Anchor Home-in Simulation with ADAMS

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Problem Description

The anchor is hoisted when a ship is to move from one place to another. The process of hoisting the anchor is called anchor home-in. In this process, the anchor is pulled up to the bell mouth on ship hull and the rigid body contact motion occurs between the anchor and the bell mouth. The anchor is consisted of the shank and the flucker which are connected with a revolute joint. Two parts of the anchor have relative rotation of about 40 degrees. In the home-in process, the flucker begin to contact with outer surface of the bell mouth. Then the flucker rotates along the chain channel direction. In some cases, the anchor can not reach to the final set position because of some unknown design parameters. If the motion of the anchor is locked during the home-in process and the ship moves, the anchor continuously generates the noise and the impact on the bell mouth. In severe cases, the anchor may be lost if the chains are disconnected becuase of the accumulated damage by the impact. Anchor home-in process should be demonstrated before the ship delivery and anchor home-in may delays the delivery if any problem happens.

The bell mouth is custom designed by shipbuilding company with the standard anchor. The bell mouth is now designed with time and cost consuming trial and error method. Even with the current design process, the successful anchor home-in is not guaranteed. In this regards, it is required that important design parameter and the design guideline be investigated with MSS.

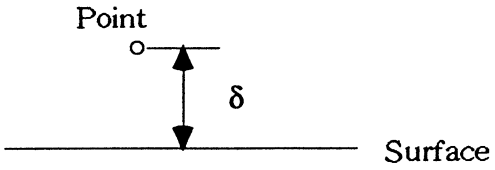
This presentation discusses the modeling and the solution process of the general 3-D rigid body contact with anchor home-in simulation.

Summary

The contact problem has been studied in the field of the metal forming. In that field, the relative motion of the contact bodies is small compared with the size of bodies and the initial contact point is maintained in the simulation. The points of interest are the contact forces and internal stresses as well as the rigid body motion. The contact problem which occurs in MSS has relatively large motion of the contact bodies comparing with the dimension of the problem. The contact points are not

fixed but may vary in most simulation period.

The interaction between a point and a surface can be represented with the surface normal force from the elastic deformation and the friction. The surface normal force is modeled as a penetration δ and its rate $\dot{\delta}$ of the point with respect the surface. If δ is less than 0, the point is in contact with the surface and the contact force is considered as a function of δ and $\dot{\delta}$. But it is not easy to determine the functional relation and its coefficient between the penetration and the contact forces.



Point to Surface Model

For the application of the point to surface contact model, the anchor is discretized into 3640 points and the bell mouth is discretized into 1300 triangular elements. The contact force from 3640x1300 point to surface contact is calculated in Subroutine GFOSUB. To investigate the influence of the contact between the chain and the bell mouth, three chains are included in the modeling. For the reduction of the problem size, a universal joint is used to connect two chains . The hoisting direction is modeled as a translational joint with a dummy part.

About 90 CPU minutes were spent for the 130 seconds simulation in R4400 Crimson with ADAMS. Through the simulation, it was found that the home-in process failed during the rotational motion of the flucker if the surface friction was greather than the driving force caused by the chain hoisting. Therefore the direction of the bell mouth surface should be evaluated for possible locking of the anchor in the home-in process. It was shown that the orientation of the bell mouth is a important parameter for the home-in. ADAMS in the anchor home-in simulation was found to be successful.

