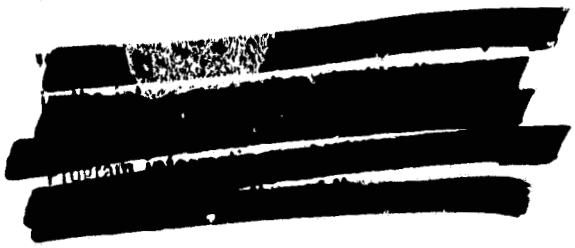
National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas 77058



PLAID EVALUATION OF VISUAL ACCESS FOR PDP BERTHING AND DEPLOYMENT

APRIL 1980

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PLAID EVALUATION OF VISUAL ACCESS FOR PDP BERTHING AND DEPLOYMENT

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PLAID EVALUATION OF VISUAL ACCESS FOR PDP BERTHING AND DEPLOYMENT

INTRODUCTION

The Plasma Diagnostics Package (PDP) is a small, pallet-mounted payload that must be deployed and berthed on-orbit by the Shuttle Remote Manipulator System (RMS). The PDP is berthed to a retention mechanism (REM) which is resting on an OSS pallet. The PDP is scheduled for STS-4; for this flight, the complement of payloads in the bay also includes an Induced Environment Contamination Monitor (IECM), which is also berthed to a REM, and a DFI pallet. Concerns about capabilities of the Payload Deployment and Retrieval System (PDRS)--namely the RMS--to perform PDP berthing and deployment culminated in a test request co-sponsored by the PDRSO and SPIDPO. The request is attached as Appendix A.

The test emphasized assessing the RMS operator's visual access (either by direct vision or CCTV) to the appropriate points of interest, as well as developing those marks or aids which would be required to complete berthing and deployment under different Orbiter lighting conditions. The original plan was to construct full-scale mockups of the OSS pallet, the PDP, and other hardware which could affect the visual access, then place these mockups in the one-g trainer to perform a preliminary assessment. A second phase of the plan was to place these mockups in the MDF and perform PDP berthing and deployment using the manipulator arm.

At the time this test request was introduced, no required pallet or experiment hardware was available, and the MDF--in the middle of an overall test to assess large payload deployment and retrieval--had a backlog of other tests waiting in line. As an alternative, the first phase of the PDP test was planned for completion using the Spacecraft Design Division's Design Performance Laboratory (DPL) computer system called PLAID.

PLAID DESCRIPTION

PLAID, which stands for Panel Layout Automated Interactive Design, is a 3-D computer graphics package which allows the user to construct models of real elements in three-space, assemble the elements as desired, then view the assembly from any specified eye point to any specified point on or around the assembly. Perspective can be enabled to produce a real-world picture of the scene.

TEST SETUP

For this application of PLAID, the PDP, pallet, Orbiter payload bay, the RMS arm, and other relevant elements were modeled in PLAID and assembled to represent the STS-4 configuration. Drawings supplied by the test sponsor were used to help ensure dimensionally accurate PDP and pallet/experiment models, and the PDRS data base used to ensure accurate placement of elements within the payload bay.

Several different assemblies were made, each one representing a "snapshot" of the PDP during the berth/deploy maneuvers. The cases selected for this study included the PDP as follows:

- berthed
- one foot up in Z
- two feet up in Z
- three feet up in Z
- six feet up in Z
- ten feet up in Z.

Each of these six assemblies was then viewed from the six possible eye/camera points, including the RMS operator's design eye point, the three payload bay bulkhead cameras (port forward and aft, starboard aft), and the two RMS-mounted cameras (elbow and wrist). For all viewpoints except the wrist camera, the look-to point was specified as the REM. For the wrist camera, the look-to point was along the camera's line-of-sight since this camera cannot pan and tilt. The fixed eye/camera locations, in Orbiter coordinates, are as follows:

VIEWPOINT	X_o	Y_o	Z_o
Design eye point	-586.0*	-15.0	-464.2
Forward port CCTV	-596.4	-71.5	-446.0
Aft port CCTV	-1286.6	-87.0	-446.0
Aft starboard CCTV	-1286.6	87.0	-446.0

RESULTS

The Figures

Thirty-six views (i.e., six views of each of six assemblies) were produced during this test. Each view (Figures 1-36) has a numerical code which appears in the upper right corner of the figure. The numerical code can be interpreted as follows. The first digit (4 in all figures) indicates the STS-4 flight configuration. The next two digits indicate the PDP position above its berthed location (e.g., 00 shows PDP in its berthed position, 02 is with the PDP 2 feet above the berthed position, 06 is 6 feet up, etc.). The last digit indicates the view-from location as follows:

01 Operator's design eye point

02 Forward port CCTV

03 Aft starboard CCTV

04 Aft port CCTV

05 Elbow CCTV

06 Wrist CCTV

For example, 4103 is the view seen from the aft starboard CCTV camera during STS-4 of the PDP 10 feet above its berthed position.

*Set aft to view past forward bulkhead.

FIGURE IMPLEMENTATION

Views of the PDP from the two aft cameras are occluded by the DFI/IECM and the pallet thermal canister. The elbow camera views are blocked by the lower arm. However, this location may still be viable to provide visual access with the implementation of the elbow camera wedge. Additional views should be run with this wedge configuration. Forward visual access is good, either from the RMS operator's design eye point location or via the port forward CCTV camera. However, this visual access does not provide good cues for determining PDP X location. The wrist camera may be useful in providing X cues by sighting in the periphery of the views on the experiment adjacent (i.e., port of) the PDP, the Solar Flare X-Ray Polarimeter (see Figures 4006, 4016, 4026, 4036, 4066, and 4106). For example, a series of short lines at the approximate X station could provide a track down which the end effector TV would be flown.

Further evaluations as specified in the test request are planned later this year in the MDF. The results of this PLAID study will be utilized in identifying preliminary marks for the test setup and in providing flight-configuration views for comparison with and extrapolation from the MDF configuration.

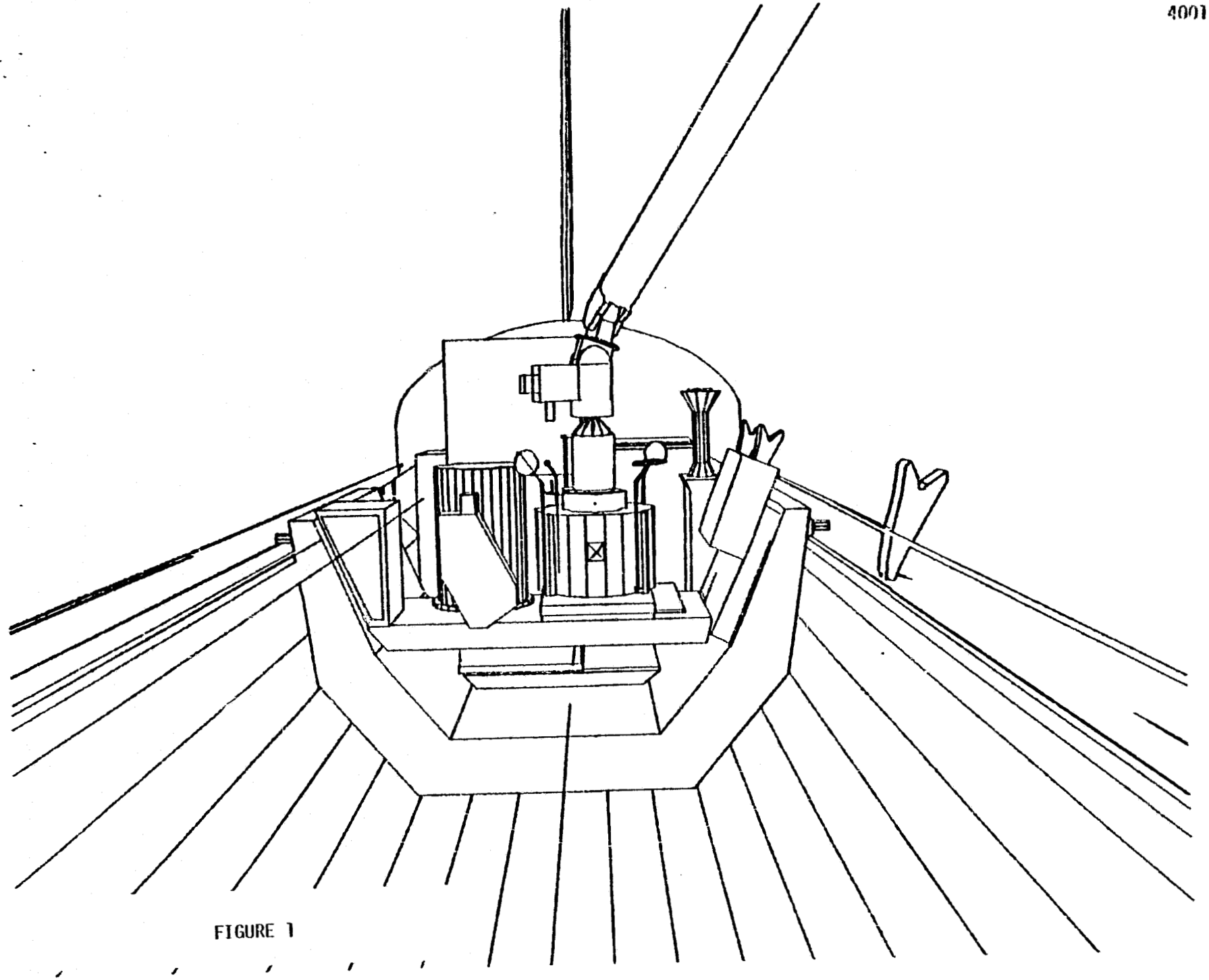
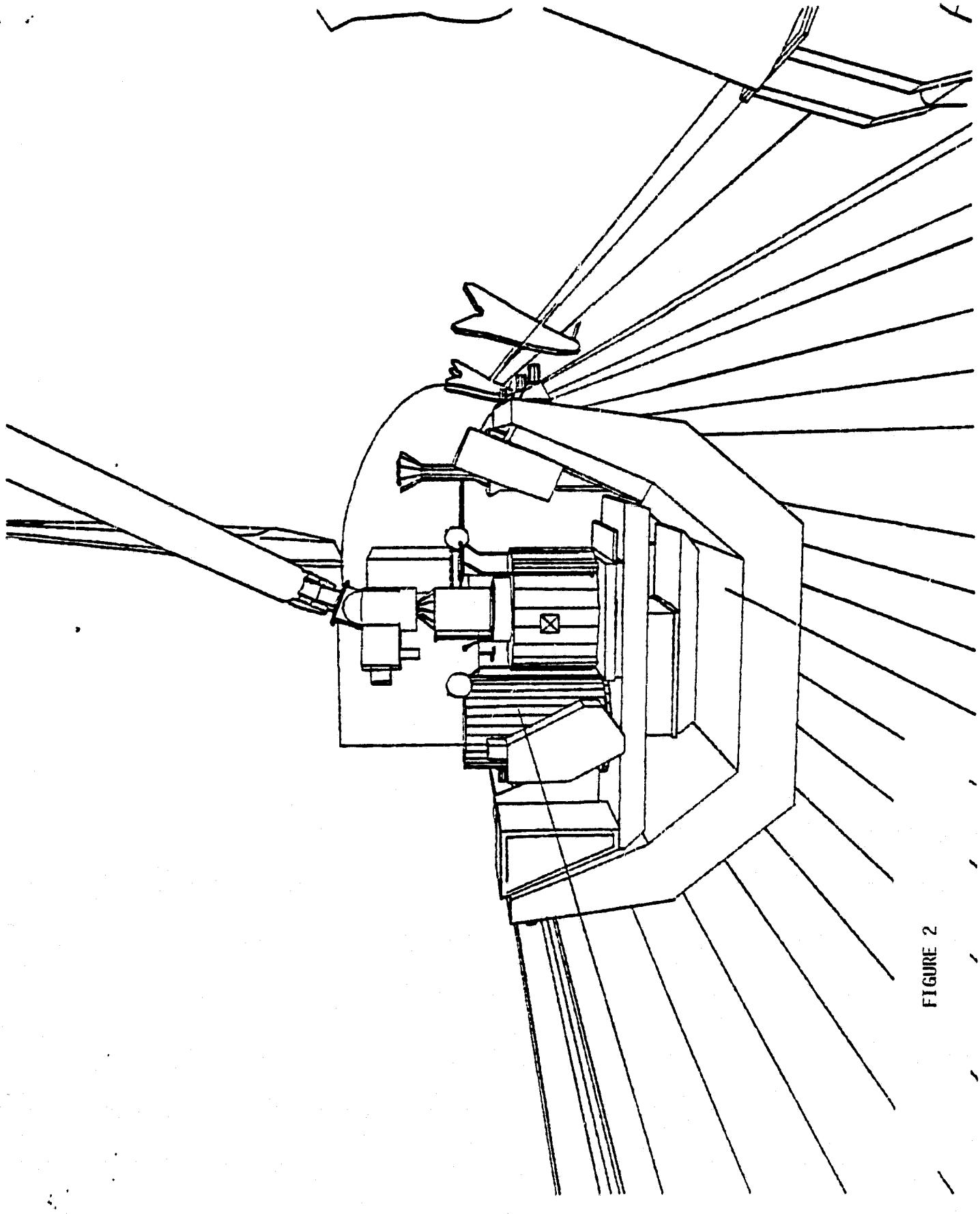


FIGURE 1



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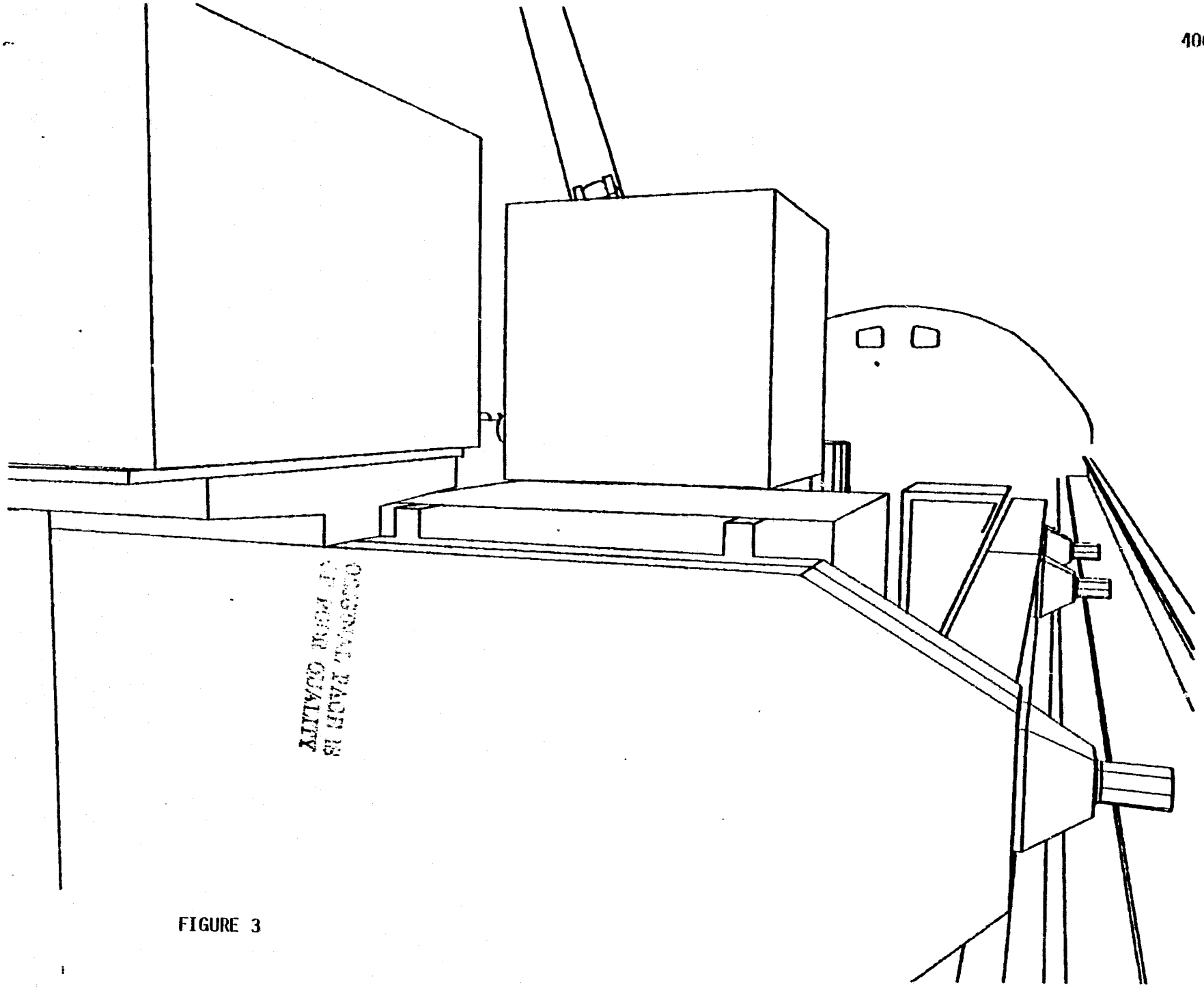

