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Autoshifting

Coke Cutting Tools

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The First Step

Prior to 1979 most cokers continued to use individual boring and cutting tools for coke removal. This required manual change out of the tool between operations. Besides being tedious, this exposes operators to the hazards of working over the top drum area, is time consuming, and involves high maintenance due to connector wear.

Although a number of designs for combined tools, and in at least one case for remote changeover, were proposed and built in this time period, they were not widely accepted. The key issues have always been reliability and ruggedness. The environment in which the tool operates is harsh (impact loads, thermal shocks, vibration, etc) and the cutting medium contaminated (chemicals, solids, etc).

The first and only widely accepted combination cutting tool is the 1979 vintage Pacific combination cutting tool. Although it was a manually shifted, still requiring it to be removed from the coke drum and manipulated by the operator, it represented a significant advance in operator safety and convenience, time savings, and connector maintenance.

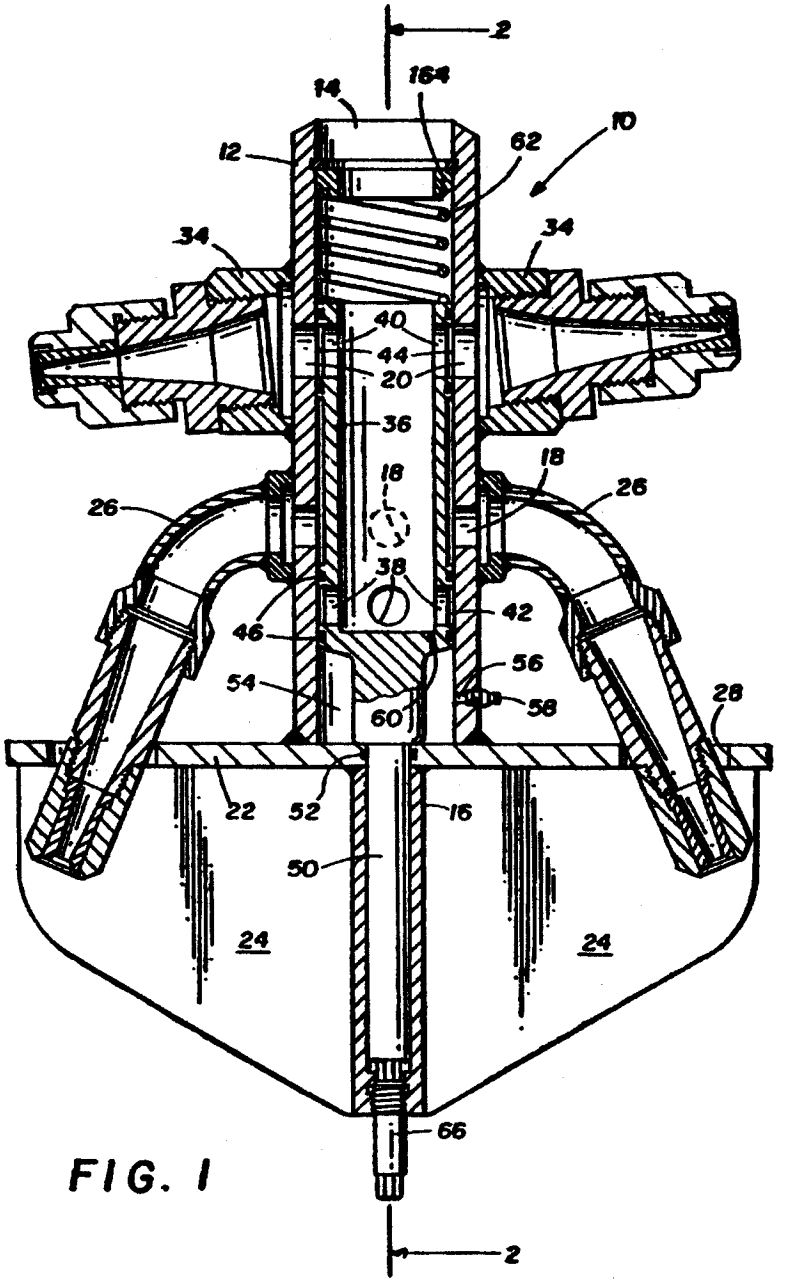

FIG. 1

Original Pacific Combination Tool (1979 "Two-fer")

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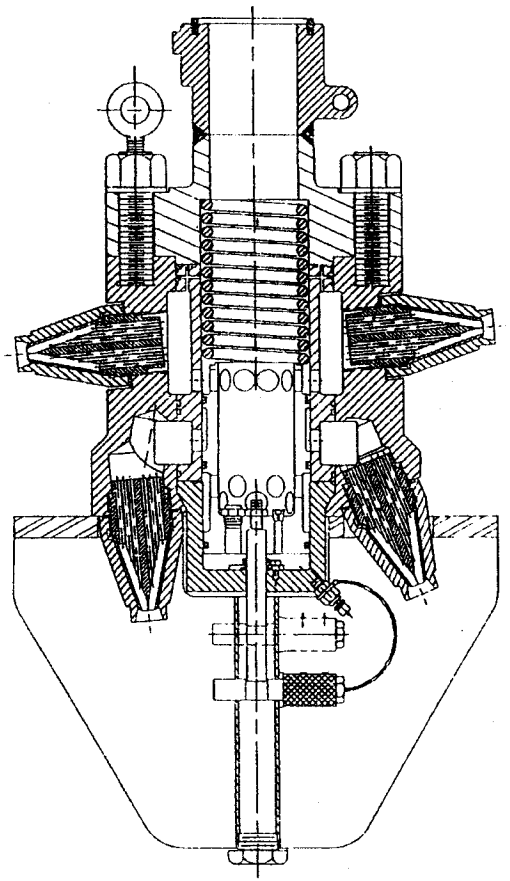
Refinement

