

Curtin University of Technology

Department of Mechanical Engineering

Adjustable Hydro-foiling Rudder
Design

Curtin University of Technology

Department of Mechanical Engineering

Engineering Graphics 232

Final Assignment –
Construction and User Guide

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1. Introduction

Welcome to the Hydro-foiling adjustable rudder user guide. This User guide was designed so that people looking to upgrade their current rudder system are able to build their own hydro foiling rudder. This particular design is has been designed to be used on the Skate class dinghy however the design can be modified to suit other dinghy's as well.

The hydro-foiling rudder design involves adding a pair of hydrofoils onto the conventional rudder blade angled perpendicular to the rudder blade. These hydrofoils are to be positioned 150mm below the water line of the rudder. The other main part of the hydro-foiling rudder is the frame in which the rudder is mounted. This frame enables the rudder not only to be able to swing left and right, as a conventional rudder does but also enables it to adjust up and down to change the angle of the hydrofoils relative to the flow of water. The angle of the rudder is controlled by a pulley system acting against a gas strut.

The goal of the hydro-foiling rudder is to be able to adjust the trim of the boat (position of the bow relative to the water) and also increase the water line length of the boat, which enables the boat to travel faster. The hydrofoils are able to do this because the rudder is adjusted so that it is tilted forward or backwards which cause the hydrofoils act like the ailerons do on planes. When the rudder is tilted forward this moves the front edge of the hydrofoils downwards which causes the rudder to pull the stern (back) of the boat down into the water, thus pushing the bow (front) up. The stern is lifted and the bow pushed down when the rudder is tilted backwards. The reason that this control is necessary is because the trim of the boat can dramatically affect it's speed and also helps reduce unfavourable capsizes.

The top speed of a boat is limited to the water line length of the boat. The water line length of the boat is considered to be the linear distance between where the bow of the boat touches the water to where the stern of the boat touches the water. How the rudder increases this is by continuing the water flow from the back of the boat onto the hydrofoils. This means that the theoretical stern of the boat has been moved back and hence increasing the water line.

2. Construction

The construction of this hydro-foiling rudder is relatively easy if done by a person experienced in fibre glassing and carbon fibre fabrication and also Stainless Steel welding.

The weight of the assembled system is an important factor because the more weight the boat has to carry the slower the boat is going to go. Therefore the construction of the frame, rudder and rudder box has to be as light as possible.

The frame in this design is constructed out of half inch (12.5mm) Stainless Steel 316 tubing. The reason that Stainless Steel 316 tubing was chosen is because the hollow section stainless steel has sufficient strength and is a lot lighter than the solid section. Stainless Steel 316 was chosen because it is a marine grade steel and because of that it doesn't corrode as much as other materials which is very important property because of the environment in which it will be used. Also because of this reason above all the fittings including the gas strut used in the assembly are marine grade Stainless Steel and the fittings are also corrosion resistant.

The rudder box, rudder and hydrofoils should be made out of a combination of a light weight wood and carbon fibre to reduce weight.

The brackets that hold the rudder assembly which are fabricated on the back of the boat should be made out of carbon fibre to ensure adequate strength as these fittings will undergo a lot of force.

The pin that holds the rudder blade in the rudder box doesn't have to be Stainless Steel because there are relatively small loads on the fitting. A piece of plastic PVC pipe provides enough strength.

The rudder has been built using H7G6 tolerances with a clearance fit. However some of the parts used are standard Ronstan Fittings and therefore haven't been tolerance.

3. Setting up of the rudder

Once the rudder has been constructed a suitable pulley system should be put together to be able to adjust the rudder. A four to one system involving two double block pulleys allows for easy adjustment. A fixed scale should be made so that the amount of adjustment can be monitored and recorded so results can be repeated later on.

If vibration of the rudder occurs this could be due to the fit between the rudder blade and the rudder box being too loose. This problem can be solved by using foam or thin carpet on the inside wall of the rudder box this will tighten the fit and hopefully stop the vibration. However if the rudder box, rudder blade or the hydrofoils are not square this could also cause vibration or trouble steering.

4. Future developments

The design and use of the rudder is still in its development stage and there are still some unanswered questions. Possible developments for this design are

1. Where the hydrofoils are best positioned to produce the best results.

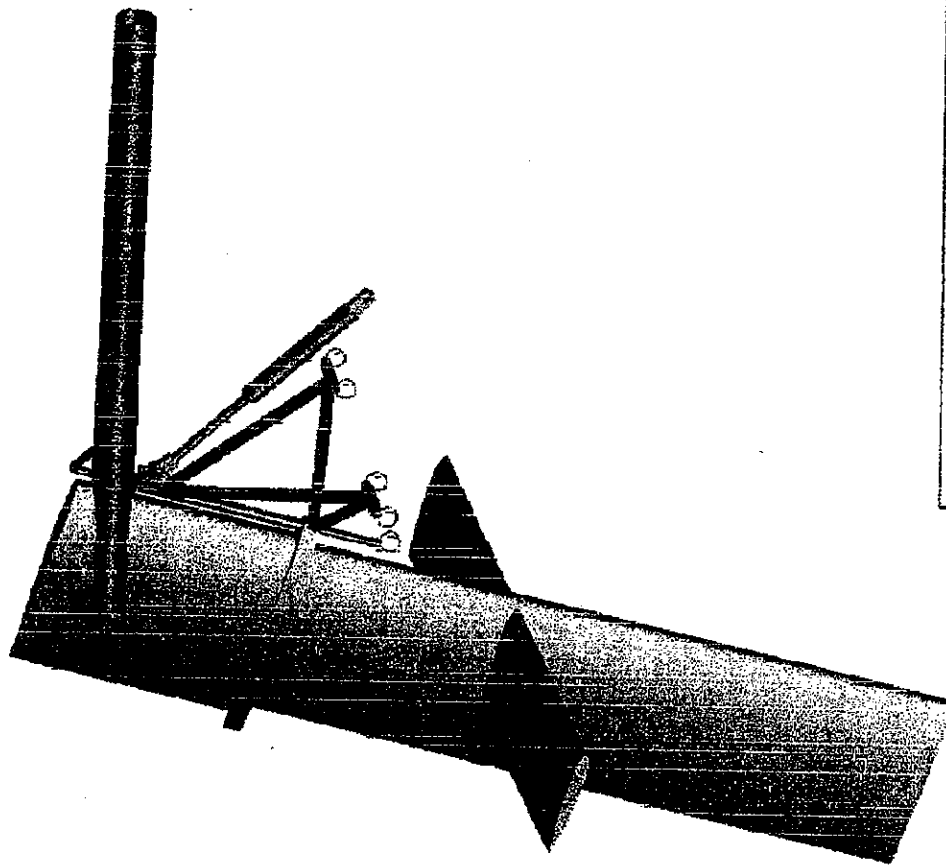
There are multiple positions on the rudder blade which could be possible positions for the hydrofoils. Will the hydrofoils when placed at the front edge or back edge of the rudder give the best results. Also whether the hydrofoils give better results at the top or bottom of the rudder has yet to be proven