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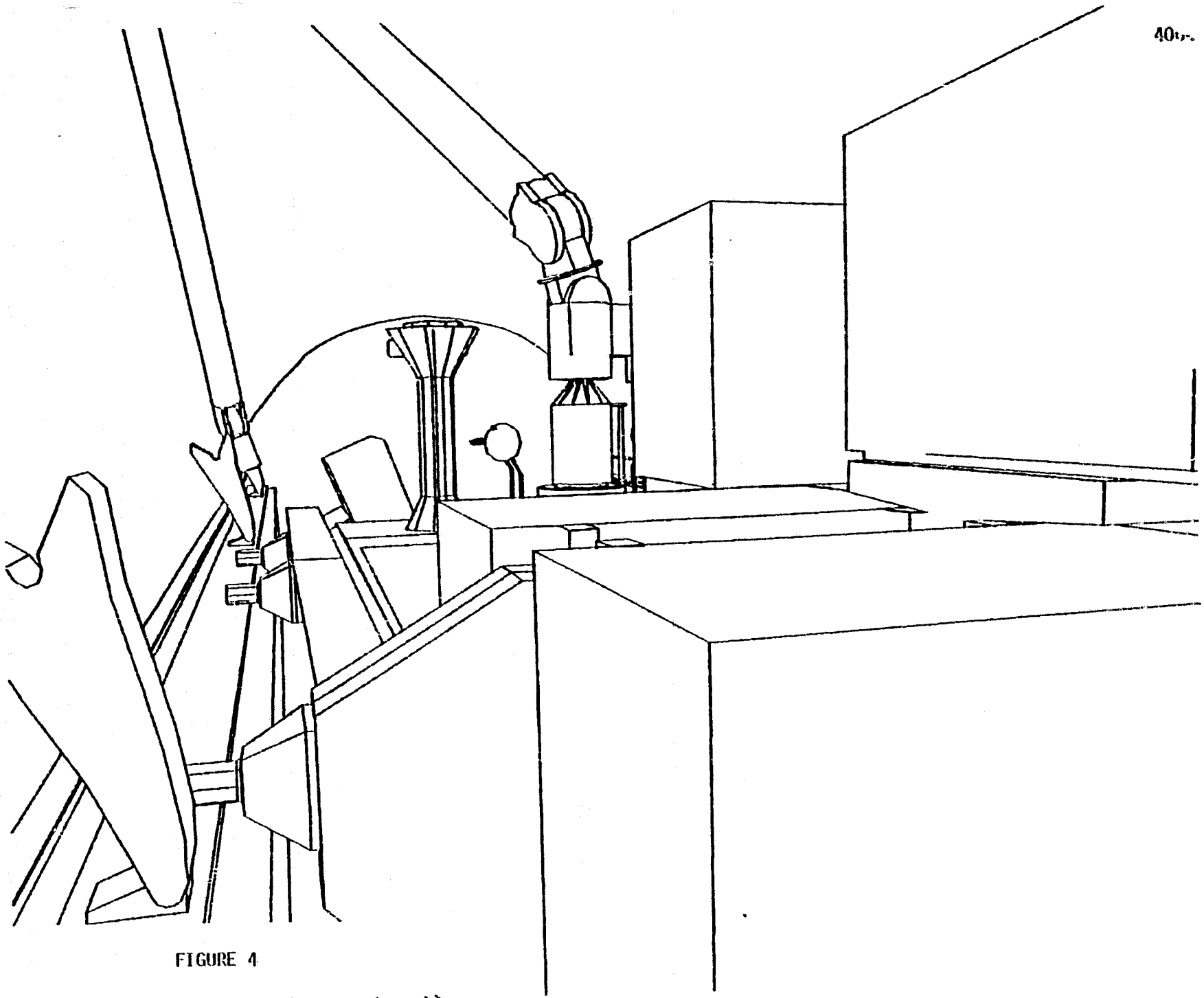

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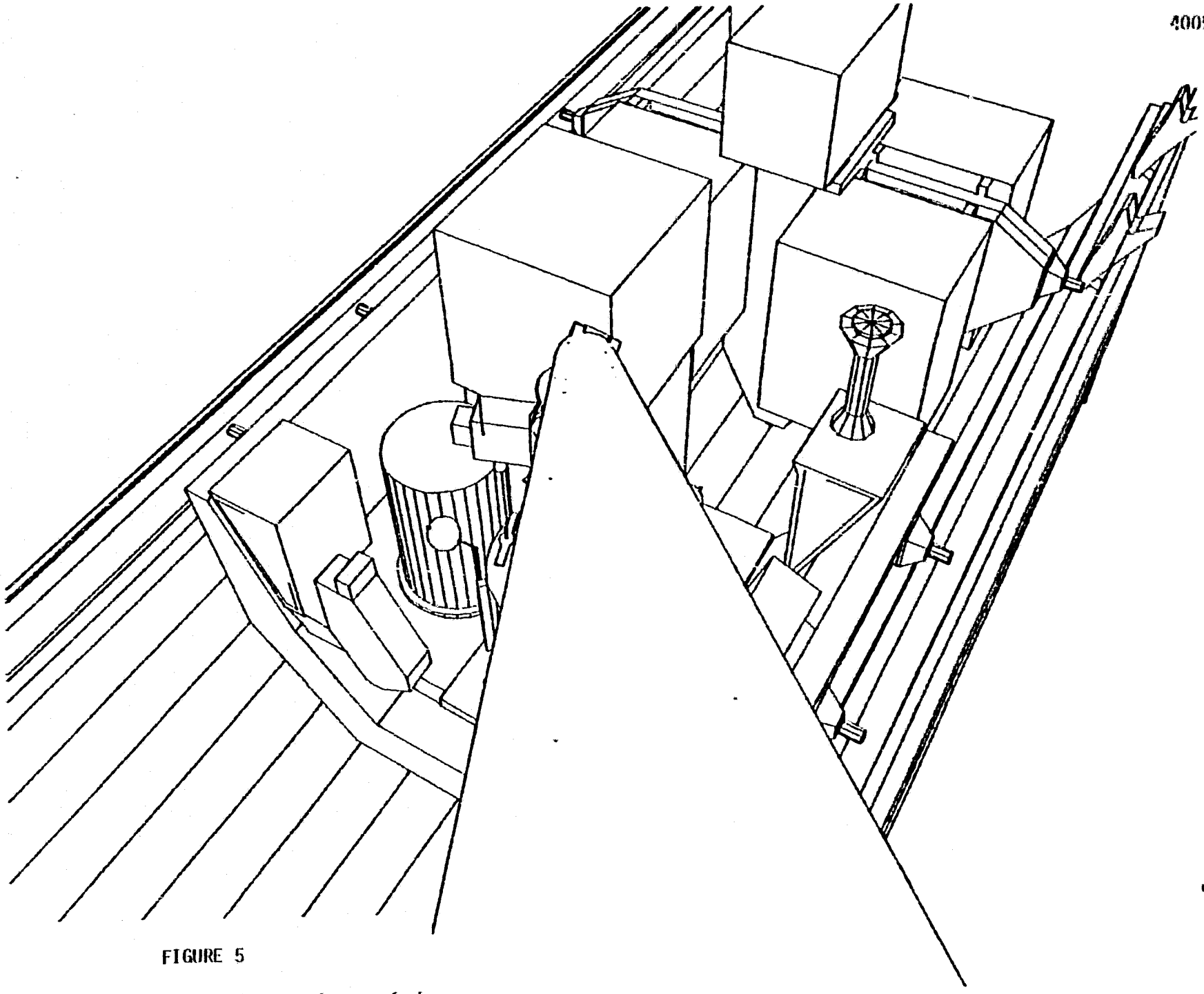

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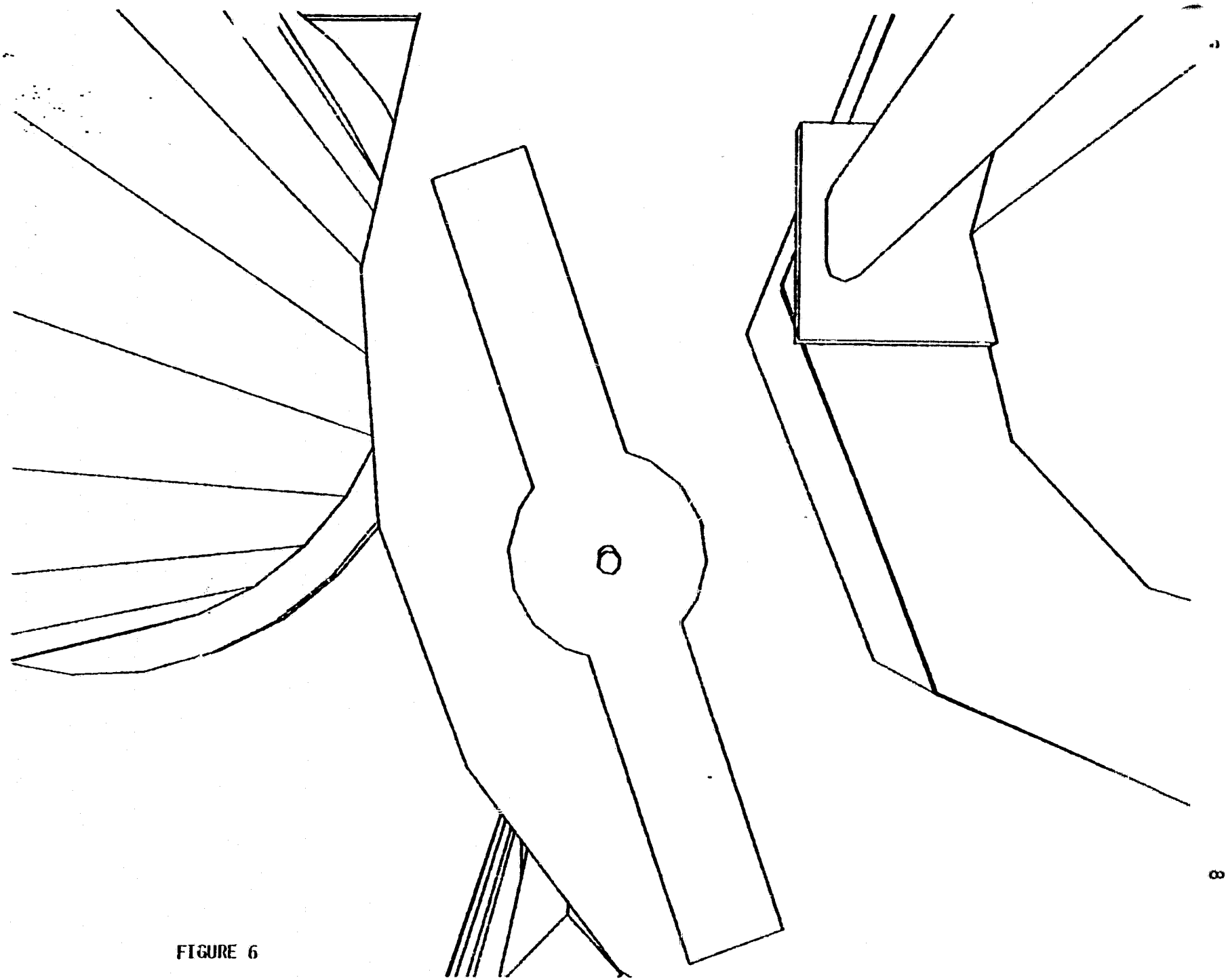

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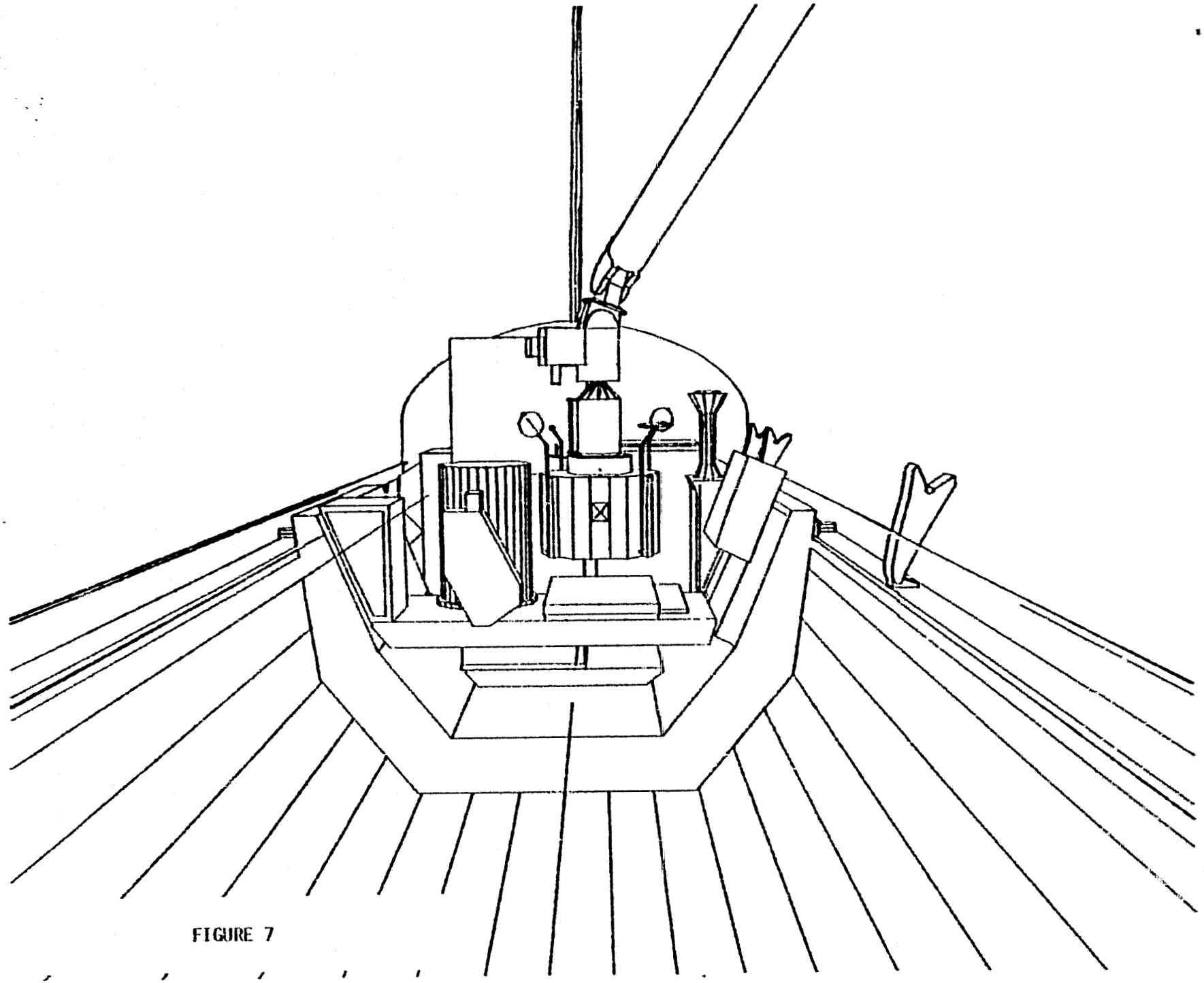

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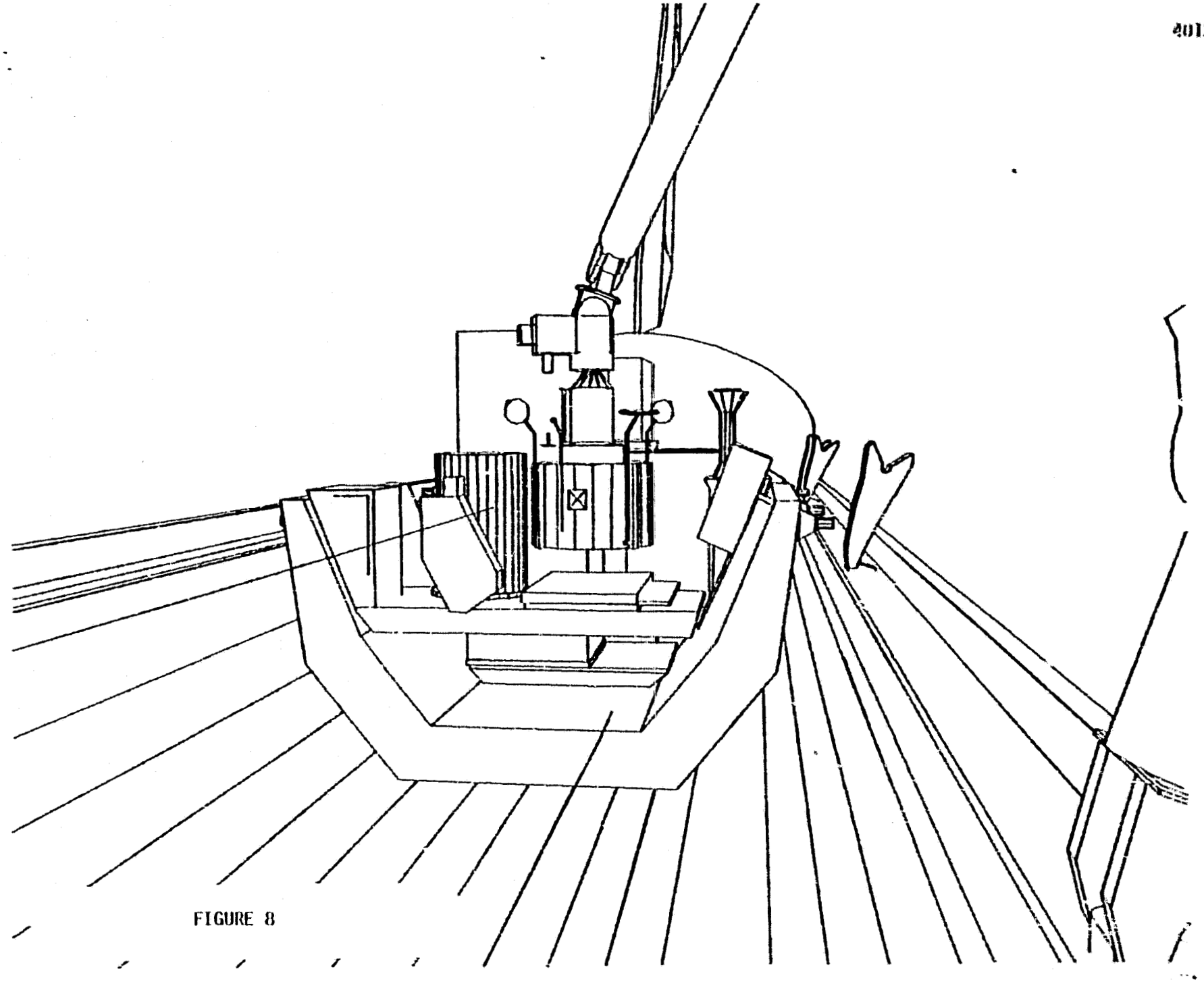