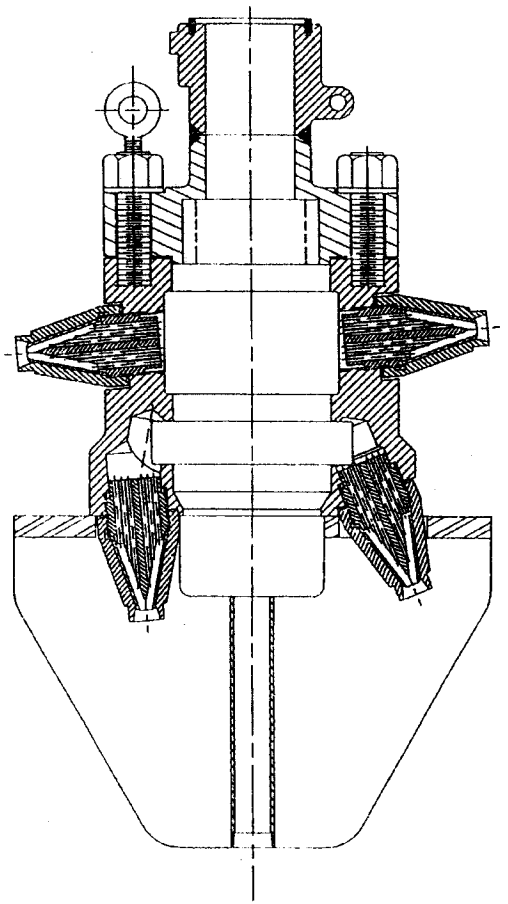
The Pacific combination cutting tool was welcomed from the beginning as a significant advance in cutting technology. However, operating experience in the harsh cutting environment showed a need to refine the design both to improve reliability and to deal with an evolving water chemistry over the next several years.

In 1996, a major upgrade to the internal shifting mechanism was introduced. This simplified the shifting operation to a quarter turn action and eliminated the need for the use of air. It also reduced the number of internal parts by half and simplified maintenance of the tool. This mechanism, too, has been refined some since then to increase its MTBR. Even so, it is still a manually shifted tool requiring manipulation by the operator at the drum top.

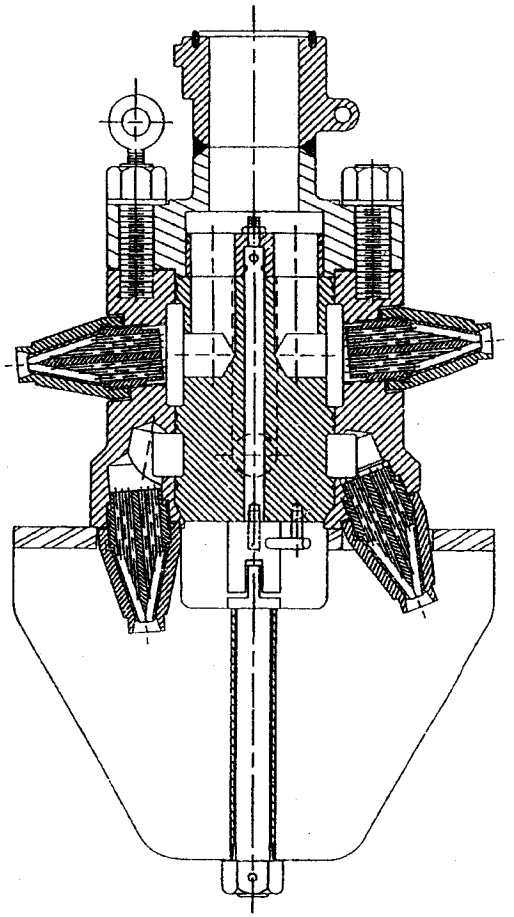
Pacific Combination Tool Evolution
1979 - 1996