2. How big to make the hydrofoils.

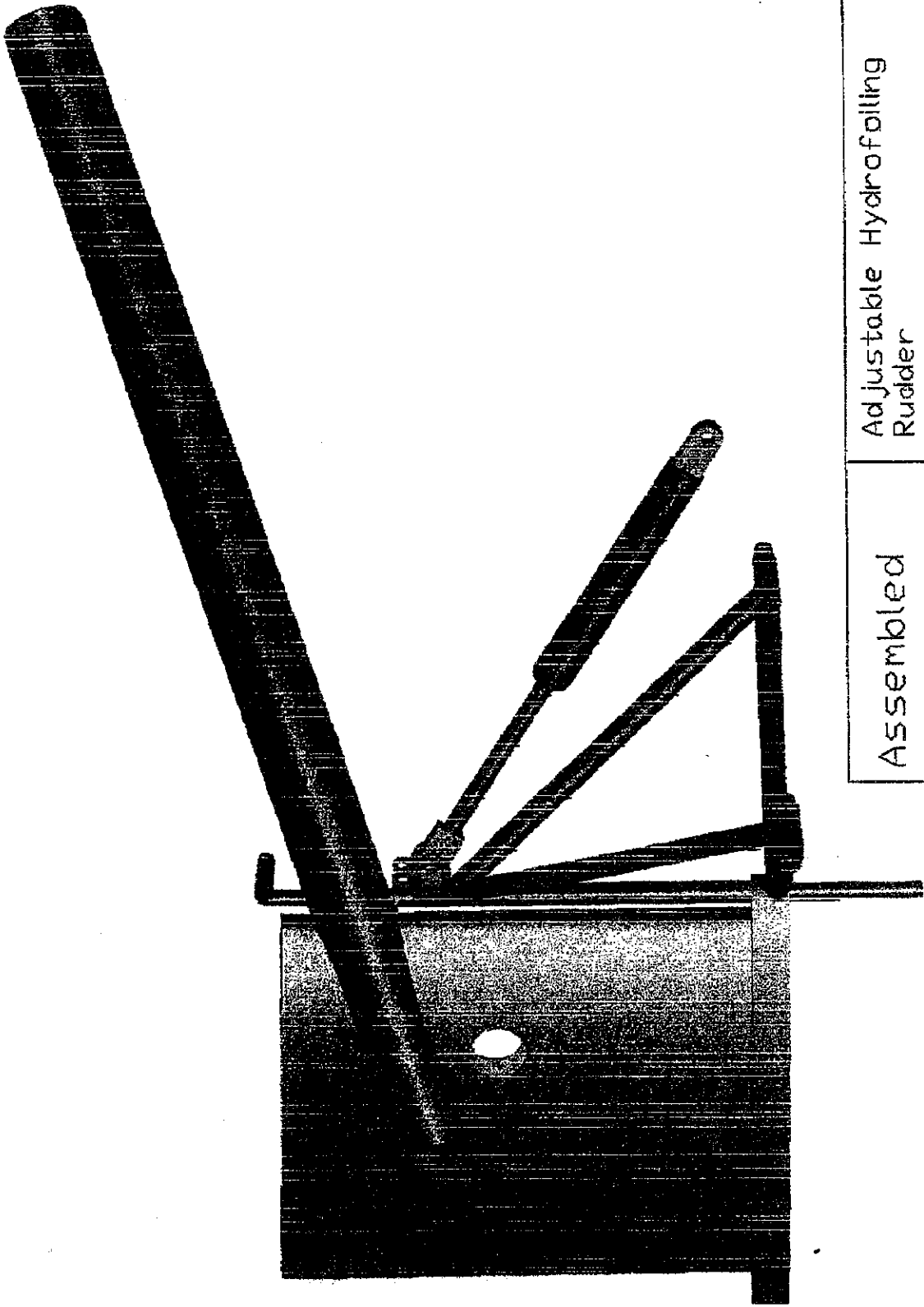
The size of possible hydrofoils is limited to how strong the hydrofoils can be attached to the rudder blade. Whether to make hydrofoils short but wide or long but skinny is another development that is yet to be explored.

5. Troubleshooting

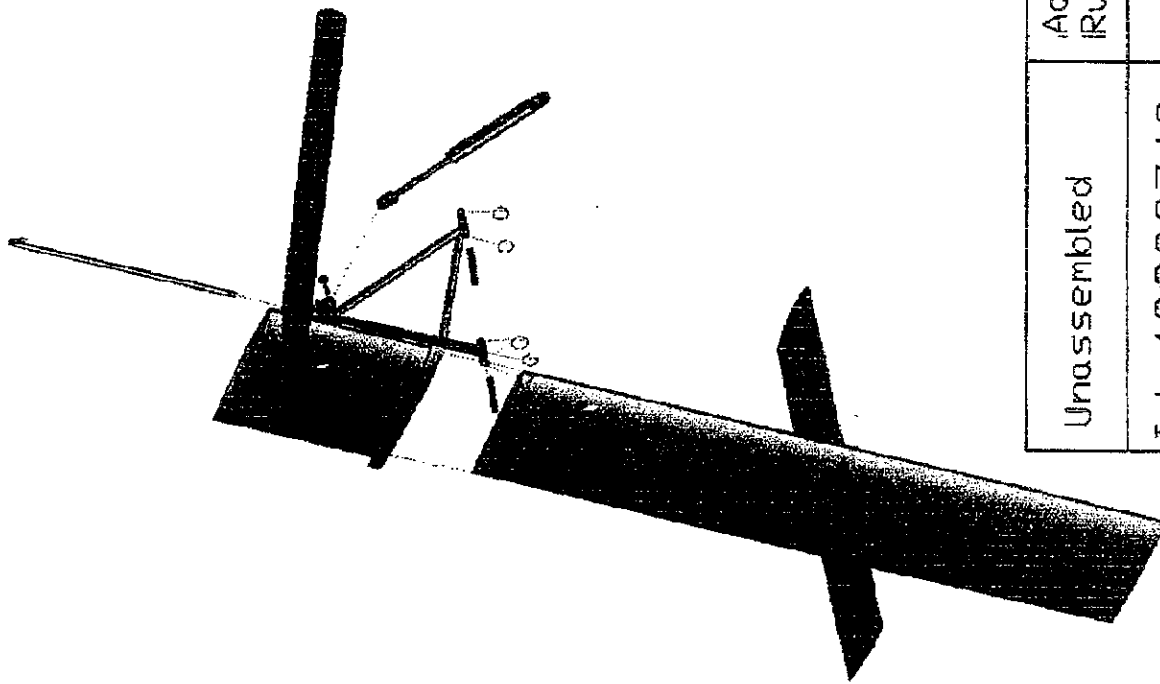
One problem which has occurred with this design is corrosion occurring between the locating pins on the frame and the mounting brackets on the stern of the boat. This problem has yet to be solved but possible solutions are to put a lining between the pin and the brackets to try and separate the two.



