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Conceptual Design of the Pantograph Type In-Vessel Transfer Machine in PGSFR

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1. Introduction

The purpose of a pantograph type in-vessel transfer machine (IVTM) is to transfer new assemblies to a reactor core, and to remove spent assemblies from a core barrel. It is also used to place them into the in-vessel storage and retrieve core assemblies from the fuel transfer port. The pantograph type IVTM has six motions, i.e., the rotation of the support tube, the pantograph movement, the gripper vertical travel, the gripper rotation, the gripper finger motion, and a hold down movement. This machine is activated in combination with a single rotating plug and is in the reactor during the refueling, in-service inspection, and repair. The pantograph motion is achieved by the extension or retraction of the pantograph arm [1].

In this study, the conceptual design of a pantograph type IVTM was performed. The 3D configuration and driving mechanisms of the IVTM were designed by considering the core configuration of the PGSFR.

2. Conceptual Design for the Pantograph Type In-Vessel Transfer Machine

2.1 Functional Requirements of the Pantograph IVTM

Fig. 1 illustrates the 2D general arrangement of the PGSFR pantograph IVTM.

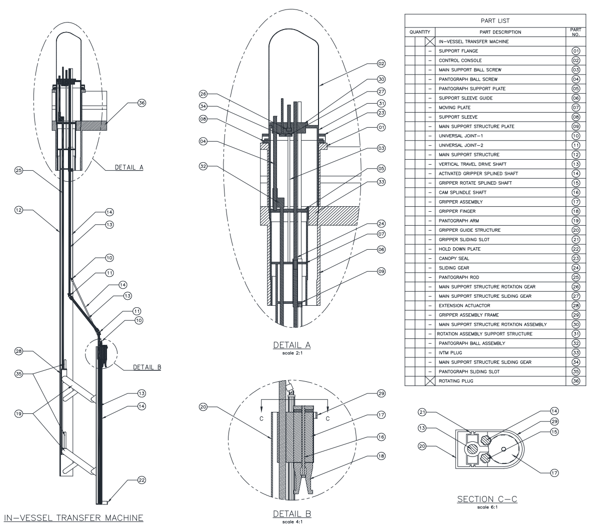

Fig. 1 2D general arrangement of the PGSFR pantograph IVTM

The PGSFR pantograph IVTM should be designed to incorporate the following functional capabilities:
- IVTM support tube: rotate about its axial centerline
- Holddown: raise and lower
- Pantograph: extend and retract
- Grapple: raise and lower
- Grapple finger: latch and unlatch
- Grapple head: rotate about its axial centerline

2.2. Mechanisms of the Pantograph IVTM

The pantograph type IVTM is composed of three main parts such as the upper section, the support tube, and the pantograph arm, which includes the gripper assembly. Fig. 2 shows the 3D configuration of the pantograph type IVTM. As shown in this figure, the upper section is installed above the flange, which is mounted to the reactor head. It contains all of the necessary drives and controls to operate the machine. The support tube section provides the physical support for the pantograph mechanism. It also houses the linkage required to move the pantograph arm and the gripper assembly, as shown in Fig. 3. It is designed as a rectangular tube 2.5 cm thick with a vertical slot to allow the extension and retraction of the pantograph arm.

A gripper mechanism, located on the pantograph arm is driven by a screw drive and vertically travels. Fig. 4 shows the gripper mechanism of the designed PGSFR. When the gripper mechanism is lowered, a gripper finger is closed.