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May 17, 1995

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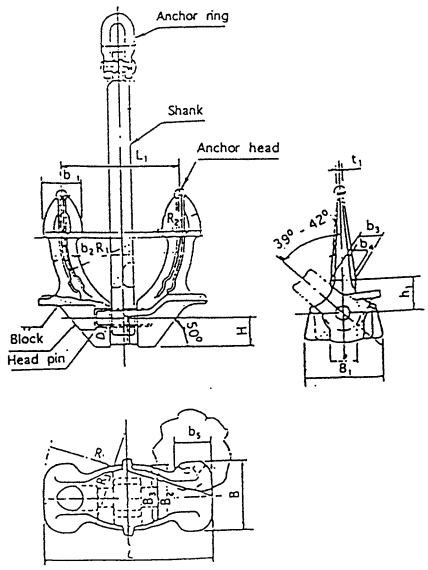
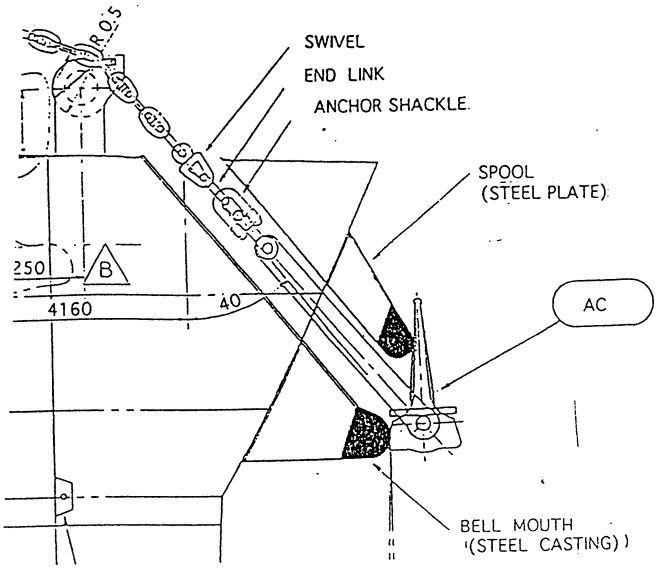
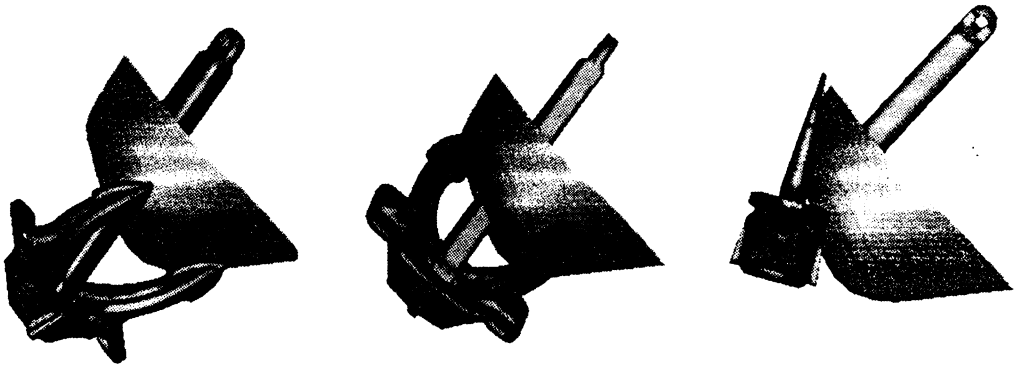
Shape of Anchor

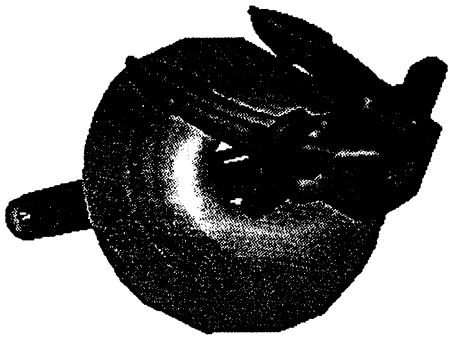


Anchor And Bell Mouth



Anchor Home–in Process





Locked Configuration

Current Design Process

- Trial and Error Design with 1/10 Mock-up
- Scale up and Fabrication
- 50% Possibility of Failure
- Evaluate the Design only after Power Installation
- Not Sufficient Time for Problem Fixation