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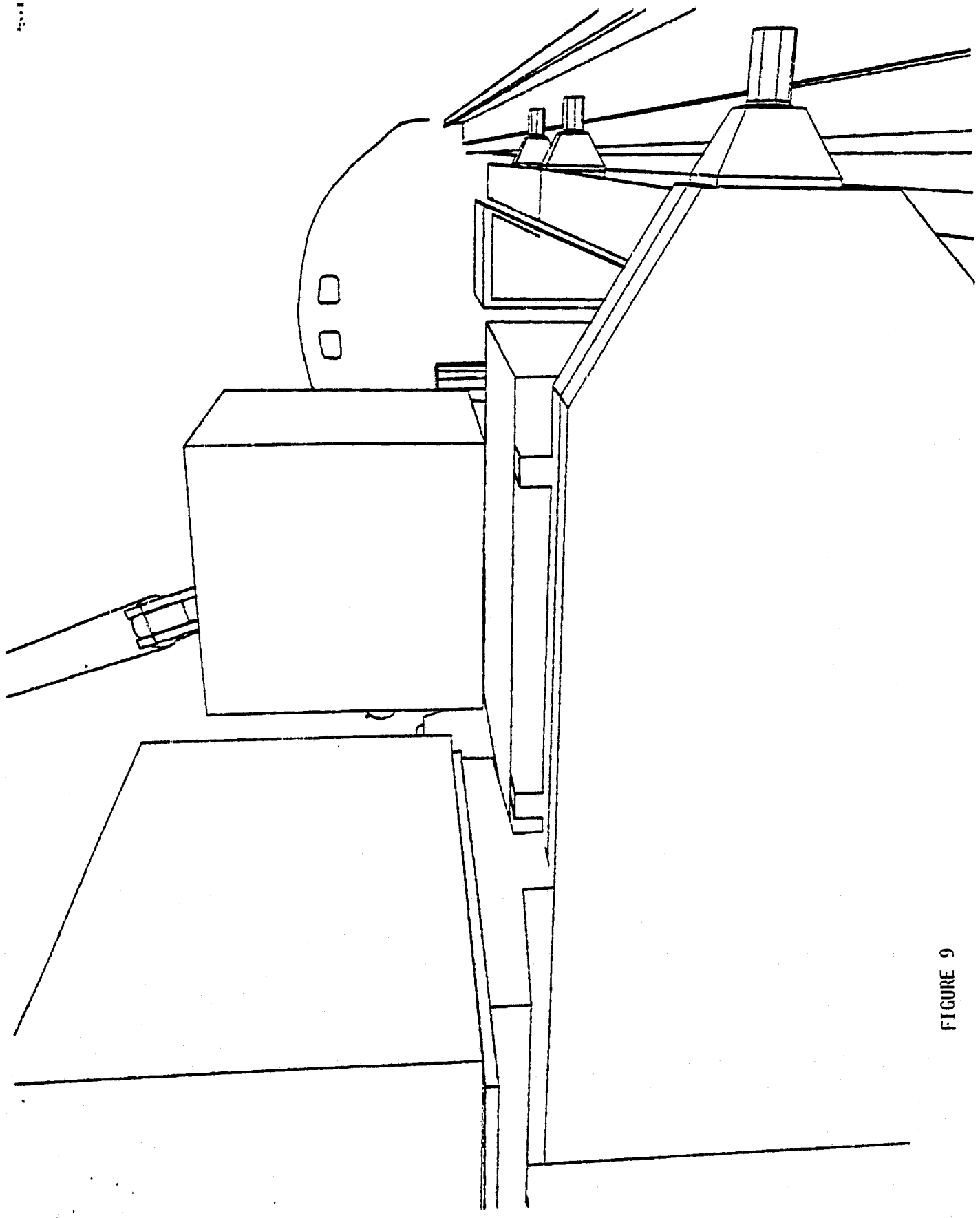

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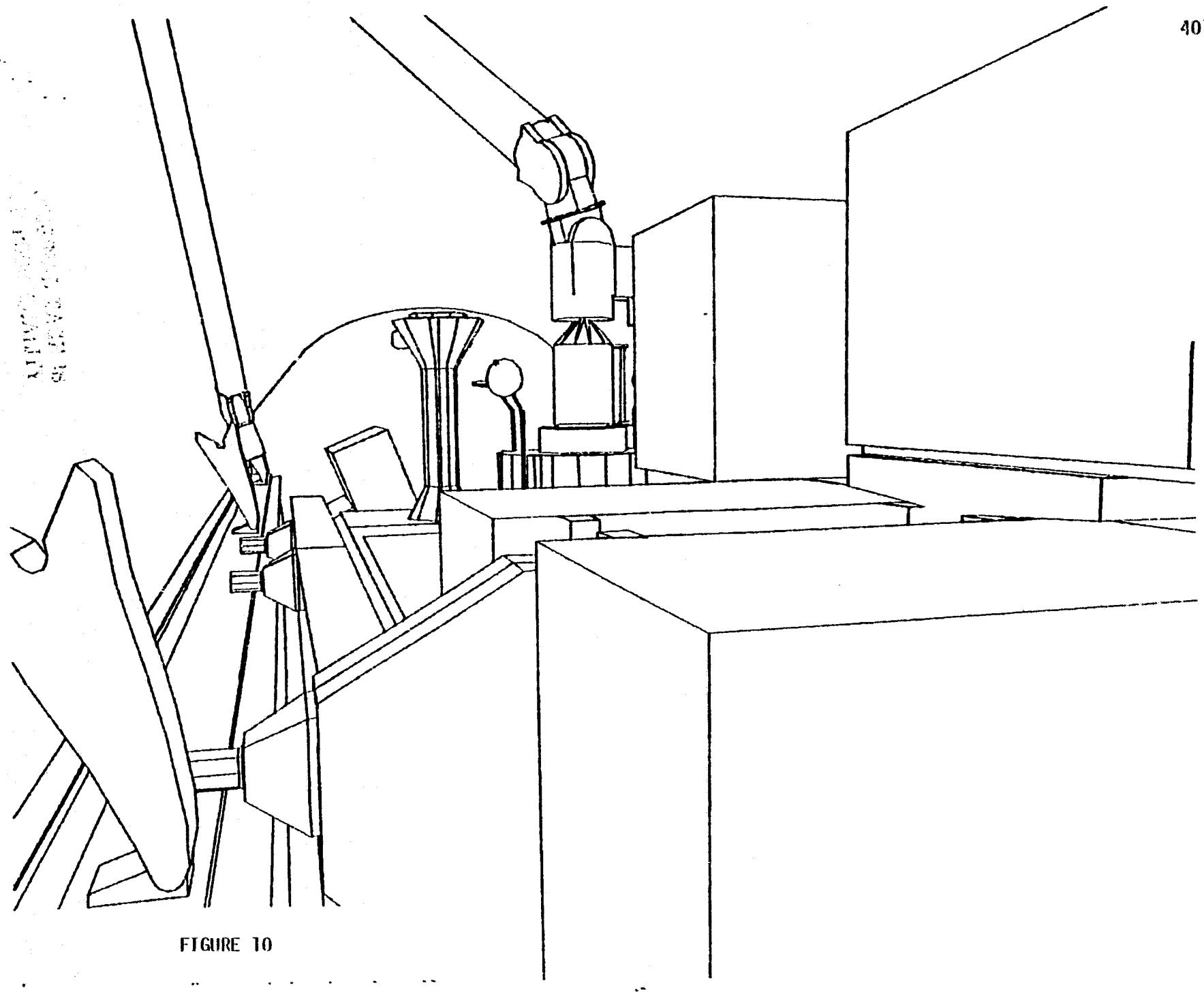

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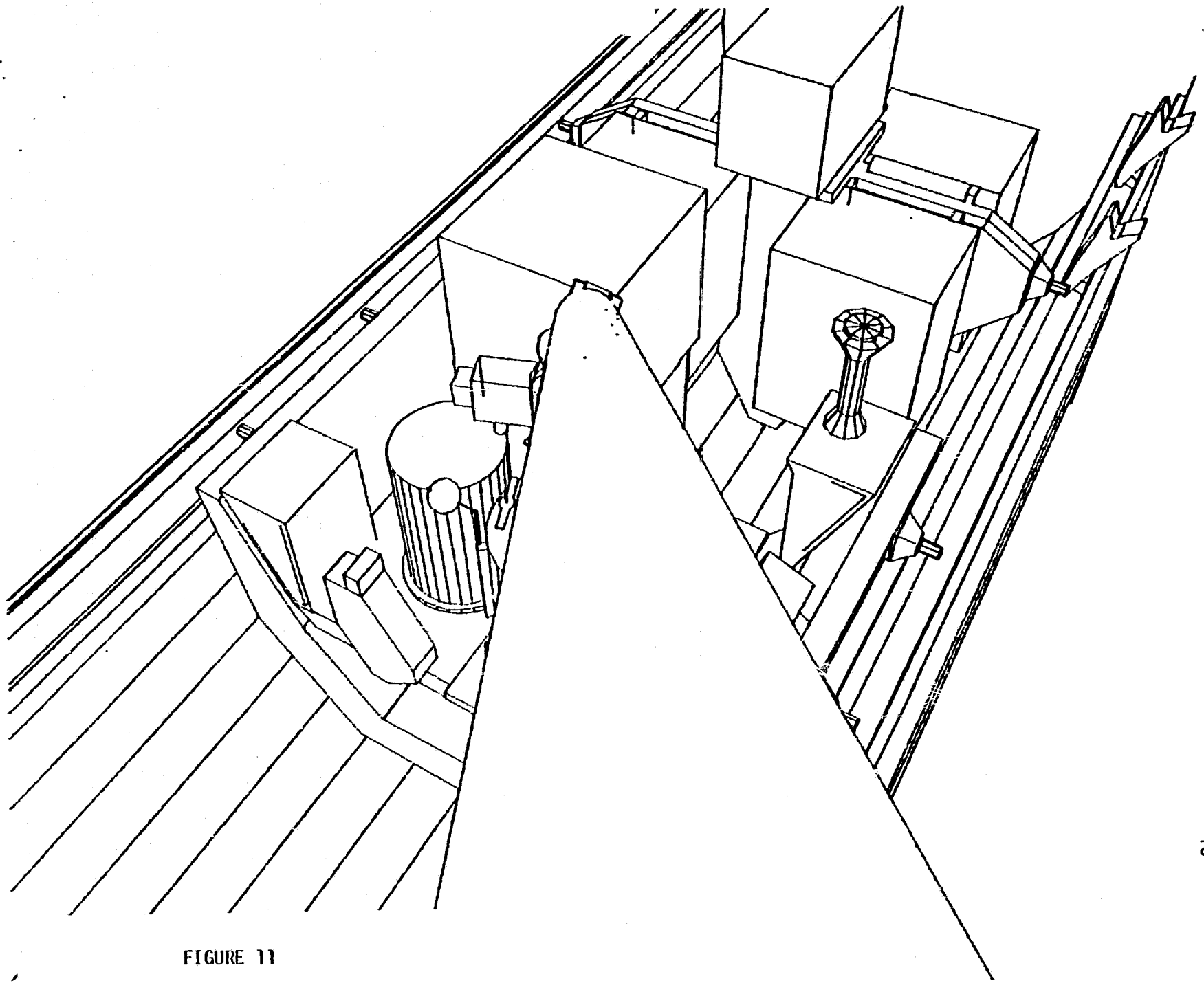

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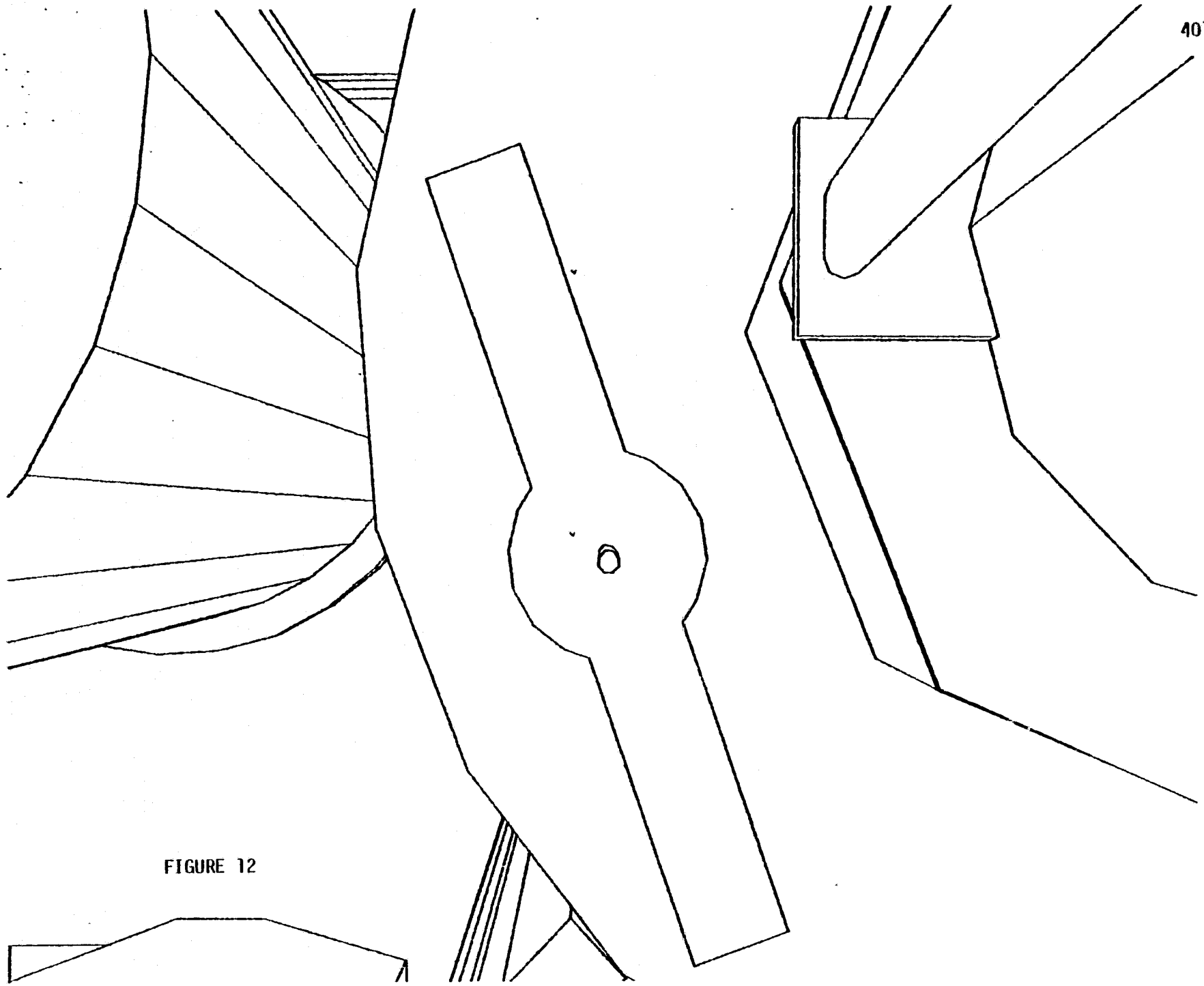

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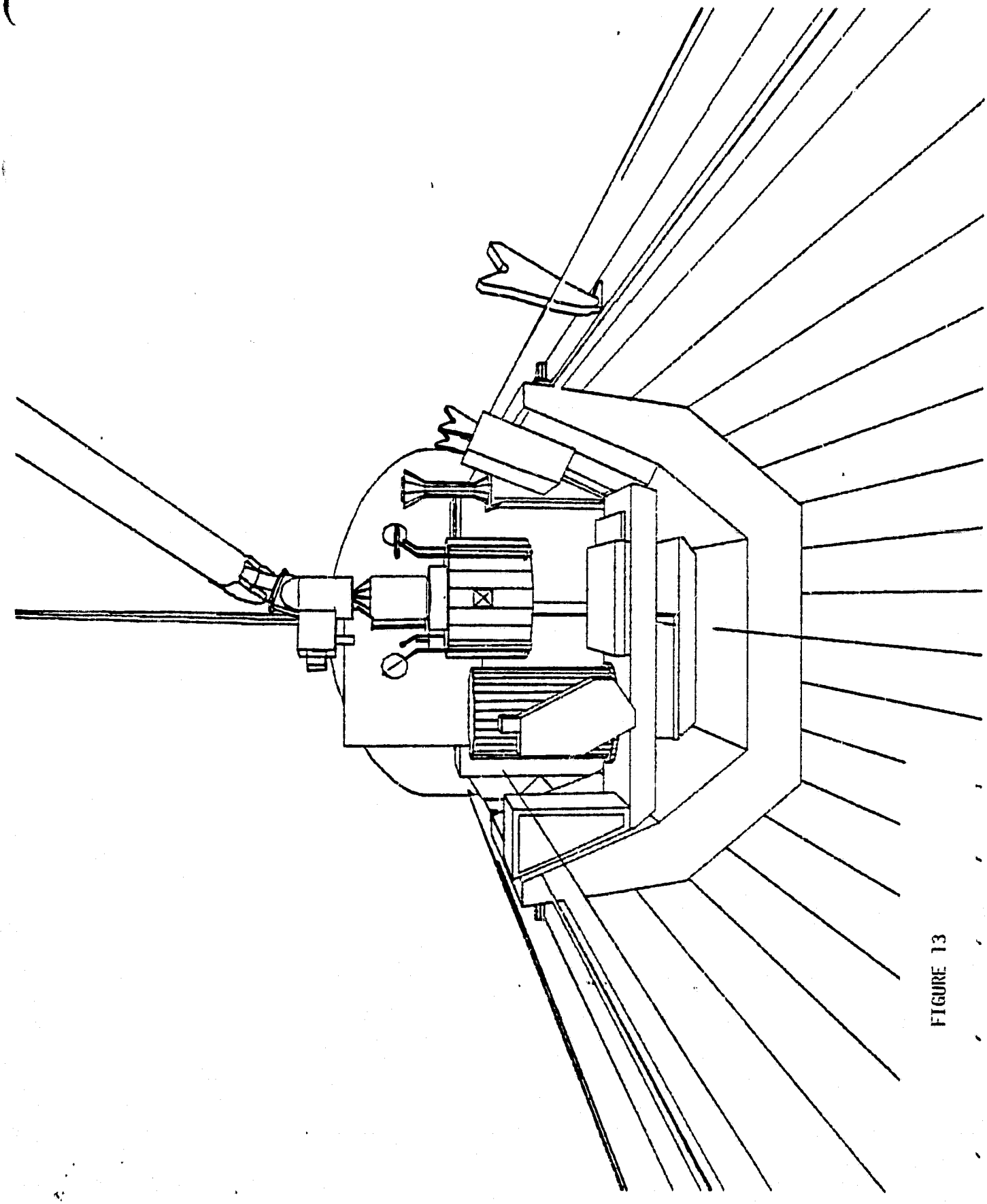