CURRENT DESIGN



REMOVE INTERNAL & REWORK FLANGE BORE



PROPOSED DESIGN

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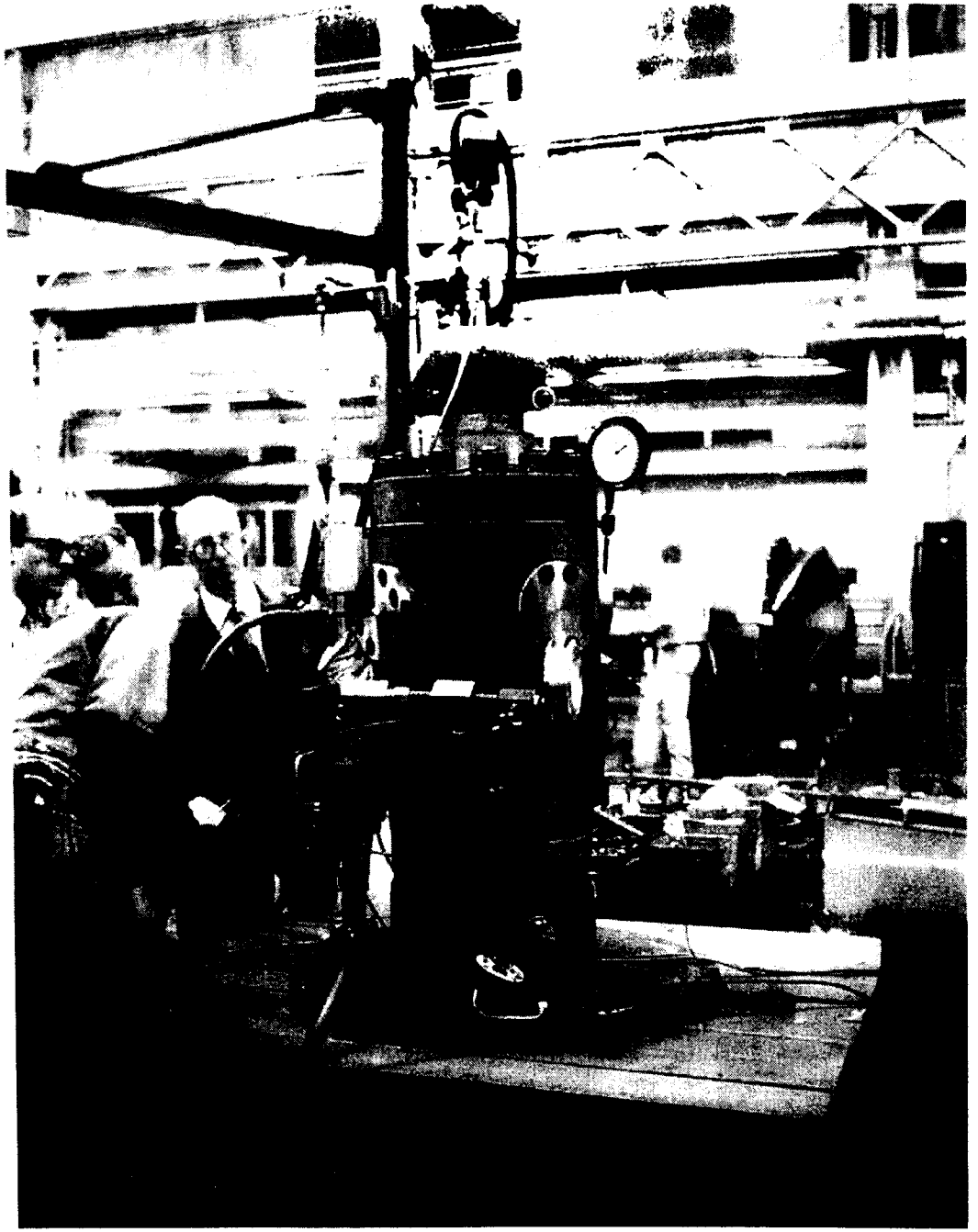
Early Autoshifting

In the early 1980's, Worthington's US operations decided to skip over manual shifting combination tool designs and go directly to an in-drum autoshifting design. A prototype was manufactured in 1983. After shop testing the tool, it was put in service in the field in the southern US.

As can be expected with such an undertaking, further refinement was necessary to give the tool the reliabilty and performance needed for a production model. Comparative nozzle tests were conducted in the field to improve the cutting hydraulics.



Worthington Autoshifting Tool Protype (1983 "R2D2")

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Development and Testing of Compact High Impact Nozzles

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A pair of second generation prototypes were produced in 1984. Shop testing showed a greatly enhanced shifting action over the first generation prototype. Both second generation protypes were put in the field for further testing.

