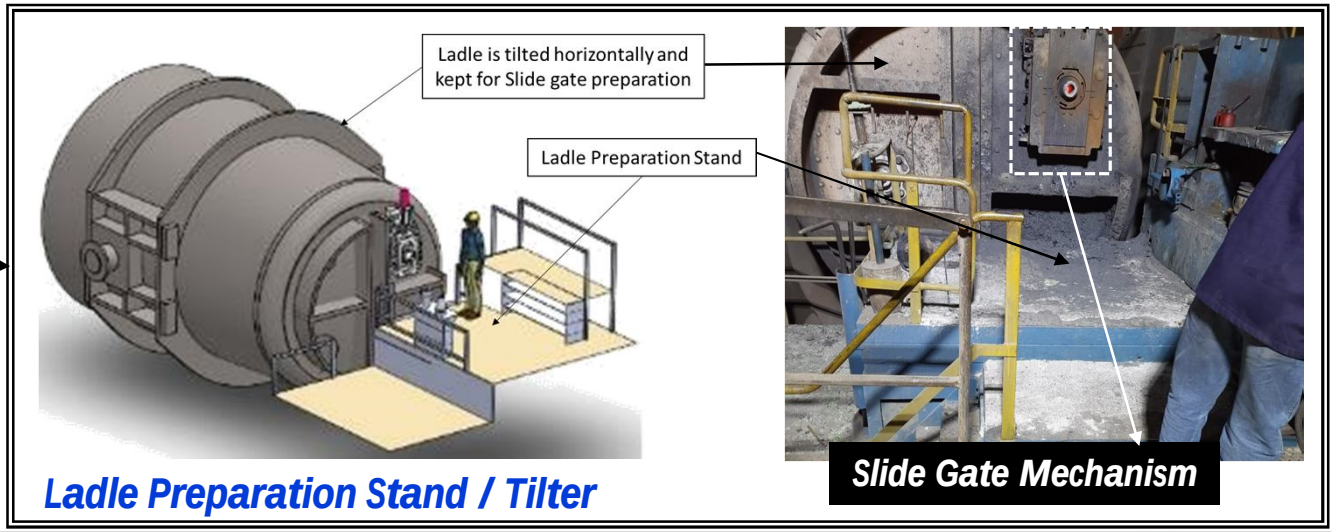
LADLE SLIDE GATE:

The device mechanically assembled, consisting of consumable refractories, installed on ladle bottom has the function to control liquid steel from the ladle to Tundish by throttling plate nozzle bore in continuous casting process.