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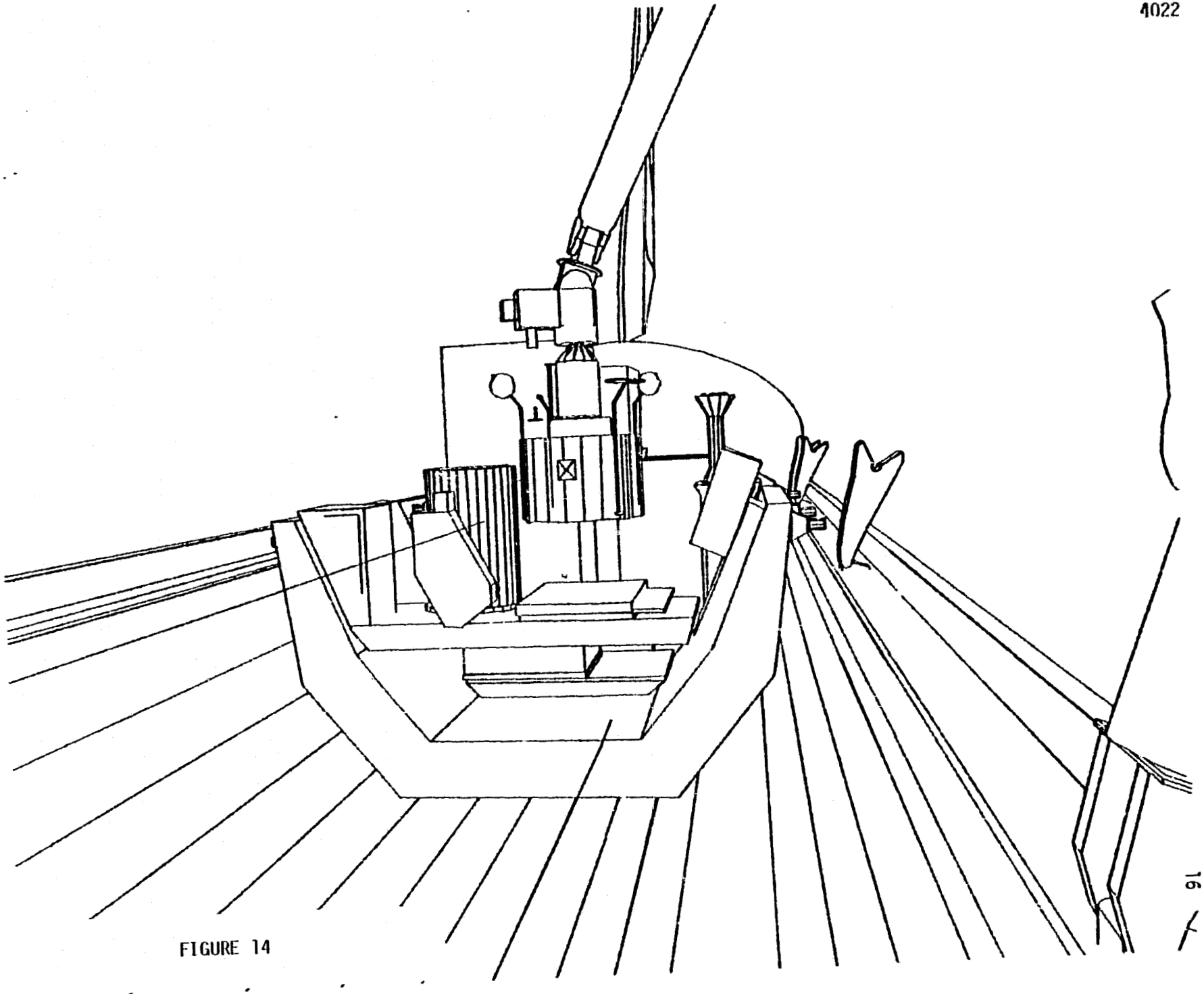

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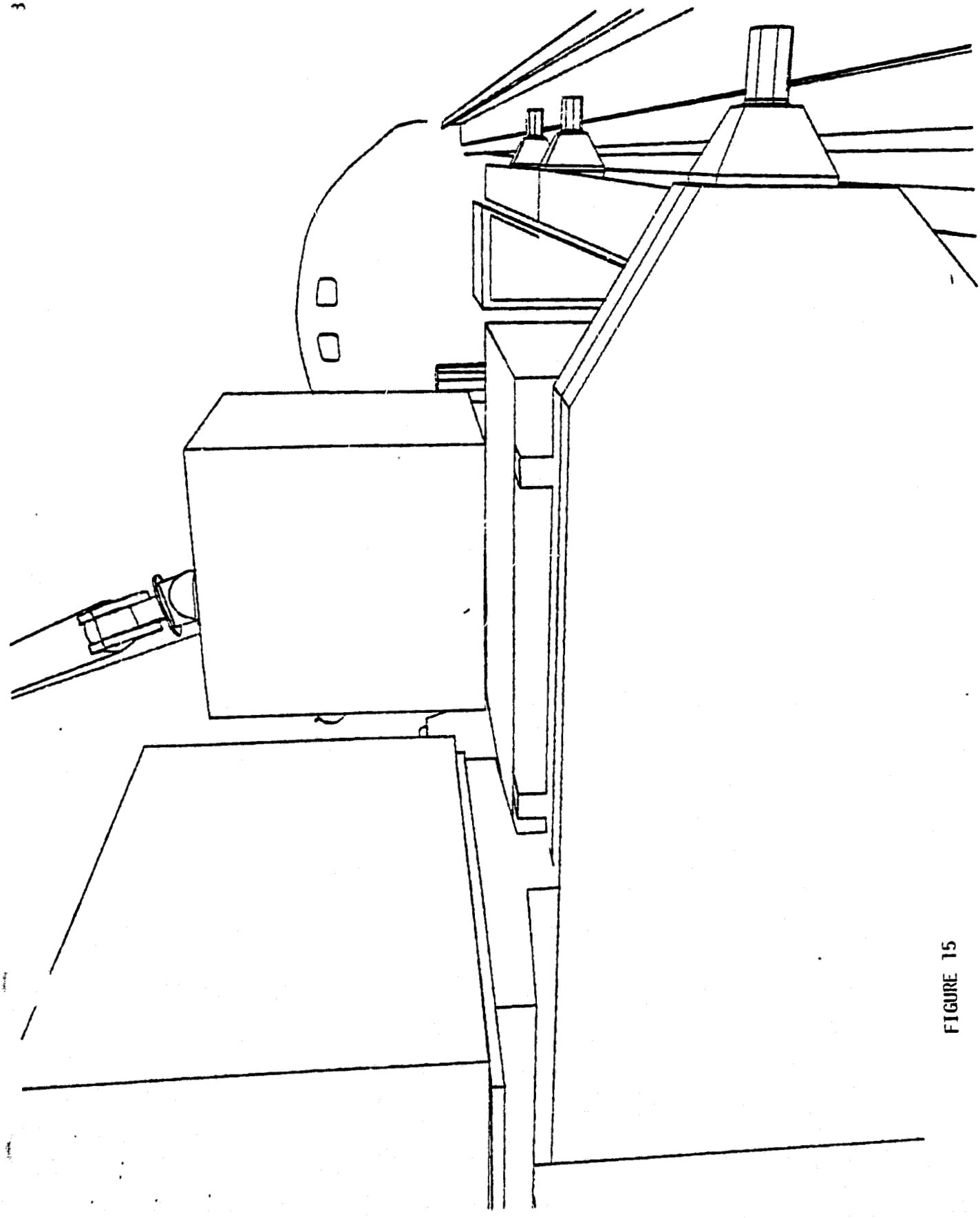

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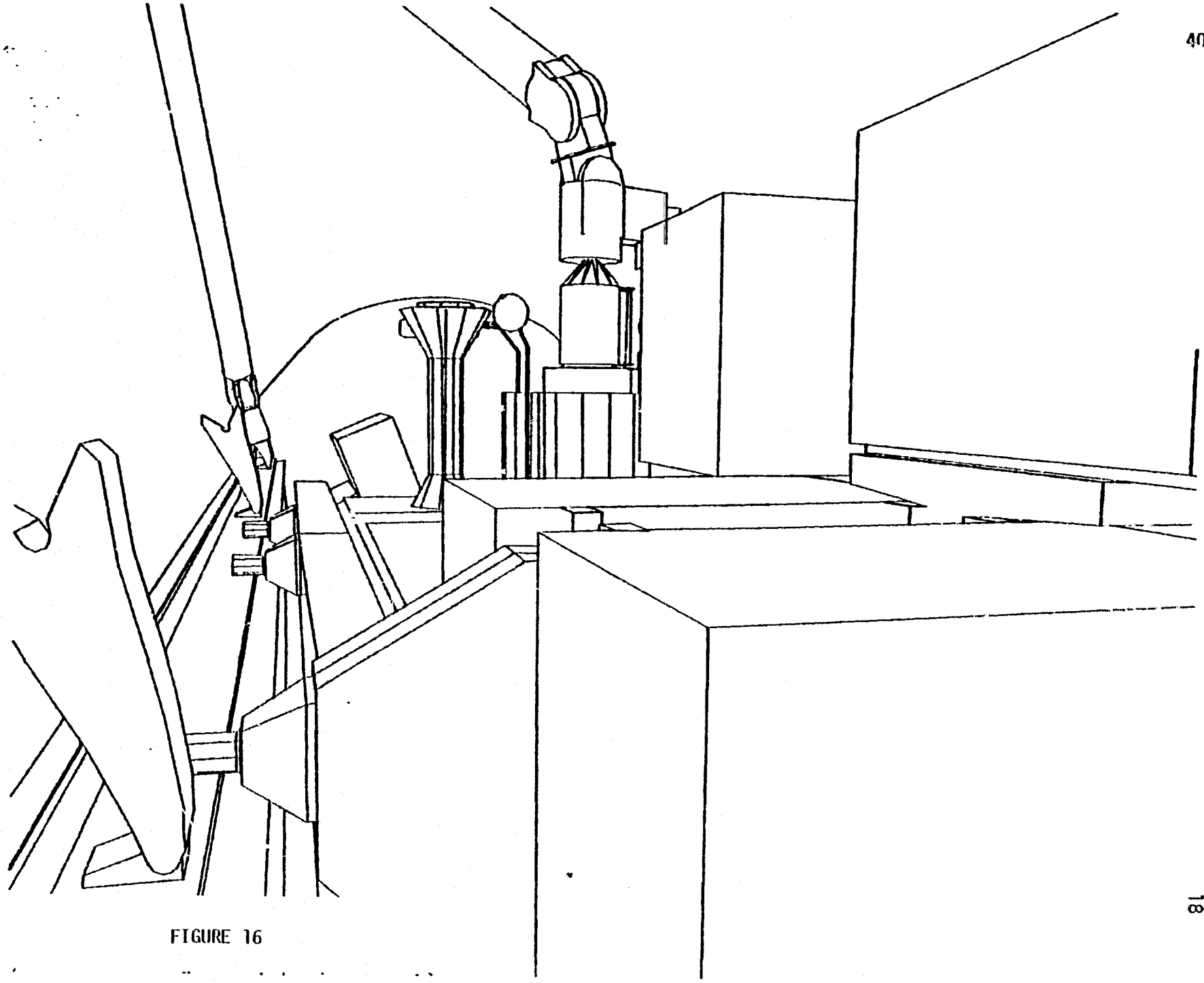

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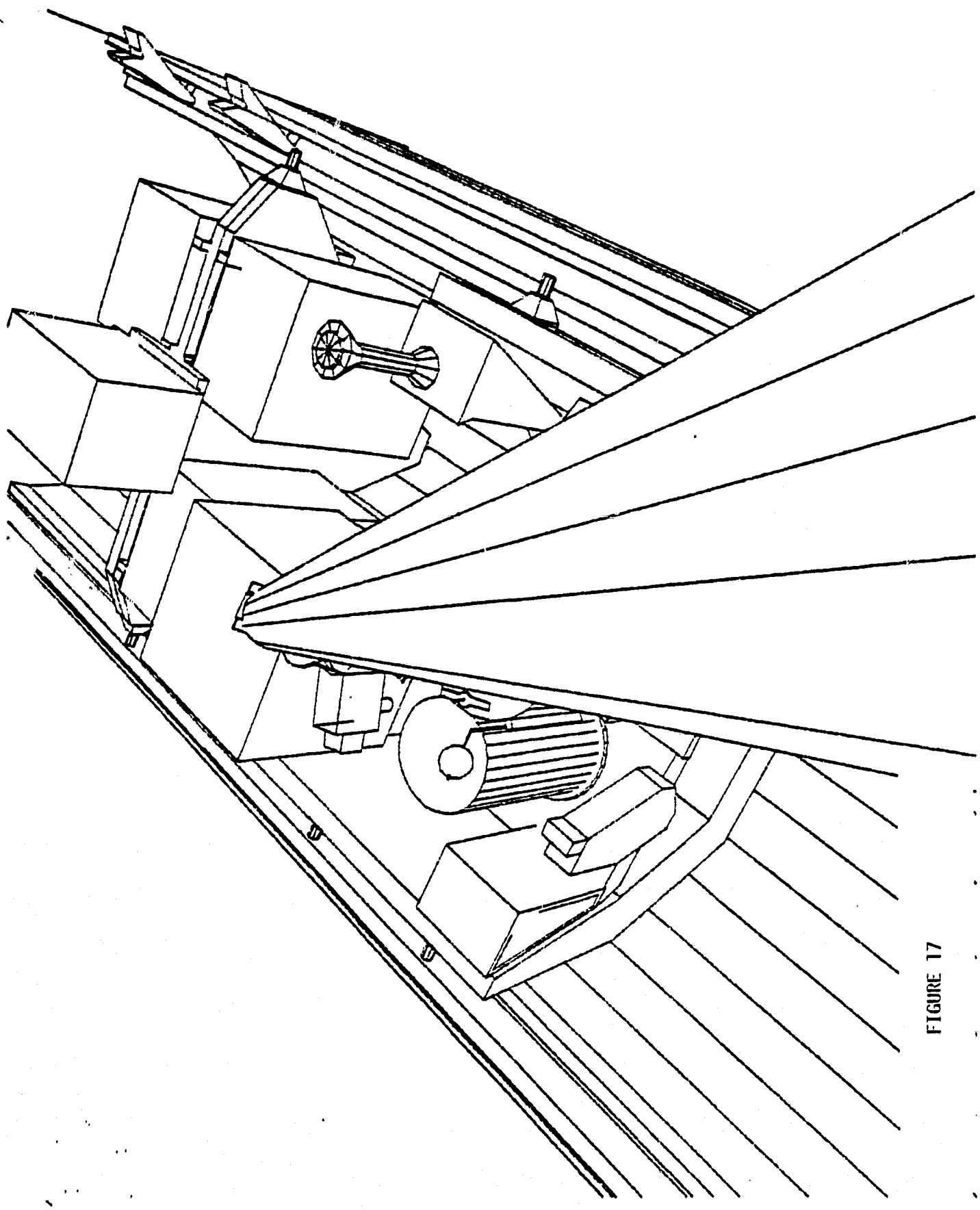

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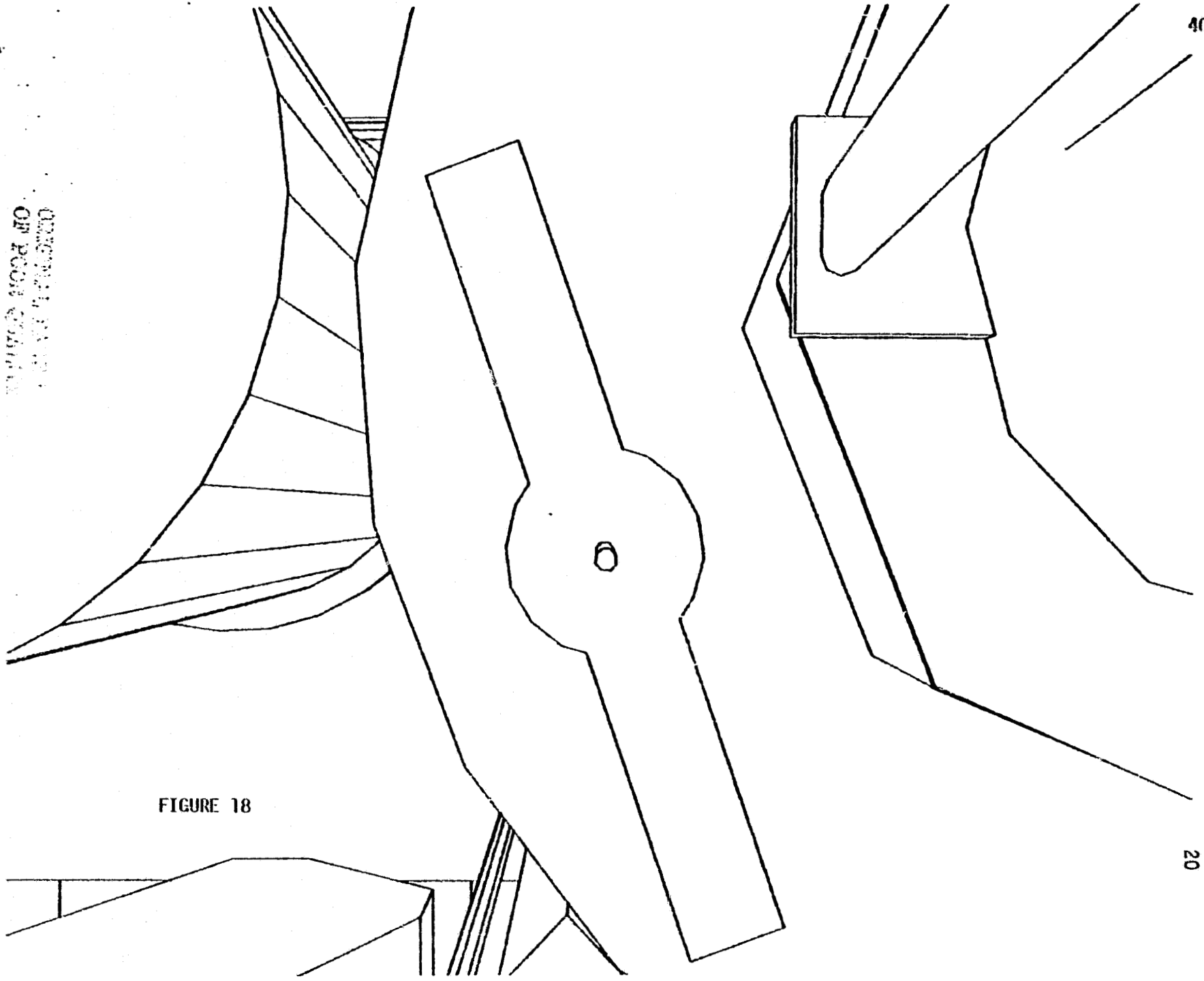