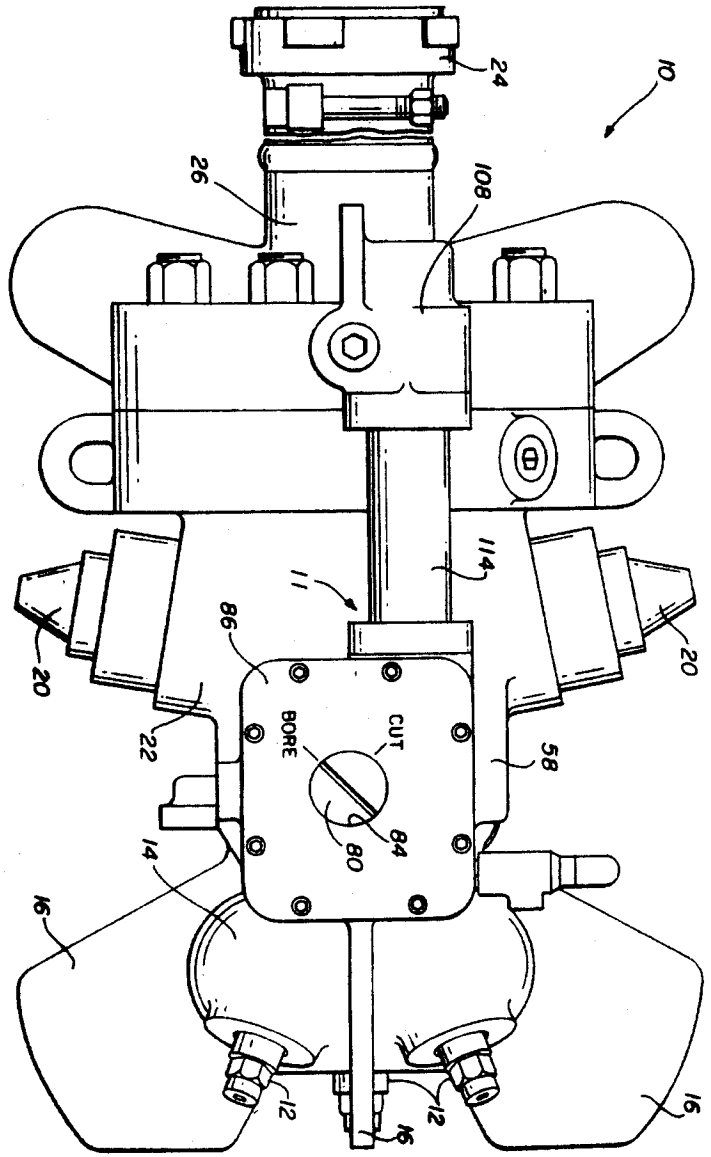

FIG. 1

Worthington Autoshifting Tool 1984

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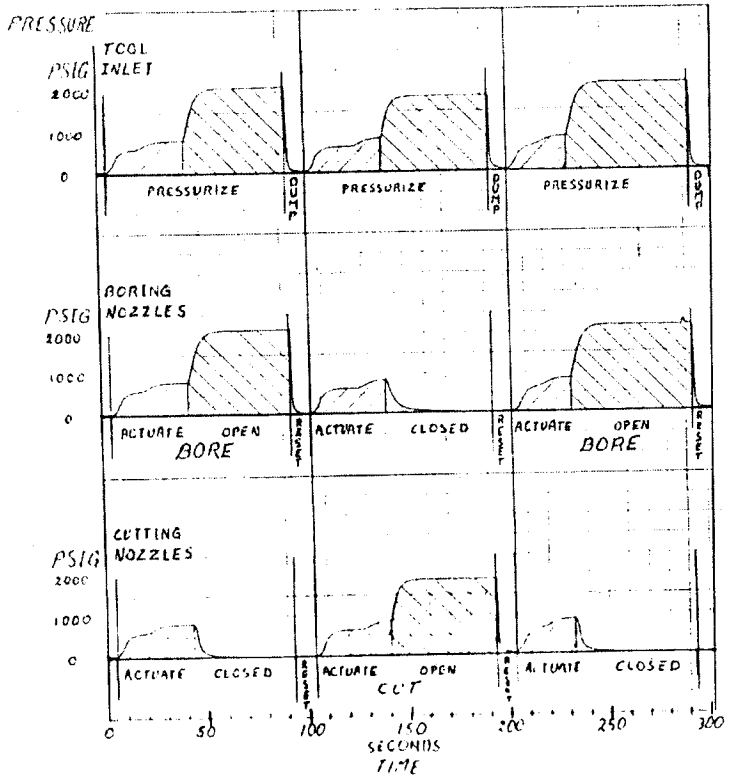
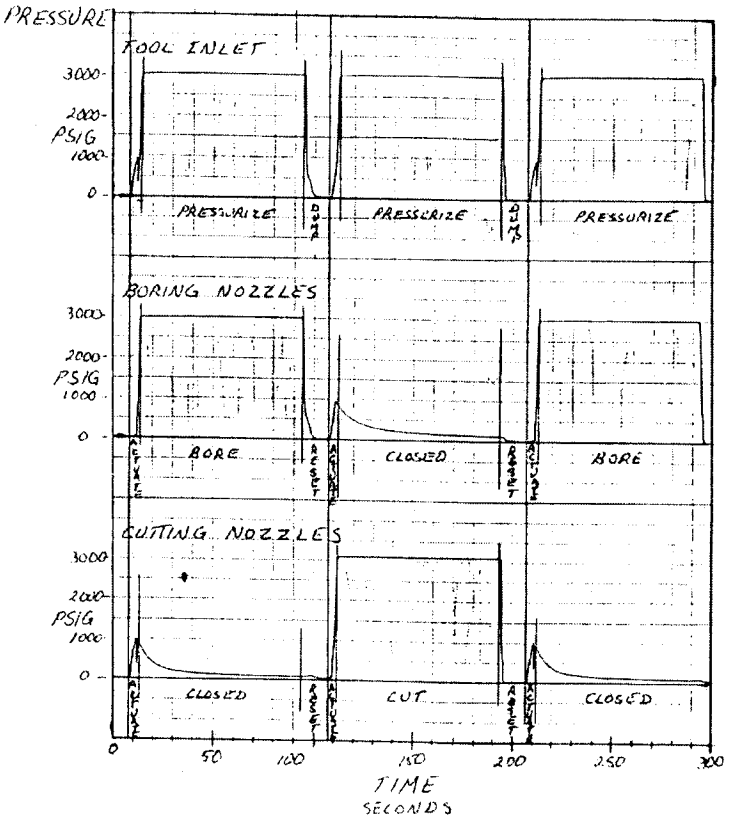
Evolution of Shifting Dynamics