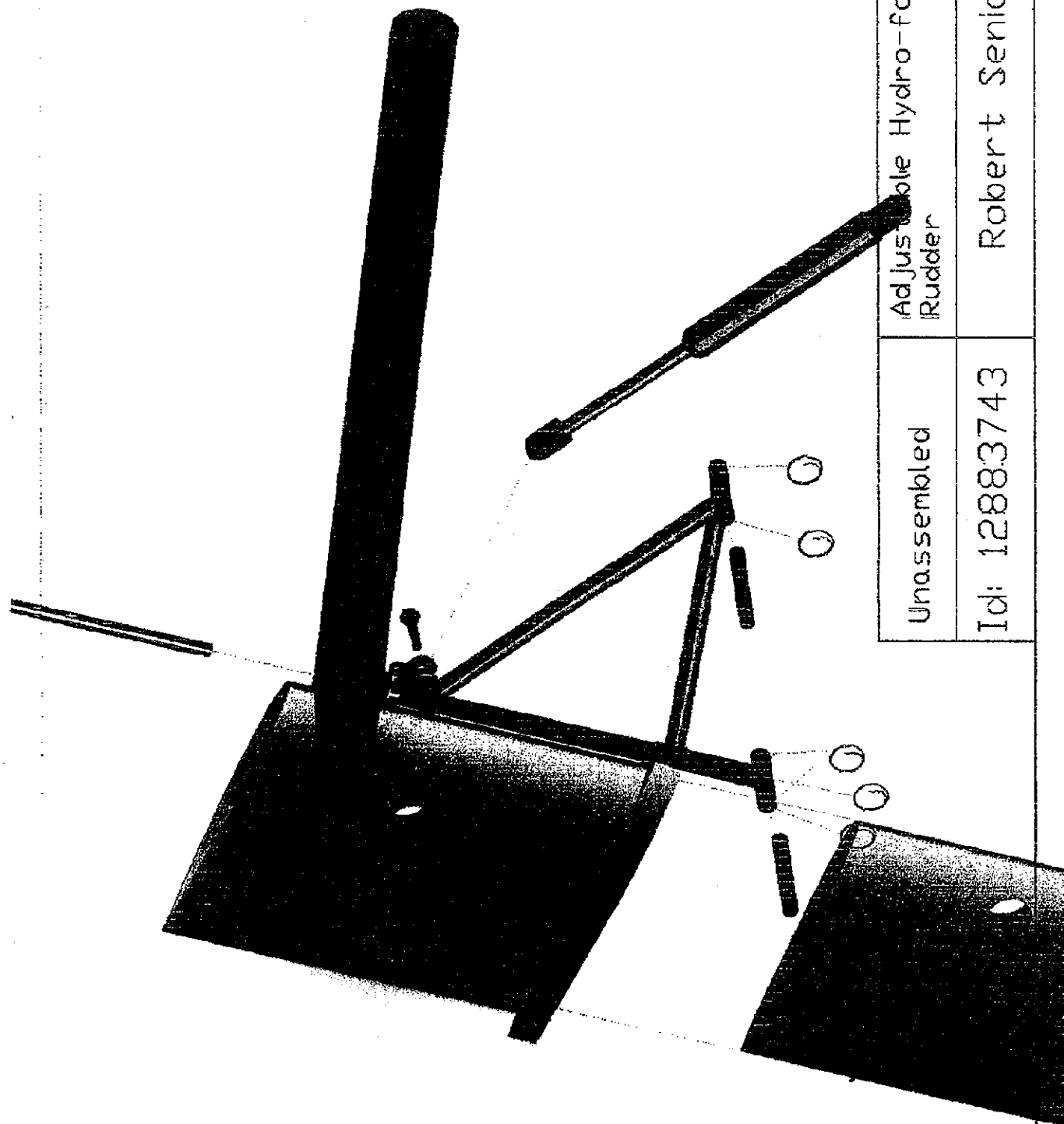
| | |
|--------------|---------------------------------|
| Assembled | Adjustable Hydro-foiling Rudder |
| Id: 12883743 | Robert Senior |



| | |
|--------------|--------------------------------|
| Assembled | Adjustable Hydrofoiling Rudder |
| Id: 12883743 | Robert Senior |



| | |
|--------------|---------------------------------|
| Unassembled | Adjustable Hydro-foiling Rudder |
| Id: 12883743 | Robert Senior |



| | |
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| Unassembled | Adjustable Hydro-falling Rudder |
| Id: 12883743 | Robert Senior |

Part List

Part A: Rudder Blade

Part B: Rudder Box

Part C: Rudder Box Pin

Part D: Rudder Pin

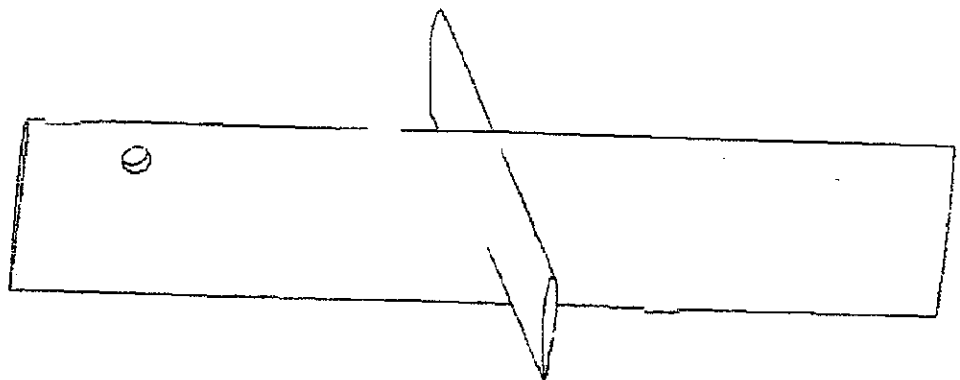
Part E: Frame

Part F: Transom Locating Pins

Part G: Split Pins

Part H: Gas Strut

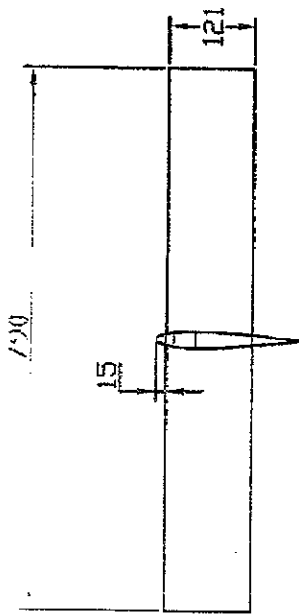
Part I: Nut and Bolt



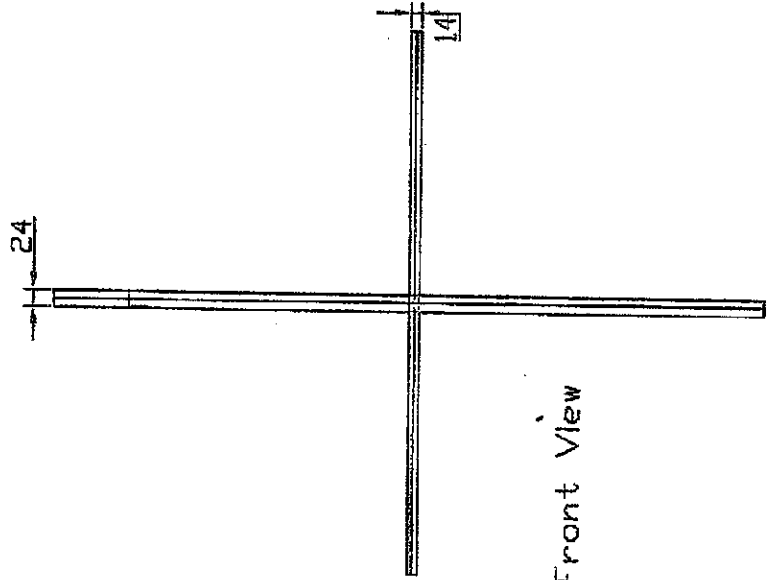
Rudder Blade

| | |
|--------------|--------------------------------|
| Part: A | Adjustable Hydrofoiling Rudder |
| Id: 12883743 | Robert Senior |