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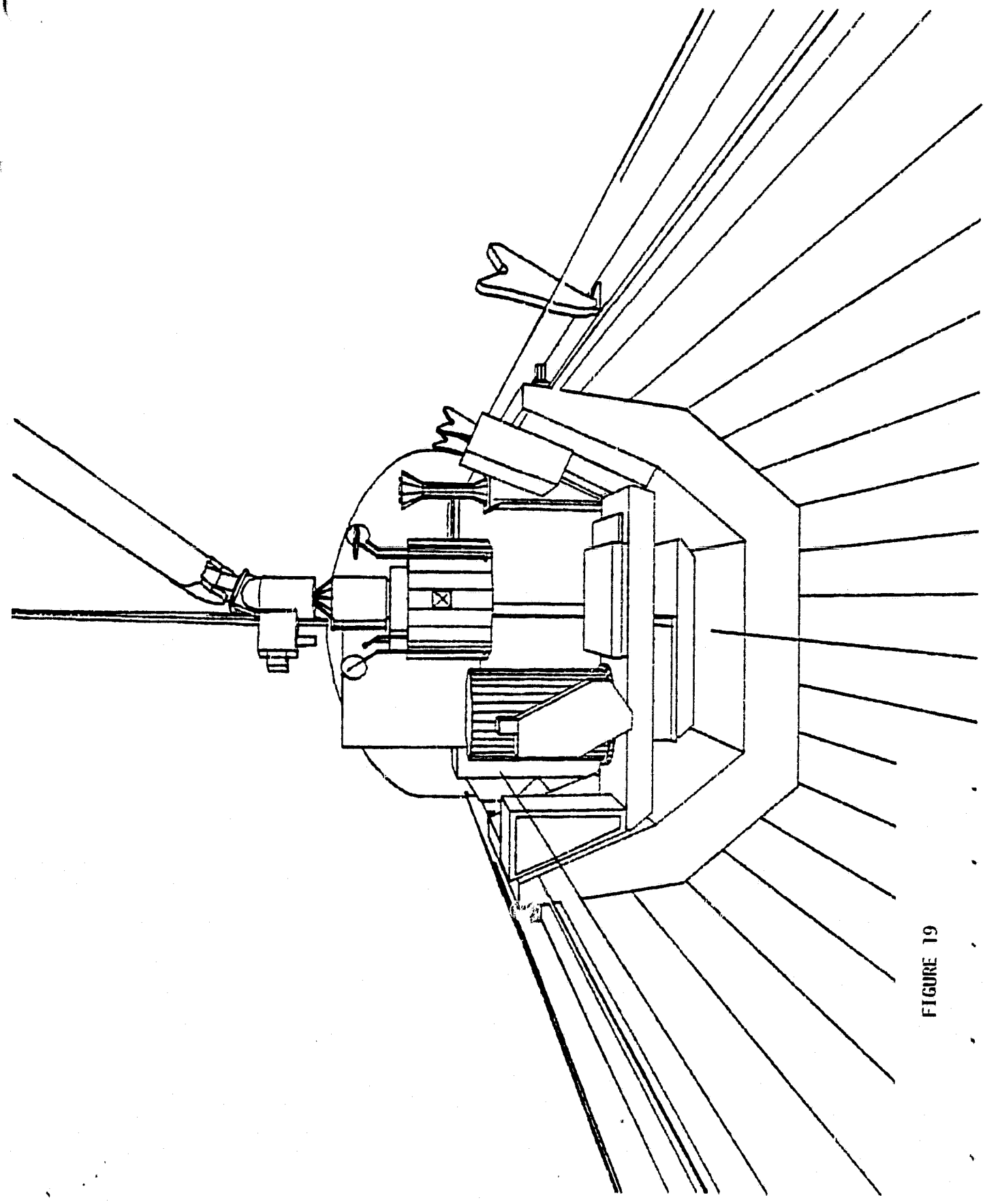

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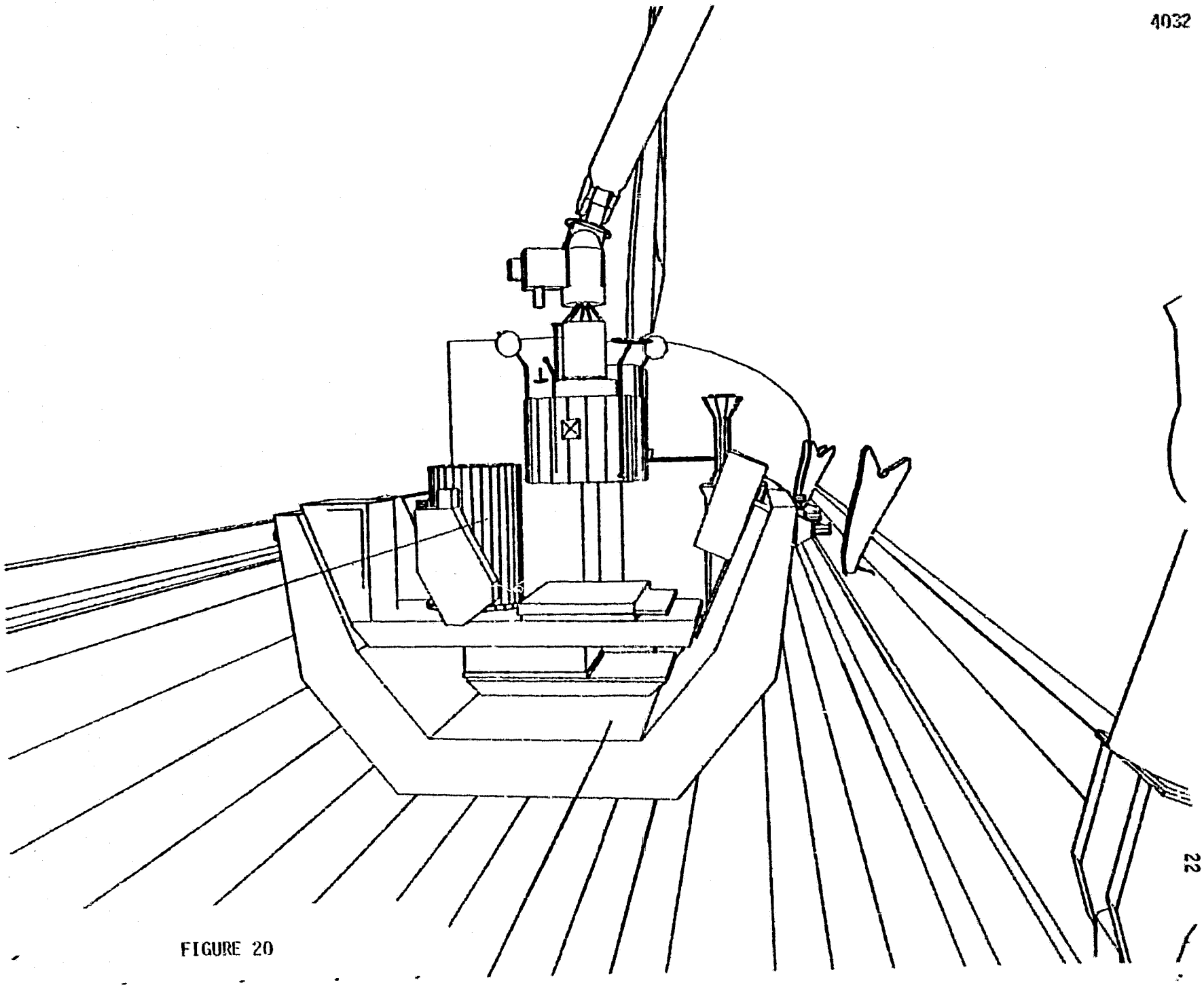

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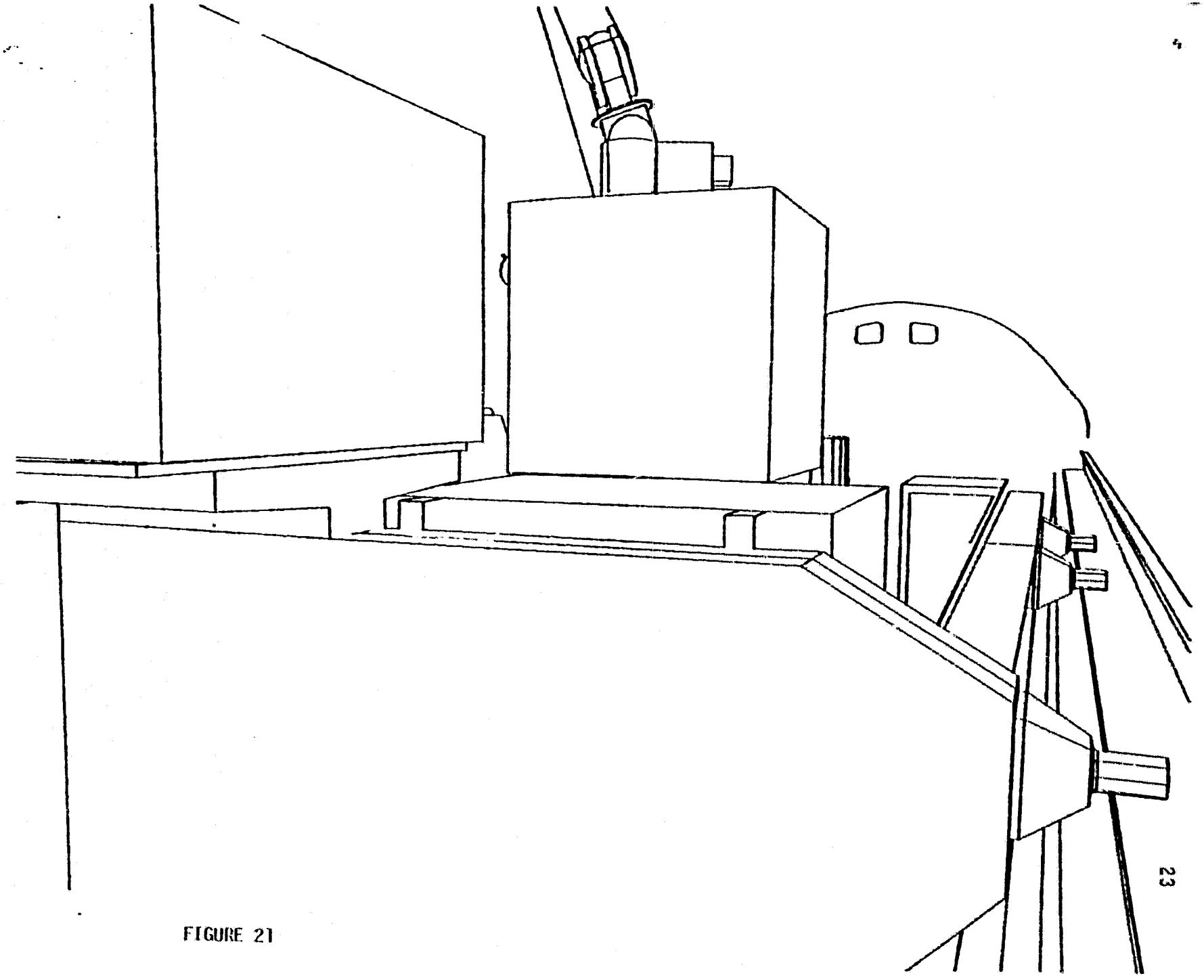

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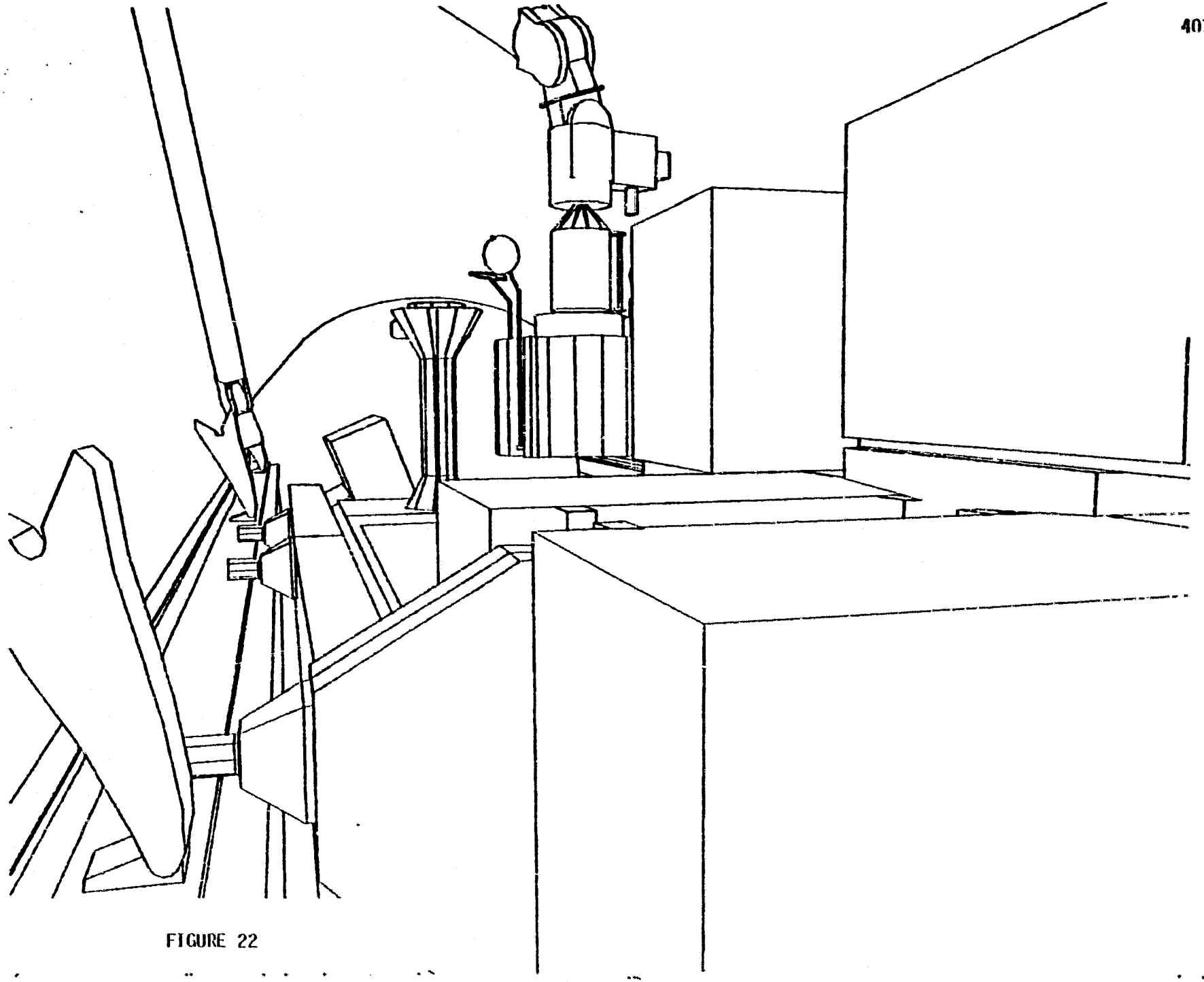

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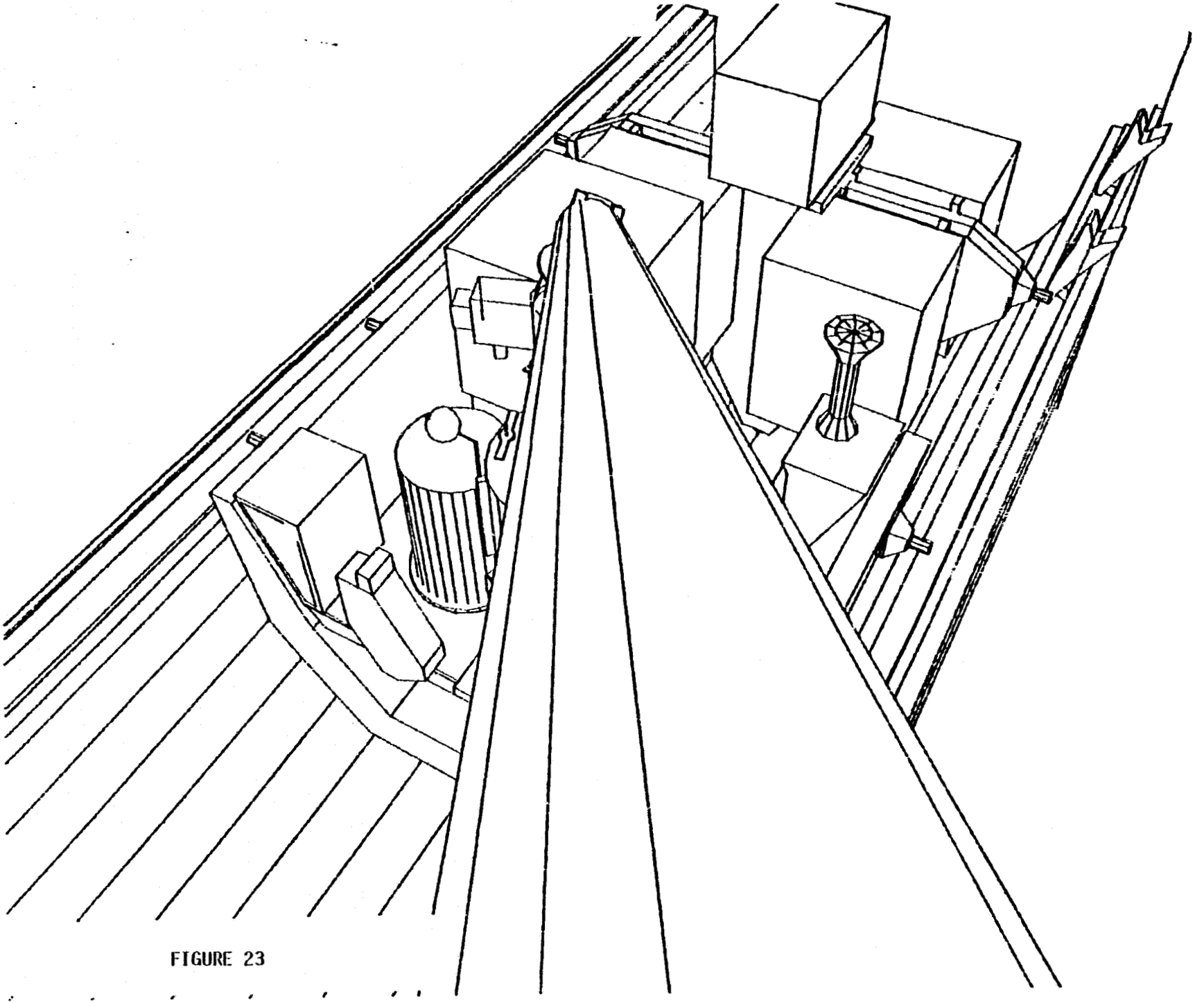

