

# **Procedures for Inspection, Maintenance, Repair, and Remanufacture of Drilling Equipment**

API RECOMMENDED PRACTICE 7L  
FIRST EDITION, DECEMBER 1995

EFFECTIVE DATE: APRIL 1, 1996



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**Exploration and Production Department**

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# Procedures for Inspection, Maintenance, Repair, and Remanufacture of Drilling Equipment

## 1 Scope

### 1.1 OBJECTIVE

The objective of this publication is to provide owners and users of equipment listed below guidelines for inspection, maintenance, repair, and remanufacture procedures that may be utilized to maintain serviceability of the covered equipment.

This recommended practice covers the following drilling equipment:

- a. Rotary tables.
- b. Rotary bushings.
- c. Rotary slips.
- d. Rotary hoses.
- e. Slush pump components.
- f. Drawworks components.
- g. Spiders not capable of use as elevators.
- h. Manual tongs.
- i. Safety clamps not used as a hoisting device.

### 1.2 PROCEDURE DEVELOPMENT

The owner or user, together with the manufacturer should jointly develop and update inspection, maintenance, repair, and remanufacture procedures consistent with equipment application, loading, work environment, usage, and other operational conditions. These factors may change from time to time as a result of new technology, equipment history, product improvements, new maintenance techniques, and change in service conditions.

### 1.3 PERSONNEL QUALIFICATIONS

Inspection, maintenance, and repair procedures should be carried out by personnel qualified by professional trade and verified by widely accepted or recognized standards covering the specific skills or knowledge required.

### 1.4 DOCUMENTATION

#### 1.4.1 Records

The equipment owner or user should maintain a record-keeping system that contains pertinent information regarding inspection equipment. Records may include the following:

- a. Information provided by the manufacturer.
- b. Inspection records.
- c. Maintenance records.
- d. Repair records.
- e. Remanufacture records.

#### 1.4.2 Identification

Unit serial number or identification marking provided by the manufacturer should be maintained on the equipment and recorded in the equipment record. Identification marking should be provided by the owner or user for unidentified equipment that required the maintenance of records.

#### 1.4.3 History

Changes in equipment status, which could affect equipment serviceability or maintenance, should be recorded in the equipment record.

#### 1.4.4 Record identification

Entries in the equipment record should include the date and the name of the responsible person(s) involved in the inspection, maintenance, repair, or remanufacture.

## 2 References

Unless otherwise specified, the most recent editions or revisions of the following standards, codes, and specifications shall, to the extent specified herein, form a part of this standard.

API

Spec 8A *Specification for Drilling and Production Hoisting Equipment*

IADC<sup>1</sup>

*Drilling Manual*

## 3 Definitions

For the purposes of this standard, the following definitions apply:

**3.1 critical area:** A highly stressed region of a primary load carrying component.

**3.2 equipment performance:** Operational capability of a piece of equipment relative to expected or predetermined parameters or standards.

<sup>1</sup>International Association of Drilling Contractors, P.O. Box 4287, Houston, Texas 77210.

**3.3 expendable parts:** Parts normally used up or consumed in service, such as seals, gaskets, filters, packing, covers, guards, breathers, drains, break/clutch linings, drive chains, dies, and miscellaneous hardware and fasteners.

**3.4 inspection:** Comparison of equipment conformity to predetermined standards, followed by a determination of action required.

**3.5 load test:** A procedure wherein a load is applied to verify the serviceability of equipment.

**3.6 maintenance:** Action, including inspection, adjustments, cleaning, lubrication, testing, and expendable parts replacement, necessary to maintain the serviceability of the equipment.

**3.7 manufacturer:** A term denoting individuals or companies, who make or process equipment or material for which API Standards have been or are being formulated.

**3.6 owner:** An individual, legal entity, or organization holding legal title to the equipment.

**3.9 primary load:** The primary load to which the equipment is subjected during normal operations, which results in stress to the critical areas.

**3.10 primary load carrying components:** Those components of the covered equipment through which the primary load is carried.

**3.11 remanufacture:** Actions performed on equipment that involve a special process or machining.

**3.12 repair:** Actions performed on equipment that involve replacement of parts (other than expendables), but exclude remanufacturing operations.

**3.13 serviceability:** The condition of a piece of equipment at any point in time that affects the ability of the equipment to perform its function(s) as intended.

**3.14 special process:** An operation that may change or affect the mechanical properties, including toughness of the materials used in equipment.

**3.15 testing:** Actions that are **carried** out on a piece of equipment to ensure that it can perform a required function.