Steel Melt Shop, Ladle and Slide Gate

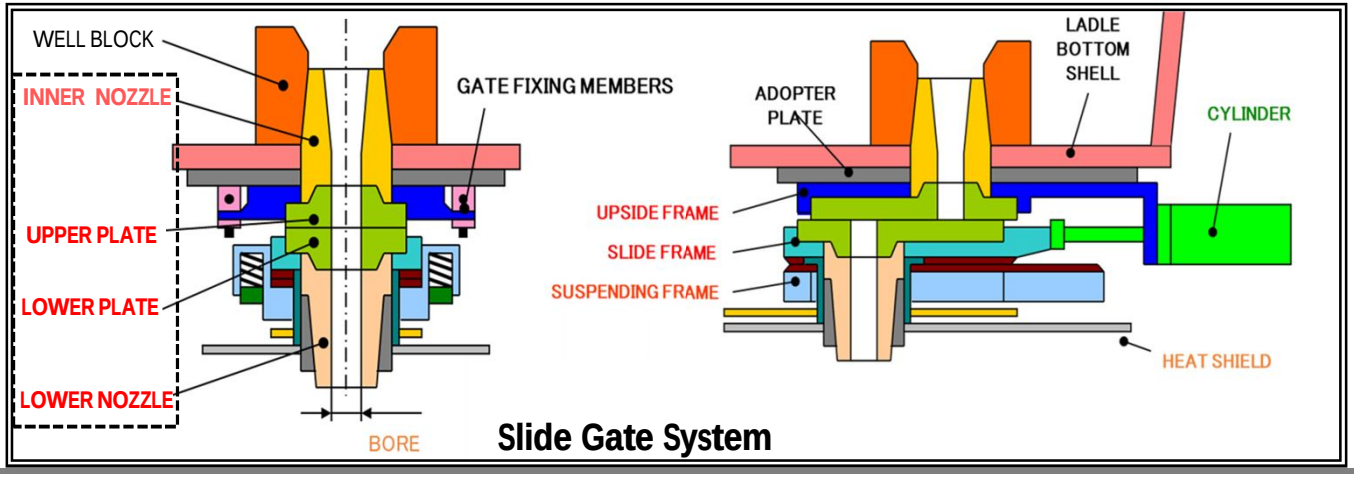


Route of Ladle in Steel Making Shop



Ladle Preparation Stand / Tilter

- These four refractory component need to be changed on periodic basis. Heaviest is "**Upper Nozzle**".
- Operator must lift heavy weight manually, during refractory components change.
- **Challenge** is to reduce the manual effort and make the process operator friendly.



Slide Gate System

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Present Practice of Upper Nozzle Fixing

Nozzle Fixing process and associated Problems

Process 1 :- Lift Upper Nozzle with jig.

Safety Hazards :- No Gripping facility, Nozzle may fall on leg.

Process 3 :- Lift Upper Nozzle.

Safety Hazards:- Back Sprain, Operator Fatigue.

Process 2 :- Mortar Application.

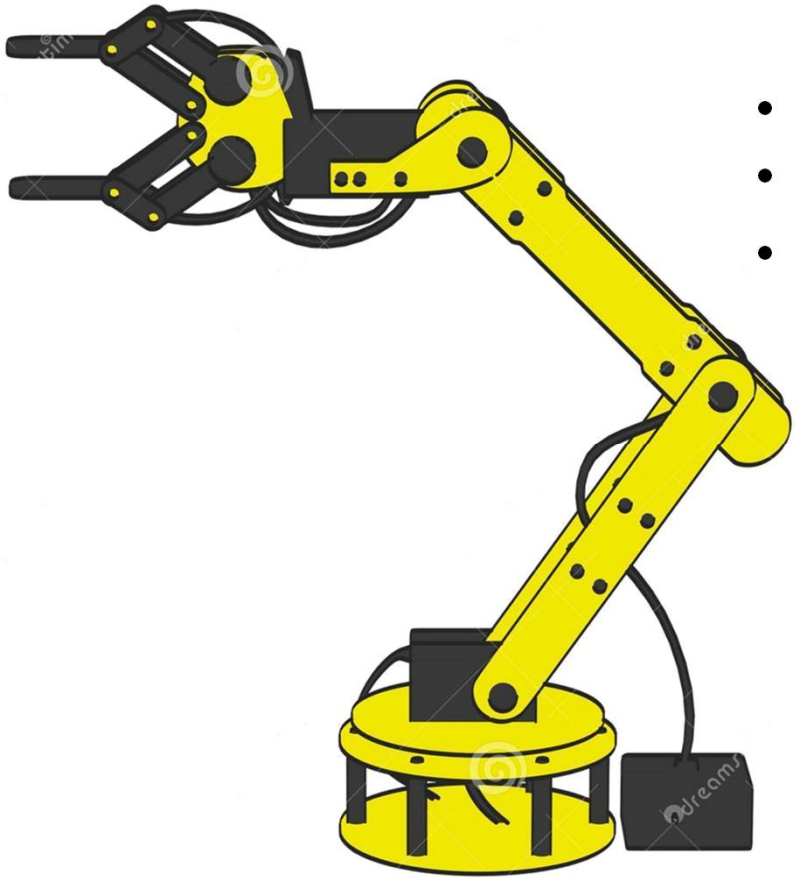
Safety Hazards :- Nozzle with Jig may fall.

Process 4 :- Take Upper Nozzle towards Well block and push in it.

Safety Hazards :-Back Sprain, Operators poor ergonomics.