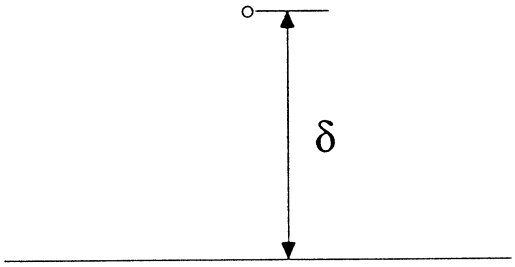
Point to Surface Contact

$$F_v = f(\delta) + g(\delta,\delta)$$

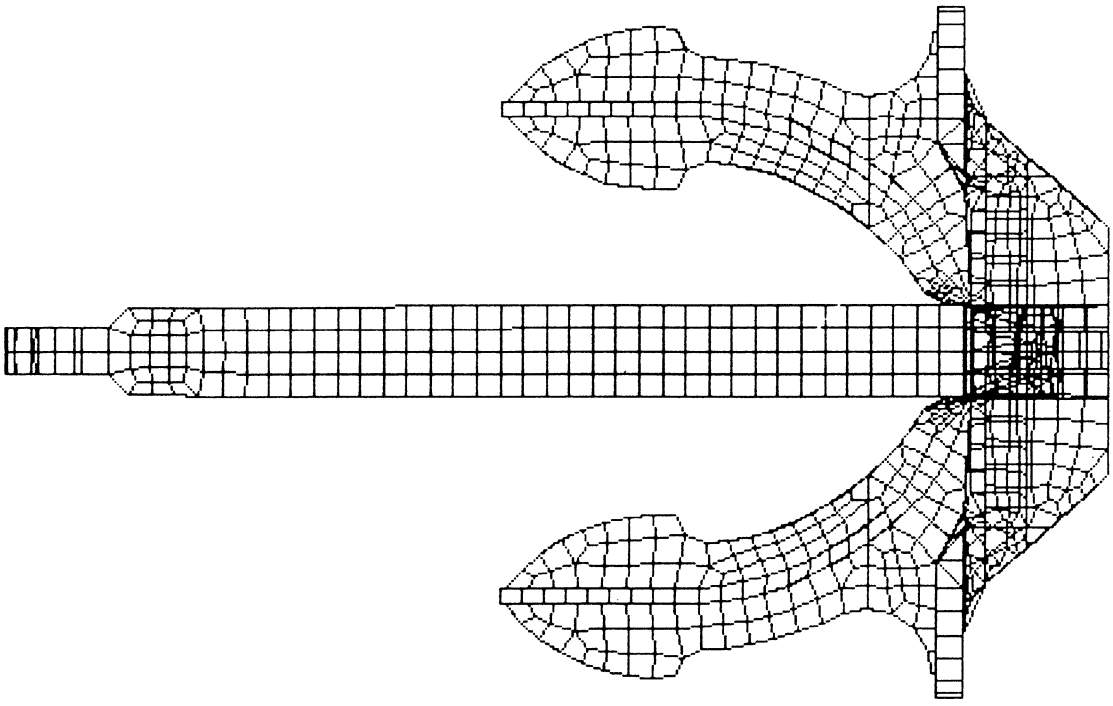
$$F_h = \mu F_v$$

$$F(\delta) = K\delta^e$$

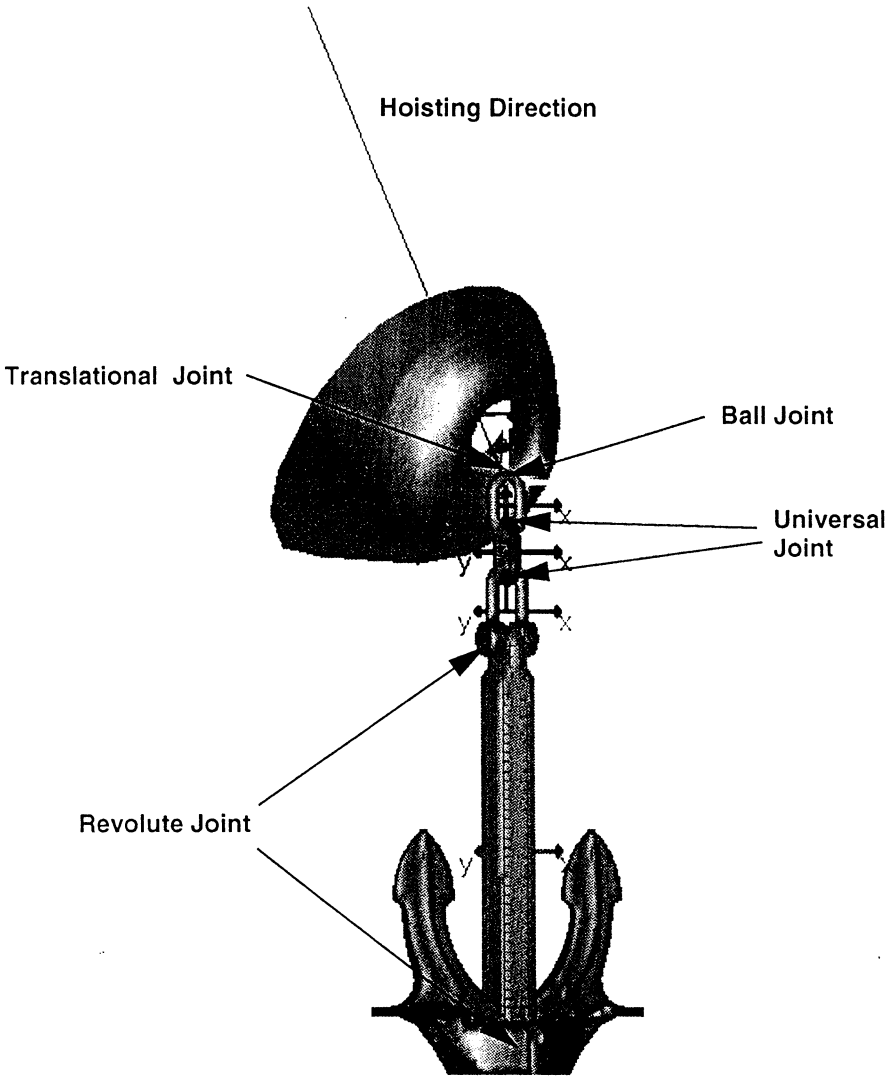
$$g(\delta) = C(\delta)\delta$$



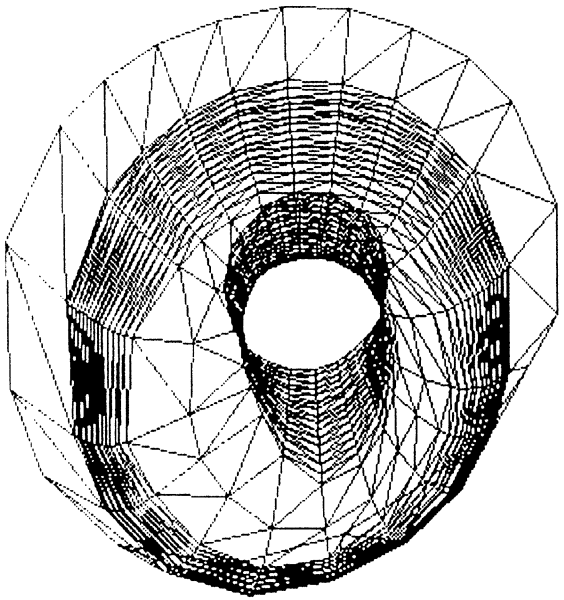