**3.16 users:** A term denoting individuals or companies, who use equipment or material, or implement recommended practices.

## 4 Inspection

### 4.1 INSPECTION CATEGORIES

#### 4.1.1 Category I

Observation of equipment during operation for indications of inadequate performance.

#### 4.1.2 Category II

Category I inspection, plus further inspection for corrosion, deformation, loose or missing components, deterioration, proper lubrication, visible external cracks, and adjustment.

#### 4.1.3 Category III

Category II inspection, plus further inspection, which should include nondestructive examination (NDE) of exposed critical areas and may involve some disassembly to access specific components, and identify wear that exceeds the manufacturer's allowable tolerances.

#### 4.1.4 Category IV

Category III inspection, plus further inspection where the equipment is disassembled to the extent necessary to conduct NDE of all primary load carrying components as defined by the manufacturer.

### 4.2 FREQUENCY

The owner or user of the equipment should develop his own schedule of inspections based on experience, manufacturers recommendations, and consideration of one or more of the following factors: environment, load cycles, regulatory requirements, operating time, testing, repairs, and remanufacture.

### 4.3 RESULTS OF INSPECTION

#### 4.3.1 Acceptance Criteria

Acceptance criteria should be established based on experience and manufacturer's recommendations. Worn equipment that does not meet acceptance criteria should not **be** accepted for operation at reduced load unless an analysis is made in accordance with the governing API Equipment **Spec**ification, or by the manufacturer if no API Specification exists.

#### 4.3.2 Rejected Equipment

Rejected equipment should be marked and removed from service for further evaluation or until deficiencies are corrected.

### 4.4 RECORDS

Records of Category III and Category IV inspections should be entered in the equipment record. Testing related to or indicating the load carrying capacity of the equipment should be entered in the equipment record.

## 5 Maintenance

### 5.1 PROCEDURES

In addition to the procedures developed in accordance with 1.2, the manufacturer should define any special tools,

materials, measuring or inspection equipment, and personnel qualification necessary to perform the maintenance procedures. The manufacturer should also specify those procedures that should be performed solely by the manufacturer's representative, within the manufacturer's facility or by other qualified facilities.

## 5.2 METHODS

Maintenance actions may include any of the following: inspections, adjustments, cleaning, lubrication, testing, and parts replacement.

## 5.3 CRITERIA

Maintenance actions may be initiated based on, but not limited to, one or more of the following criteria: specific time intervals, measurable wear limits, load cycle accumulation, nonperformance of equipment, environment, experience (history), regulatory requirements, and other measurable limits.

## 5.4 RECORDS

Maintenance activities involving the replacement of any primary load carrying component should be entered in equipment record. Testing related to or indicating the load carrying capacity of the equipment should be entered in the equipment record.

# 6 Repair

## 6.1 PROCEDURES

Manufacturers should provide adequate inspection criteria to allow the equipment owner or user to identify the nature of repairs that may be required. If repairs are not performed by the manufacturer, they should be performed using methods or procedures established in accordance with 1.2.

## 6.2 SURFACE INDICATIONS

Surface indications identified by NDE may be allowable or nonallowable, depending on the size, shape, and location as defined by the manufacturer.

### 6.2.1 Allowable Surface Indications

Allowable surface indications are surface indications of size, shape, and location that need not be removed.

### 6.2.2 Nonallowable Surface Indications

Nonallowable surface indications may be classified as follows:

a. **minor surface indications:** Minor surface indications may be removed by a limited degree of filing or grinding within limits specified by the manufacturer. Caution should be exercised to prevent heating to an extent that could change the mechanical properties, including toughness, of the material.

b. **major surface indications:** Major surface indications, which require material removal beyond the limits specified by 6.2.2.a, should be corrected by remanufacture.

## 6.3 BEARINGS

Bearings play an important part in the serviceability of equipment. The most likely causes for bearing replacement are: loose or bent cages (rolling element retainers); corrosion, abrasion, lubrication problems; and spalling from fatigue. Internal clearance in excess of manufacturer's allowance may indicate improper adjustment or assembly, which should be corrected. Repair of antifriction bearings should not be attempted by field or shop personnel. Consultation with the equipment manufacturer is recommended in the event of unexplained or repeated bearing failure.

## 6.4 REPLACEMENT PARTS

Replacement parts should meet or exceed the original equipment manufacturer's criteria.

## 6.5 RECORDS

Entries describing all repair activity, with the exception of those under 6.2.1 and 6.2.2.a should be included in the equipment record.

# 7 Remanufacture

## 7.1 PROCEDURES

Remanufacture of equipment should be performed using methods and procedures developed in accordance with 1.2. Equipment found to be unsuitable for remanufacture should be destroyed.

## 7.2 VERIFICATION

Following remanufacture, a load test or NDE should be performed to verify the serviceability of the equipment.

## 7.3 RECORDS

Entries describing all remanufacture activity should be included in the equipment record.



## APPENDIX A-RECOMMENDED PRACTICE FOR CARE AND USE OF ROTARY HOSE

Note: Where applicable, the following recommended practices should also be used for vibrator hose.

### A.1 Hose Length

In order to avoid kinking of hose, the length of hose and height of standpipe should be such that while raising or lowering, as in making mousehole connections, the **hose** will have a normal bending radius at the swivel when the hose is in its lowest drilling position and at the standpipe when the hose is in its highest drilling position. The recommended length of **hose** is given by the following equation (see Figure A-1).

$$L_H = \frac{L_T}{2} + \pi R + S \quad (\text{A-1})$$

Where:

- $L$  = length of hose, ft (m).
- $L_T$  = length of hose travel, ft (m).
- $R$  = minimum radius of bending of hose, ft (m).
  - = 3 ft (0.9 m) for 2-in. hose.
  - 4 ft (1.2 m) for 2½ and 3-in. hose.
  - 4½ ft (1.4 m) for 3½ in. hose.
- $s$  = allowance for contraction in  $L_H$  due to maximum recommended working pressure, ft, which is 1 ft (0.3 m) for all sizes of hose.

### A.2 Standpipe Height

The recommended standpipe height is given by the following equation (see Figure A-1).

$$H_S = \frac{L_T}{2} + Z \quad (\text{A-2})$$

Where:

- $H_S$  = vertical height of standpipe, ft (m).
- $L_T$  = length of hose travel, ft (m).
- $Z$  = height, ft, from the top of the derrick floor to the end of hose at the swivel when the swivel is in its lowest drilling position.

Note: When the actual length of hose is greater than the length calculated in A.1, the standpipe height should be increased by one-half the difference between the actual length and the calculated length.

### A.3 Hose Connections

The threaded connection on rotary hose is capable of handling the rated pressure and should not be welded to its connector as this will damage the hose. The connections

between the rotary hose, standpipe, and swivel should be consistent with the design working pressure of the system. The connections attaching the hose to the swivel and to the standpipe should be as nearly tangential as possible. The use of a standard connection on the swivel gooseneck (see Section 5 of API Specification 8A) will ensure this relationship at the top of the hose. It is recommended that a 180-degree gooseneck be used on the standpipe connection if the standpipe is vertical. A 160-degree gooseneck should be used if the standpipe has the same slope as the derrick leg.

### A.4 Handling

In order to minimize the danger of kinking, the hose should preferably be removed from its crate by hand, laid out in a straight line, then lifted by means of a **catline** attached near one end of the hose. If a **catline** is used to remove the hose from its crate, the crate should be rotated as the hose is removed. The use of a carrier to protect the hose in moving to a new location is recommended practice. It is considered bad practice to handle hose with a winch, to hang the hose from a truck gin pole, or to place heavy pieces of equipment on the hose.

### A.5 Twisting

Hose should not be intentionally back twisted. Twisting is sometimes employed to force the swivel bail out of the way. This places injurious stresses in the structural **members** of the hose body, because one spiral of reinforcing wires is opened and the other is tightened, thus reducing the resistance of the hose to bursting and kinking. In order to prevent twisting, it is suggested that a straight swivel be installed on one end of the hose. Each length of hose has a longitudinal lay line of a different color than the hose cover. This should be used as a guide in making certain the hose is installed in a straight position.

### A.6 Clearance

The hose installation should be such as to give adequate clearance between the hose and the derrick or mast.

### A.7 Safety Chain

All rotary hose and all vibrator hose 8 feet (2.4 meters) or longer shall have Safety Clamps installed at the locations specified in Spec 7K, but such clamps will not necessarily

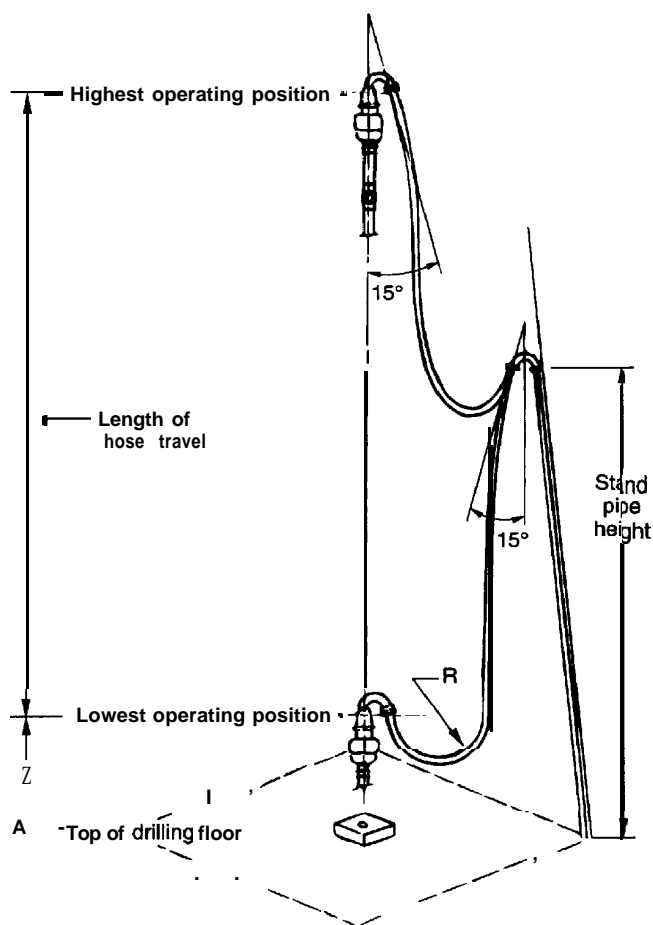


Figure A-1 -Layout for Rotary Hose

be installed by the hose manufacturer. The hose manufacturer shall mark the hose as specified in **Spec 7K** to indicate the location at which **Safety Clamps** shall be installed. The **Safety Clamps**, **Clevis**, and **Chain** shall be installed. The **Safety Clamps**, **Clevis**, and **Chain** shall have a minimum breaking strength of 16,000 pounds (7264 kilograms) and the clamp shall incorporate a  $1\frac{1}{8}$  in. (28.6 millimeters) minimum diameter hole for attaching **clevis/chain** and will be so designed as to allow adequate clearance from the hose. The clamp should be of the proper size, and should be tightened securely but not to such extent as to injure the hose or reduce the inside bore diameter. In the case of rotary hose, the safety chain should be attached to a derrick upright at the standpipe end, rather than a transverse girt, so that the chain will be free to move upward, without restricting the movement of the hose, should the traveling block be raised too high.

## A.8 Vibration and Pulsation

Continual flexing is injurious to rotary hose and reduces its service life. Surge chambers and pulsation dampeners of the proper size should be used in the mud line after the pumps to minimize vibration in the mud lines and hose. The pulsation dampener should be set at 10 percent of the maximum pump pressure. The lines on the suction side of the pump should be **precharged** or operated with a flooded suction. The use of a suction hose is recommended to minimize pulsation.

## A.9 Working Temperature

Working temperature should not exceed 180°F (82°C). High temperatures in combination with abrasive conditions such as encountered in gas or air drilling should be avoided.

## A.1 0 Working Pressure

The recommended maximum working pressure for rotary hose is one-half ~~the~~ specified test pressure. Working pressure includes the pressure surges that occur in the system. See A.8, Vibration and Pulsation.

## A.11 Oil Base Muds

The use of oil base muds having an excessively high aromatic content will cause the hose inner liner to swell and shorten its service life. It is recommended that oil base muds be held to a minimum aniline point of 150°F (66°C).

## A.12 Barge Attended Offshore Rigs

Where rotary hose is used as a flexible line between barges and offshore drilling rigs, care must be used so the hose is in alignment between both end connections. It is recommended that swivel joints be used at both ends. Drilling in rough weather and high seas resulting in abnormal flexing and jerking of the hose will cause premature failures.

## A.1 3 Field Test Pressure

Field testing of rotary hose, when required for establishing periodic safety levels of continued operation, should be conducted with these factors as a guide:

- a. Visual inspection should include examination of any external damage to the body, end structure, and couplings. Safety chain should be checked and properly attached for complete safety compliance.
- b. All back twist (see A.5) must be avoided.
- c. Hose to be suspended in normal unstressed position from standpipe to swivel.

d. Rate of pressure rise not less than 1,000 pounds per square inch (6.9 megapascals) nor greater than 10,000 pounds per square inch (68.9 megapascals) per minute.

e. Permissible test medium: mud, oil, or water with precaution that all air be bled off.

f. Duration of test pressure limit not to exceed 10 minutes.

g. Field test pressure not to exceed 1.25 times the maximum rated working pressure.

h. Field testing to be conducted under full responsibility of user.

Note: Because of the manufacturer's trend to higher test pressures on delivery (in excess of 5,000 pounds per square inch [34.5 megapascals]) it should be understood that **field** testing recommendations are limited to a maximum test pressure of 1.25 times ~~the~~ maximum **rated** working pressure, regardless of the delivery test pressure involved.

## A.1 4 Operating Limits

Operating personnel should be advised as to the highest and lowest drilling positions, length of standpipe, and so forth, for which the hose was selected, and drilling operations should be carried out within such limits.

## A.1 5 Aftercoolers

Air or gas compressors should always be equipped with aftercoolers to lower the temperature to tolerable limits. When aftercoolers are not used, air or gas entering the hose is at excessively high temperature. The hose inner liner is aged at an accelerated rate, thus reducing resistance to abrasion.

Note: When used hoses are recoupled, or when used rotary drilling hoses are cut and recoupled to make vibrator hoses, the API monogram and the original manufacturer's label shall be removed.

## APPENDIX B-RECOMMENDED PRACTICE FOR SLUSH PUMP NOMENCLATURE AND MAINTENANCE

### B.1 Slush Pump Maintenance

The International Association of Drilling Contractors Sections J3, J4, J5, and J6, establish maintenance practices for assistance in solving fluid end problems. The ***Drilling Manual*** is available from The International Association of Drilling Contractors, P. O. Box 4287, Houston, Texas 77210.

### 8.2 Slush Pump Nomenclature

The intent is to standardize nomenclature for principle parts of slush pumps, but not including a relatively small number of associated parts. This will provide a common language for the industry, to be particularly valuable for communications.

### 8.3 Old Designs

This language is to be used for old pumps as well as newly designed pumps even though the manufacturer's literature might not be consistent with the standard. Manufacturers are expected to comply with this standard on newly designed pumps. For old designs, their literature should be

made to comply when it is opportune to do so. In communications between user and manufacturer, the part number must be used as positive identification where nomenclature inconsistencies occur.

### B.4 Types

The type pumps included in this nomenclature standard are duplex and triplex power slush pumps.

### B.5 Designation

Power end (Table B- 1 and Figures B- 1, B-2, and B-3) and fluid end parts (Table B-2 and Figure B-4, and Table B-3 and Figure B-5) will be grouped in separate categories. Right- and left-hand parts for all groups will be determined by the same rule. The rule is: when standing at the power end and looking over the power end toward the fluid end, those parts to the right of the centerline are designated as right hand when needed to differentiate from other like parts; and, similarly, those to the left are designated as left hand. For triplex pumps, those parts on the centerline needing differentiation from like parts are designated center.

Table B-1 -Power End Parts, Duplex and Triplex Pumps

Part No.	Description	Part No.	Description	Part No.	Description
101	Frame	106	Connection Rod <sup>a</sup>	111	Crankshaft Bearing Housing <sup>a</sup>
102	Crankshaft	107	Crosshead <sup>a</sup>	112	Pinion Shaft Bearing
103	Main Gear	108	Crosshead Pin <sup>a</sup>	113	Crosshead Pin Bearing <sup>a</sup>
104	Pinion	109	Connecting Rod Bearing	114	Crosshead Extension Rod (Pony)
105	Pinion Shaft	110	Crankshaft Bearing (Main)	115	Crosshead Extension Rod Wiper

<sup>a</sup> Exact location of these parts designated as right, or left, and center if for triplex pump.

Table B-2—Fluid End Parts, Duplex Pumps

Part No.	Description
101	Fluid End-When Fluid End is sectionalized, refer to Right or Left.
102 <sup>a</sup>	Cylinder Head
103 <sup>a</sup>	Cylinder Head Cover
104 <sup>b</sup>	Valve Cover
105 <sup>b</sup>	Valve Guide
106 <sup>b</sup>	Valve Spring
107 <sup>b</sup>	Valve Seat
108 <sup>a</sup>	Liner
109 <sup>a</sup>	Liner Packing
110 <sup>a</sup>	Piston
111 <sup>a</sup>	Piston Rod
112 <sup>a</sup>	Stuffing Box
113 <sup>a</sup>	Junk Ring
114 <sup>a</sup>	Stuffing Box Packing
115 <sup>a</sup>	Gland
116 <sup>c</sup>	Gland Nut

Note: For further detailed nomenclature see *IADC Drilling Manual*.

<sup>a</sup> Exact location of these parts designated as right or left.

<sup>b</sup> Exact location of these parts designated as right or left, or when more convenient, the *IADC Drilling Manual* numerals may be used.

Table B-3—Fluid End Parts, Triplex Pumps

Part No.	Description
101	Fluid End-When Fluid End is sectionalized, refer to Right, Left, or Center.
102 <sup>a</sup>	Valve Cover
103 <sup>a</sup>	Valve Guide
104 <sup>a</sup>	Valve Spring
105 <sup>a</sup>	Valve Seat
106 <sup>b</sup>	Liner
107 <sup>b</sup>	Liner Packing
108 <sup>b</sup>	Piston
109 <sup>b</sup>	Piston Rod
110 <sup>b</sup>	Liner Spray

Note: For further detailed nomenclature see *IADC Drilling Manual*.

<sup>a</sup> Exact location of these parts designated as right, left, or center; or when more convenient, the *IADC Drilling Manual* numerals may be used.

<sup>b</sup> Exact location of these parts designated as right, left, or center.

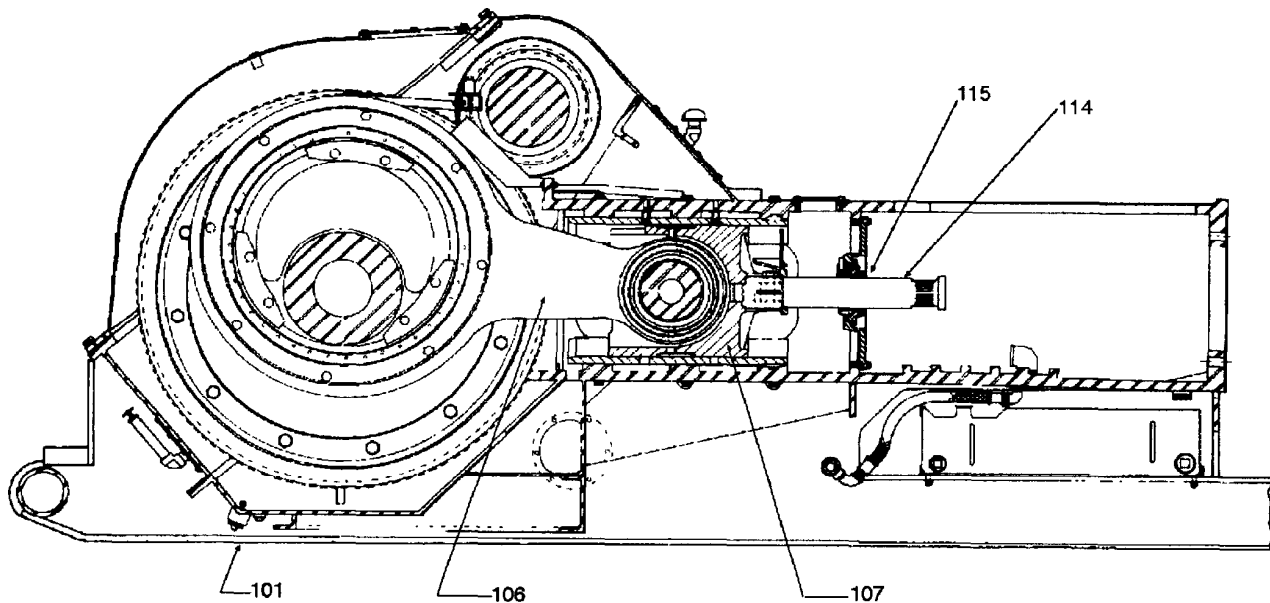


Figure B-1--Section Through Power End  
(See Table B-1)

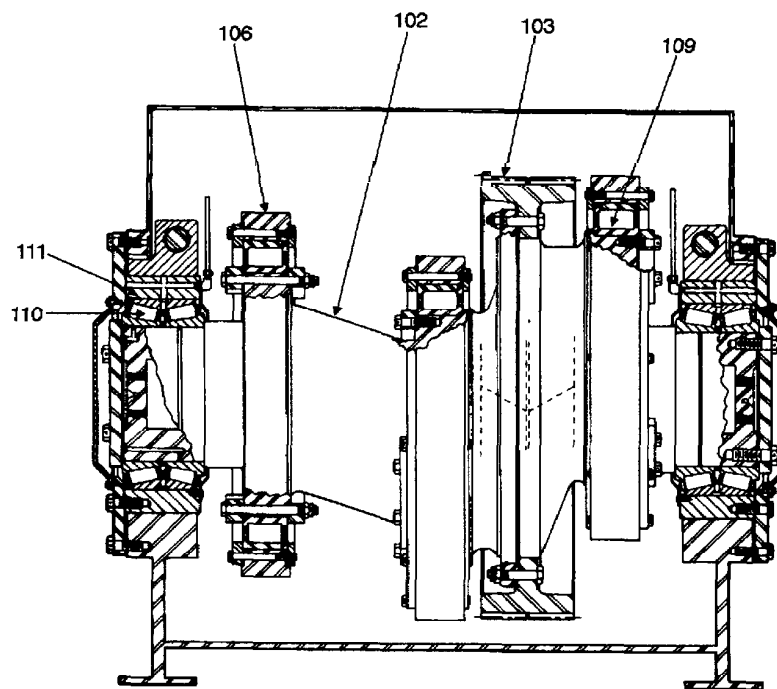


Figure B-2—Section Through Crankshaft  
(See Table B-1)

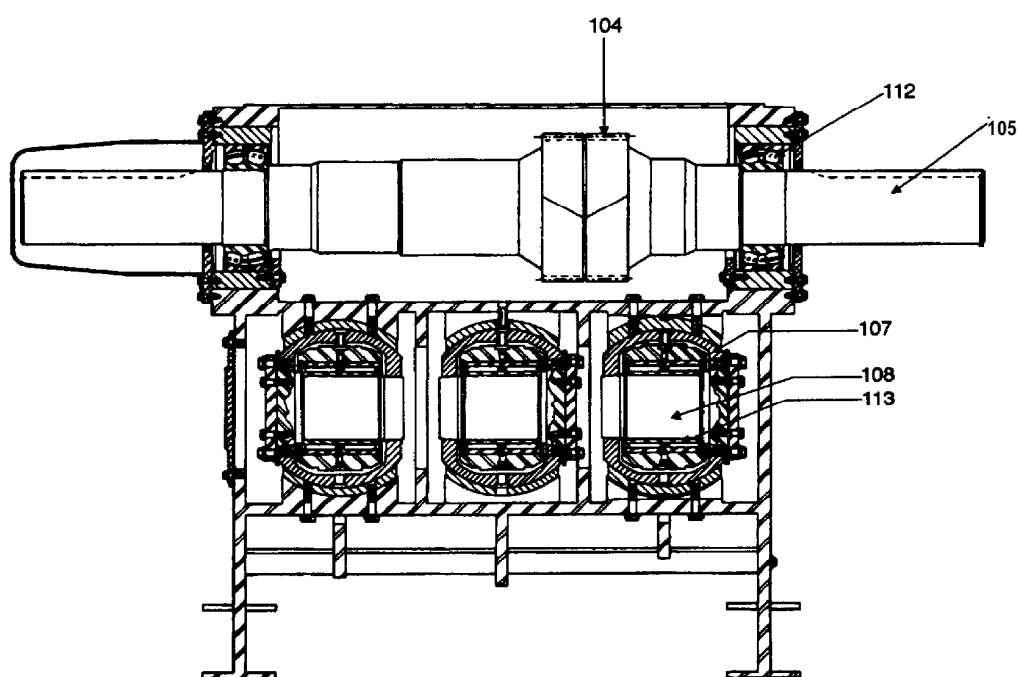


Figure B-3—Section Through Pinion Shaft and Crossheads  
(See Table B-I)

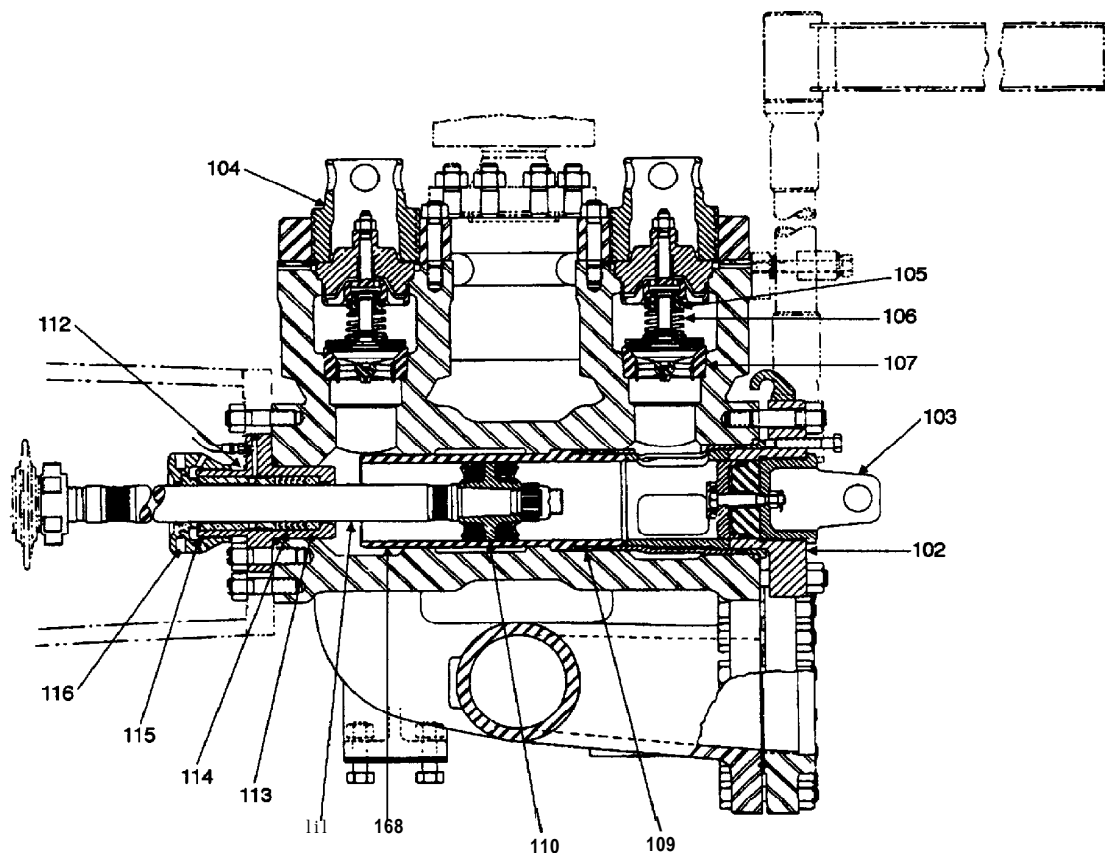


Figure B-4—Fluid End of Duplex Double Acting Mud Pump  
(See Table B-2)



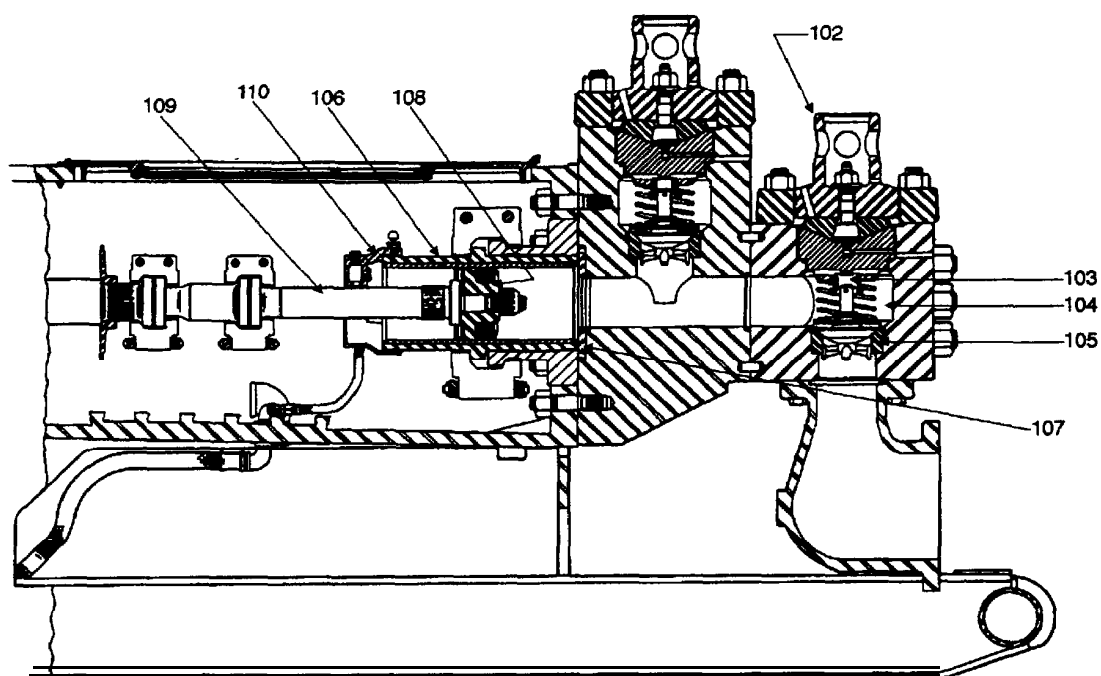


Figure B-5—Fluid End of Triplex Single Acting Mud Pump  
(See Table B-3)

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