Top View

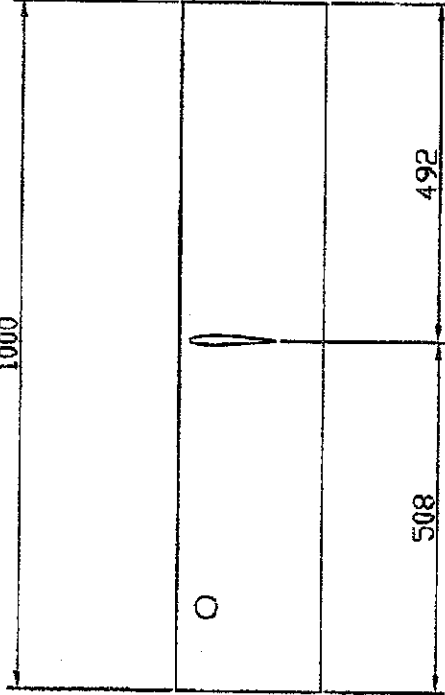


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Front View

1000



Side View

Rudder Blade

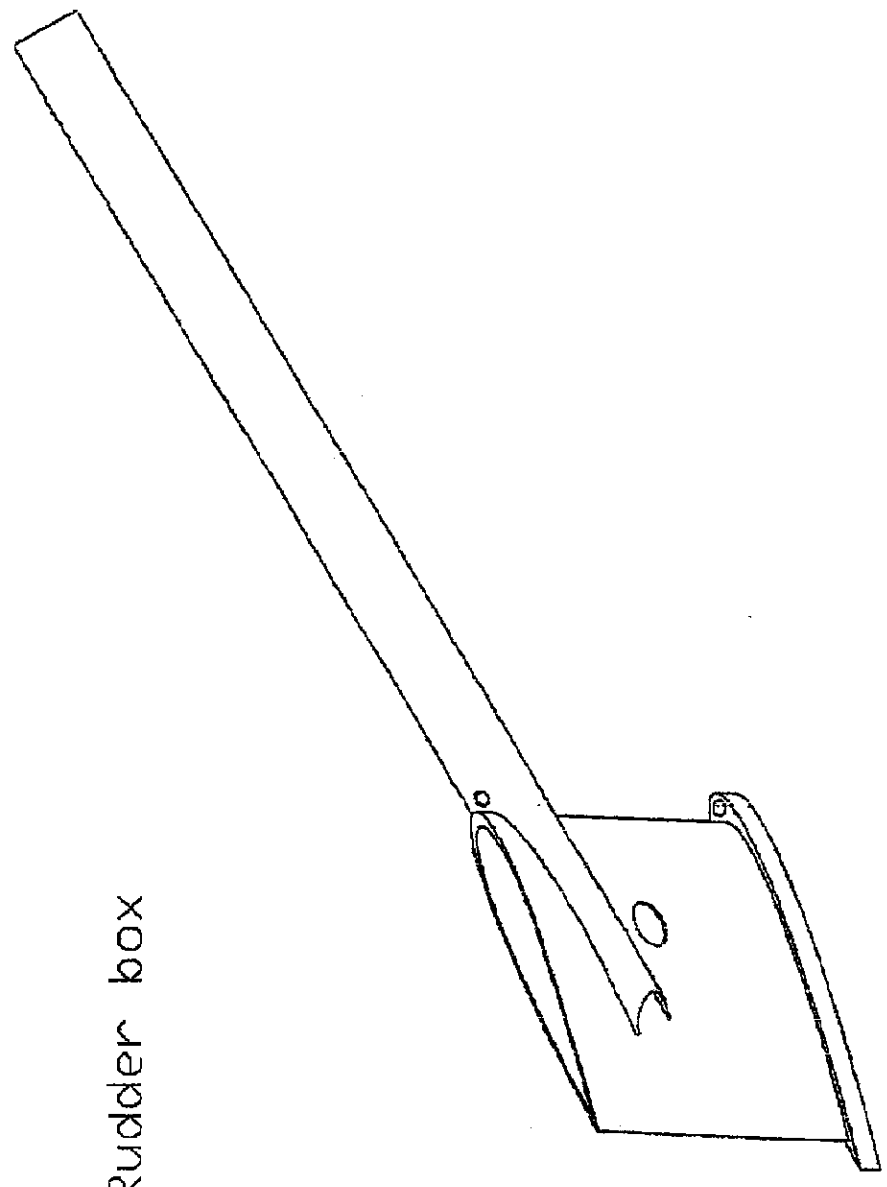
Part: A

Adjustable Hydrofoiling Rudder

Id: 12883743

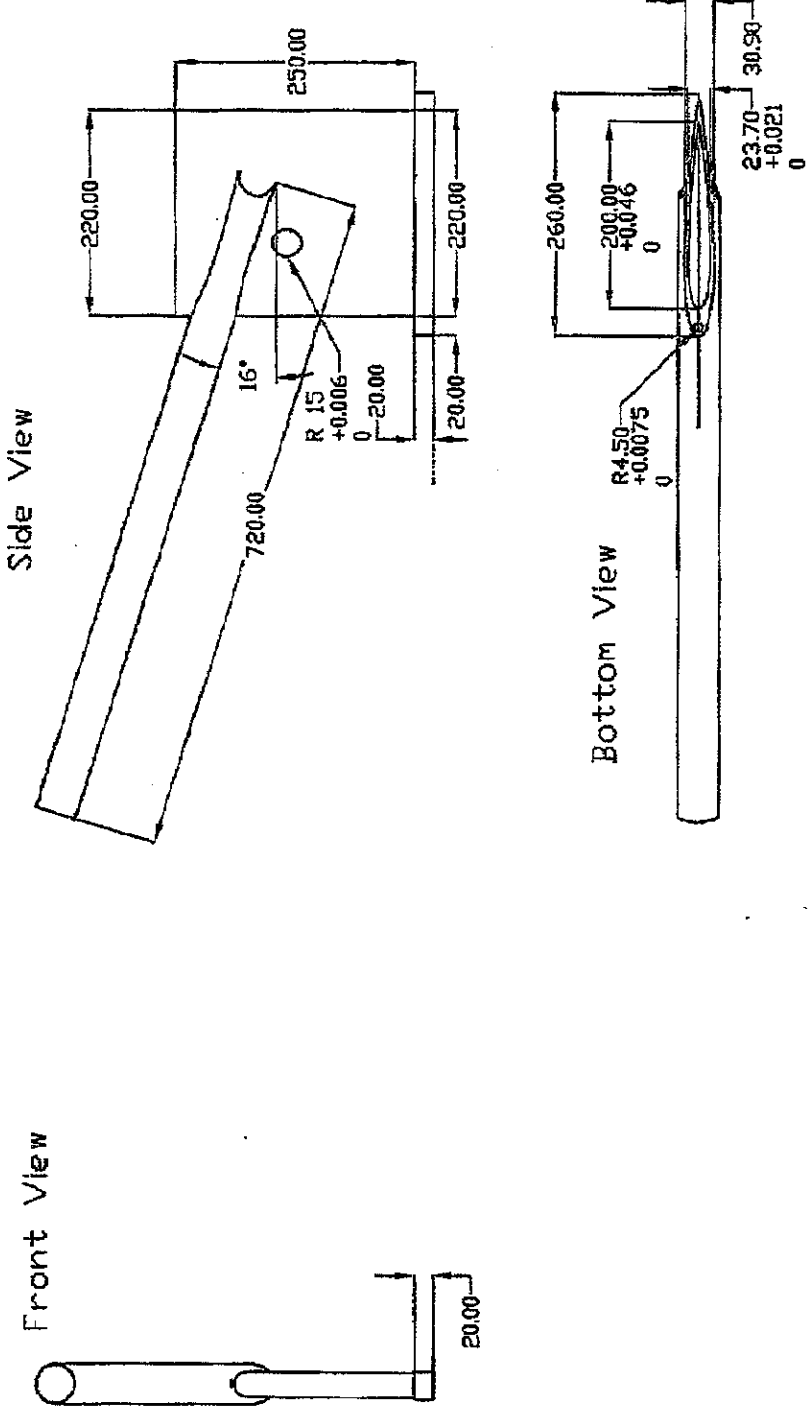
Robert Senior

Rudder box



| | |
|--------------|--------------------------------|
| Part: B | Adjustable Hydrofoiling Rudder |
| Id: 12883743 | Robert Senior |

Rudder Box

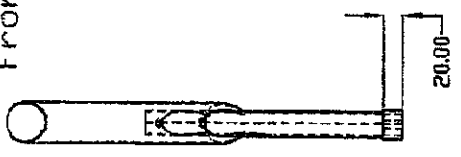


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| Part: B | Adjustable Hydrofoiling Rudder |
| Id: 12883743 | Robert Senior |