COMBINED CUTTING TOOL
FUNCTIONAL TEST
MACK I
S/N 56-010293

DY-133935
HRD 6092

D Adams 11/16/83



COMBINED TOOL
FUNCTIONAL TEST
MACK II
S/N 56-010840

DX-132873
HRD 6092

D Adams 12/2/84

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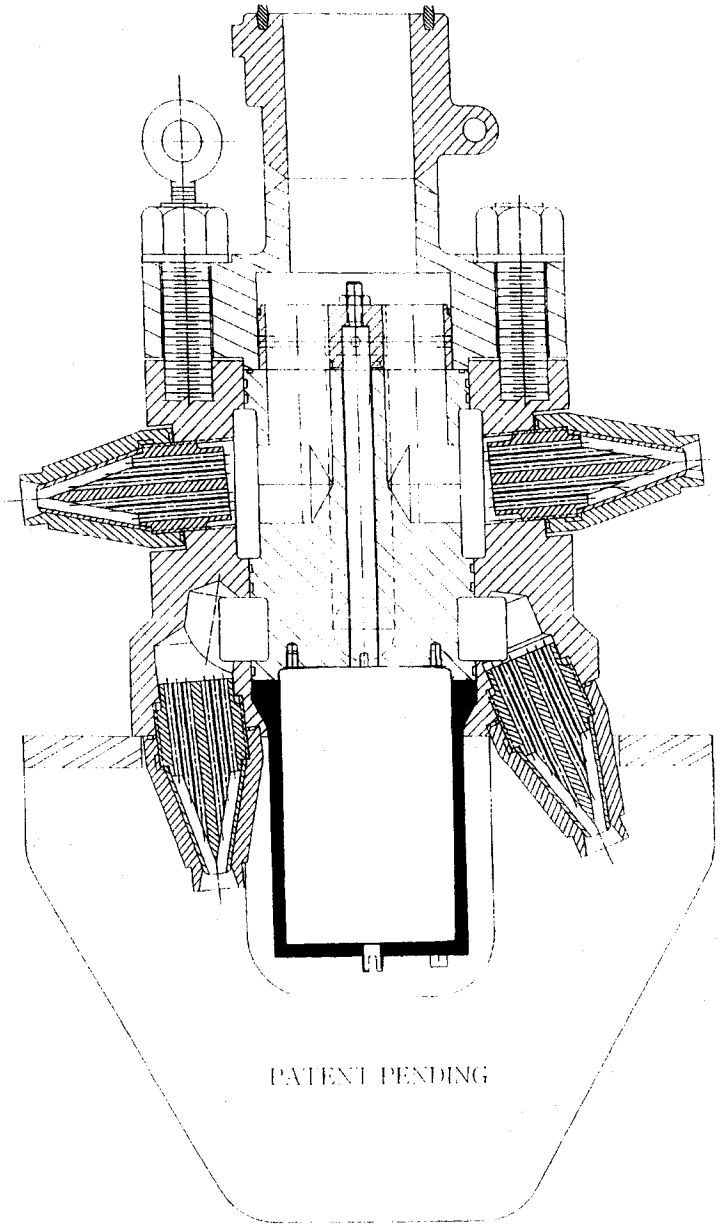
However when Worthington & Pacific merged in 1985, the Pacific combination tool had gained a significant field population. The idea of completing the development of a separate toolthan the Pacific on a completely different platform with the existing field population was not considered the best approach to bringing the concept to market.

Instead, in 2001, Flowserve set out to take the knowledge gained from the Worthington tool and use it to design a retrofit for the existing Pacific combination tool to upgrade it to an autoshifting tool. The prototype has now been completed and is in the testing stage.