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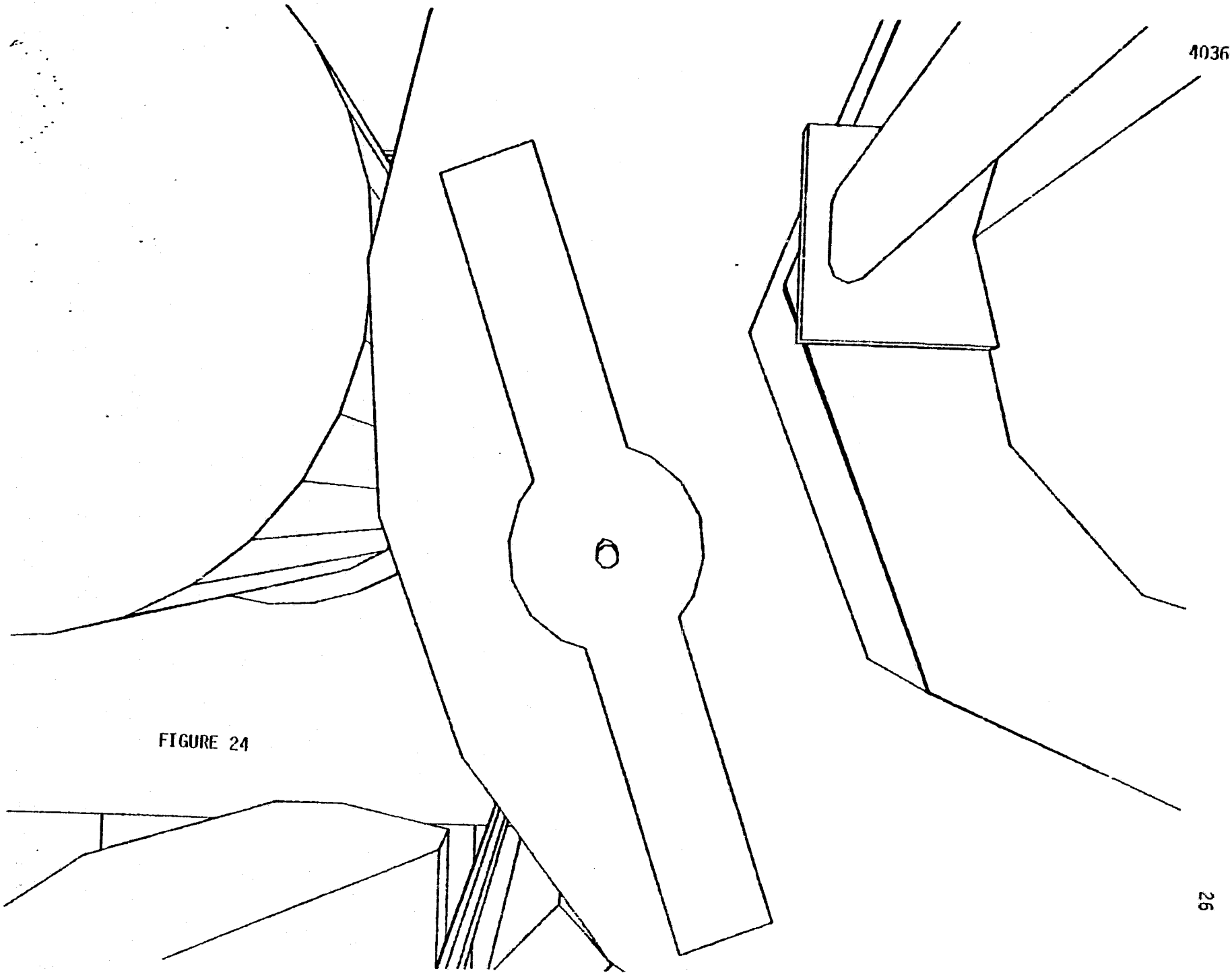

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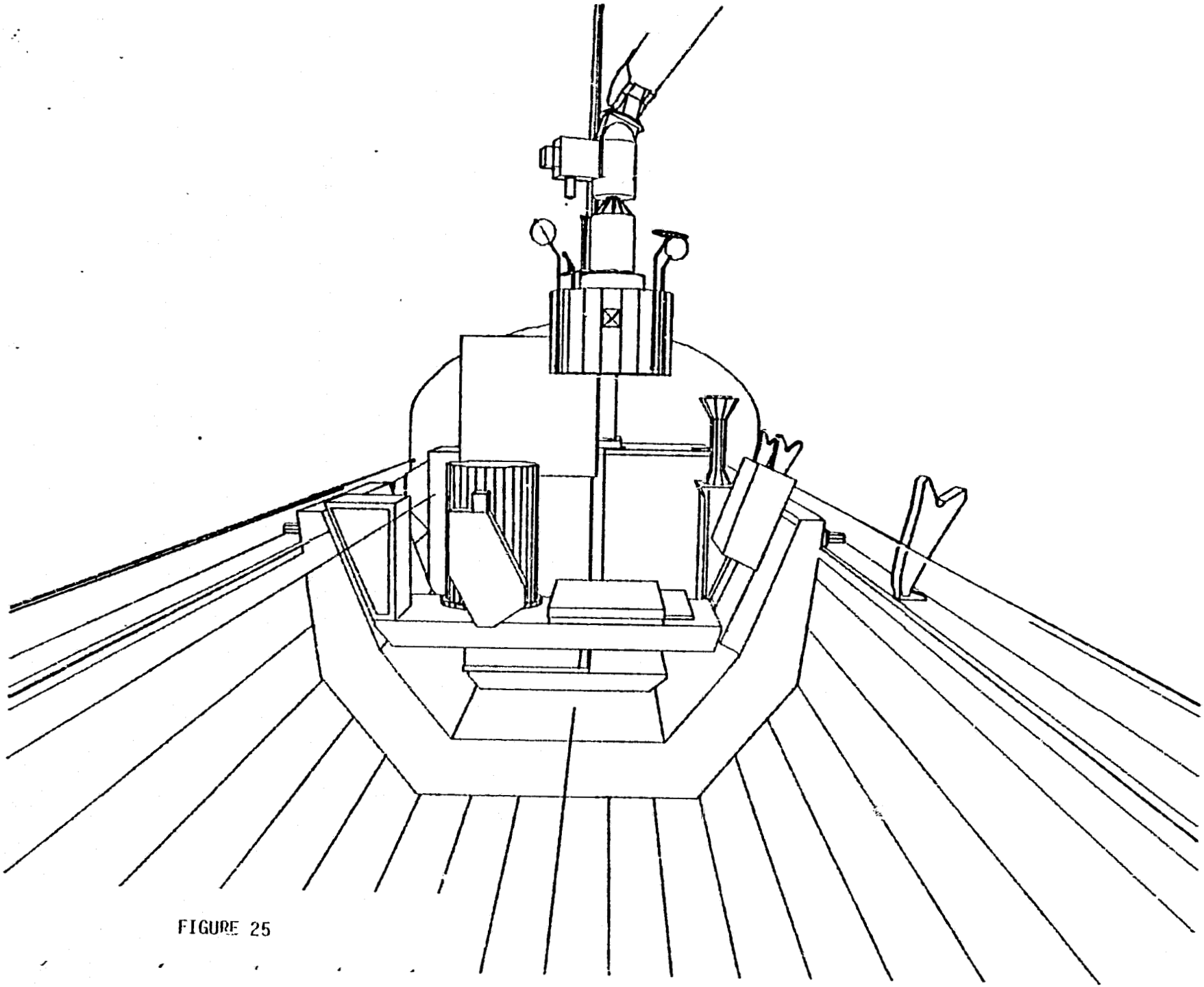

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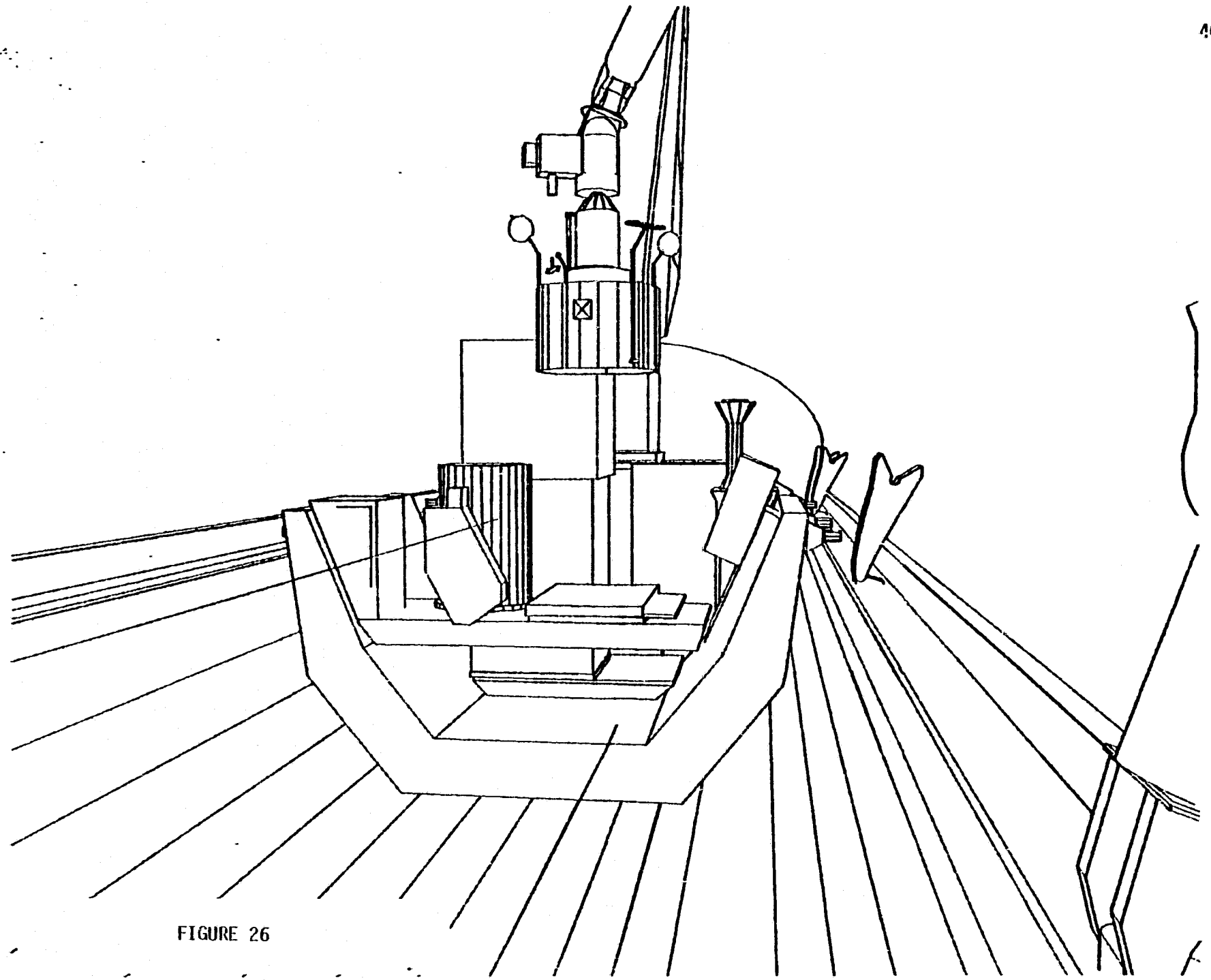

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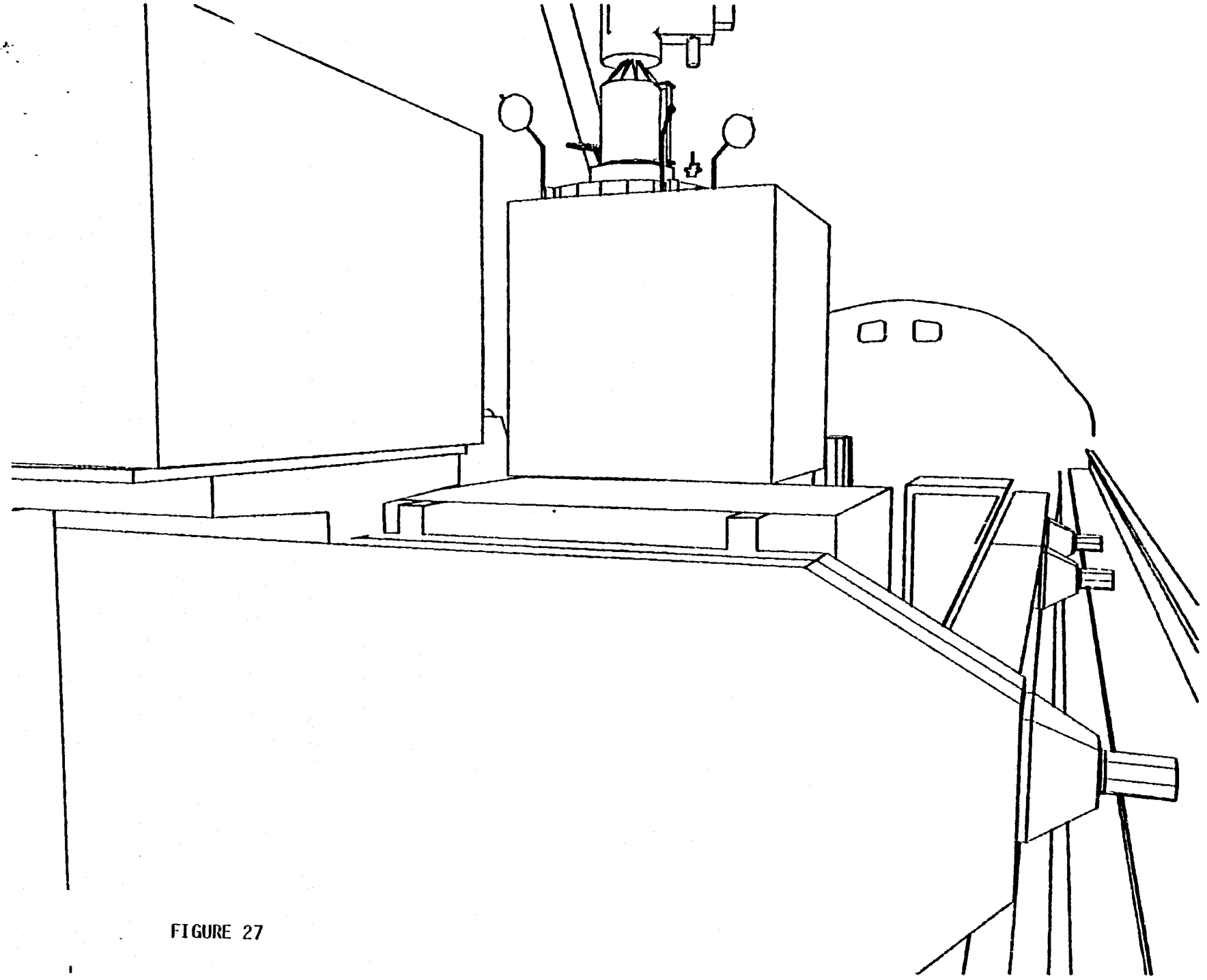

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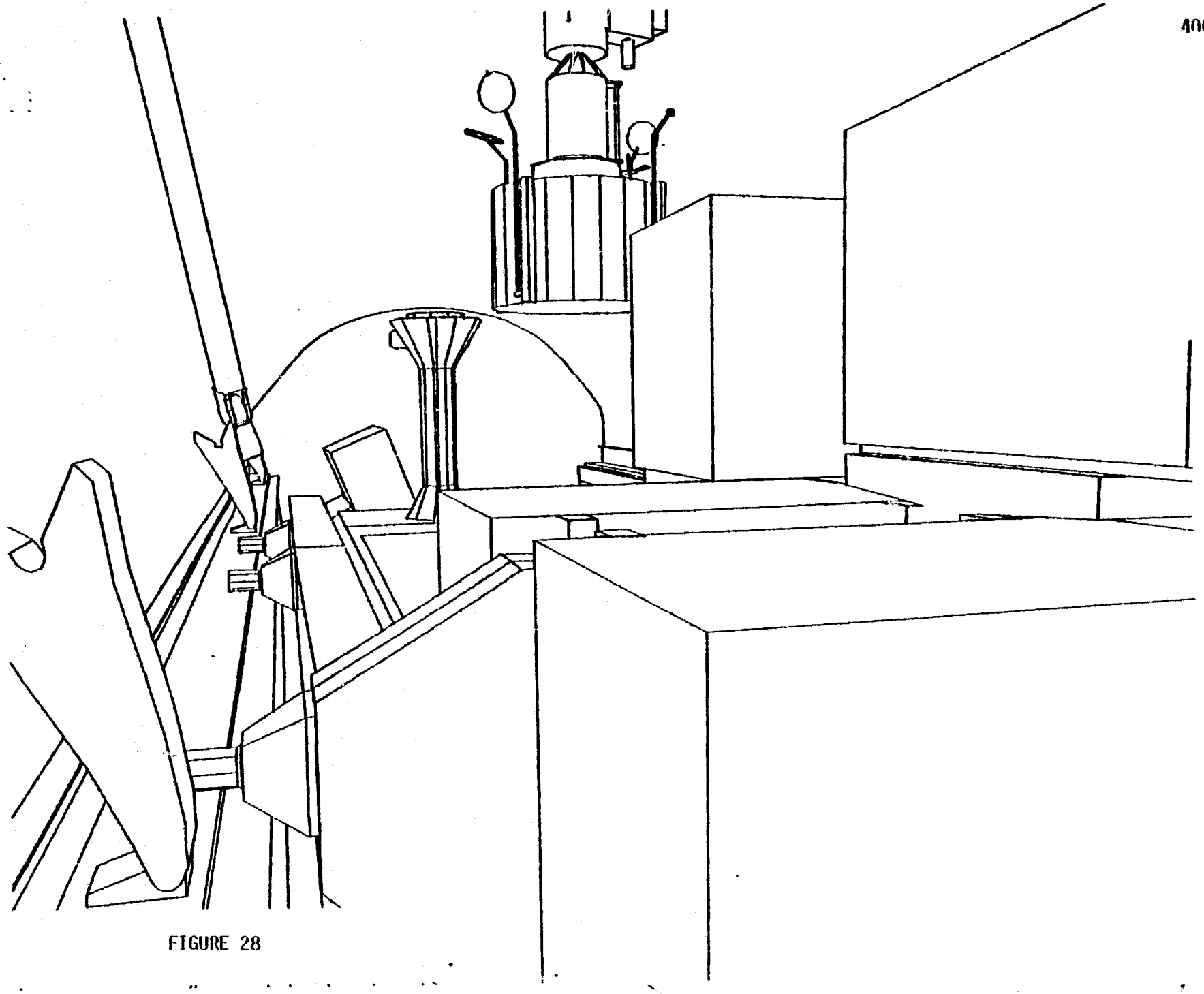

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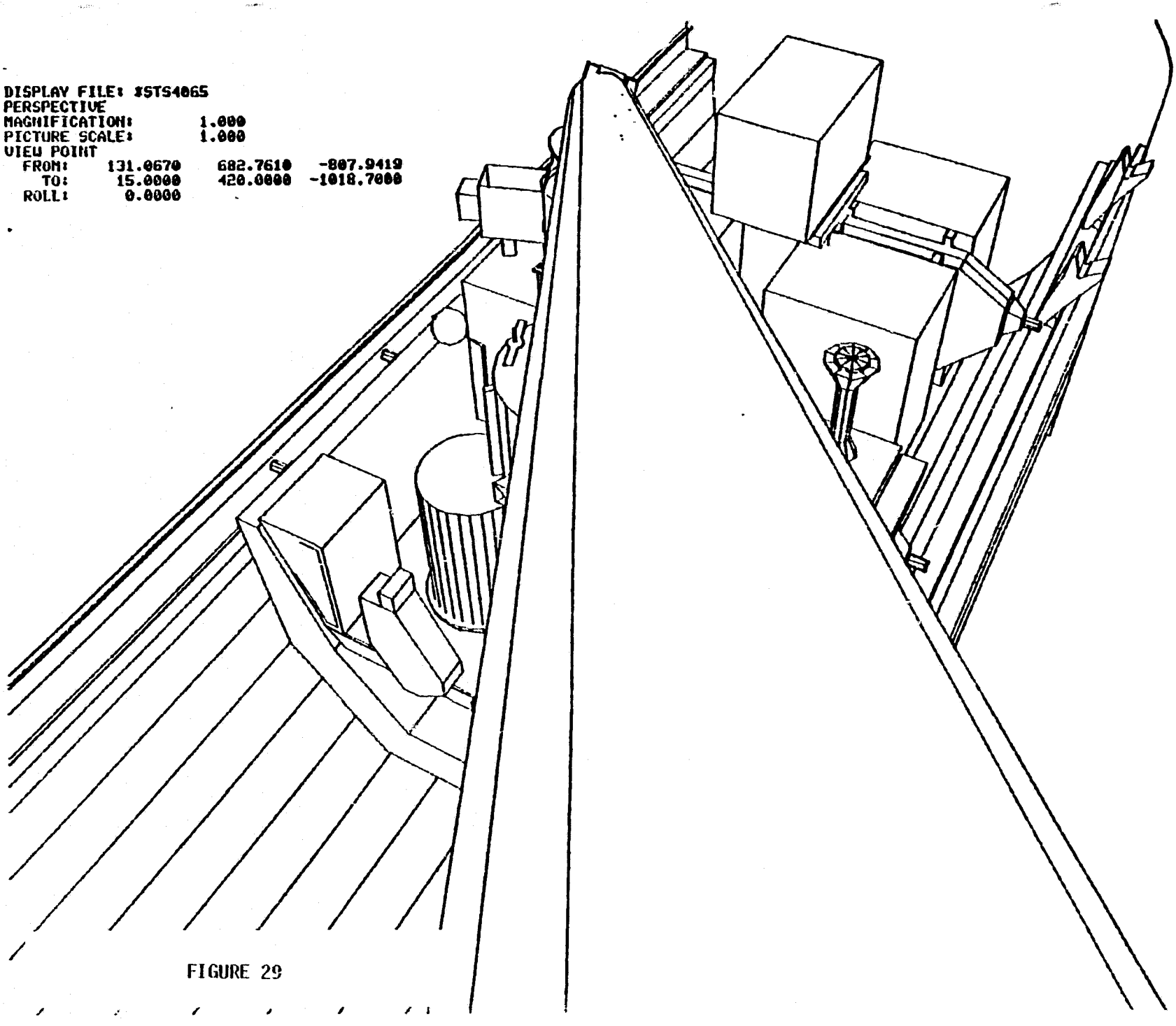
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PICTURE SCALE: 1.000
VIEW POINT
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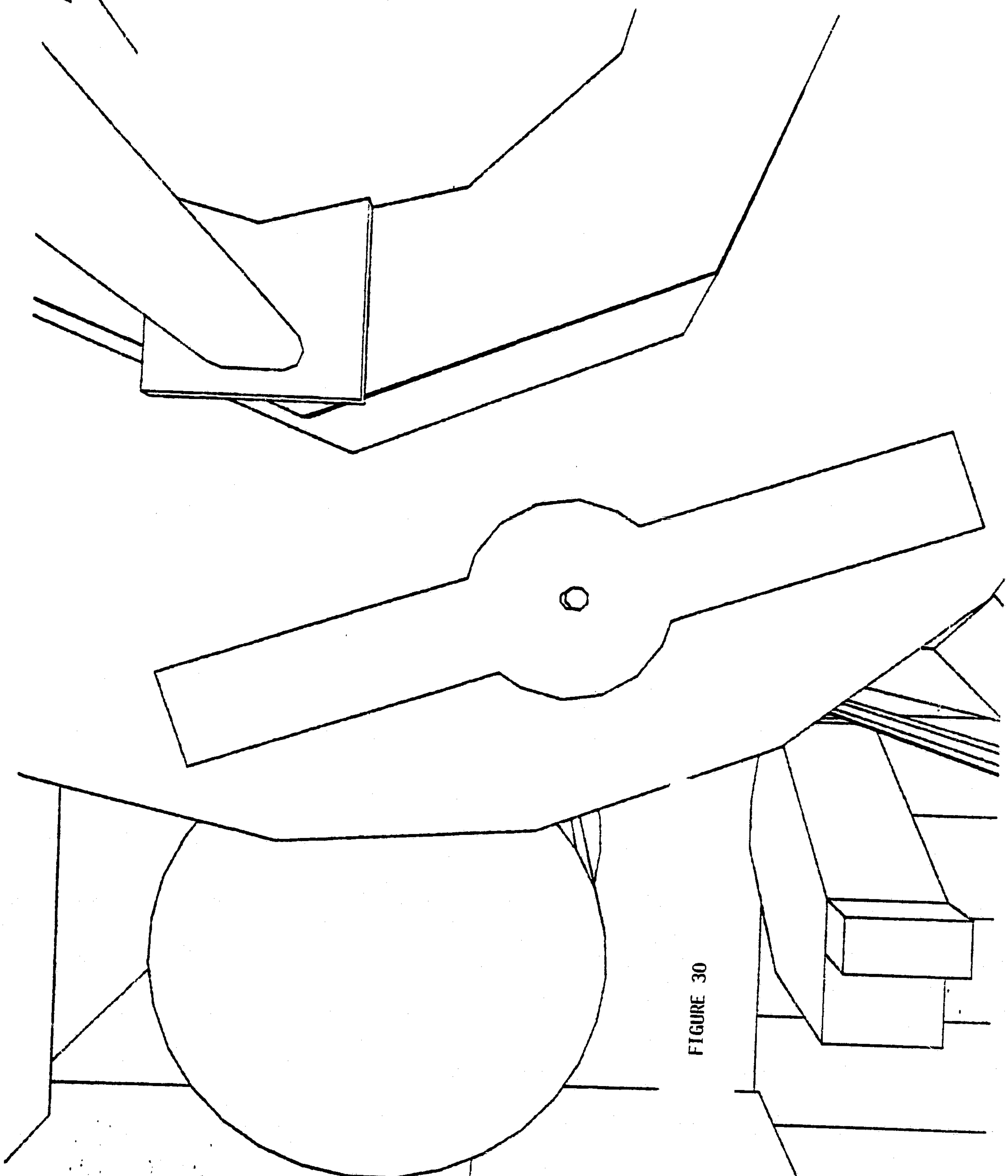
TO: 15.0000 420.0000 -1018.7000
ROLL: 0.0000

FIGURE 29

4066



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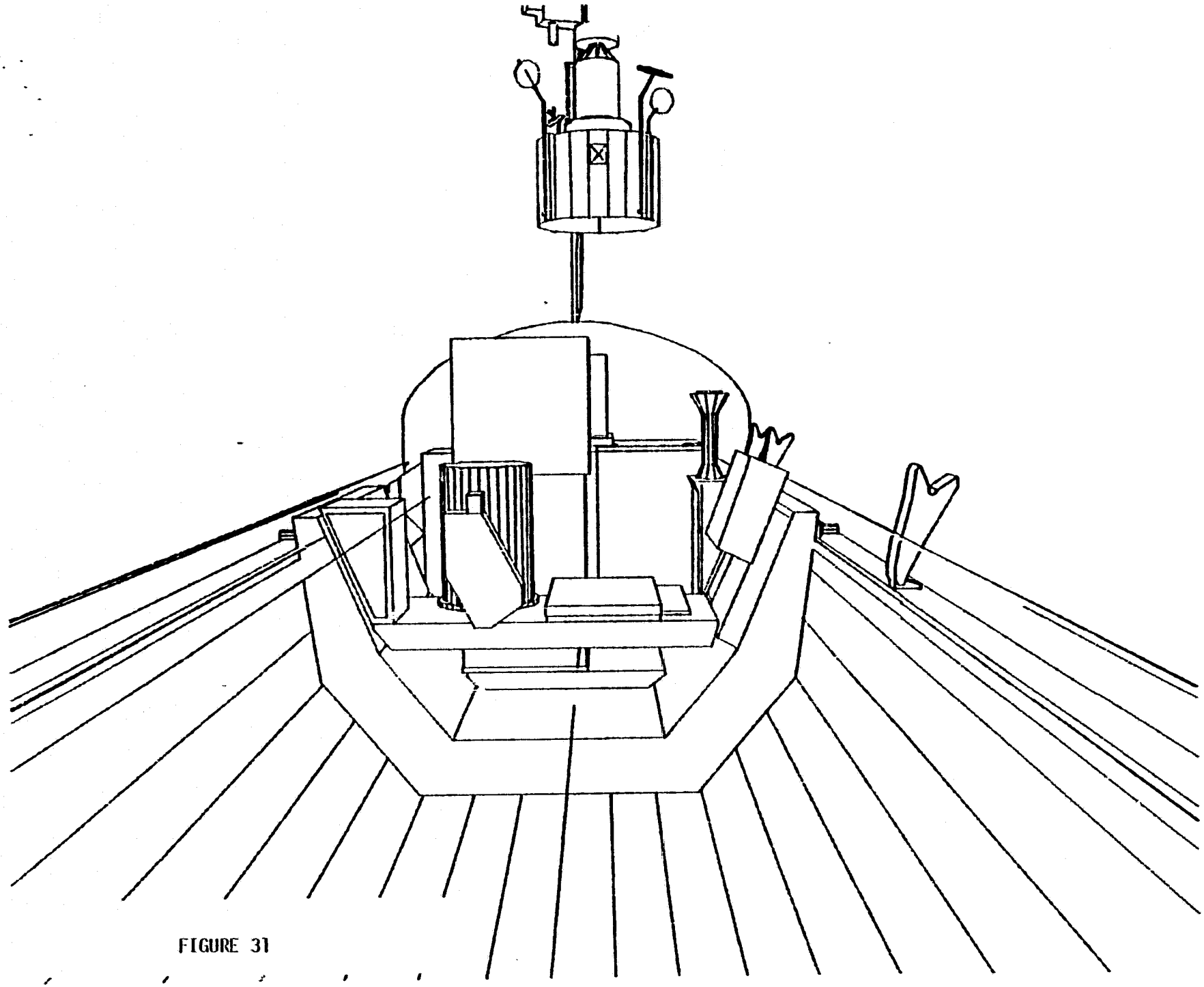

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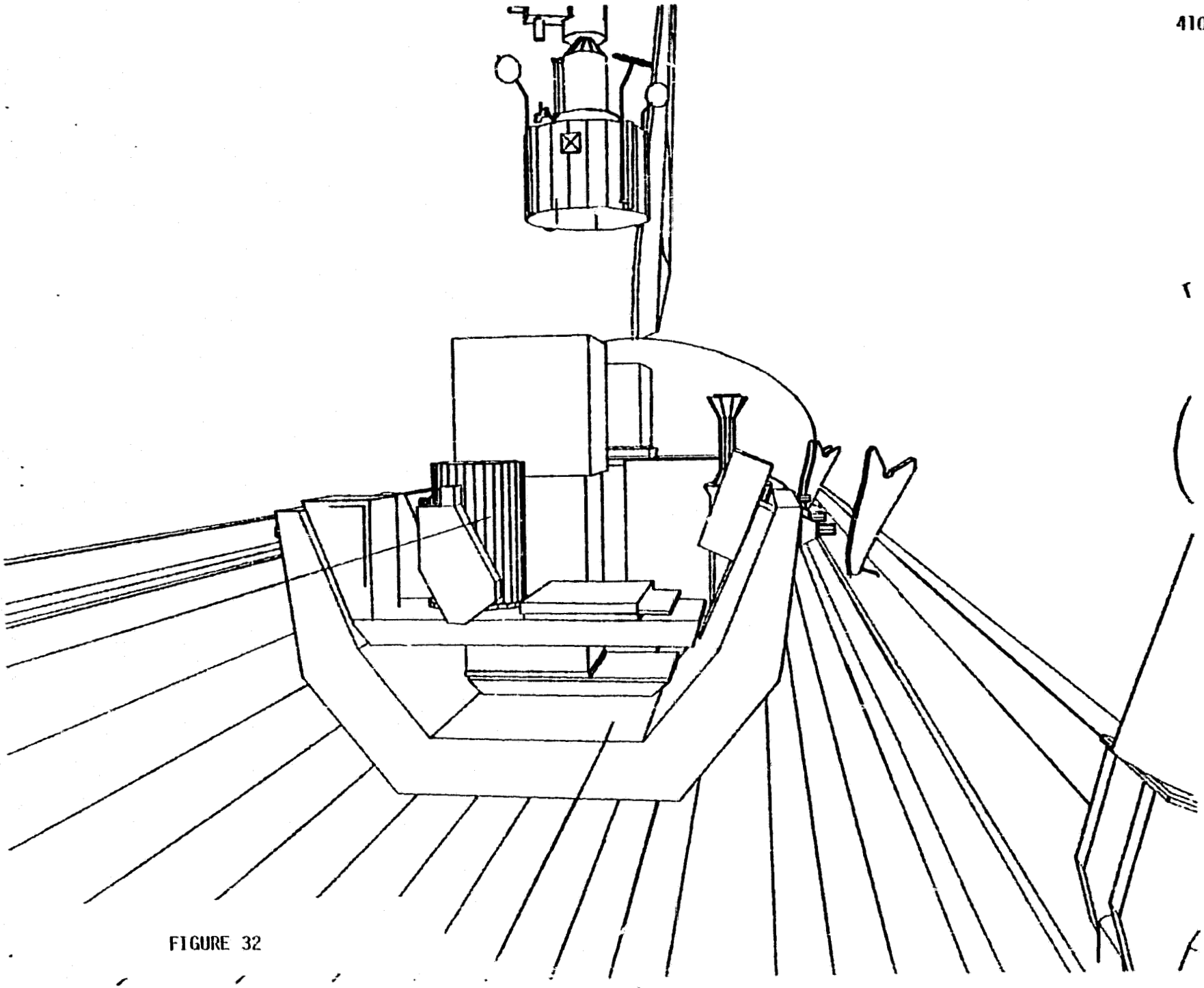

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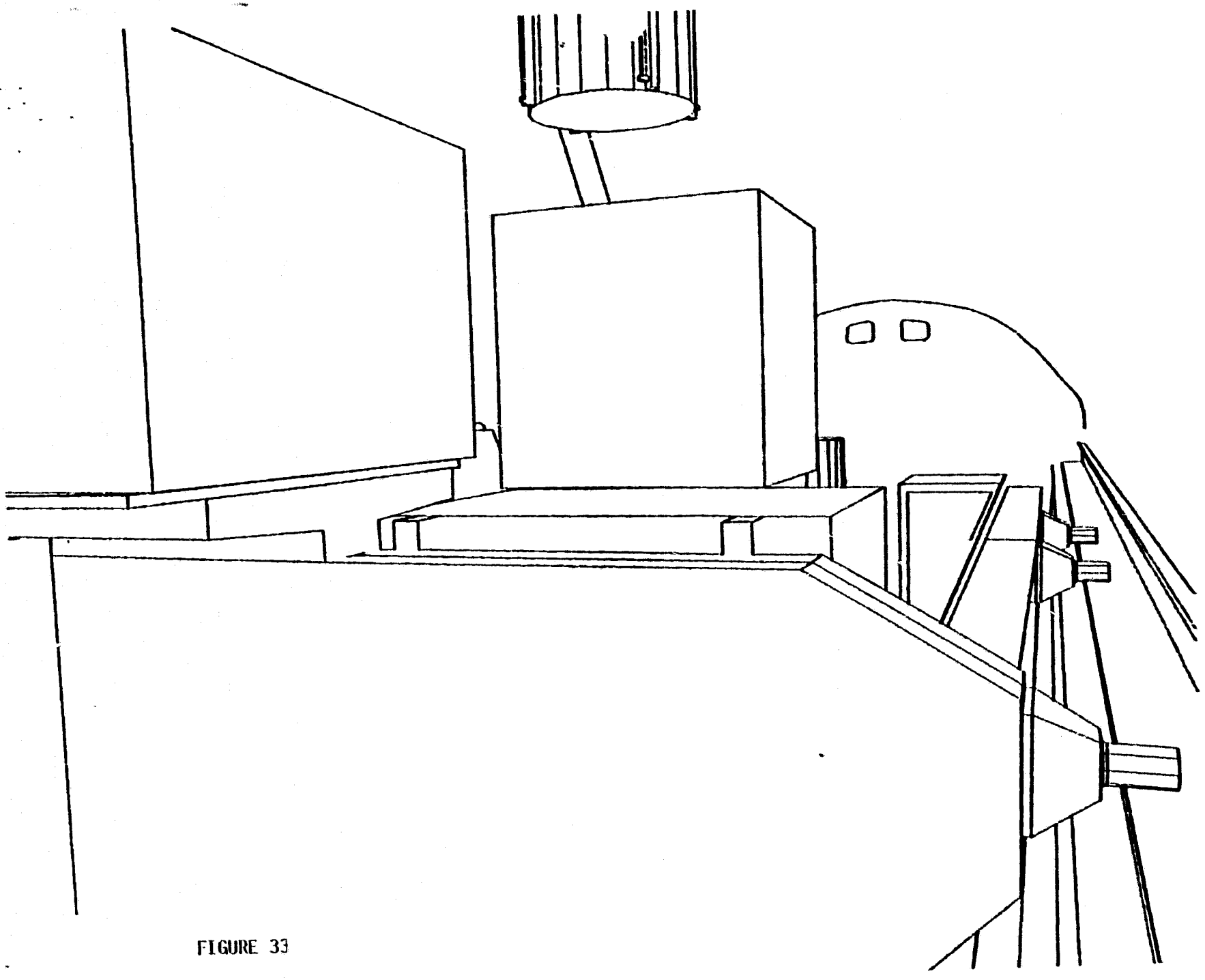

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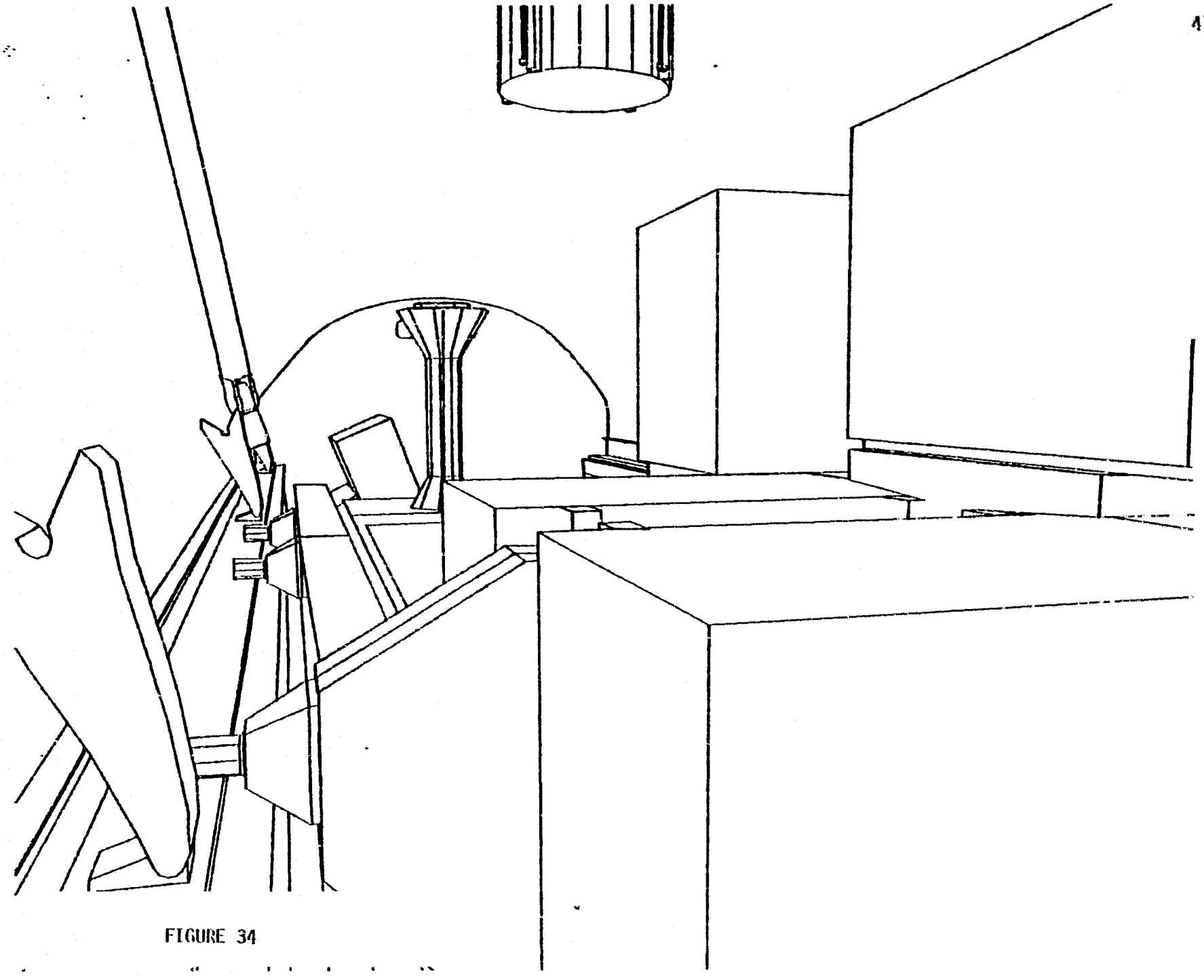

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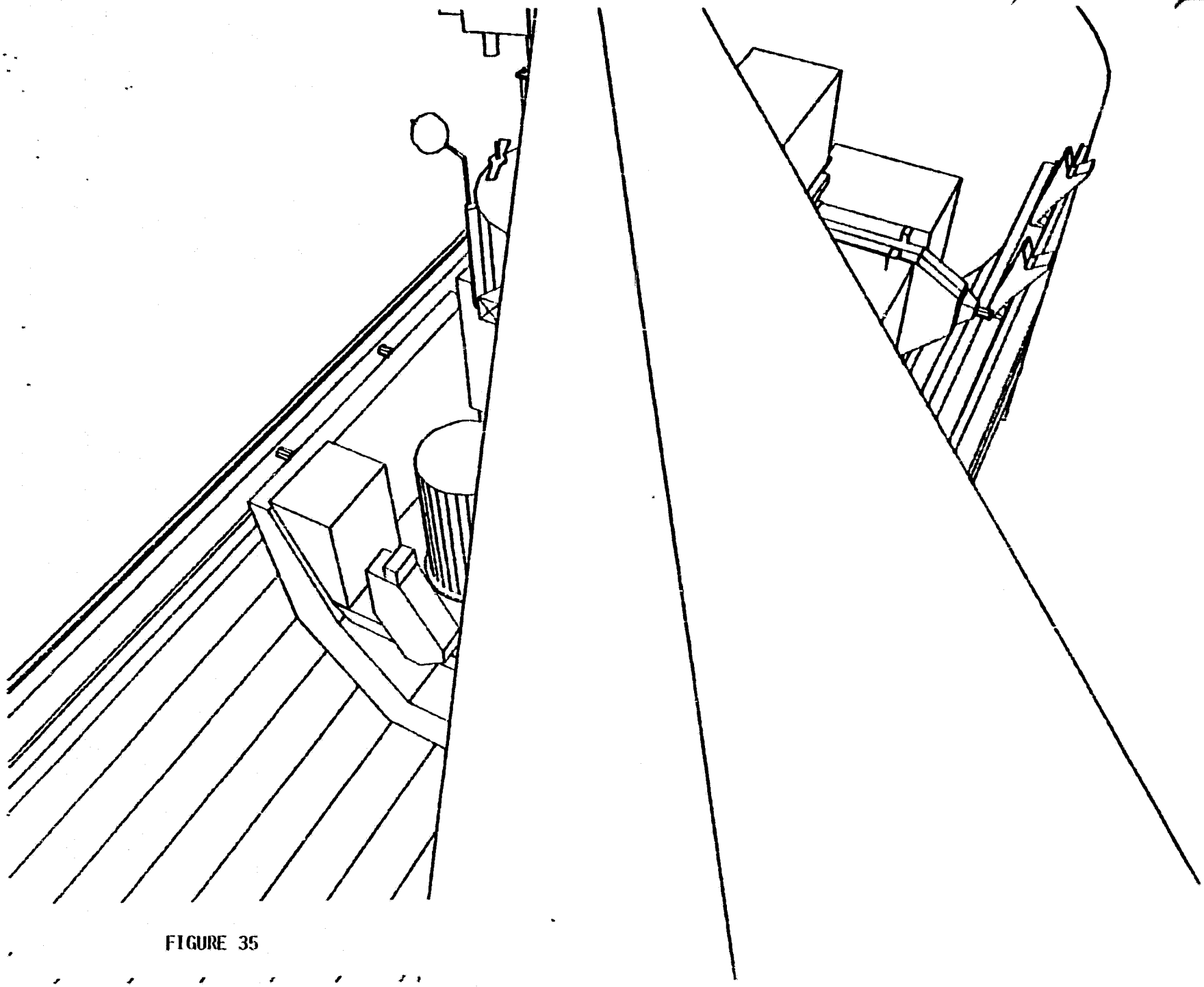

FIGURE 35

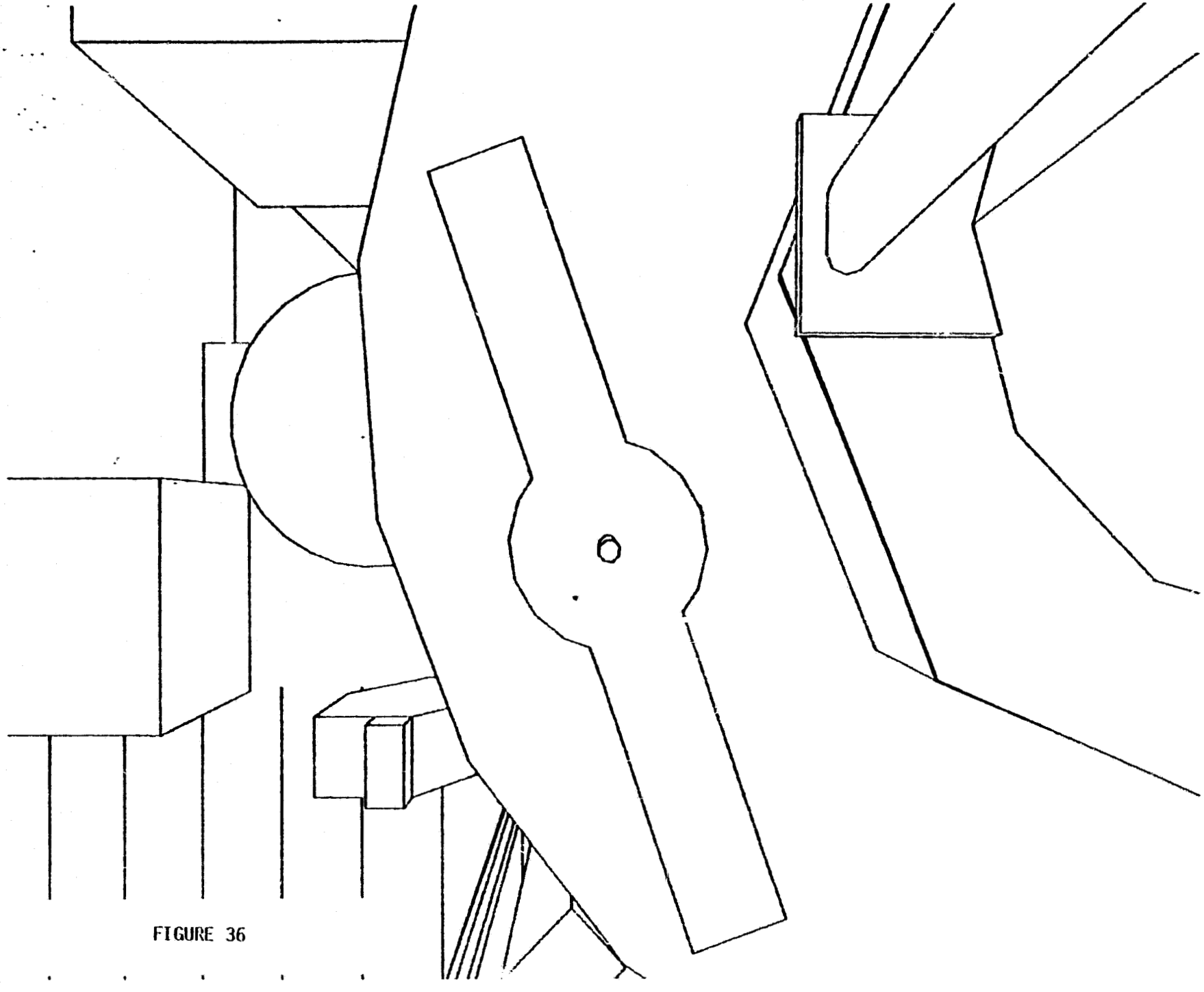

FIGURE 36

APPENDIX A: FACILITY UTILIZATION REQUEST NO. 175

Development of Visual Cues for Berthing the Plasma Diagnostics Package (PDP)

40

FACILITY UTILIZATION REQUEST

FOR SDD USAGE ONLY

DATE RECEIVED

REQUEST NO. 175 | Page ___ of ___

IDENTIFYING INFORMATION

DATE OF REQUEST	INITIATOR/EXTENSION	INITIATING OFFICE
April 20, 1979	P. Jaschke/S. Davis	PF
WORK SITE PROGRAM	**DATE REQUIRED**	**TYPE**
	(Initial phase could be conducted August 15, 1979 earlier)	___ SUITED X UNSUITED

FACILITIES

- [X] Manipulator Development Facility
- [ ] E&D Mockup Facility
- [ ] Precision Air Bearing Floor
- [ ] Design Performance Lab
- [ ] Lighting Evaluation Lab
- [ ] Trainer Support
- [ ] Water Immersion Facility
- [ ] Other

TITLE

Development of Visual Cues for Berthing the Plasma Diagnostics Package (PDP)

DESCRIPTION. *(Include purpose, test objectives and guidelines)(Use additional sheets, if necessary.)*

The test objective is to evaluate the RMS operators visibility for deployment and berthing of the PDP from/to the OSS pallet release mechanism (REM), assess the Orbiter/PDP configuration (including CCTV) under various lighting conditions, and define any markings required for PDP berthing. The test may be divided into two phases-- the first phase could be conducted in the 1-g Trainer, to provide an early assessment of visibility to the PDP berthing interface and to permit an early definition of berthing markings required. The second phse should be conducted in the MDF, using the same basic mockup hardware, but with man-in-the-loop the simulation of the PDP berthing operation.

REMARKS. *(Special hardware requirements, support equipment, safety procedures, etc.)*

Required Hardware (For detail see test plan)

1. OSS pallet (or equivalent) and PDP mockup. The OSS pallet should include mock-up of instrumentation adjacent to the PDP to provide an accurate visual representation for the RMS operator.
2. Good fidelity hardware of the REM berthing interface. It is desirable that this be available for use during both phases of this test.
3. Complete payload bay configuration, including the DFI pallet.
4. Overhead crane as required.

APPROVALS

REQUESTER	REQUESTING ORGANIZATION	SDC FACILITY DIRECTOR	SDC REVIEW BOARD

5. CCTV bulkhead cameras (2 aft and one forwart--port), RMS cameras.

6. Payload bay lights.

7. 1-g Orbiter cabin and payload bay mockup for Phase I, MDF Orbiter cabin and payload bay mockup for Phase II.

TEST PLAN

Introduction

This test is required to evaluate RMS operator visual accessibility for extraction and berthings of the Plasma Diagnostics Package (PDP) from the OSS pallet.

Objective

The major test objective is to assess visibility for the PDP handling and berthing operations and to define any markings or other visual aids required for successful RMS operations.

Test Description

The test will be conducted in a full-scale mockup of Orbiter cargo bay. To provide an early assessment of requirements for PDP berthing alignment markings or aids, the test could be conducted in the 1-g trainer. RMS operator visual accessibility to PDP handling and berthing could be evaluated through use of the overhead crane, to simulate vertical motion of the PDP to/from its berthing platform. The primary objective of this early phase of the test is to define required markings or aids proposed direct and indirect (CCTV) viewing, under various light environments. The second phase of the test will evaluate the markings or aids proposed from the first phase, but with man-in-the-loop simulations for RMS handling and berthing of the PDP to its baseline berthing platform. The PDP/OSS-1 pallet should be located in the cargo bay identical to the actual flight location for STS-5 (see attached figure). In each phase of the test, the cargo bay elements that effect the operator viewing capabilities should also be included, such as the DFI pallet.

Test Procedures

1. With the PDP in its stowed position, adjust the CCTV cameras pan and tilt units for optimium viewing of the berthing interfaces. Adjust the TV cameras zoom for optimium viewing.

2. Photograph the different CCTV views on a TV monitor. Also photograph the view out the aft port window.

3. Have the facility personnel move the PDP a foot forward on the REM. (away from the latch position).

4. Repeat step 2.

5. Have the facility personnel move the PDP a foot toward port on the REM, (away from the latch position).

6. Repeat step 2.

7. With overhead crane, lift PDP about a foot above the REM.

8. Repeat step 2.

9. With overhead crane, raise the PDP to about six feet above the REM. Note the out the window and TV views. Lower the PDP on to the REM.

10. If the camera views were not adequate to deploy and both the PDP, find new locations for the cameras where they will do the job. Follow the above procedures to verify the views from the new camera locations.

11. Place berthing markings on the PDP and REM as required to facilitate the deploy/berthing task. When the optimium markings are determined, the photographs as in step 2 and also closeup documented photos of the markings.

This sequence is written for phase one, the second phase is similar, but with the RMS and operator performing the PDP motions and berthing.

Data Requirements

The documentary photographs indicated by the test procedures and the subjective comments of the operators will be the only required data.

Test Configuration

The cargo bay should be configured with the OSS pallet/PDP located as shown in the attached figure. The DFI Pallet/IECM mockup should be installed to represent a realistic visual situation. The OSS pallet and associated experiments mockup should be of sufficient fidelity to provide to the RMS operator the expected viewing for berthing and translating the PDP to its latching interface. A flight-like PDP release mechanism (REM) should be used for at least the man-in-loop phase of the test. The PDP should be dimensionally correct and include the grapple fixture located as indicated by drawings which will be provided. The baseline CCTV configuration should be provided, including the elbow camera. If the 1-g trainer is used for the initial test phase, facilities should be provided to position a camera representative of the elbow camera location when berthing conditions deploying the PDP. Variable lighting conditions should be provided during the tests.