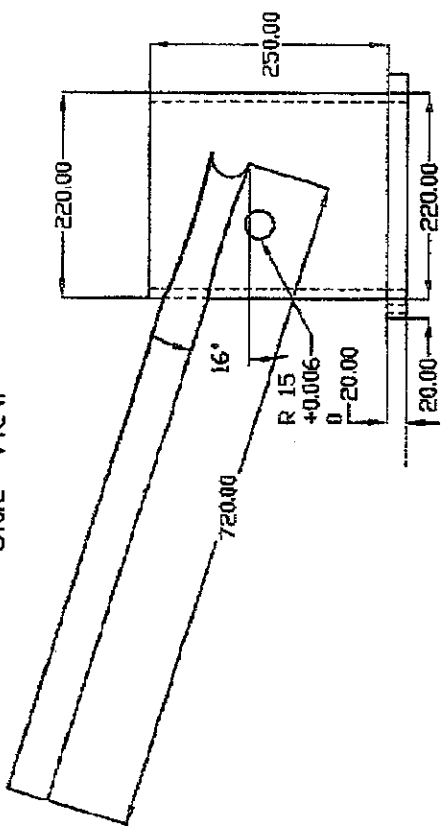
Rudder Box (with hidden lines)

(lines)

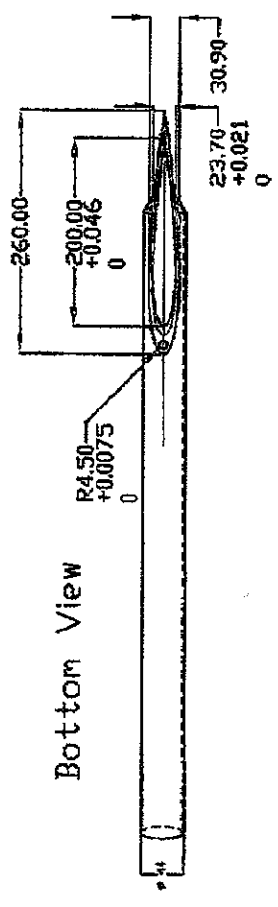
Front View



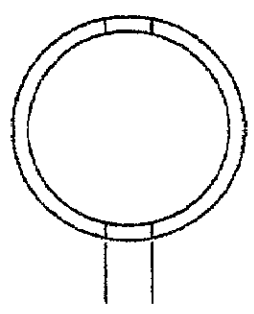
Side View



Bottom View



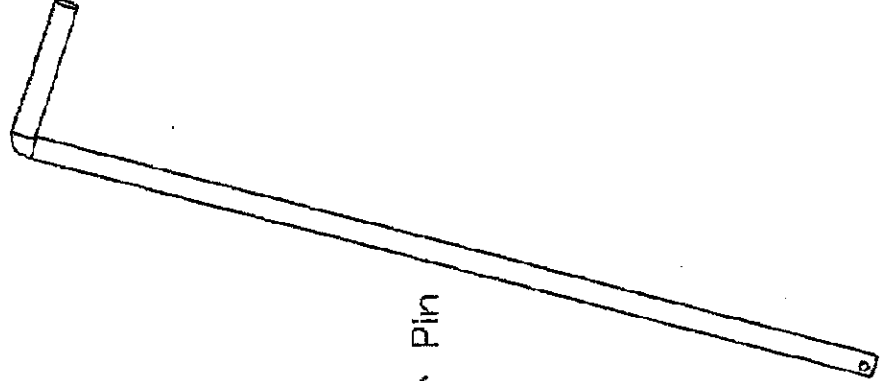
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|--------------|--------------------------------|
| Part: B | Adjustable Hydrofolling Rudder |
| Id: 12883743 | Robert Senior |



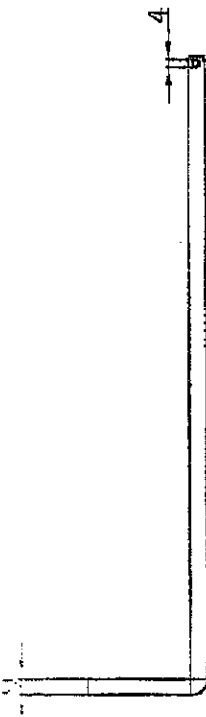
End View

Standard Section of
VC Pipe

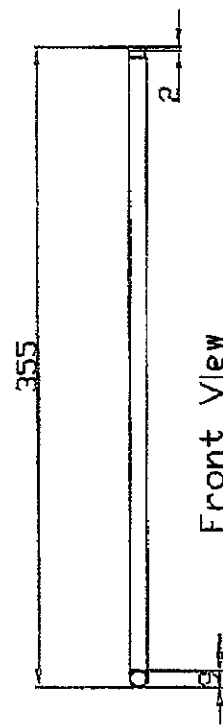
| |
|-----------------------------------|
| Adjustable Hydrofoiling Rudder |
| Robert Senior |