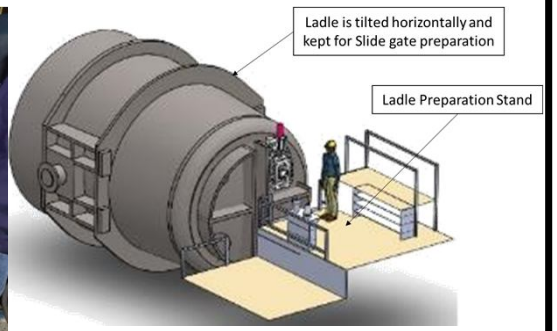
Possible Solutions

Use of Robots for Ladle Preparation



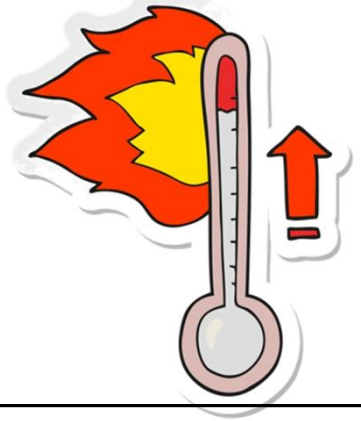
- High Capital cost.
- High maintenance Skills.
- It's in developmental stage, still not in regular use.

Challenges

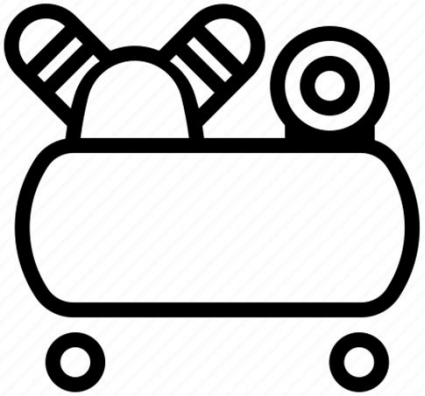


Area and Height were limited

Dusty Environment



Higher working temperature



Energy source was limited to pneumatic

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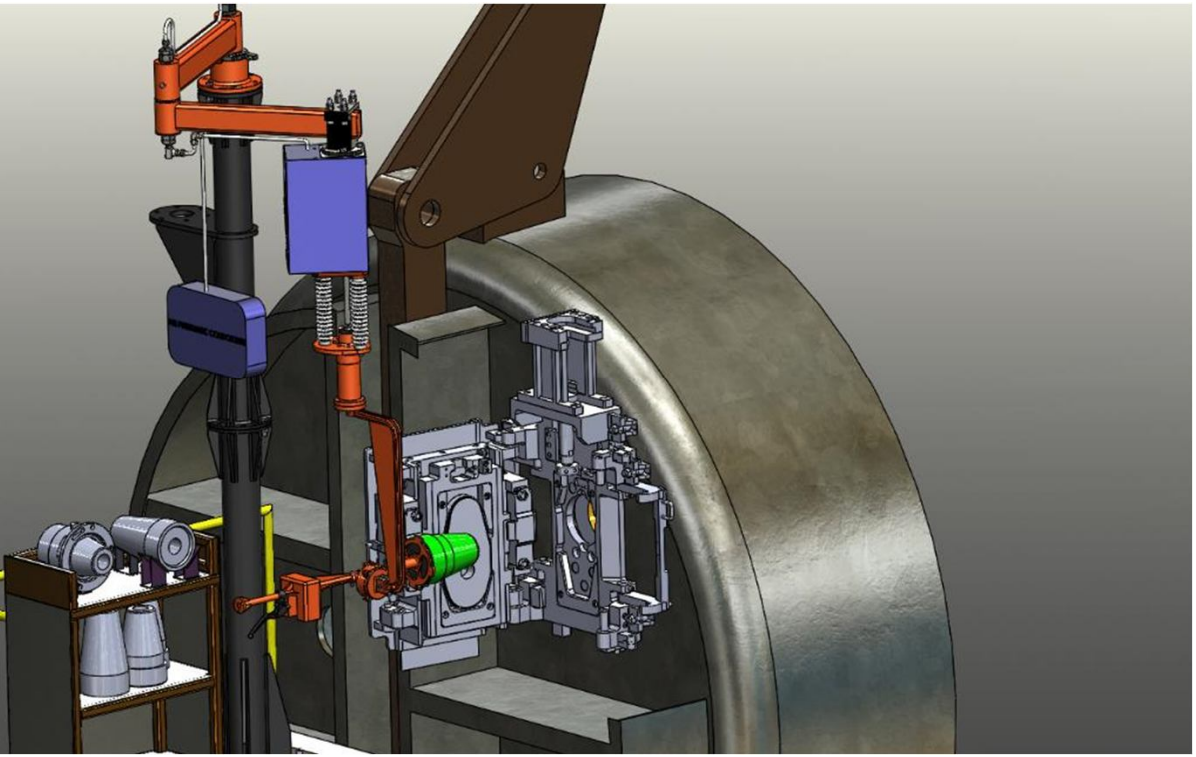
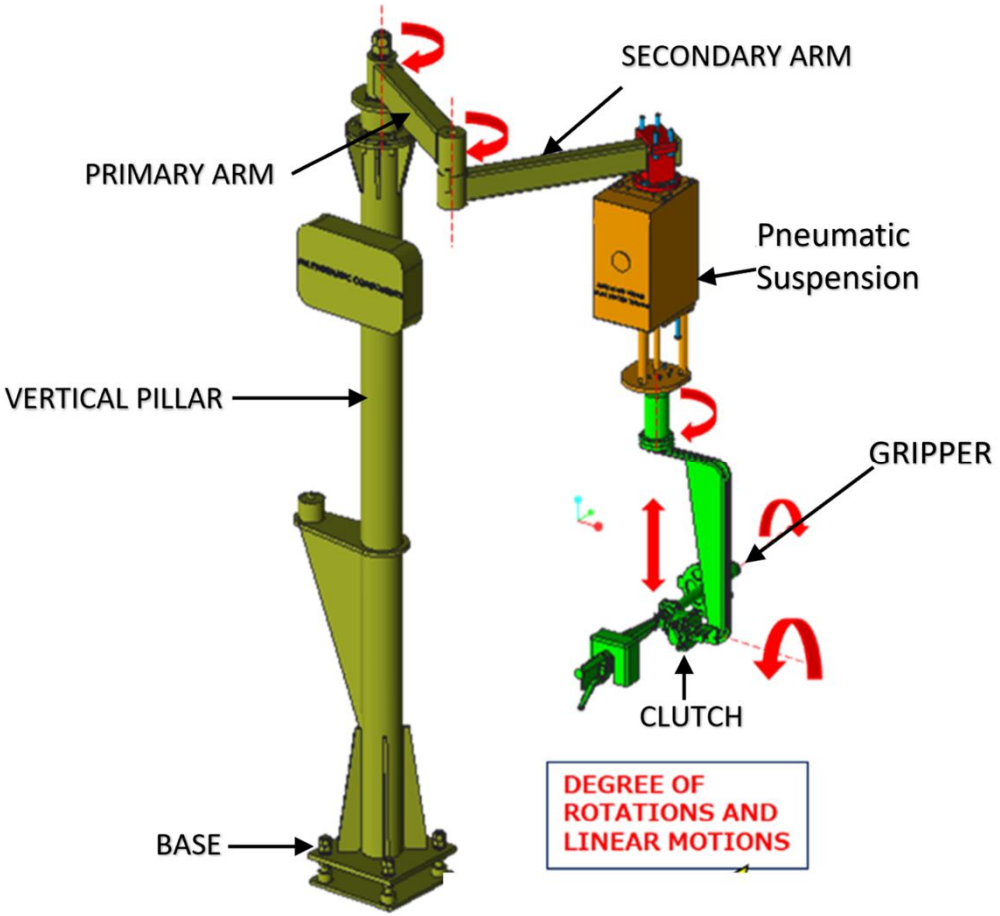
Semi Mechanized Manipulator





Cost Effective and Reliable

Semi Mechanized Manipulator

Major parts- Slide Gate Refractory Handling Manipulator

Vertical Pillar - Its function is to provide support to the whole structure.

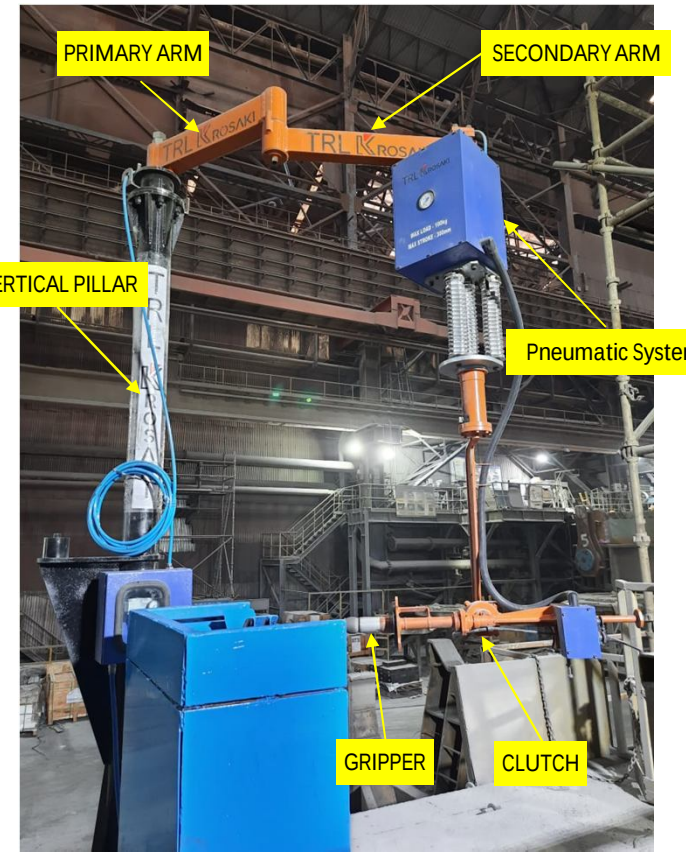
Arms - Provide Degree of freedom and movement to system.

Pneumatic System – Carries the load and balance the weight. Operator only needs to apply 1-2 Kg of force to lift 40 Kgs of load due to the weightless suspension.

Clutch - Its function is to control the rotational movement and helps in precise positioning.

Gripper - Grips the Refractory by Pneumatic force without damaging and works in high temp.

Manipulator Installed at Site



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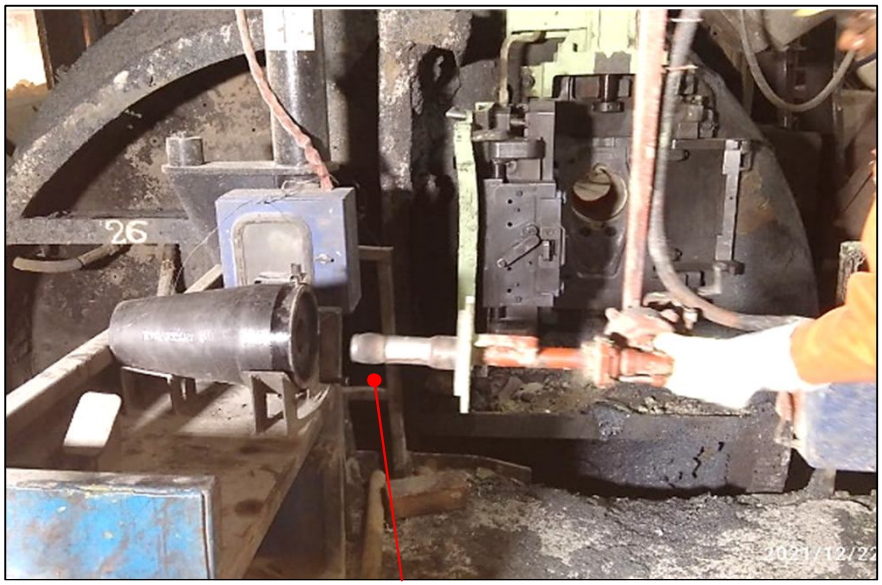
Semi Mechanized Manipulator

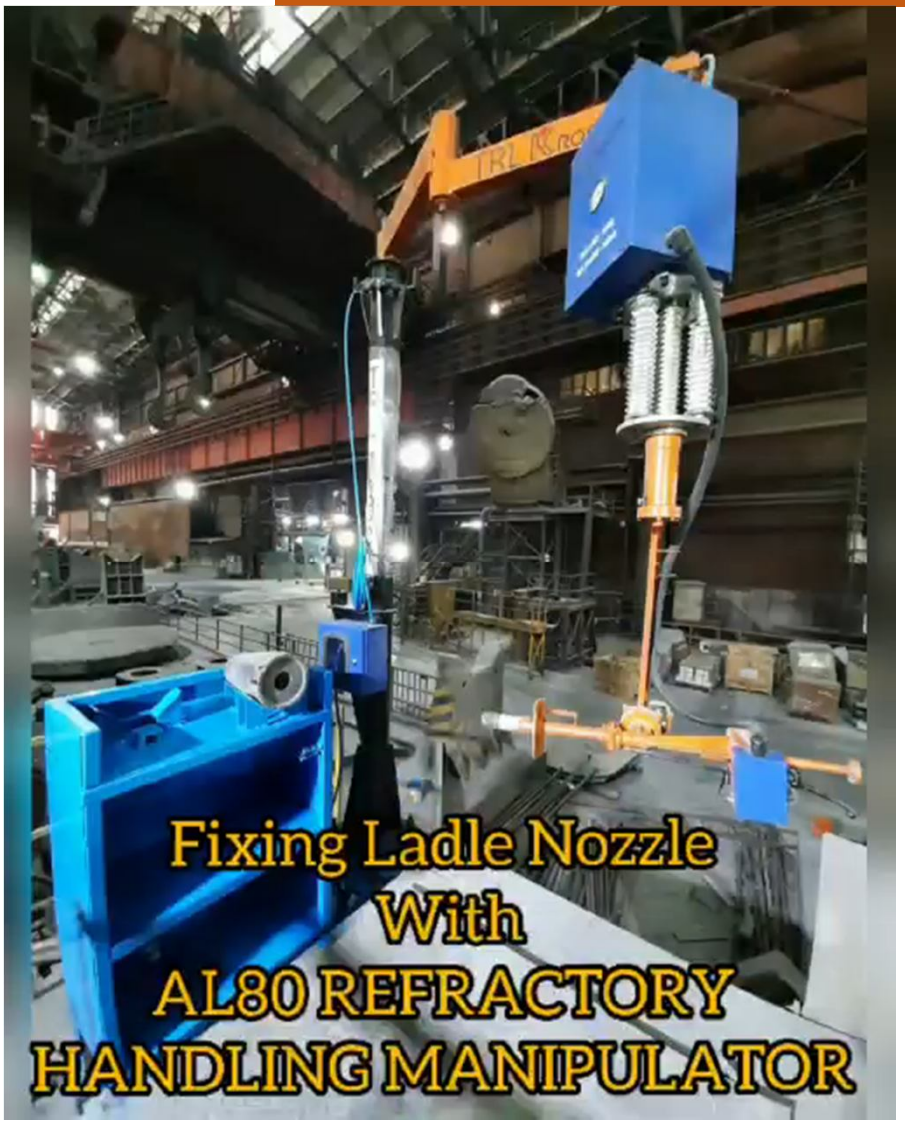
CLUTCH LEVER



GRIPPER

CLUTCH LEVER

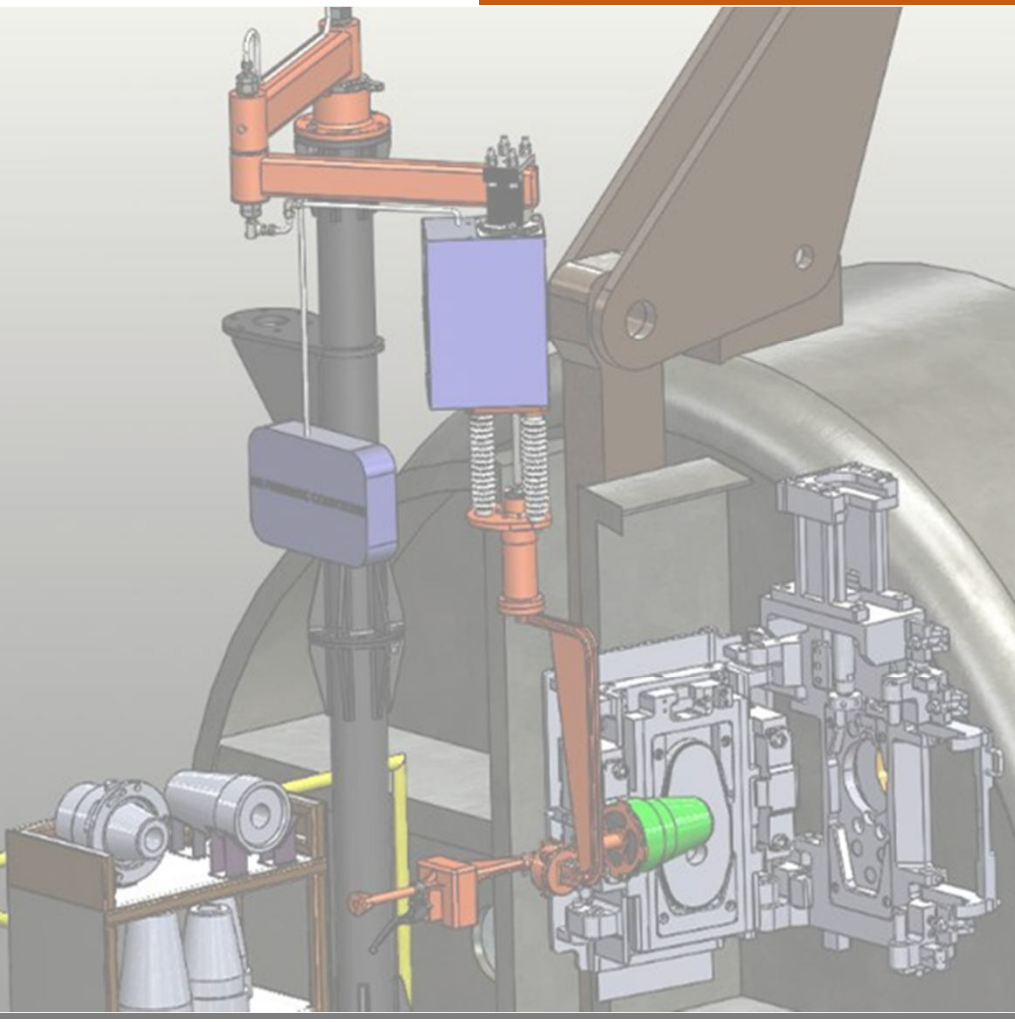
Nozzle Fixing with Manipulator



Nozzle fixing with Manipulator

1. Gripper grips Inner Nozzle, thus **preventing from falling.**
2. Pneumatic system **carries "Inner Nozzle".**
3. Pneumatic pressure around 4 to 6 bar required to operate the system.
4. Operator need to apply **force of 2-3 kg** for up and down movement.
5. Operator only need to guide Inner Nozzle into Well Block Bore, thus **Precision improved.**
6. **Ergonomics Improved.**

Safety features



- ❑ Positive locking of full manipulator in case of issue in pneumatic air supply.
- ❑ Upper Nozzle locking with Gripper.
- ❑ Manipulator is in locked parking position during ideal period.

Conclusion

- Our one of prestigious customer satisfied with Manipulator Performance and decided to convert their all Tilter with TRLK'S Manipulator.
- Very cost-effective, as compared to Imported & reliable.
- TRLK is working to add more Functions in same Manipulator, like Porous Plug Fixing and removal, at Ladle Tilter.
- This Manipulator can be customized according to need and can be widely used for various application in Steel Plant as well as other industries.
- This development is in line of "Make in India" Policy.

THANK YOU..!

TRL Krosaki, Belpahar
Aerial View