Discretized Anchor



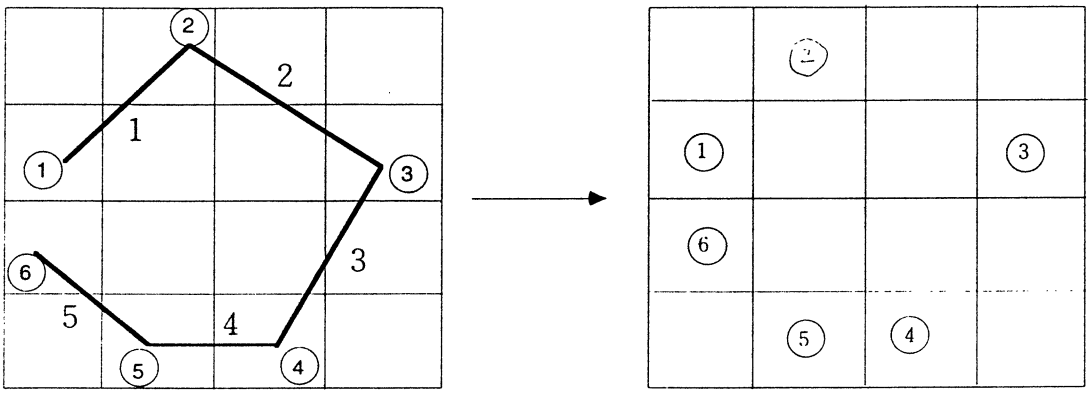
ADAMS Model



Discretized Bell Mouth



Bucket Sorting



Node #	Related Element
1	1
2	1,2
3	2,3
4	3,4
5	4,5
6	5

Bucket Neighbor Information

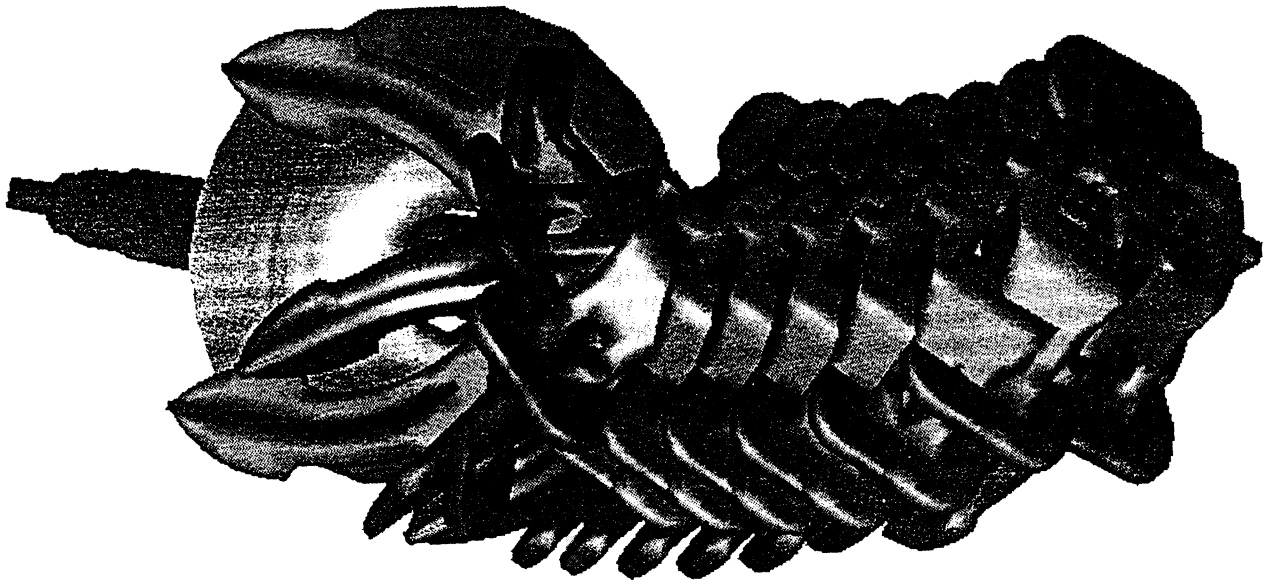
Simulation

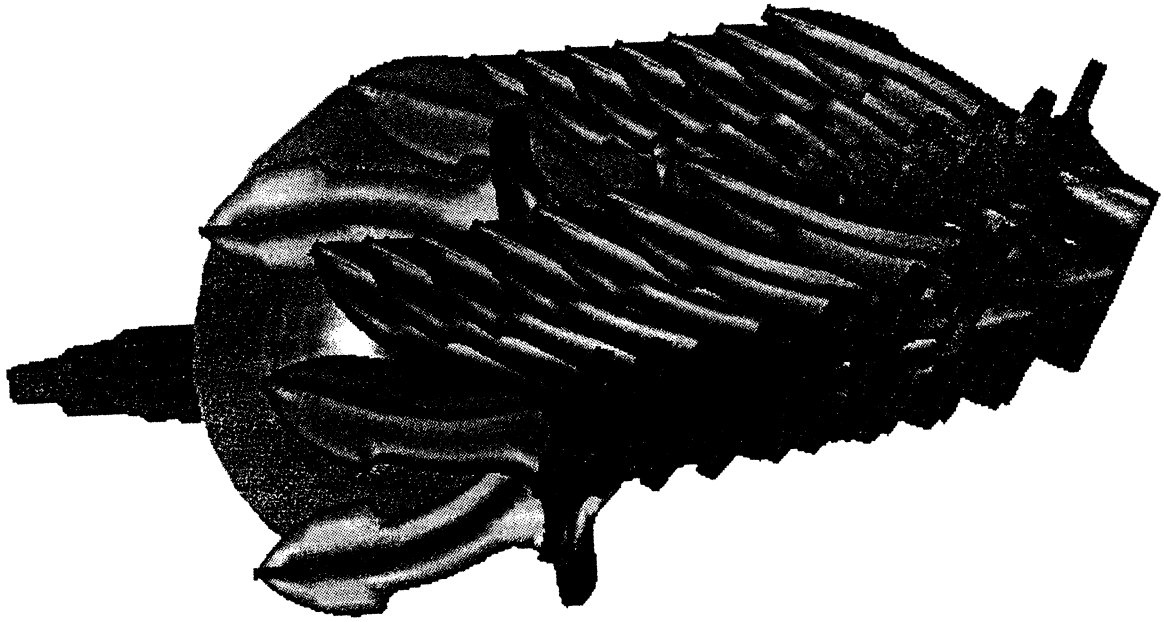
- Anchor Weight of 10.5 Ton