Standard Ronstan Rudder Pin

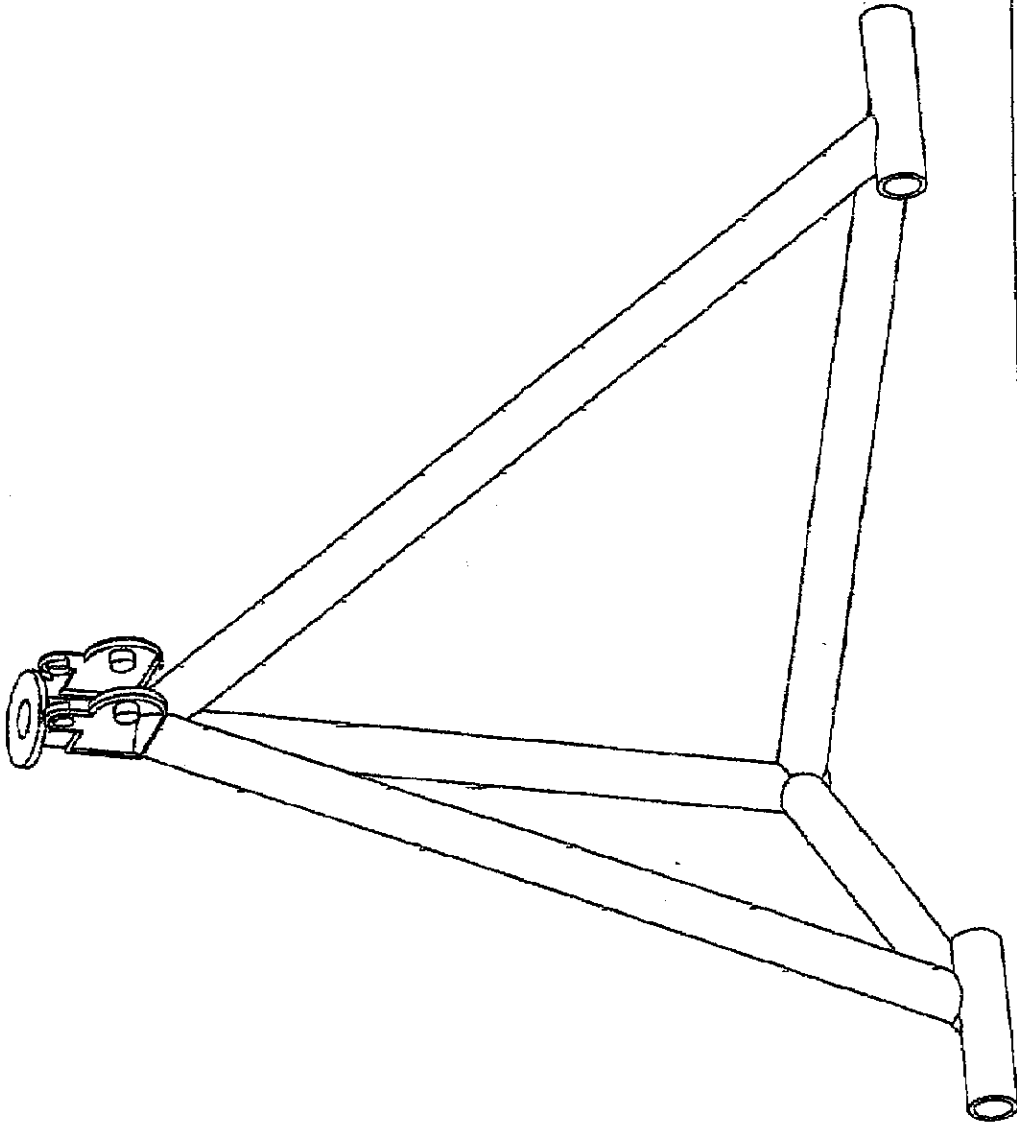


Side View



Front View

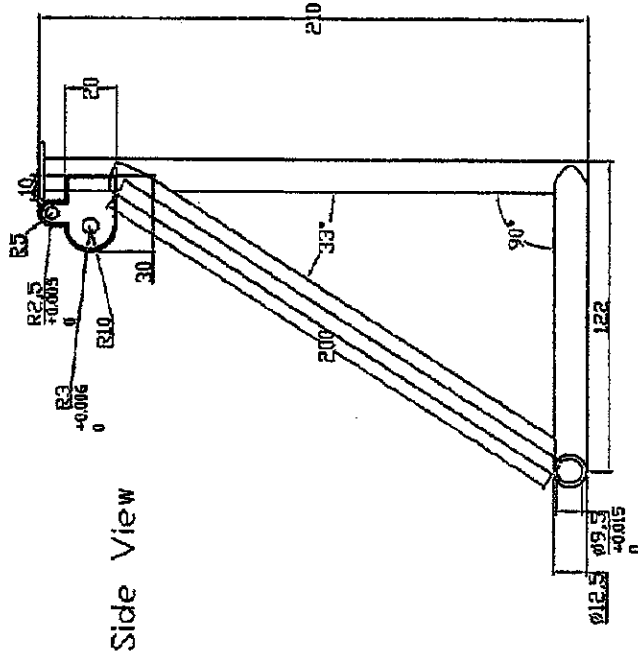
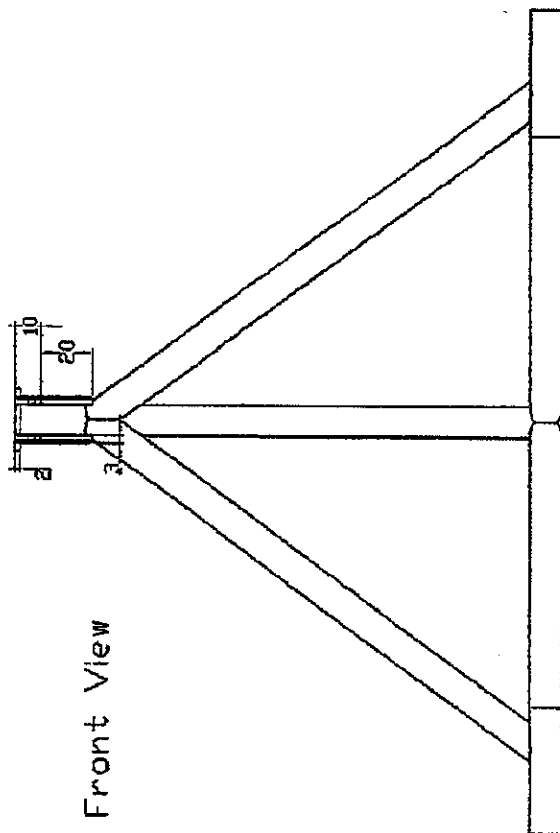
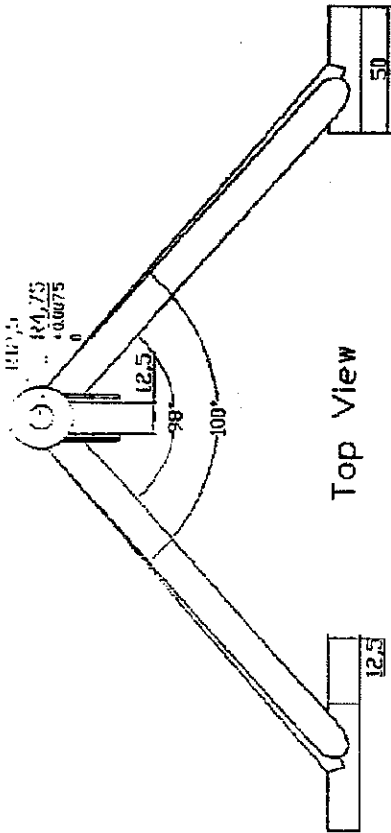
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|--------------|--------------------------------|
| Part: D | Adjustable Hydrofoiling Rudder |
| Id: 12883743 | Robert Senior |



Frame

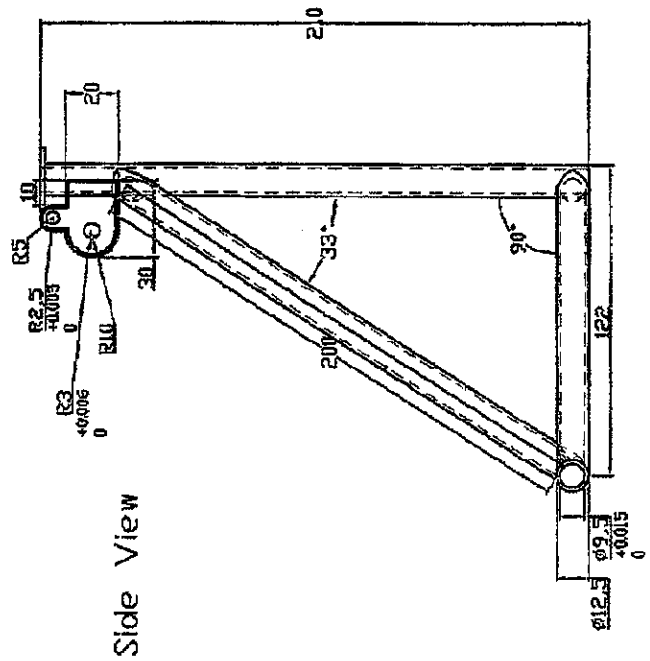
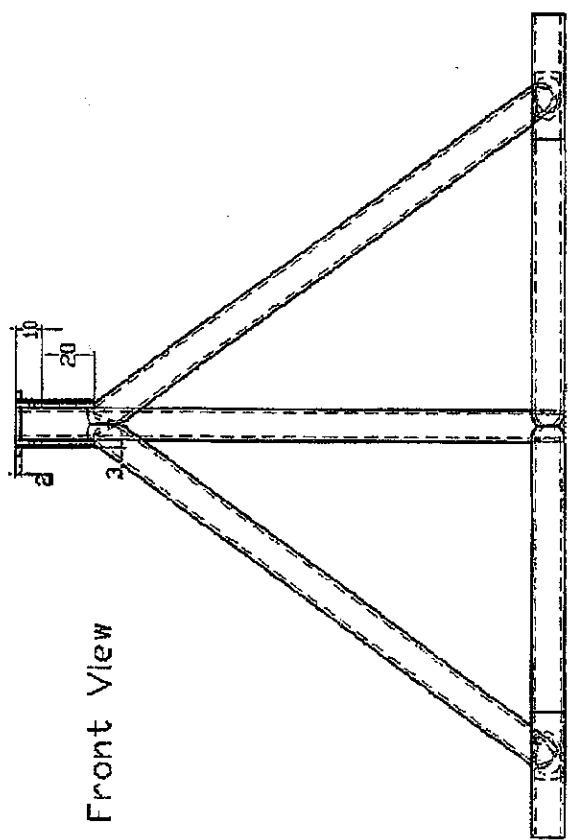
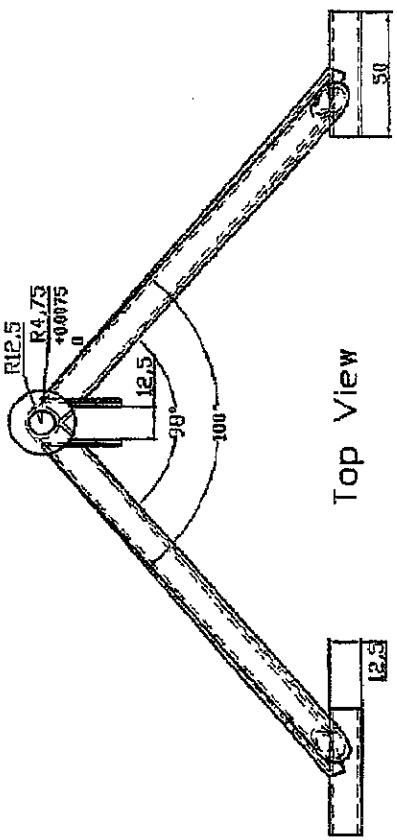
| | |
|--------------|-----------------------------------|
| Part: E | Adjustable Hydrofolling Rudder |
| Id: 12883743 | Robert Senior |

Frame
(without hidden
lines)



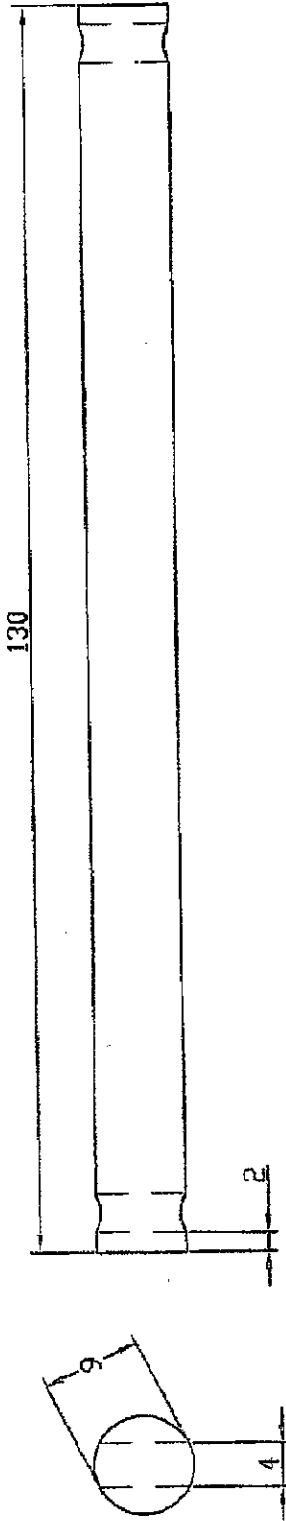
| | |
|--------------|--------------------------------|
| Part: E | Adjustable Hydrofoiling Rudder |
| Id: 12883743 | Robert Senior |

Frame
(with hidden lines)



| | |
|--------------|--------------------------------|
| Part: E | Adjustable Hydrofoiling Rudder |
| Id: 12883743 | Robert Senior |

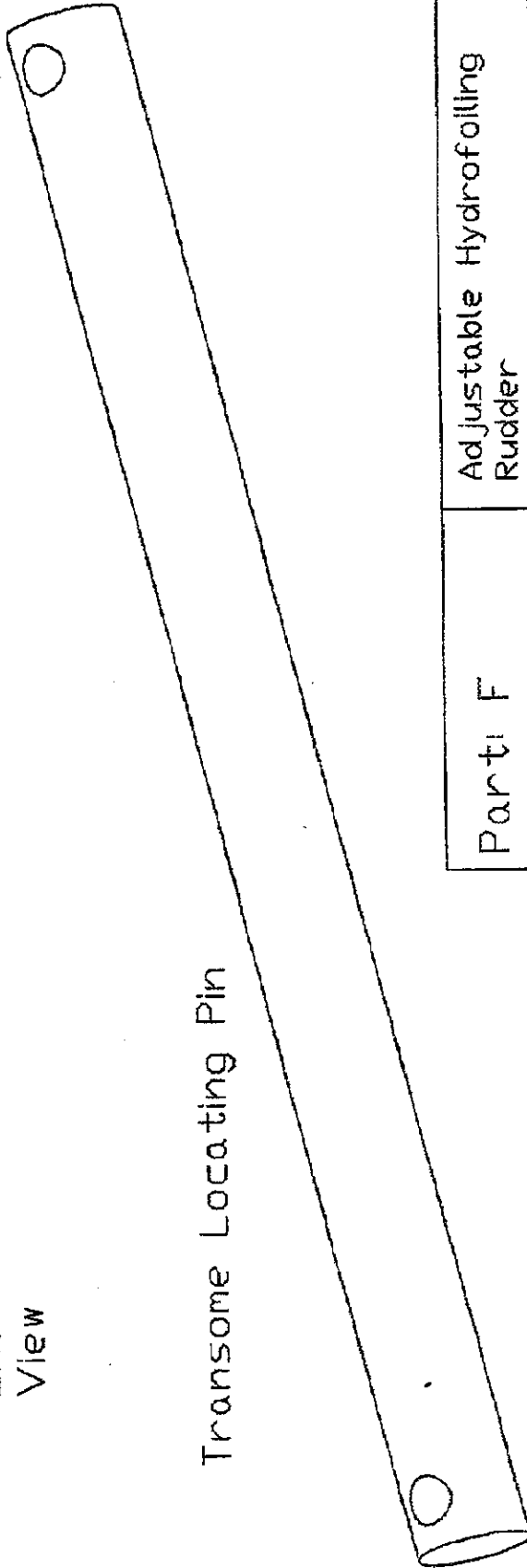
Standard Ronstan Fitting



Side View

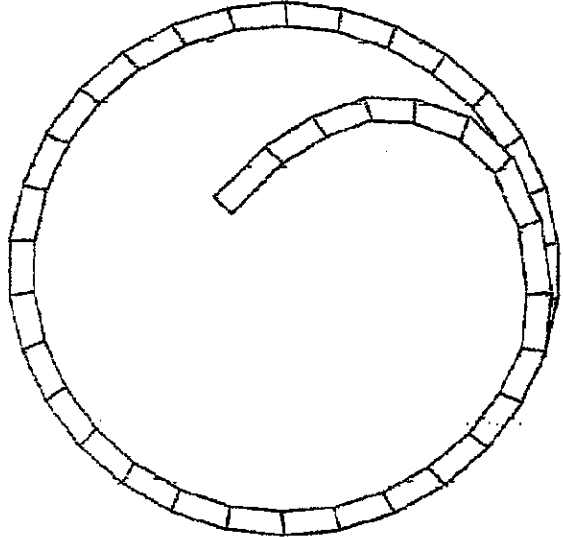
End View

Transome Locating Pin

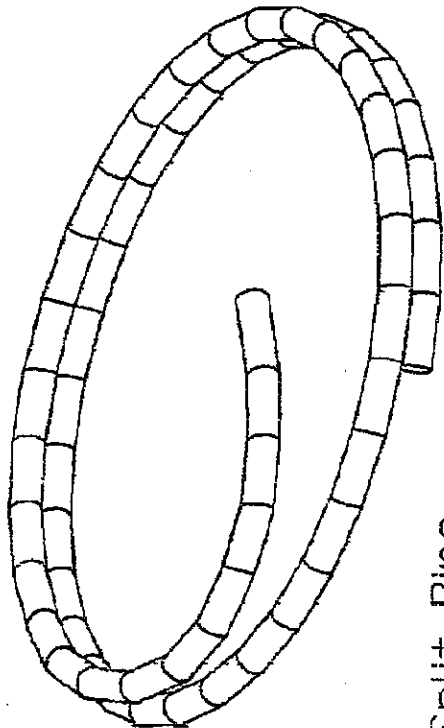


| | |
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| Part: F | Adjustable Hydrofolling Rudder |
| Id: 12883743 | Robert Senior |

Approximate Diameter = 11mm
 Approximate Diameter of Wire
 = 1mm
 Standard Ronstan Fitting



Top View



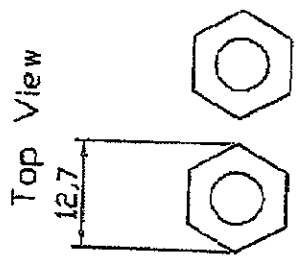
Split Ring



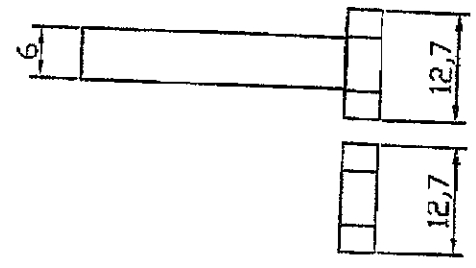
Side View

| | |
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| Part: G | Adjustable Hydrofoiling Rudder |
| Id: 12883743 | Robert Senior |

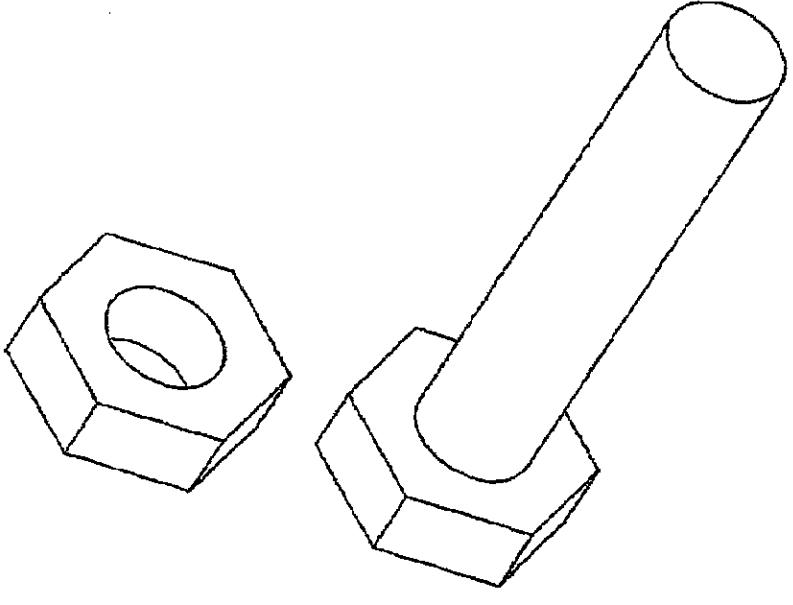
Nut and Bolt



This is a Standard M6 Nut and Bolt



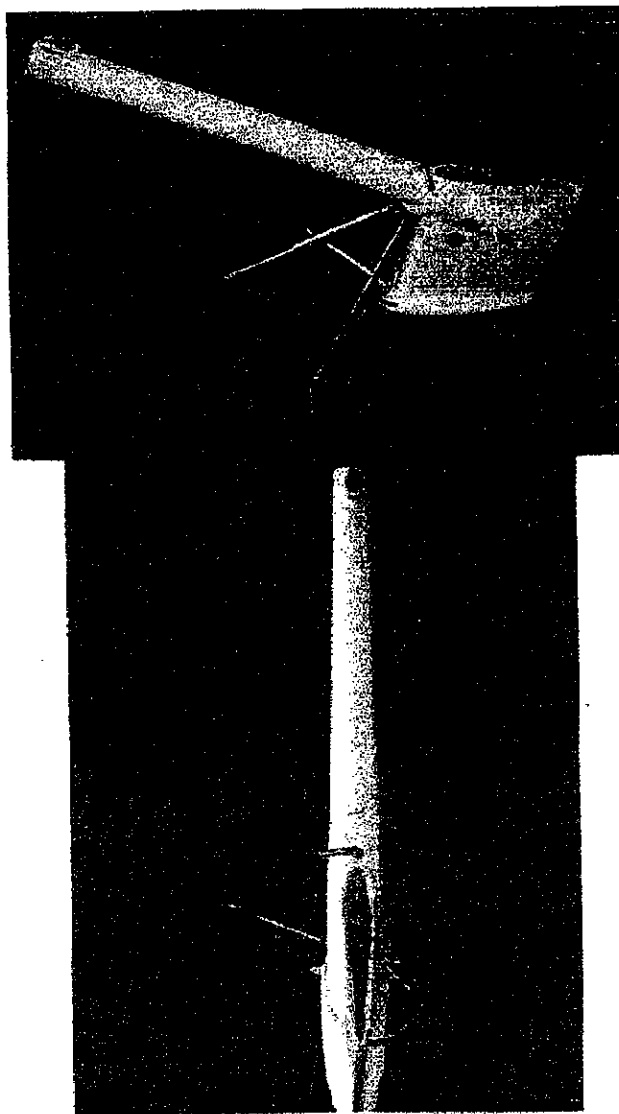
Side View

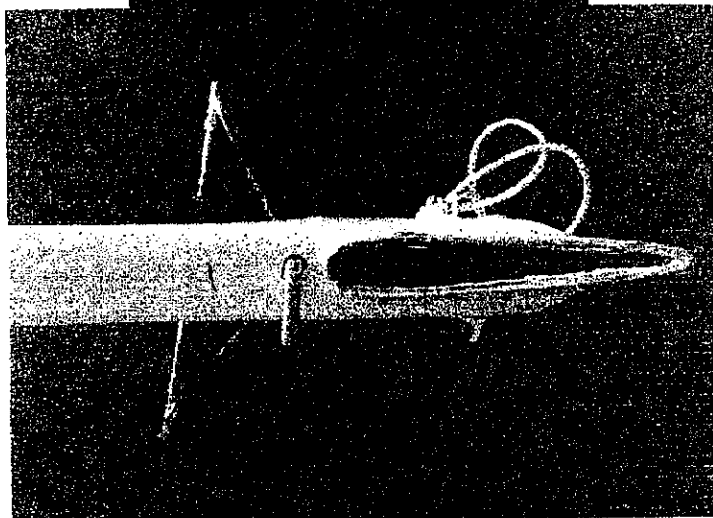
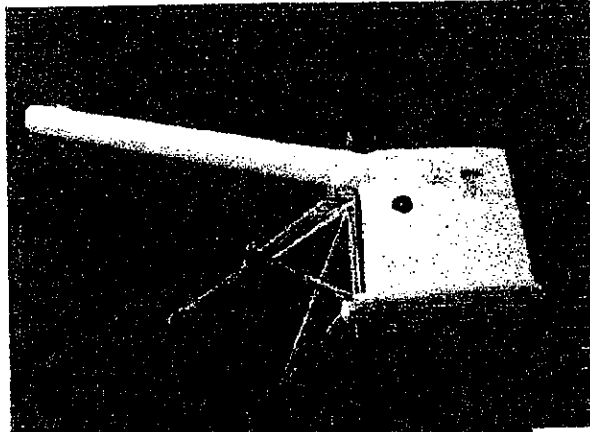


| | |
|--------------|--------------------------------|
| Part: I | Adjustable Hydrofolling Rudder |
| Id: 12883743 | Robert Senior |

Appendices

These are photos of the Rudder Box Assembled without the rudder blade.





Theses are pictures of the Rudder Blade