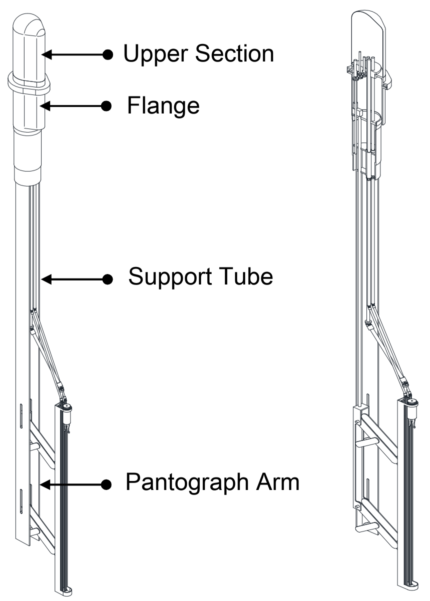

Fig. 2 3D conceptual design of the PGSFR pantograph IVTM

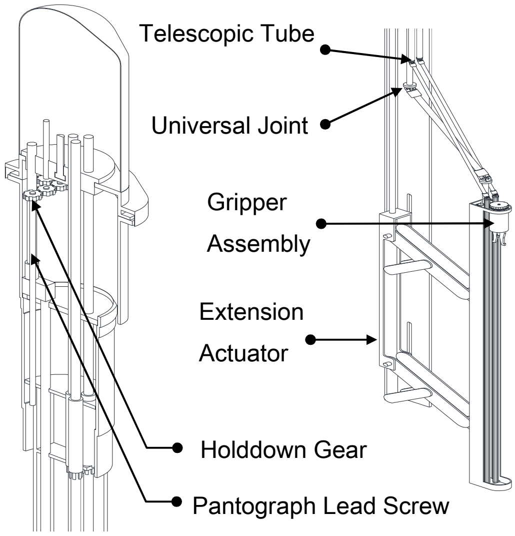

Fig. 3 Pantograph mechanism and gripper assembly in PGSFR

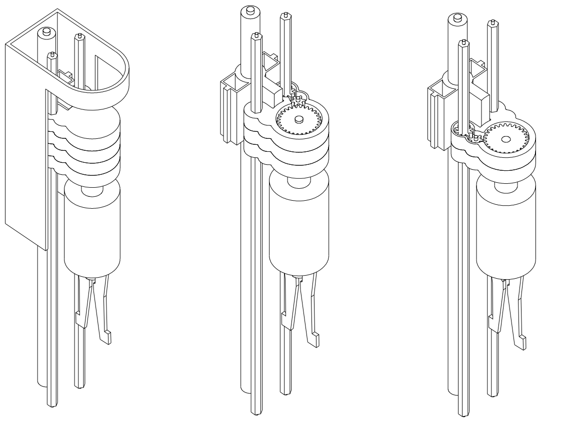

Fig. 4 Driving mechanism of the PGSFR gripper assembly

On contact with the end of the core assembly, the left shaft that operates gears to drive the cam spindle is rotated. At that moment, the gripper assembly picks up the core assembly and is raised with it. The gripper can then be rotated to re-orient the assembly for reinsertion, or can be removed and replaced

2.3 Maintenance and Repair Concept

For the pantograph type IVTM in PGSFR, the pantograph arm is designed to reach up to a maximum of 1.13 m from the rotation center through the upper internal structure slot, as shown in Fig. 5. Also, it can be retracted to a minimum of 0.35 m for the removal through the penetration hole, as shown in Fig. 6. The drive unit is designed to allow the limited maintenance and repair of the mechanisms while the in-vessel section is installed inside the reactor, but under abnormal conditions, the in-vessel section should be removed from the reactor by using the removal adapter.

To minimize a cover gas leakage during a reactor operation, the seal welding, as shown in Fig. 6, is incorporated in the IVTM and reactor head interface design.

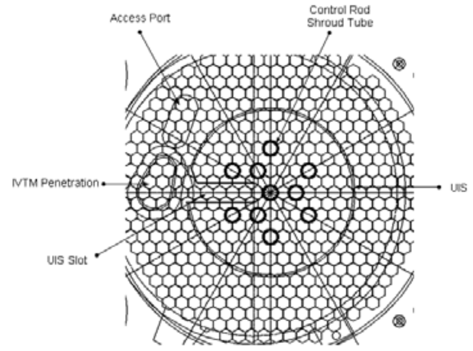

Fig. 5 Top view for the IVTM and upper internal structure in PGSFR

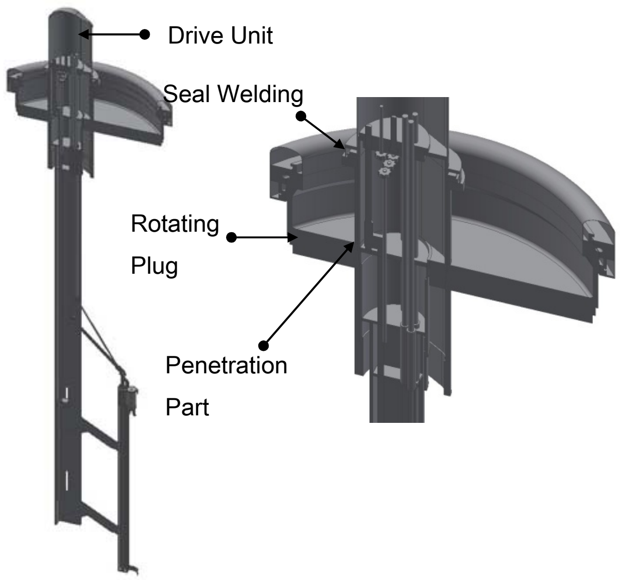

Fig. 6 IVTM penetration and seal welding part in PGSFR

3. Conclusion

The conceptual design of the pantograph type IVTM in the PGSFR was performed, and the driving mechanisms for the pantograph movement, the support tube structure and the gripper assembly were reviewed.

Acknowledgements

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REFERENCES

[1] ANL, Advanced Burner Test Reactor Preconceptual Design Report, ANL-ABR-1, 2006.