Flowserve Autoshifting Tool (2003)

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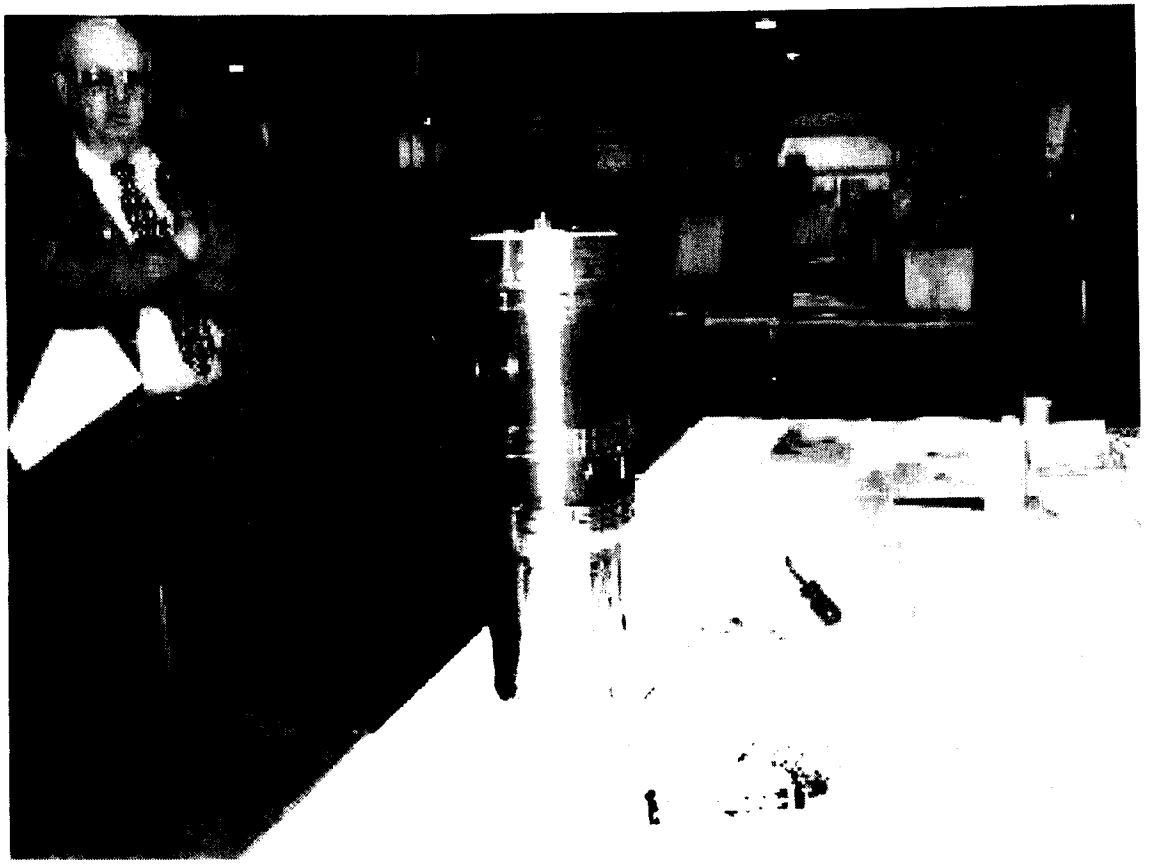

Autoshifting Tool Inner Element

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Features

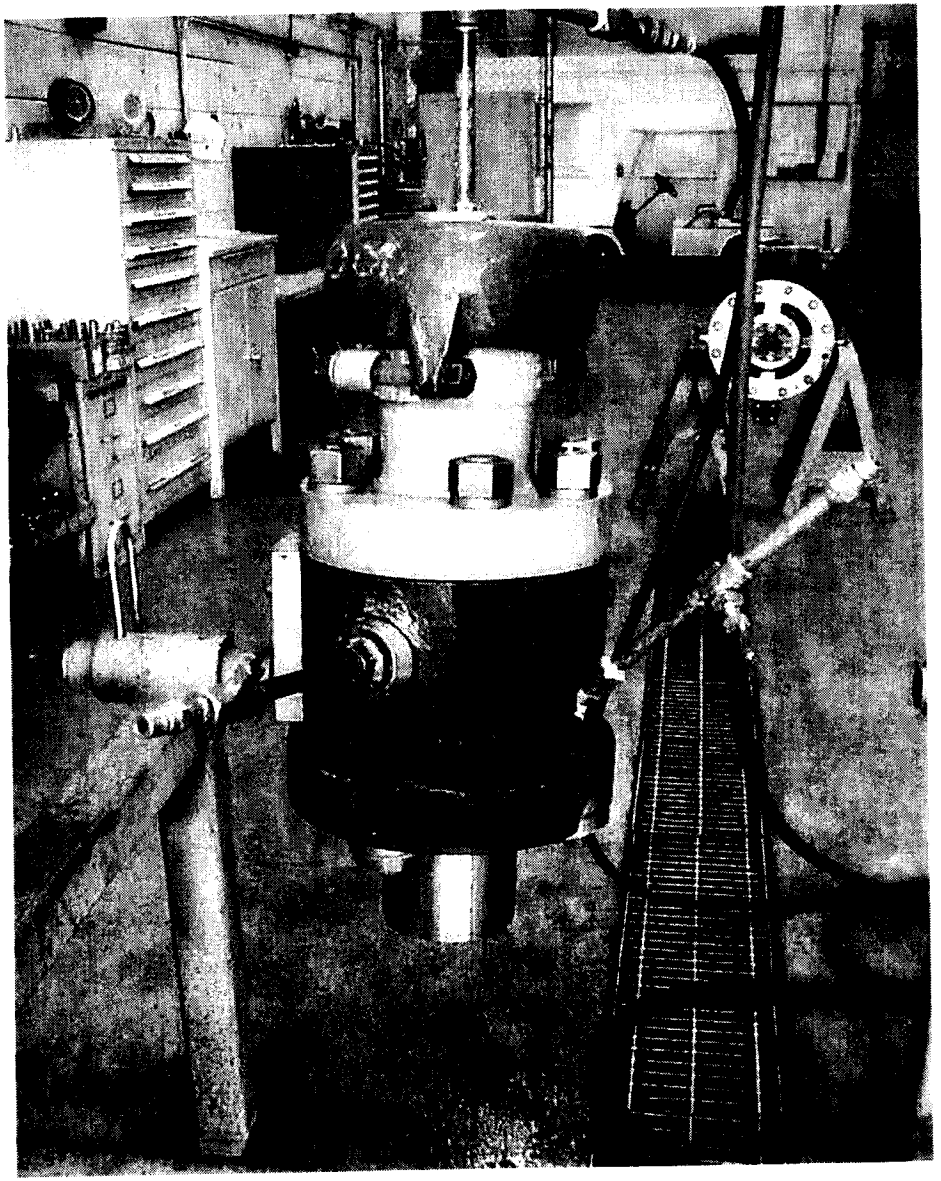
- Autoshifting assembly fits existing cutting tool platform with minimal rework.