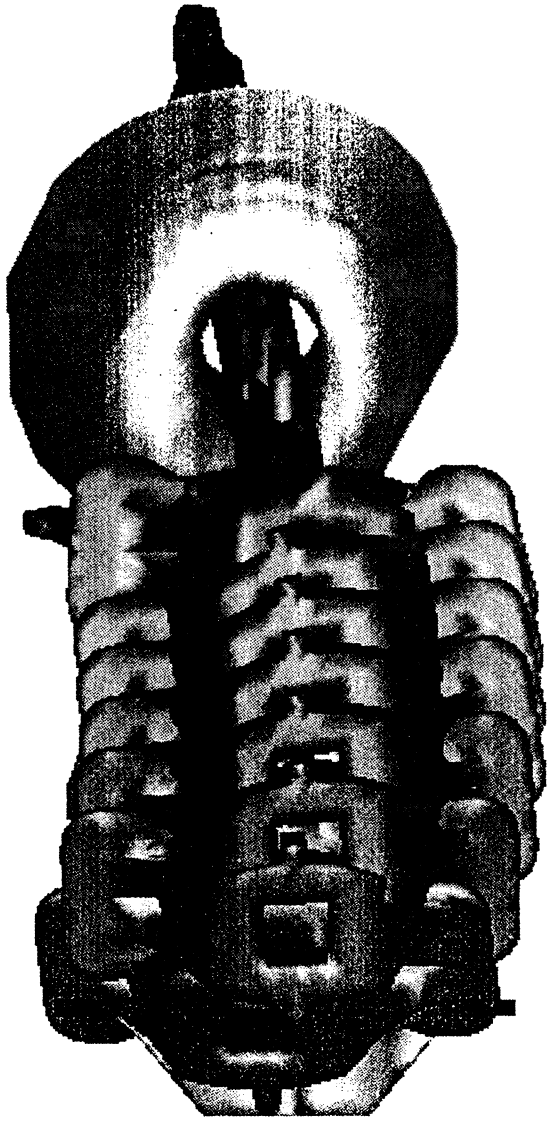
- Subroutine GFOSUB

- 90 CPU min for 130 sec Simulation

- Several Simulations with Different Parameter

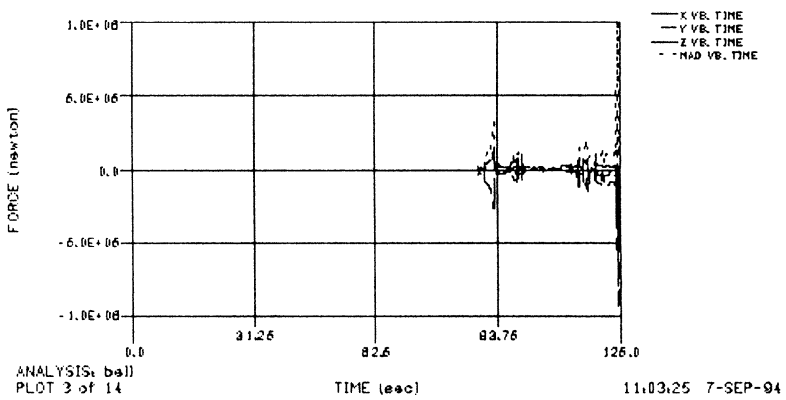




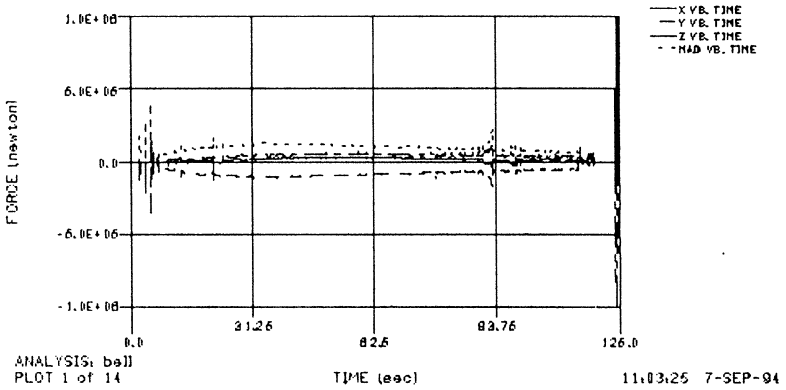


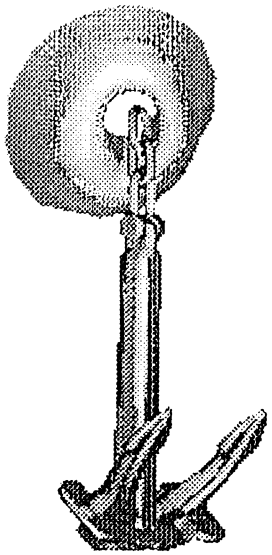
Contact Forces

Contact Force Between Flucker & Bell mouth



Contact Force Between Shank & Bell mouth





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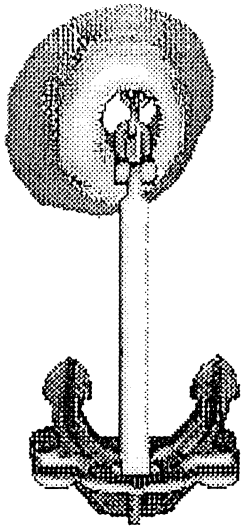

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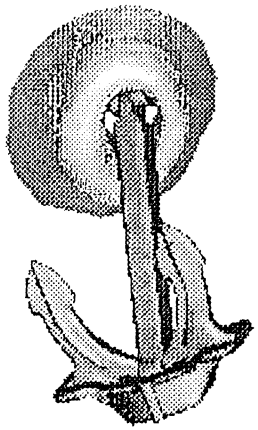

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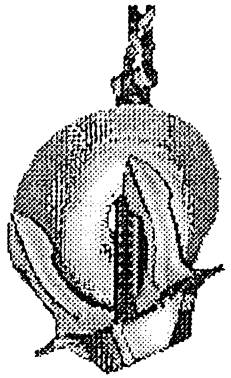

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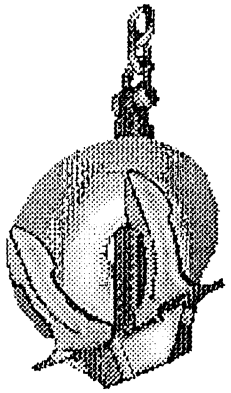

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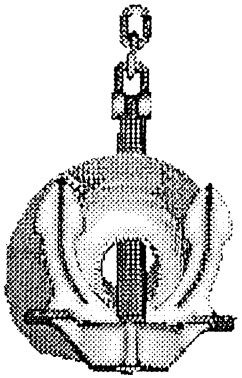

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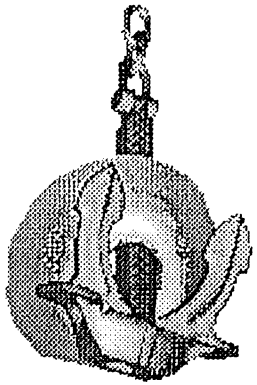

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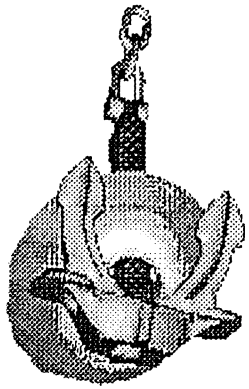

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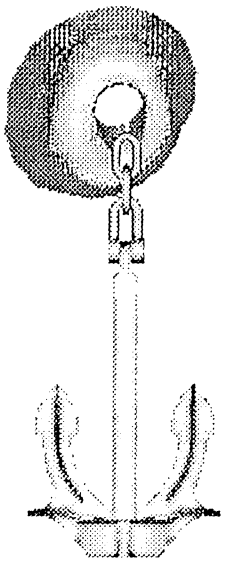

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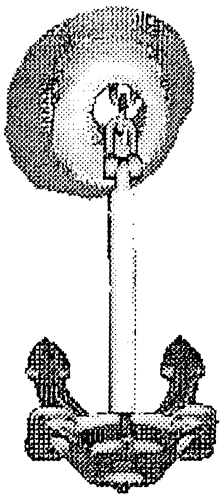

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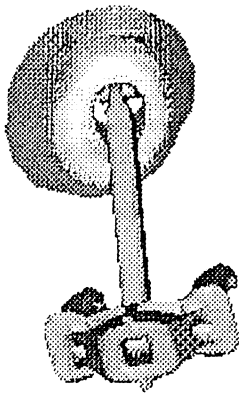

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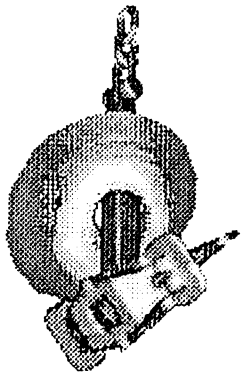

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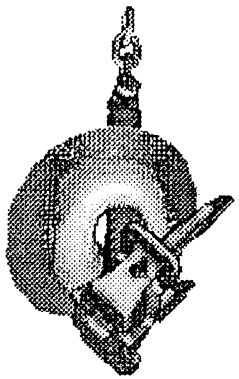

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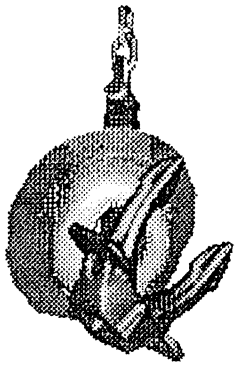

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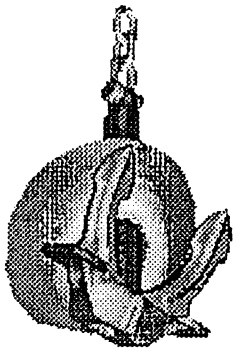

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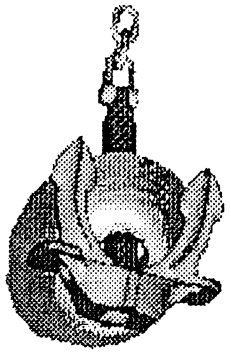

t = 190.6

Anchor Home-in Process

- Anchor is hoisted

- Shank begins to contact with Lower Part of Bell Mouth

- Anchor rotates CounterClockwise

- Left part of flucker begins to contact with
  Right Lower Part of Bell Mouth

- Anchor Rotates by the Contact Force with Bell Mouth

- Final Set Position

Parameter for Successful Home-in

- Shape of Bell Mouth

- Grooved Shape of Lower Bell Mouth

- Orientation of Bell Mouth

- Direction of Chain Hoisting

Conclusion

- Solution of 3 D Rigid Body Contact Problem

- ADAMS was Successful for This Simulation

- Suggests Important Design Parameters and Design Guideline for Bell Mouth

Future Application

- DY Winding Analysis

- Design and Analysis of 3 D Cam

- Backlash in Gear System

- Tolerance Analysis

- General 3D Rigid Body Contact Problem