- Shifting is actuated by pressure changes. Removal from the coke drum is not required.

- The shifting mechanism uses the current proven rotary shift design with some limited interchangeability.

- The autoshift can be manually over-ridden.

Autoshifting Testing



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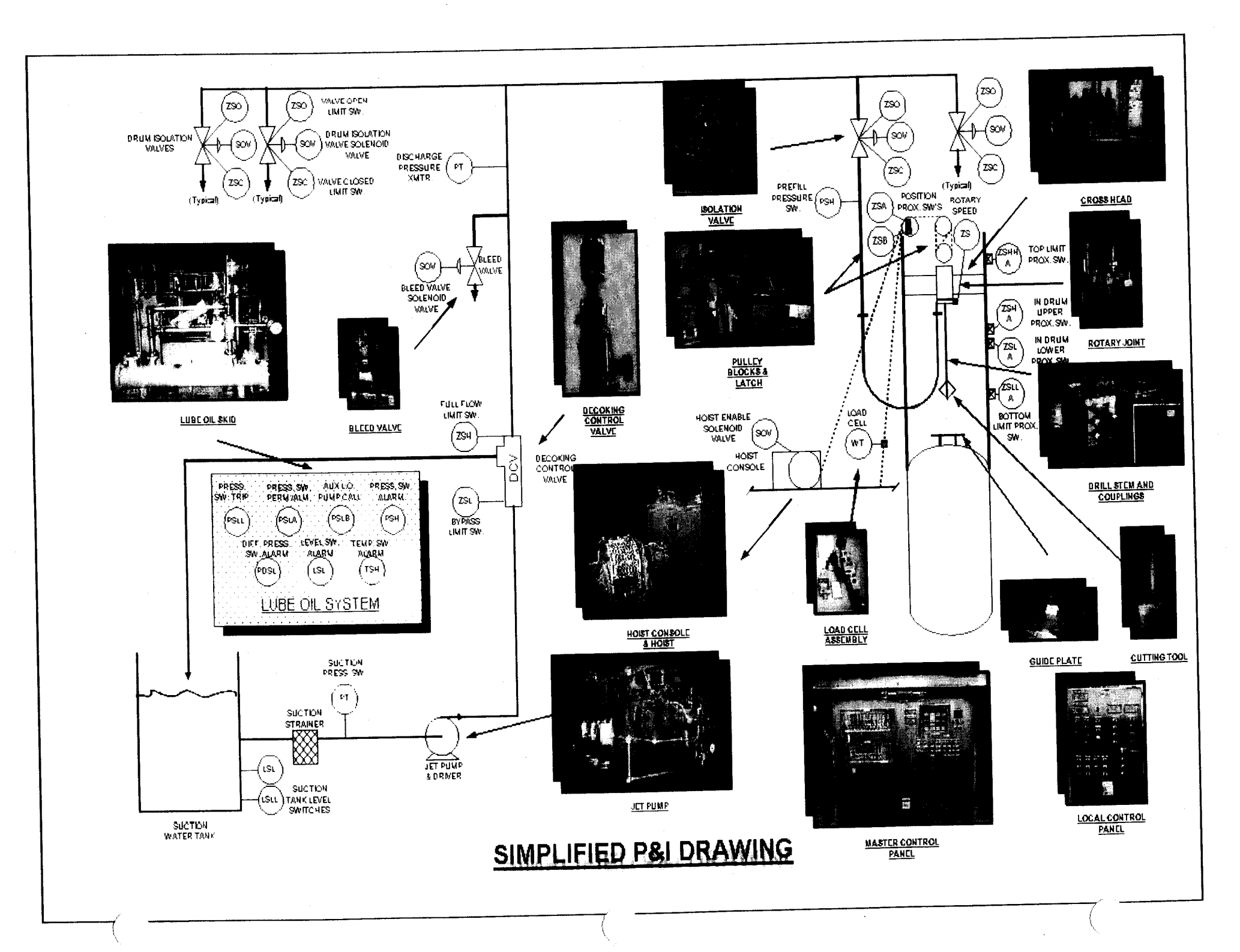
Flowserve
Applied Controls & Engineering
Decoking Permissive System

Presented By:

James Snowden & Rick DiCarlo

Applied Controls and Engineering

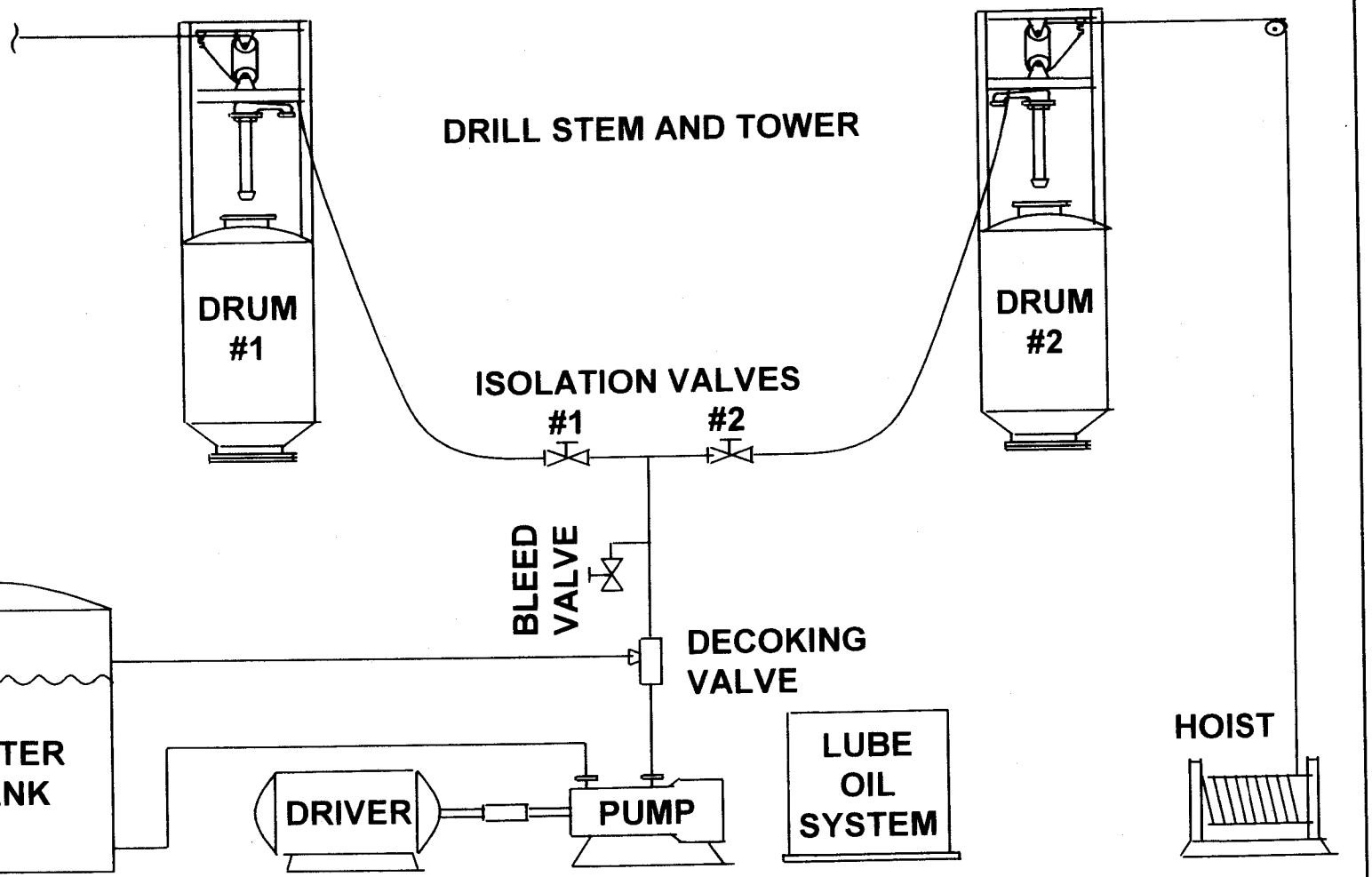


SIMPLIFIED P&I DRAWING

Introduction:

- Basic Purpose of the System is:
  - To Monitor the Jet Pump's Operation and Provide Permissive Starts, Alarms, and Shutdowns.
  - To Provide Drum Selection Interlocks by Controlling and Monitoring Isolation Valves.
  - To Monitor Drill Stem Position and Provide Assurance that the Selected Drill Stem is in the Drum Before Cutting can Commence.
  - To Provide Safety Interlocks and Prevent Removal of the Drill Stem from the Drum unless the Decoking Valve is in the Bypass Position and the Isolation Valves are Closed.
  - To Control the Decoking Valve's three positions.

Decoking System Overview:



Decoking System Overview: