

STATE OF DELAWARE
UNIVERSITY OF DELAWARE
DELAWARE GEOLOGICAL SURVEY

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PART I

OPERATIONS MANUAL
UNIVERSITY OF DELAWARE
DRILLING RIG

BY
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NEWARK, DELAWARE
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OPERATIONS MANUAL
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by

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Delaware Geological Survey

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FOREWORD

This manual has been prepared to promote safe, efficient use of a research tool that is of great importance in Delaware. It has been written in three parts; only the first appears between these covers. Parts II and III deal with technical aspects of the operation and maintenance of the equipment and are of principal interest within the DGS. They will not be distributed, but will be retained on open file and are available for consultation at the offices of the DGS.

NOTE: This manual refers specifically to the University of Delaware Drilling Rig which is:

Manufacturer: Central Mine Equipment Co.
Model: CME-55
Serial Number: 34775
Year: 1967
Power Unit: Ford D-172
Serial Number: 16895-T9KH
Engine type: B8PD-6002-BE

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PART I
POLICIES AND PROCEDURES

OPERATIONS MANUAL
UNIVERSITY OF DELAWARE DRILL RIG

Roland E. Bounds

MANAGEMENT POLICIES

Purpose and Usage of the Drill Rig

The University drill rig is a research tool, and should be used principally to support geologic and hydrologic research at the University, particularly that of the Delaware Geological Survey (DGS). Piezometers may be installed for obtaining water levels and water quality samples, but the rig cannot be used for drilling water supply wells.

Requests by University departments, State or local agencies, corporations, or individuals, to use the equipment for exploration or monitoring of ground water or mineral resources, or in support of geologic research, will be evaluated by Robert R. Jordan, Director, DGS, on the basis of the contribution this exploration can make to the overall programs of the University and the DGS. If exploratory drilling is approved, the department, agency, corporation, or individual, shall bear the operating costs.

Drilling will not be conducted in environmentally or otherwise unsafe areas such as on hazardous or toxic waste sites. All applicable permitting and safety procedures must be followed.

The information contained in this Manual has been reviewed and is complete and correct to the knowledge of the DGS at the time it is issued. Users are reminded to check with the DGS for any changes that may be made to update the manual.

Personnel and Responsibilities

The drill rig is assigned to the Water Resources Center (WRC) of the University of Delaware, Robert D. Varrin, Director. The management and operational decisions relating to the drill

rig, including arrangements for drilling and assignment to projects, technical and maintenance procedures, and record-keeping, are the responsibility of Robert R. Jordan, DGS Director and State Geologist.

Operation and maintenance of the rig and ancillary equipment are the responsibility of the DGS Senior Field Technician, Roland E. Bounds, who reports to Robert R. Jordan. The Senior Field Technician must be a licensed well driller in the State of Delaware (Department of Natural Resources and Environmental Control, "Regulation for Licensing Water Well Contractors, Pump Installer Contractors, Well Drillers, Well Drivers and Pump Installers") and have a Class B driver's license (Delaware Division of Motor Vehicles, Drivers Manual). The Senior Field Technician shall keep written records of vehicle operations (mileage, fuel, maintenance, etc.) and drill rig operations (hours, footage, repairs, etc.), and shall provide weekly reports to the Director, DGS, who shall transmit monthly reports to the Director, WRC.

Fees for Drilling Operations

Funds received are used for maintenance and replacement of the equipment. Funding is handled through the WRC drill rig account. The following fee schedule became effective August 1, 1980 but is subject to change. Prospective users may contact the Director, DGS, at 451-2833 to obtain current rates.

- (1) \$1.50/foot for auger or rotary drilling.
- (2) \$7.00/split spoon or Shelby tube sample (>50% recovery).
- (3) \$10.00/foot for diamond or carbide coring.
- (4) \$0.50/mile for drill rig mobilization and demobilization.
- (5) Supplies (drilling mud, concrete, gravel pack, casing, etc.) can be furnished at cost by advance arrangement with the Senior Field Technician.
- (6) Drilling assistants may sometimes be available at hourly rates determined by the University.

State Laws and Regulations

All operations must be conducted in accordance with applicable laws and regulations: Regulations of Water Resources (Chapter 60 of Title 7, Delaware Code); Regulation for Licensing

Water Well Contractors, Pump Installer Contractors, Well Drillers, Well Drivers and Pump Installers, and, where applicable, the Geologists Registration Act (Chapter 36 of Title 4, Delaware Code). Additional information is available from the Water Resources Section of the DNREC (Philip J. Cherry, 736-3686) and the State Board of Registration of Geologists (Vivian Murphy, 571-3286).

User Responsibilities

It shall be the responsibility of all persons concerned with drilling operations to be familiar with the contents of this operations manual. Use of the drill rig should be requested through the Director, DGS, by using a letter similar in form to that found in Appendix A: Generalized Letter for Drill Rig Usage Request. Sufficient advance notice must be given to permit arrangements to be made and any necessary information regarding drilling locations and plans must be provided. A means for payment must also be established to reimburse expenses associated with rig operations. The user, and all others involved with drilling, must sign the Drill Rig Safety Training Certification Sheet (see Appendix F) or already have one on file at the DGS before drilling can commence.

DRILL SITE SELECTION AND CLEARANCES

Site Selection

Safe access to the drilling site is the major factor affecting site acceptability. The drill rig is mounted on a large (gross weight 15 tons) six-wheel truck which is 8 feet wide and 12 feet high when the drilling mast is in the traveling position (when up, the mast and truck combination is nearly 25 feet high). A careful watch must be kept to avoid restricted height, width, and weight obstacles.

Soft, slippery, and excessively rugged terrain also must be avoided to prevent getting stuck, or damaging the frame or suspension of the truck. Normally, these conditions are cause for site rejection in the original evaluation by the Senior Field Technician. If the site is approved and the vehicle gets stuck, it is the user's responsibility to pay the necessary towing costs or provide suitable help and equipment for safe

extraction. To avoid this additional cost, the Senior Field Technician should be contacted to evaluate each site for accessibility before proceeding to further clearances.

Permission to Work

Following the preliminary site evaluation by the Senior Field Technician, several levels of additional clearance are required. Drilling will usually be done on public property such as Delaware Division of Highways right-of-way or other State property. However, this is not always the case. Therefore, the necessary clearance procedures will depend upon site ownership.

Written permission must be received before drilling on any property. It is the responsibility of the user to obtain written permission from land owners, other than Division of Highways, with a signed copy of a letter similar to that found in Appendix B: Generalized Site Access Permission Letter. The DGS will obtain the necessary Division of Highways clearances from the appropriate district engineers:

- a. North District - J. Lutrzykowski 323-4485
- b. Central District - J. J. Schuh 736-4219
- c. South District - A. Redden 856-5200

In projects involving piezometer installation on Division of Highways right-of-way, it may be necessary for the Senior Field Technician to obtain a Permit for Construction on Right-of-Way from the appropriate district office. In all cases, DGS responsibility may be specifically delegated to outside units or individuals with the approval of the Director, DGS.

DNREC Permits

After receiving written permission to drill from the appropriate landowner, it is necessary to obtain a well drilling permit if a piezometer is going to be installed. Blank permits can be obtained from the DNREC Water Supply Section in Dover. There is a \$50.00 per project filing fee. For such permits to be processed, they must be filled out accurately and completely. The permit applications will be checked by the Senior Field Technician prior to being submitted to DNREC, to make sure proposed construction coincides with current regulations. The

user will then file the permits along with the necessary fee, unless other arrangements have been made. A DNREC permit is required only when a piezometer is to be installed.

An example of a DNREC Application For A Permit To Drill A Well is provided in Appendix C. The ownership designated on the permit and the completion report (see Appendix D) should coincide with the user requesting rig use. Only for DGS projects should the DGS be listed as the owner.

For DGS projects, operation and maintenance will be the responsibility of designated DGS personnel until the test holes or piezometers are abandoned in an approved manner. For non-DGS projects, all DGS responsibility ends with completion of the test holes or piezometers. The contracting unit (user) will then assume ownership of the test hole or piezometer and will have the responsibility for disposition of same.

Utility Clearance

The need for utility clearance is important for several reasons: it protects personnel from contact with dangerous equipment, it protects the utility's equipment from damage, and may assign responsibility if something is damaged. Initial observations of overhead utility lines can exclude a site from use (exceptions may be made in cases of dire need and only on sites cleared by "Miss Utility" and properly protected). The drill rig is not to be operated within 20 feet lateral distance of any overhead electrical lines measured from the center line of the erect mast. Be particularly aware of lines crossing roads.

The majority of all utilities can be cleared through "Miss Utility," a state-wide clearance service established by the major utilities of the State to promote public safety and to eliminate service interruptions. The toll free number in Delaware is 1-800-282-8555.

When calling to clear a drilling site, you will be asked the following questions:

- (1) your name?
- (2) your telephone number?
- (3) your company or agency?
- (4) the specific nature and location of the work intended?

- (5) the projected starting time and date?
- (6) the most convenient time to reach you if a return call is necessary?

Give "Miss Utility" at least 48 hours advance notice (emergency clearances may be obtained faster). Do not call more than 10 days ahead of time. After calling and providing the necessary information, you will be given a ticket number to use as a reference when taking return calls from the utilities. Retain the ticket number for future reference.

Each utility, depending on conditions, will locate and identify the position of its facilities by staking or marking the horizontal path on the surface with either flags or paint.

Locations of holes will have to be planned in adequate detail and sufficiently far in advance in order to determine the acceptability of sites. Although exact location of the boring may not be necessary for the useful interpretation of the obtained information, the location of the boring can be very important for safety in an area where utilities are present. Location requirements must yield to safety considerations.

When locating a boring site for clearance, have it staked out or flagged in an easily discernible manner. Locate any nearby features that can be used as a reference for the site location by utility personnel. At a bare minimum, this requires a road number, a distance, and a direction along the road from a marked intersection or landmark. Note numbered utility poles or boxes and the distances from them to the site.

Utility designations are usually imprinted on small metal plates nailed to poles or on letters and numbers glued onto boxes. Delmarva Power and Light (DP & L) plates have the pole number on them, and on every fifth pole there is a line number on another plate. Both of these numbers are necessary to identify the proposed drill site. Diamond State Telephone (DST) poles and Delaware Electric Cooperative (DEC) poles also have similar numbered plates. DST and DP & L surface boxes for buried lines also have numbered tags on them. Any poles without markings should be located along a county route and then cleared. High voltage lines will not be numbered but instead will have a letter designation.

Major natural gas pipelines are marked along most roads by small signs denoting the owner of the system.

Privately owned utility devices will generally need separate clearance from either the land owner or the builder. This includes areas containing septic fields, drainage systems, and, in some cases, underground electric or water lines. Care must be taken in rural areas because of feeds to and from electrically powered pumps for both housing and agricultural uses.

The only major utility service not encompassed by "Miss Utility" is the New Castle County (NCC) Sewer System. To clear NCC sewerage equipment it is necessary to contact the County dispatcher at 302-323-2649. The dispatcher will fill out a work order and arrangements should be made to assure return notification when the utility has been cleared or marked. This procedure should be followed for all areas of New Castle County.

Contact with the public and municipal utilities is not usually necessary except under advisement by "Miss Utility." Contact should be made with the utilities when a piece of their equipment has been damaged. For this purpose the list in Appendix E has been included.

If anyone is injured by coming in contact with utility equipment, the primary objectives are to aid the injured person and then take care of the utility problem. In populated areas, the initial calls should be to the police or fire station in the area and only thereafter to the utility involved.

SAFETY AND CONTROL OF RIG IN FIELD (Compliance with These Procedures is Mandatory)

The operator and all other persons assisting in drilling operations shall observe appropriate safety measures, particularly the wearing of steel toe boots, (see American National Standards Institute, Z41), hard hats, (Z89), and eye protection, (Z87) (J. Domorod, personal communication). Visitors are requested to remain a safe distance from the rig during operations.

Final judgment regarding drill site feasibility and all matters pertaining to the actual operation of the equipment, rests with the Senior Field Technician-Driller. The driller will take under consideration all of the pertinent factors,

including safety and the limitations of the equipment, during the site evaluation and drilling operations. The driller may not be overruled in these matters.

All drilling equipment and conditions involve some hazard. The principal requirements for safety are awareness and care by all persons involved in drilling operations. For their safety, and the safety of others, no person who is uncomfortable with the equipment and site conditions should attempt to participate in drilling operations.

To encourage safety, drilling will not be done in rain, snow, or when roads are icy. Extreme cold is detrimental to the equipment. Poor attention factors of those involved in handling heavy and dangerous equipment make drilling under these weather conditions more dangerous than normal. Because of equipment limitations, cold weather drilling is restricted to augering and, if possible, should be postponed until the weather is warmer.

In addition to safety boots, hard hats, and safety glasses, heavy leather gloves are recommended for handling the equipment on the drill rig. This will help protect hands from rope or wood splinters, burrs on metal parts and wire lines, and general abrasion from the sand and rock fragments frequently adhering to the drilling equipment.

When working in the vicinity of overhead utilities, be extremely careful not to raise equipment or materials into contact with same. Overhead hazards are also present from the rig in the form of suspended equipment which may drop if a rope or wireline breaks. Broken wirelines are particularly dangerous because of their tendency to snap like a whip after breaking. Remain at a safe distance from the wireline when not involved with its operation.

Like all machinery, the drill rig has numerous moving parts which should be avoided during drilling. Pay special attention to the area around the drilling head and to the cathead, which may not be in motion at all times, but may be put in motion when least expected. An additional hazard involved with the cathead comes from getting caught and dragged into the cathead by a loop of rope.

In case of emergency, two safety switches are located on the drill rig: (1) on the left, front corner of the main control panel, and, (2) just below the cathead on the right side of the

mast base. To stop rig operation, these switches are simply pushed in. An on-board fire extinguisher is located on top of the auger rack on the driver's side and is released for use by flipping the hold-down latch. Prior to commencement of drilling, the Senior Field Technician will advise all participants as to the location of the fire extinguisher and safety switches, and their operation.

The DGS does much of its drilling on highway right-of-way and is thus in constant proximity to moving traffic. To minimize the danger of traffic hazards, it is standard procedure to place warning signs near the work area as detailed by the Department of Transportation in Delaware Traffic Controls. A high intensity yellow flasher is also activated when working along roads to insure high visibility.

The dangers in working with drilling equipment are very real and should not be taken lightly. Only properly instructed individuals should be involved in the operation of the equipment. The necessary instruction will be presented by the Senior Field Technician at the initiation of the drilling project. The major key to safety in this type of operation is awareness. Always be aware of what you are doing and possible repercussions.

Parts II and III of this manual refer to the specific operation and servicing of the DGS CME-55 drill rig and truck. These sections do not require general distribution and are therefore printed in limited number. They may be consulted at the DGS, where they are retained on open file.

ACKNOWLEDGMENTS

Special thanks are due to Robert D. Varrin, Director, Water Resources Center, and Stuart W. Kline, Director, Safety Division, both of the University of Delaware, for reviewing this manual. Robert R. Jordan, Kenneth D. Woodruff, Thomas E. Pickett, Nenad Spoljaric, and John H. Talley, of the DGS, are also to be thanked for their critical reviews and assistance during the initial drafting of this report.

The author wishes to thank the following companies for the use of illustrations and text from their equipment manuals in parts II and III of this manual:

Baroid Mud Mixer Construction Illustration
NL Baroid Division, NL Industries, Inc., Houston, TX

CME-55 Drill Rig Parts Manual
Central Mine Equipment Company, St. Louis, MO

Longyear Core Barrel Assembly and Use Instructions
Longyear Company, Minneapolis, MN

Robbins and Myers "L6" Drive End Service Manual for Moyno
Pumps, Moyno Industrial Products, Fluids Handling
Division, Robbins and Myers, Inc., Springfield, OH

SUMMARY OF CLEARANCE PROCEDURES
(For clarification, see appropriate section in text)

- (1) Obtain permission to use drill rig from the Director, DGS.
- (2) Be familiar with this operations and safety manual.
- (3) Select drilling sites according to accessibility and safety.
- (4) Contact Senior Field Technician to evaluate site(s).
- (5) Obtain written permission of property owner for drilling on his land. DGS will handle Division of Highways internally.
- (6) Obtain DNREC well construction permit if a piezometer is to be installed.
- (7) Obtain utility clearances from the "Miss Utility" service. On advisement by "Miss Utility" contact other utilities, municipalities, and individuals directly. Give at least 48 hours notice and do not call more than 10 days ahead of time.
- (8) When all clearances are obtained, set up drilling schedule with the Senior Field Technician.
- (9) Drill.

SUMMARY OF RECORDS DISTRIBUTION

For User

- (1) Send request letter with proposed drilling and site plans to the Director, DGS.
- (2) Send signed property owner permission letters to the Senior Field Technician, DGS. (Division of Highways will normally be handled internally by DGS.)
- (3) Forward DNREC well permits and completion report forms: completed, paid for, and approved by DNREC, to the DGS Senior Field Technician.
- (4) Copies of geologist's and geophysical logs should be forwarded to the Senior Field Technician within 3 to 5 working days, for entry into the DGS data base and for use in filling out the completion reports due to DNREC.

For DGS

- (1) The Senior Field Technician will report daily operation records of the drilling rig to the Director, DGS on the weekly report form.
- (2) When necessary, completion reports will be sent to DNREC by the Senior Field Technician.
- (3) The Senior Field Technician will retain copies of rig and truck use records, service records, and, lists of project names, permits, and well numbers.
- (4) Well numbering and entry onto DGS base maps (Room 103, Penny Hall) should be done by DGS personnel only. Procedures outlined in DGS Special Publication No. 11 (Talley and Windish, 1984) will be followed.
- (5) Samples should be entered in the catalog books in Room 103 Penny Hall and then stored in Room 018, Penny Hall Annex I.
- (6) Year-end records for use in the annual report: tallies must be made of the number of holes drilled, footage drilled, miles driven, number of samples taken (by type), and

together with a list of the year's projects, must be submitted to Thomas E. Pickett, Associate Director, DGS, in June of each year.

APPENDIX A

GENERALIZED LETTER FOR DRILL RIG USAGE REQUEST

MEMORANDUM

TO: Robert R. Jordan, Director,
Delaware Geological Survey

FROM: (Project initiator)

SUBJECT: REQUEST FOR DRILL RIG USAGE

(Project initiator's name or unit) requests the use of the University of Delaware drilling rig for (piezometer construction/drilling test borings).

(# of holes) (borings/piezometers) will be (drilled/constructed) at the following site(s): (List where, how many, and proposed depths).

The (borings/piezometers) are for (generally describe the nature of the project). Assuming approval of use and availability, the project will be started on or around (date of initiation).

*

.....

(Project initiator)

*Insert for projects involving piezometer construction: After installation, the piezometers become the property of (project initiator).

APPENDIX B

GENERALIZED SITE ACCESS PERMISSION LETTER

MEMORANDUM

TO: (Property Owner)

FROM: (Project Initiator)

SUBJECT: Approval to (Drill/Install Monitoring Piezometers)

(Project initiator's name or unit) requests your permission to (drill/install monitoring piezometers) on your property at (describe location). The (borings/piezometers) will be used for (generally describe the project's purpose).

(# of holes) (borings/piezometers) will be (drilled/constructed) according to all applicable regulations, by the Delaware Geological Survey's licensed well driller. The project is scheduled to start on or around (starting date). *

If these provisions meet with your approval, please sign and return one copy of this letter to me.

APPROVAL:

(landowner's name)

(date)

* If piezometers are installed, include a statement about the length of use and abandonment of the piezometers.

APPENDIX C

WATER SUPPLY BRANCH
DIVISION OF ENVIRONMENTAL CONTROL
P.O. BOX 1401
DOVER, DELAWARE 19901

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES
AND ENVIRONMENTAL CONTROL

APPLICATION MUST BE SUBMITTED
AND PERMIT RECEIVED BEFORE
DRILLING IS STARTED.

APPLICATION FOR A PERMIT TO DRILL A WELL

OWNER _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

TELEPHONE AREA CODE () _____

WELL CONTRACTOR _____ LIC. NO. _____

PUMP INSTALLER _____ LIC. NO. _____

ESTIMATED CONSTRUCTION DATE _____

PURPOSE: ☐ TEST ☐ PERMANENT

USE:
☐ DOMESTIC ☐ AGRICULTURAL
☐ COMMERCIAL ☐ INDUSTRIAL
☐ IRRIGATION ☐ PUBLIC
☐ MONITOR ☐ DEWATERING
☐ HEAT PUMP RECHARGE ☐ HEAT PUMP SUPPLY
☐ OTHER _____ (Specify)

IS THIS A REPLACEMENT WELL? ☐ YES ☐ NO

REPLACEMENT REASON _____

ABANDONMENT DATE FOR OLD WELL _____

TYPE OF ABANDONMENT _____

SEPTIC SYSTEM PERMIT NO. _____

DRILLING METHOD

☐ AUGERED ☐ BORED ☐ CABLE TOOL
☐ DRIVEN ☐ JETTED ☐ AIR ROTARY
☐ MUD ROTARY ☐ REVERSE ☐ WASHED
☐ OTHER (Specify) _____

AQUIFER _____

APPROXIMATE TOTAL DEPTH _____

| | NO. 1 | NO. 2 | NO. 3 | NO. 4 |
|-----------------|-------|-------|-------|-------|
| CASING TOP | | | | |
| CASING BOTTOM | | | | |
| CASING DIAMETER | | | | |
| CASING MATERIAL | | | | |

TENTATIVE SCREEN SETTING _____ (TOP) TO _____

TENTATIVE SCREEN LENGTH _____ MATERIAL _____

TYPE OF GROUT _____ FROM _____ (TOP) TO _____

GRAVEL PACK ☐ YES ☐ NO

GRAVEL PACK INTERVAL _____ FROM _____ TO _____

DESIRED CAPACITY _____ GPM.

MAXIMUM DAILY USE _____ GPD.

I HEREBY AFFIRM THE INFORMATION I HAVE IS ACCURATE AND CORRECT

APPLICANT ☐
REPRESENTATIVE ☐

LOCATION MAP - ROAD MAP

PROJECT COUNTY _____
SUBDIVISION _____
LOT NO. _____
NAME OF NEAREST TOWN _____

DRAW A SKETCH BELOW SHOWING LOCATION OF WELL IN RELATION TO ROADS AND GIVE DISTANCE FROM WELL SITE TO NEAREST ROAD JUNCTION.

SITE PLAN (INCLUDE SUITABLE PLOT PLAN IF AVAILABLE)

PERMIT NO. _____

FOR OFFICIAL USE ONLY
MODIFIED GRID _____ FORMATION _____
DRAINAGE BASIN _____

FOR OFFICIAL USE ONLY - DO NOT WRITE BELOW THIS LINE

PURSUANT TO PROVISIONS OF 7 DELAWARE CODE , CHAPTER 60, PERMISSION IS HERBY GRANTED TO CONSTRUCT AND USE A WELL AS DESCRIBED ABOVE. ALL CURRENT REGULATIONS GOVERNING WELL CONSTRUCTION AND WATER RESOURCE USE MUST BE FOLLOWED. THE FOLLOWING CONDITIONS MUST BE OBSERVED:

THIS PERMIT EXPIRES: _____ SIGNED: _____

PERMIT NO. _____

REPORT FILED _____

A COMPLETION REPORT MUST BE FILED WITH THE DIVISION OF ENVIRONMENTAL CONTROL WITHIN TWENTY ONE (21) DAYS AFTER COMPLETION OF THIS WELL. FAILURE TO DO SO MAY RESULT IN LICENSE SUSPENSION.

APPENDIX D

WATER SUPPLY BRANCH
DIVISION OF ENVIRONMENTAL CONTROL
P.O. BOX 1401
DOVER, DELAWARE 19903

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES
AND ENVIRONMENTAL CONTROL

WELL COMPLETION REPORT MUST
BE RETURNED 21 DAYS AFTER
CONSTRUCTION DATE

WELL COMPLETION REPORT

PLEASE PRINT

| | |
|--|--|
| PERMIT NO. _____ LOCAL ID _____ | TYPE OF PERMANENT PUMP INSTALLED: |
| OWNER _____ | PUMP MANUFACTURE _____ |
| CONSTRUCTION DATE _____ | RATED CAPACITY (GPM) _____ |
| PURPOSE: <input type="checkbox"/> TEST <input type="checkbox"/> PERMANENT | PUMP INTAKE SETTING _____ FT. BELOW GRADE |
| USE: <input type="checkbox"/> DOMESTIC <input type="checkbox"/> AGRICULTURAL | THE COMPLETED WELL IS? |
| <input type="checkbox"/> COMMERCIAL <input type="checkbox"/> INDUSTRIAL | YES NO |
| <input type="checkbox"/> IRRIGATION <input type="checkbox"/> PUBLIC | A. AT LEAST 5' FROM ANY OVERHANG <input type="checkbox"/> <input type="checkbox"/> |
| <input type="checkbox"/> MONITOR <input type="checkbox"/> DEWATERING | B. AT LEAST 50' FROM ANY SEPTIC TANK <input type="checkbox"/> <input type="checkbox"/> |
| <input type="checkbox"/> HEAT PUMP RECHARGE <input type="checkbox"/> HEAT PUMP SUPPLY | C. AT LEAST 10' FROM TOWN SEWER LINE <input type="checkbox"/> <input type="checkbox"/> |
| <input type="checkbox"/> OTHER (Specify) _____ | D. AT LEAST 100' FROM THE NEAREST EDGE OF ANY TILE FIELD <input type="checkbox"/> <input type="checkbox"/> |
| IS THIS A REPLACEMENT WELL? YES <input type="checkbox"/> NO <input type="checkbox"/> | THE NEAREST NEIGHBORS (CIRCLE ONE) |
| ABANDONMENT DATE FOR OLD WELL _____ | SEPTIC TILE FIELD CESSPOOL OR PRIVY |
| ABANDONMENT METHOD _____ | IS _____ FROM COMPLETED WELL. |
| | IS COMPLETED WELL LOCATED AS SHOWN ON APPLICATION FORM? <input type="checkbox"/> <input type="checkbox"/> |
| | IF NO, DESCRIBE LOCATION CHANGE OR OTHER COMMENTS. |
| DRILLING METHOD | |
| <input type="checkbox"/> AUGERED <input type="checkbox"/> BORED <input type="checkbox"/> CABLE TOOL | |
| <input type="checkbox"/> DRIVEN <input type="checkbox"/> JETTED <input type="checkbox"/> AIR ROTARY | |
| <input type="checkbox"/> MUD ROTARY <input type="checkbox"/> REVERSE <input type="checkbox"/> WASHED | |
| <input type="checkbox"/> OTHER (Specify) _____ | |
| TOTAL DEPTH DRILLED _____ | |
| CASING SEQUENCE | |
| | INNER OUTER |
| CASING TOP | |
| CASING BOTTOM | |
| CASING DIAMETER | |
| CASING MATERIAL | |
| SCREEN SEQUENCE | |
| | INNER OUTER |
| SCREEN TOP | |
| SCREEN BOTTOM | |
| SCREEN DIAMETER | |
| SCREEN MATERIAL | |
| WRITTEN APPROVAL FOR SCREENING/ GRAVEL PACKING MORE THAN ONE AQU- IFER MUST BE OBTAINED FROM DNREC. | |
| GROUT TYPE: CEMENT <input type="checkbox"/> BENTONITE CLAY <input type="checkbox"/> | |
| OTHER: _____ | |
| FROM _____ TO _____ FEET | |
| NON-GROUT BACKFILL OF WELL ANNULUS TYPE _____ FROM _____ TO _____ FEET | |
| GRAVEL PACK: TYPE _____ | |
| FROM _____ TO _____ FEET | |
| STATIC WATER LEVEL: DATE _____ | |
| _____ FT. (Below, above) GROUND SURFACE | |
| PUMPING WATER LEVEL: _____ FT. BELOW GRADE | |
| AFTER _____ HOURS AT _____ GPM. | |
| WELL HEAD COMPLETION: | |
| TYPE: PITLESS ADAPTOR <input type="checkbox"/> | |
| OTHER <input type="checkbox"/> _____ | |
| _____ INCHES ABOVE GRADE. | |
| SUPPLEMENTAL DRILLERS LOG ATTACHED YES <input type="checkbox"/> NO <input type="checkbox"/> PAGE 1 OF ____ PAGES COMPANY NAME _____ SIGNATURE OF DRILLER IN CHARGE: _____ DATE _____ | |

DOCUMENT NO. 40-08-78-01-03

WHITE - DNREC

CANARY - CONTRACTOR

PINK - OWNER

APPENDIX E

UTILITY CONTACTS

Delmarva Power & Light:
Transmission & Distribution (North), Jim Shaw - 454-4100
Harrington Division, W. Douglas Boyce, Manager - 398-8111
Gas Department, Frank Perry, General Manager - 429-3838
Supervisor of Safety, Thomas W. Sterner - 454-4248
General Information - 429-3011
System Operator - 429-3321
Call only if equipment is damaged

Delaware Electric Cooperative: - 349-4571
or toll free 1-800-282-8595

Diamond State Telephone:
(repairs) 1-800-243-8443

Columbia Gas System, Inc. - 429-5000
Artesian Water - 453-6922
Rollins Cablevision - 655-0144
Wilmington Suburban Water - 798-1436
Eastern Shore Natural Gas Company - 734-7443
Lincoln-Ellendale Electric Company - 422-4055
Dover: Water and Sewer - 736-7000
Electric - 736-7091
Lewes: Public Works - 645-6228
Electric - 645-6547
Sewer - 645-6450
Middletown: Light and Water - 378-2211
Milford: Electric - 422-6616
Sewer and streets (emergency) - 422-8081
New Castle: Water and Light - 328-3423
Newark: Electric - 366-7050
Sewer - 366-7055
Emergency - 366-7000
Seaford: Light and Power - 629-9173
Wilmington: Water Division - 571-4295
After Hours - 571-4165

APPENDIX F

DRILL RIG SAFETY TRAINING CERTIFICATION

Department: Delaware Geological Survey

Date of Training: _____

I certify I have received training pursuant to Delaware Geological Survey and University of Delaware Policy. In addition to training on my rights as detailed by the Operations Manual University of Delaware Drilling Rig, I:

- _____ have read the Operations Manual.
- _____ have been instructed in the physical and health hazards involved with the drilling operation.
- _____ understand the protective measures and emergency procedures necessary for the job.
- _____ have knowledge of the location and operation of the safety cutoff switches and the fire extinguisher aboard the drill rig.
- _____ have received a copy of the Operations Manual.

_____ Signature of Employee/Student

Signature of Supervisor/Instructor

Distribution: Delaware Geological Survey
:

REFERENCES

- Baroid mud mixer construction illustration (not dated), Baroid Division, N. L. Industries, Inc., P. O. Box 1675, Houston, TX 77001.
- Bounds, R. E., 1986, Operations Manual University of Delaware Drilling Rig: Delaware Geological Survey Special Publication No. 13, Parts II and III, 72 p.
- CME-55 drill rig parts manual (not dated), Central Mine Equipment Company, 600 North Broadway, St. Louis, MO 63147.
- Division of Motor Vehicles, 1979, Drivers manual: Dover Litho Printing Company, Dover, DE (1979).
- Longyear core barrel assembly and use instructions (not dated), Longyear Company, 925 Delaware Street Southeast, P. O. Box 1368, Minneapolis, MN 55440.
- National Drilling Federation drilling safety guide (not dated): Prepared by (DCDMA) Diamond Core Drill Manufacturers Association and (NDCA) National Drilling Contractors Association.
- Robbins and Myers "L6" drive end service manual for Moyno pumps, 1983: Moyno Industrial Products, Fluids Handling Division Robbins and Myers, Inc., Revised Edition, Springfield, OH.
- Talley, J. H., and Windish, D. C., 1984, Instructions for preparation of DGS data base schedules: Delaware Geological Survey Special Publication No. 12, 119 p.

STATE OF DELAWARE
UNIVERSITY OF DELAWARE
DELAWARE GEOLOGICAL SURVEY

SPECIAL PUBLICATION NO. 13
PARTS II AND III

OPERATIONS MANUAL
UNIVERSITY OF DELAWARE
DRILLING RIG

BY
ROLAND E. BOUNDS

NEWARK, DELAWARE
JUNE 1986

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PART II

OPERATION OF THE RIG

OPERATIONS MANUAL
UNIVERSITY OF DELAWARE DRILL RIG

Roland E. Bounds

CME-55 Operating Instructions

A. Safety Switch Operation

1. Safety switches are located on the control panel (see Fig. 1, control A) and under the cathead (see Fig. 2, control A).
2. Push safety switch to stop drill engine.
3. Switches must be in the "out" position for the engine to operate.
4. Switches should be checked for correct function at the start of each job.

B. Drilling Set-Up and Operation

1. Position drill rig on boring site and set parking brake.
 - a. Put on hard hat and safety shoes or boots.
 - b. Rig should face uphill for best use of hydraulic leveling jacks.
 - c. Check site for utility clearance markings and obstructions such as trees or structures that might interfere with the drilling operation. If clear, proceed.
2. Start drill engine (see Fig. 1); pull out choke (control B), use key to turn on ignition (control C), and starter button (control D) to engage starter. Allow engine to warm up several minutes at idling speed, after pushing in choke following start-up.

3. Raise drill mast. Follow procedures outlined under item (C).
4. Set hydraulic jacks to level drill. Follow procedures outlined under item (D), and for increased leveling capability, support jacks on one or more wooden blocks.
5. Move the sliding base to the drilling position. Follow procedures outlined under item (E) and connect appropriate drilling equipment (augers, A-rods, or coring barrels).
6. Using procedures outlined under item (F), set drill bit into ground using the feed control with no rotation of drill string.
7. When bit has been set, follow procedures outlined under item (G) to select the correct gear range for initiation of drilling, preferably low gear to get the hole started correctly.
8. This completes set up for auger drilling. Mud rotary requires a mud pit and mud pumping system to be set up following procedures outlined in item (H).
9. When the limit of the first auger or rod is reached, disconnect drill string by undoing retaining screw or unscrewing rod and insert an additional section of auger or rod by following procedures in item (I) or (J), or else follow one of the sampling procedures described in item (K) and then add additional drill string.
10. When hole has reached necessary depth and all samples have been taken, pull drill string and either install casing as detailed in item (L) or abandon hole as detailed in item (M).
11. If a geophysical borehole log is desired, it may be run through the hollow stem augers previous to extraction or in a mudded hole after drill string has been removed. It may also be run in a cased hole but, as with using hollow stem augers, this limits the logs which can be run.

12. After cleaning up tools and other debris from the drilling operation, restore rig to traveling mode, and make sure everything on rig will ride safely.
13. Leave drill site in as close to original condition as possible (take trash, fill holes, and clean up cuttings).
14. Sites should be revisited to be certain that no caving occurs.

C. Mast Elevation Control Operation (see Fig. 1)

1. Raising mast:

- a. Disengage sandline clutch (control E) and brake (control F).
- b. Clear ropes from equipment for free travel during mast elevation.
- c. Slightly open fold-over valve (control G) until drill mast slowly raises into position.
- d. Push feed lever (control H) until rotary table raises about 24 inches.
- e. Remove kelly bar coupling retaining pin and let coupling slide onto right angle drive (see Fig. 3).
- f. Insert hold down bolt and tighten (see Fig. 3).

2. Lowering mast:

- a. Slide kelly bar coupling up kelly bar and insert retaining pin.
- b. Remove hold down bolt. (Always do this in this order so that there is never any danger of bending the kelly bar by lowering the mast without disconnecting it.)
- c. Lower rotary table to within one inch of kelly bar coupling.
- d. Slightly open fold-over valve to slowly lower mast to a horizontal position.
- e. The rotary table can be moved when the mast is horizontal, except to the point where it interferes with the engine exhaust or wire line reel.

***** CAUTION: The drilling mast cannot be moved into the elevated position when the rotary table is in the up position, the piston

used to raise the mast is not strong enough to lift the unit in this position.

D. Operation of Hydraulic Jacks (see Fig. 1)

1. Jacks are operated independently by moving the hydraulic jack control levers (controls I).
2. When the levers are in neutral, the position of the jacks is fixed. To lower a jack, press the lever down. To raise a jack, pull the lever up.
3. The levers are located on the rear edge of the control panel.

E. Sliding Base Control Operation (see Fig. 1)

1. Moving sliding base lever (control J), slide the base of the drill 15 inches outward or inward. The lever is located in the top front of the control console.
2. All drilling is done with the base in the outward position, although this does not mean that the base should be all the way out; leave room to compensate for an off center hole by only extending the base about 12 inches instead of all 15 inches.
3. Tools are withdrawn from the hole by wire line or cathead-pulled rope, with the base in the inward position.

F. Feed Control Operation (see Fig. 1)

1. Move feed lever (control H) to raise or lower rotary table. It is located on the top front of the control console.
2. Advance or retract speed is variable depending on how far feed valve (control H) is opened in combination with the bypass (control K) and restrictor (control L) valve settings on the top rear of the control console. These settings are not normally changed except during diamond and carbide coring operations, where slow

steady advancement is needed for extended periods of time. This makes it impractical to control the speed by partial lever movements because of the danger of jamming up or twisting off equipment with an accidental tug on the control. This is remedied by the bypass and restrictor control valves which allow the full lever pull to give a much slower and controlled feed and ends the danger of a quick feed jamming up the equipment.

3. Increasing engine RPM [by turning throttle (control M) counter clockwise] increases the feed rate.
4. Down pressure and speed are reduced by opening the bypass control valve (control K). With bypass open, speed can be further reduced by closing the restrictor valve (control L). When augering, the bypass valve is closed and the restrictor valve is open.

G. Rotary Speed Control (see Fig. 1)

1. Rotary speed ranges are selected by shifting transmission (control N) when the clutch is disengaged (control O).
2. There are four (4) forward and one (1) reverse speed ranges.
3. Disengage clutch by pulling clutch lever toward operator.
4. Throttle control (control M) regulates rotary speed within each range.

H. Set-Up of Mud Pumping Equipment

1. Equipment needed in addition to the normal drill string: (see Fig. 4).
 - a. surface casing with side spill "T" (not shown).
 - b. portable or dug mud pit (not shown).
 - c. suction hose with foot valve.
 - d. pressure hose with mud mixer attachment.
 - e. water swivel (see Fig. 6).
 - f. powdered bentonite or other drilling compound.

2. Install surface casing at top of hole, [hollow stem augers may be used as surface casing but a side spill "T" (see Fig. 4) must be connected and the augers must be supported at the surface in case of washout].
3. Position or dig mud pit in a convenient spot, usually controlled by the length of suction hose and position of side-spill "T."
4. Connect recharge hose to 1½" outlet on pressure side of mud pump (see Fig. 5, Valve A) and then connect mud mixer to hose.
5. Connect suction hose with foot valve to 1½" outlet on suction side of mud pump (see Fig. 5, valve B).
6. Connect water swivel to 1" outlet over control console (see Fig. 1, control P) and use drive pin (see Fig. 7) to retain swivel in rotary drive (see Fig. 9).
7. Fill mud pit by mixing bentonite with water jetted through mud mixer (see Fig. 4).
 - a. Valve settings: (to start) (see Fig. 5);
 1. valves on control console: both closed (Fig. 1).
 2. valves to main water tanks: both open (not shown).
 3. valve from tanks to mud pump: open (valve C).
 4. valve from suction hose to mud pump: closed (valve B).
 5. hose valve: closed (valve D).
 6. valve to mud mixer: open (valve A).
 - b. Valve settings (when mud pit is full) (see Fig. 5);
 1. control console valves: both closed (see Fig. 1).
 2. valves to main water tanks: both open (not shown).
 3. valve from tanks to mud pump: closed (valve C).
 4. valve from suction hose to mud pump: open (valve B).
 5. hose valve: closed (valve D).
 6. valve to mud mixer: open until mud is correct thickness (valve A).
 - c. Valve settings (to drill) (see Fig. 5).
 1. control console valves: hose, closed; water swivel, open (see Fig. 1).

2. valves to main water tanks: both open (not shown).
 3. valve from tanks to mud pump: closed (valve C).
 4. valve from suction hose to mud pump: open (valve B).
 5. hose valve: closed (valve D).
 6. valve to mud mixer: closed (valve A).
- d. Cautions
1. When adding more water from tanks to drilling mud during drilling, do so slowly, otherwise the mud pump has the tendency to pull only clean water from the tanks which causes the mud in the hole to thin out and then the hole will cave around the drill string.
 2. Do not let mud become too thick as this causes the pump to pump sand back through the hole and could ruin the pump.
 3. When finished rotary drilling, flush all hoses, valves, and lines with clean water to keep the mud from clogging later operations.
8. When mud is mixed and being cycled through the drill string, up the hole and back to the mud pit, drilling may commence at a speed which is determined by a combination of drilling resistance and the speed of cuttings removal.
9. When changing to another rod:
- a. stop rotation of drill string.
 - b. stop circulation of mud.
 - c. break joint between top rod and water swivel.
 - d. knock in slips to keep string in position.
 - e. unscrew swivel.
 - f. raise rotary table with swivel on it, lubricate with Koppercote,^{*1} and screw next rod onto swivel.
 - g. when in position, lubricate rod, then screw next rod into hanging string.
 - h. tighten all joints with pipe wrench.
 - i. start circulation.
 - j. start rotation (wait for returns and then start drilling again).

^{*1} Koppercote - one variety of an antilocking lubricant.

10. Useful observations:

- a. When changing rods take note if mud has the tendency to reverse flow into rods and out of rods at surface when pump pressure is off. This generally means the mud is too thin and the hole is collapsing.
- b. Keep an eye on mud pump pressure gauge (Fig. 1, gauge Q) on top of console, this will tend to indicate blockages as the pressure jumps up over 200 psi from a more normal range of 75-120 psi.
- c. If mud pump pressure is low but returns stop coming up, you are probably in very coarse or highly fractured material and are losing drilling fluid. Thicken mud and hope the area can be closed up with the mudcake.

I. Changing Augers (see Fig. 7)

1. Adding:

- a. Unscrew auger retaining screw.
- b. Raise rotary table.
- c. Place second auger on top of first so that the cup of the top auger is over the bottom auger's socket and the screw holes align.
- d. Insert screw and tighten to connect augers.
- e. Run rotary table down so that adaptor cup covers the top auger socket and screw this together.
- f. All screws except the one in the adaptor should be wrench tightened till they squeak.

2. Removing Augers:

- a. Raise stem and insert fork below the joint to be broken.
- b. Unscrew screw at bottom of auger to be removed.
- c. Lift auger off of string and rest on edge of flight while unscrewing screw on the adaptor.
- d. Have assistant remove auger when you raise rotary table adaptor off socket. Auger should be placed on timbers to be washed off at finish of work.

3. Augers may be pulled using sand line [see item (O)] and hoisting socket; up to four at a time may be raised and then broken down on the ground.

J. Changing A-Rods (see Fig. 4)

1. Adding A-rods:
 - a. Break joint between top pipe and water swivel after stopping rotation and circulation.
 - b. Knock in slips to support string in hole.
 - c. Unscrew water swivel and raise rotary table.
 - d. Lubricate water swivel threads with Koppercote and screw on next 5' rod.
 - e. Lubricate end of rod and screw into top of string.
 - f. Tighten connections with pipe wrench then knock loose slips.
 - g. Restart circulation and then rotation when you get more returns.
 - h. Use the drill rig engine and a pipe wrench to break joints if necessary but do not have body parts between rig and wrench when doing this.
2. Removing A-rods:
 - a. Raise string.
 - b. After stopping rotation and circulation, break joints at top and bottom of top A-rod.
 - c. Knock in slips to support string in hole.
 - d. Unscrew top A-rod from string.
 - e. Lower rotary table and unscrew A-rod.
 - f. Lay A-rod on timbers to be washed and put away.
3. A-rods may be removed 20 feet at a time and then broken down on the ground using the sand line and rod hoisting plug.

K. Sampling Methods (see Fig. 6):

1. Ditch sampling:
 - a. Off of auger, just pick representative grab sample.
 - b. From rotary cuttings, use strainer to get sample from mud returns (note: this method does not retain all fine material and necessitates procurement of additional sample type for mechanical analysis).
2. Split Spoon:
 - a. Mount split spoon on A-rod and work down hole by adding more A-rod until bottom is reached.
 - b. Attach safety hammer to top of A-rod string with spoon on bottom and mark off the drive length (this is to keep spoon from being overdriven in most

- cases, but the A.A.S.H.O. has strict procedures for using this data in the procedure for the standard penetration test).
- c. Using hammer pulled by rope around cathead [see procedure in item (N)] pound spoon into hole bottom until full, or >100 blows per 6 inches is obtained.
 - d. Remove spoon by tapping out with hammer, or just pulling on rope in softer sediments.
 - e. Pull string to surface and open spoon for sample.
3. Shelby Tube (see Fig. 6):
 - a. Connect sharpened metal tube to adaptor.
 - b. Connect adaptor to A-rods.
 - c. Run down to bottom of hole.
 - d. Mark up length of tube on A-rods.
 - e. Connect rods to rotary drive and push tube into soft sediments.
 - f. Let tube sit so sample will expand in it then pull out and remove string.
 - g. Because these samples are normally taken for many moisture dependent soil tests (shear, compression, etc.) the tube should be sealed with wax at the surface and stored on end as found in the hole.
 4. Diamond or Carbide Coring (see Fig. 6):
 - a. Connect appropriate bit to core barrel.
 1. Diamond bit, for hard rocks.
 2. Carbide, for softer rocks like limestone.
 - b. Connect core barrel to A-rods and run down to bottom of hole.
 - c. Connect A-rods to water swivel after setting up spill "T," mud pit, and suction hose.
 - d. Using only water (not drilling mud), set up pumping valves as follows (see Figs. 1 and 5):
 1. Control console valves (Fig. 1): hose (valve R), closed; water swivel (valve P), open.
 2. Valves to main tanks: both open (not shown).
 3. Valve from tanks to mud pump: open till pit is full.
 4. Valve from suction hose to mud pump (valve B): closed until pit is full.
 5. Hose valve (valve D): closed.
 6. Valve to mud mixer (valve A): closed.

7. When mud pit is full of water, open the valve from the suction hose to the mud pump (valve B) and then close the valve from the mud pump to the main tanks (valve C).

L. Installation of Piezometers (see Fig. 8)

1. A well construction permit must be on file with DNREC before proceeding with installation.
2. Written permission must also be received from the landowner.
3. All installation specifications and procedures must conform to the requirements detailed in Regulations of Water Resources (Chapter 60, Title 7, Delaware Code).
4. A well completion report must be filed by the Senior Field Technician, with DNREC, when piezometer is completed.
5. General Information:
 - a. Piezometer use generally determines the diameter:
 1. 2" or less diameter, for sampling and levels.
 2. 4" to larger in diameter, for installation of recorder or submersible pump.
 - b. Piezometer should be screened at least 3 feet below surface of water table to allow for low flows.
 - c. The limit for "pushing" 2" or smaller diameter PVC casing in an augered hole in unconsolidated material is 75 feet or less; deeper holes must be drilled by mud rotary.
 - d. The limit for "pushing" 4" or larger diameter PVC casing in an augered hole in unconsolidated material is 20 feet; to assure reaching necessary depth, all 4" and larger holes should be drilled by mud rotary.
 - e. In smaller diameter piezometers, using push points (Fig. 8) instead of caps increases the depth attainable and ease of pushing.
 - f. Slot size in the well screens should be determined by the grain sizes present in unit to be screened.

M. Abandonment of Piezometers or Open Holes

1. Open holes and test borings should be abandoned as detailed in the "Regulations of Water Resources."

2. Piezometers must also be abandoned in the same way with the difference of needing to file a well abandonment permit with DNREC and pulling casing if possible.
3. The filled and abandoned hole or piezometer should be checked for settling at a later date and additional fill should be added as necessary.

N. Operation of Cathead (see Fig. 1)

1. The cathead shift lever (control S) has two forward speeds, one reverse and two neutral positions. It is located alongside the frame base just over the control console.
2. The transmission clutch (control O) must be disengaged when shifting the cathead lever.
3. When running the cathead, the sandline clutch (control E) should be disengaged and the sandline brake (control F) should be on.
4. Never wrap the rope, used on the cathead, around any part of your body. You could be pulled into the equipment if the rope gets caught.
5. Wear grooves in the cathead are cause for its replacement.
6. Worn rope should be replaced.
7. Be aware that if the rope breaks, suspended equipment will be dropping.
8. The cathead is only for lifting materials and equipment, it should not be used for work such as pulling out stuck vehicles. The mast is not constructed to support this type of pull.
9. Wear gloves to avoid rope splinters when using cathead.
10. Any rust on the cathead should be wire brushed off before using.
11. Cathead rope should be kept clean.
12. To use cathead, shift transmission into gear selected and engage clutch.
13. Wrap rope around spinning cathead: pulling on loose end will increase pull on lifting end; use one, two, or three wraps and beware of breaking rope (never use more than three wraps).

O. Operation of Sandline (see Fig. 1)

1. With the sandline brake (control F) on, and the sandline clutch (control E) disengaged, shift the cathead lever (control S) into one of the two forward speeds as detailed in item (N).
2. Raise a load by simultaneously loosening the sandline brake (control F) and engaging the sandline clutch (control E).
3. Suspend a load by simultaneously loosening the sandline clutch (control E) and engaging the sandline brake (control F).
4. Lower a load by disengaging the sandline clutch (control E) and slowly loosening the sandline brake (control F) allowing the sandline to free-spool.
5. These controls are located on the top rear of the control console.
6. Beware of burrs of wire on damaged wireline, always wear gloves when using the sandline.
7. The sandline is not made for pulling vehicles, only for handling drill equipment.

P. Water Pump Controls and Hookups (see Fig. 1)

1. Water pump controls are located on the left side of the control panel, a three-position lever (control T) and above the panel a restrictor valve (control U).
2. The water pump has two different modes of operation: it can pump water or it can suction it.
3. Pump: this mode is where water or mud is drawn from the water tank or another source through one of two inlets and then pumped out of one of the four outlets to where it is used. To use this mode, the pump control lever is pushed down from its central neutral position.
4. Suction: this mode is where the pump draws water or mud from an external source and then either fills the tanks or some other reservoir. To use this mode, lift up on the pump control lever.
5. Flow rate of the pump is controlled by the hydraulic valve (control U) at the top of the control panel and also the engine RPM.
6. A water pressure gauge (Gauge Q) is installed in the system, on the control panel, so that the operator can monitor system pressure. (During coring, the pressure through the water gauge should

be kept below 150 psi, if the pressure goes above this reading when the pump is running at full flow, there is probably a blockage in the coring bit.)

7. Never run the pump without having water in the system because it will burn up the pump's bearings.

Q. Drill Rod Chuck Operation (Not presently used)

1. Adjust two locking bolts until drill rod is centered.
2. When loosening rod in chuck, it is necessary only to loosen one locking bolt. Be sure to tighten the same bolt when rechucking.
3. Different sizes of chuck jaws can be used with the same chuck body.
4. Do not tighten centering screws. These screws are positioned at the factory.

PART III
MAINTENANCE AND SERVICE DATA

A. Service Instructions - Drill Rig and Truck

Rig

- Daily: - Check oil and water, on the engine: check hydraulic fluid tank.
- Lubricate all fittings every 10 hours or more often if needed due to hard usage.
 - Change oil every 100 hours: and change the filter every other oil change (filters can be purchased at Delaware Auto Parts).
 - Tune-up every 500 hours - change plugs, points, and condenser; also have valve clearance checked.

Truck

- Daily: - Check oil and water. Blow moisture from the air tank using the pressure relief valves.
- Grease fittings on the front every 1,000 miles.
 - Every 3,000 miles; change oil and complete lubrication
 - Change the oil filter every other oil change.
 - Every 10,000 miles: tune-up, change plugs, points, and condenser.

B. Storage of Parts and Tools

Tools and extra parts for the rig are stored at the DGS garage, located on the University of Delaware Agriculture Farm. Also stored here is the drilling mud and a large drum of Texaco P type hydraulic oil.

Replacement parts can be picked up at a supplier with the appropriate purchase order.

All parts and tools for the rig, as well as any repair work done, will be funded through the Water Resources Center Rig Account. Therefore all rig bills and receipts should be turned in at the Office of the University Research Coordinator, to the Director, WRC.

C. CME-55 Maintenance Instructions

1. Lubrication schedule

- a. Engine - see Ford manual
- b. Transmission - Use SAE 90 oil. Fill to check plug level on power takeoff side of transmission.
- c. Right Angle Drive - Use SAE 90 Oil. Fill case to top plug.
- d. Rotary Drive Bearings - Use "Lubriplate" or equivalent heavy duty bearing grease. Grease every 100 hours.
- e. Kelly Bar Bearing - Use "Lubriplate" or equivalent heavy duty bearing grease. Grease every 100 hours.
- f. Power Take Off Bearing - Use "Lubriplate" or equivalent heavy duty bearing grease. Grease every 100 hours.
- g. Rotary Slide Bushings - Use "Lubriplate" or equivalent heavy duty bearing grease. Fill through zerk fitting on back side of slide tube until grease comes out of top or bottom of bushing. Grease every 15 hours of operation.
- h. Frame Fold-over Pivot Pin - Use "Lubriplate" or equivalent heavy duty bearing grease. Grease every 100 hours.
- i. Tilt Cylinder Pivot Pin - Use "Lubriplate" or equivalent heavy duty bearing grease. Grease every 100 hours.
- j. Kelly Bar - Use graphite base grease. If not available use "Lubriplate" or equivalent heavy duty bearing grease. Grease every 15 hours of operation.

- k. Hydraulic Oil Tank - Use good grade of hydraulic oil; such as Texaco, PC-R, and O. Fill to within one inch of filler cap. Replace oil and filter every six months of operation.
- l. Cathead - Use SAE 90 oil in gear box. Fill to center check plug. Oil chain drive every 15 hours.
- m. Sandline - Use SAE 90 oil in gear box. Fill to center check plug. Use bearing grease (Lubriplate or equivalent) in two outboard bearings. Grease every 25 hours. Oil chain drive every 15 hours.
- n. Sliding Base - Oil sliding base rails every 15 hours.
- o. Water Pump Assembly - Use lithium base grease to lubricate the bearings and packing. Lubrication of the bearings is necessary only every 1,500 hours and the main pump shaft must be taken out to do it (see Moyno folder). Packing should be greased sparingly but often through the associated grease fittings on the side of the pump.
- p. Tower Sheaves - Use "Lubriplate" or equivalent heavy duty bearing grease. Grease every 15 hours.
- q. Hydraulic Jacks - Put several ounces of oil through opening in top of cylinder housing as needed. This lubricates bronze bushings at bottom of housing.

2. Slip Clutch Adjustment

- a. Two setscrews on adjusting nut must be loosened before nut can be turned.
- b. To loosen slip clutch, turn adjusting nut counter-clockwise.
- c. To tighten slip clutch, turn adjusting nut clockwise.
- d. Use torque wrench supplied with drill to turn adjusting nut.

- e. After clutch is adjusted, tighten setscrews on adjusting nut.
3. Rotary Box Chain Adjustment (1/8" per total L)

Loosen top and bottom bearing bolts on spindle and turn adjusting screws for proper chain tension. Tighten bearing bolts. Care should be taken not to adjust chain too tight.
 4. Cathead Chain Adjustment

Loosen four bolts on cathead slide plate. Position slide plate for proper tension by adjusting top and bottom adjusting screws. Tighten slide plate bolts.
 5. Sandline Chain Adjustment

Loosen hold down bolts and adjusting bolts for proper chain tension; tighten hold down bolts.
 6. Sandline Clutch Adjustment
 - a. Pull out spring-loaded clutch collar pin.
 - b. Rotate clutch collar assembly clockwise to increase clutch pressure. Rotate clutch collar assembly counterclockwise to decrease clutch pressure.
 - c. Relocate spring-loaded clutch collar pin in nearest hole in clutch pressure plate.
 7. Periodically Check Tightness of Nuts and Bolts.
 8. Hydraulic Valve Relief Settings
 - a. Remove acorn nut on relief valve.
 - b. Loosen adjusting screw jam nut.
 - c. Turn adjusting screw clockwise to raise pressure; counterclockwise to reduce pressure.
 - d. Tighten adjusting screw jam nut and replace acorn cap.
 - e. Adjust pressure in feed valve to 1,300 p.s.i.
 - f. Adjust pressure in jack valve to 1,500 p.s.i.
 - g. Adjust pressure in hydraulic winch valve to 2,000 p.s.i. (Not presently used on DGS rig).

9. Hydraulic Cylinder Servicing Instructions

a. Recommended Tools for Disassembly of Cylinders:

1. Chain wrench - such as wrench No. 887 manufactured by the Owatanna Tool Co., Owatanna, Minnesota, or wrench No. CW 12 manufactured by the Diamond Tool and Horseshoe Co., Duluth, Minnesota.
2. Hook and Spanner wrench - such as wrench No. 474 manufactured by the Armstrong Brothers Tool Co., Chicago, Illinois. (The above chain and spanner wrenches are sold in most cities by bearing distributors or most hardware stores, or they may be obtained from CME).
3. Drift punch and hammer.
4. A sharp hooked tool, such as a nut pick.
5. A lead hammer.
6. A blunt nose screw driver.
7. A flashlight.

b. Piston Rod Packing Adjustment:

1. The packing set consists of one male adapter, a given number of vee rings and a female adapter. The two lips, formed by the "V" shape of each vee ring, face the fluid pressure and contact the inner and outer surfaces to be sealed. Lip interference (the flare built into the vee ring) preloads the packing automatically. Each vee ring in the packing set functions as a separate pressure seal. With a new set of packing installed, the packing gland must be drawn up lightly to a snug adjustment only. If excessive packing gland adjustment is used, the packing will not function automatically. Friction increases, therefore, shortening packing life and actually causing the packing to leak.
2. Initial operation of the cylinder may show some oil leakage before the vee rings are properly set. Operate the cylinder several

times before tightening the packing gland. Allow the plunger to operate with a slight film of oil on its surface.

3. If, after extended time of cylinder operation, the packing starts to leak, loosening of the packing gland will sometimes eliminate the leak. This is because the packing will have a tendency to swell in oil which increases the tension of the lips against the sealing surfaces. When this pressure is relieved, the lips resume their normal automatic sealing action.
4. If the piston is wiping dry, this usually indicates dry packing. Loosen the packing gland one-half to three-quarters turn and leave it there while cycling the cylinder. If a slight film of oil appears (this is not considered leaking), it is not necessary to tighten the packing gland.
5. A damp to light film of oil on the piston rod indicates good cylinder operation. After many cycles of the cylinder, a small accumulation of oil may be noticed on the piston rod, at the rod and in the extended position. This must not be mistaken for packing leakage.

c. Removal of Piston Rod Packing:

1. Extend the piston rod part way out and loosen packing gland with the hook spanner wrench and remove from stuffing box.
2. Remove the packing set with the sharp hooked tool or screw driver.
3. The bushing, beneath the packing set on the cylinder, need not be removed unless excessive wear is in evidence.

d. Installing New Packing Set:

1. Be sure packing cavity is clean and free of any small pieces of old packing.

2. Install each component of the new packing set separately, beginning with the male (bottom) adapter. Next insert one vee ring at a time, making sure all rings are firmly set and seated on the preceding ring.
3. The lips of the vee rings must always face the inside or fluid pressure side of the cylinder.
4. Use the blunt nose screw driver, and a flashlight (depending on light conditions) to install the packing adapters and vee rings. Push the vee ring carefully into position by starting at one point on the vee ring and working around the entire circumference of the ring several times. Be careful not to damage or curl the vee ring lips - proceed cautiously.
5. Finally, install the female (top) adapter of the packing set.
6. Replace the wiper ring in the packing gland, if it is damaged.
7. Screw the packing gland back into the stuffing box. Draw up packing gland lightly - see Piston Rod packing adjustment, Section B).

e. Removal of Stuffing Box:

With the chain wrench, unscrew the stuffing box with care. If threads become tight, try tightening and loosening. Alternate this procedure carefully until threads become free. Use a soft hammer by applying it to the tube O.D. while unscrewing the stuffing box.

f. Replacement of Piston Cup Packing:

1. Back-off the packing gland a few turns to relieve the packing pressure on the piston rod.

2. Unscrew the stuffing box (see Section e above) and remove the entire piston rod assembly from the cylinder tube.
3. Place the piston in a vise with copper plates or some suitable soft metal to protect the rod.
4. With a hammer and drift pin, remove the roll pin from the rod nut.
5. Remove the nut, cup followers, piston, and cups.
6. Install the new cups in the piston assembly. Make sure the O.D. of the cast iron piston doesn't have any steel fragments imbedded in its surface. Along with this, inspect the cylinder tube I.D. for any possible score marks.
7. Replace O-ring located on the stuffing box, if it is frayed or cut.
8. Replace O-ring located under piston, if it is frayed or cut. Place a light coating of all-purpose grease on this O-ring and carefully slide complete piston assembly on rod.
9. Secure in place with rod nut and roll pin.
10. Place a light coating of all purpose grease on the stuffing box O-ring and piston cups.
11. Carefully insert piston rod assembly in cylinder tube, making sure not to rub cups or O-ring against the cylinder tube threads.
12. Place a light coat of oil and graphite or "Molykote" on the stuffing box to facilitate easy assembly. Secure stuffing box in place with the chain wrench.

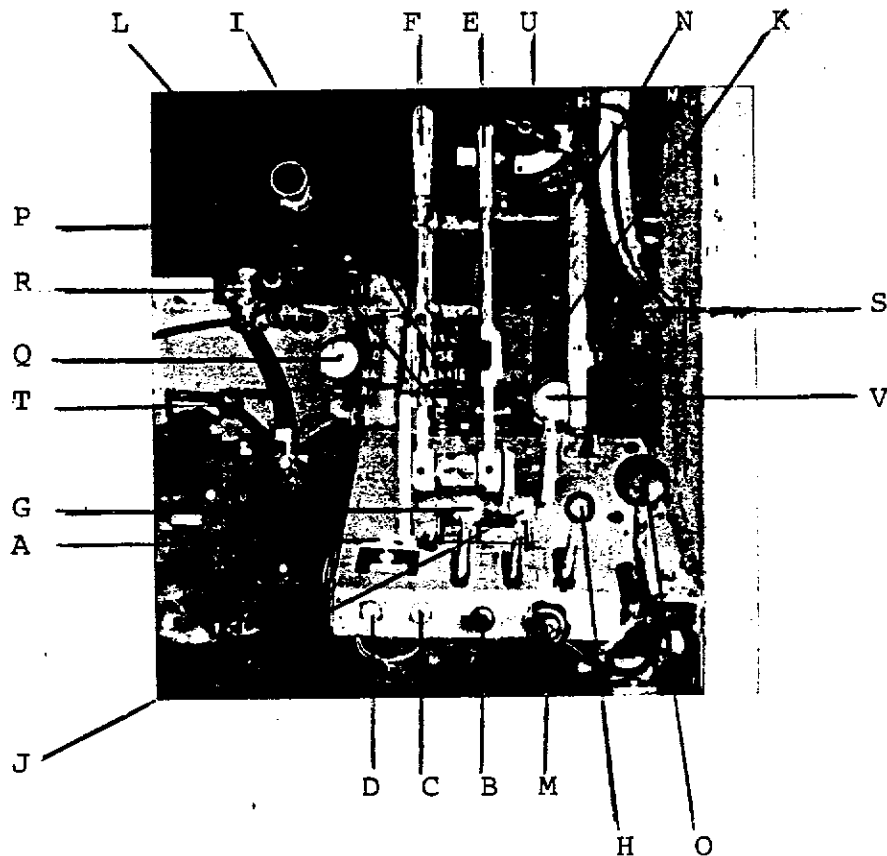
g. Special Instructions for Hydraulic Jack
Cylinders:

1. For replacing packing set in the jack cylinder where the piston rod cylinder port interferes with the packing gland removal and packing installation from the rod end, the piston and rod assembly must be removed from the cylinder tube assembly.
2. Disassemble the piston and stuffing box from the piston end of the rod (see Section f, Replacement of Piston Packing). The packing gland may be left on the rod.
3. Slide the new packing set on the piston rod from the piston end, then slide on the stuffing box. Assemble the piston on the rod, insert the piston rod assembly in the cylinder tube and secure stuffing box.
4. With the piston rod extended, install the packing, as per Section D above. Do not install packing set in stuffing box prior to replacing stuffing box on the piston rod. The vee ring lips may be cut when passing over drilled holes in piston rod at the piston end.

APPENDIX G

ILLUSTRATIONS OF DRILL RIG PARTS AND ASSOCIATED PARTS LIST

FIGURE 1. Control Console:



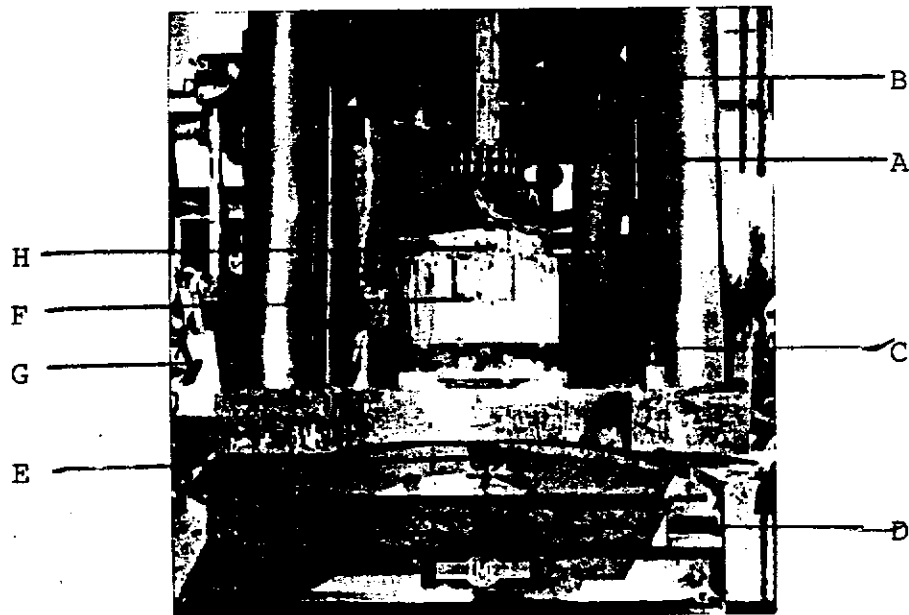
- A - Safety Switch
- B - Choke
- C - Ignition Switch
- D - Starter Button
- E - Sandline Clutch
- F - Sandline Brake
- G - Fold-over Valve (for mast elevation)
- H - Feed Control Lever
- I - Leveling Jack Control Levers
- J - Slide-base Control Lever
- K - Hydraulic Bypass Valve
- L - Hydraulic Restrictor Valve
- M - Throttle
- N - Transmission Gearshift
- O - Clutch
- P - Water Swivel Connector and Valve
- Q - Pumping System Pressure Gauge
- R - Standard Hose Valve
- S - Cathead Gearshift
- T - Pump Control Lever
- U - Pumping System Hydraulic Restrictor Valve
- V - Hydraulic Pressure Gauge

FIGURE 2. Cathead and Safety Switch



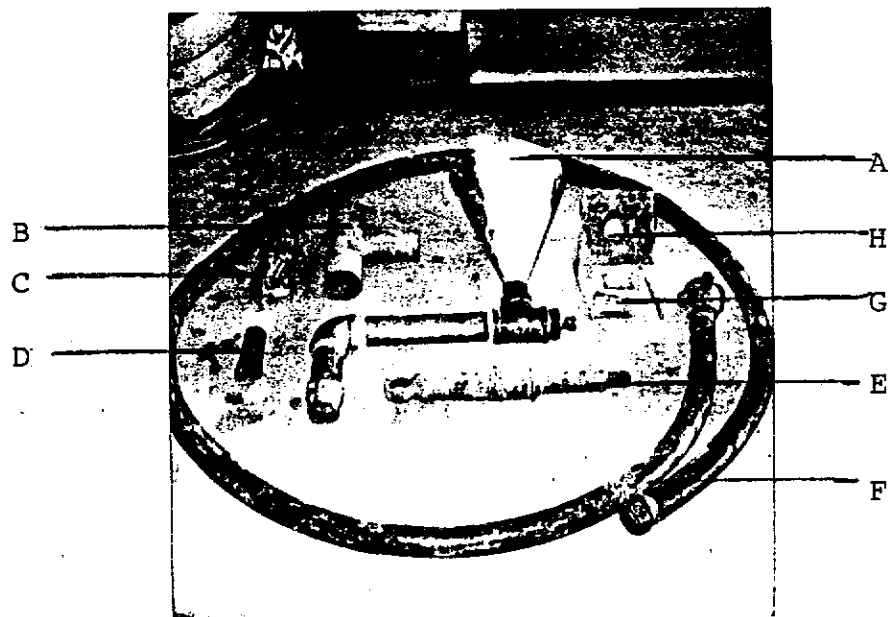
- A - Safety Switch
- B - Cathead
- C - Cathead Oil Check Plug
- D - Right-angle Drive
- E - Cathead Oil Drain Plug
- F - Guard for Chain Drive

FIGURE 3. Right-angle Drive and Mast Retaining Features



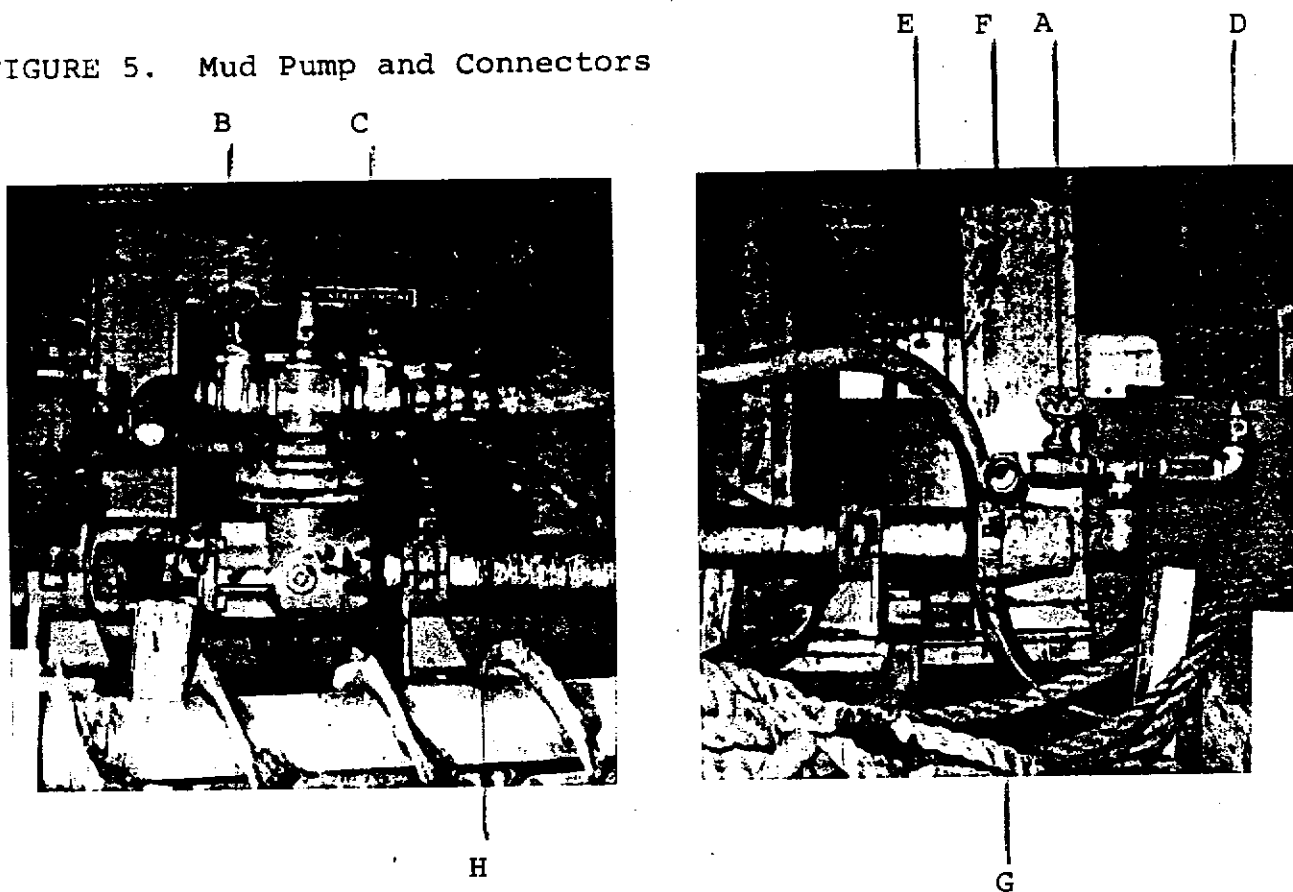
- A - Kelly Bar Flexible Coupling
- B - Kelly Bar
- C - Right-angle Drive Oil Drain Plug
- D - A-rod Rack Cover
- E - Mast Hold Down Bolt
- F - Right-angle Drive
- G - Control Console
- H - Right-angle Drive Oil Check Plug

FIGURE 4. Mud Rotary Equipment (see fig. 6 for water swivel)



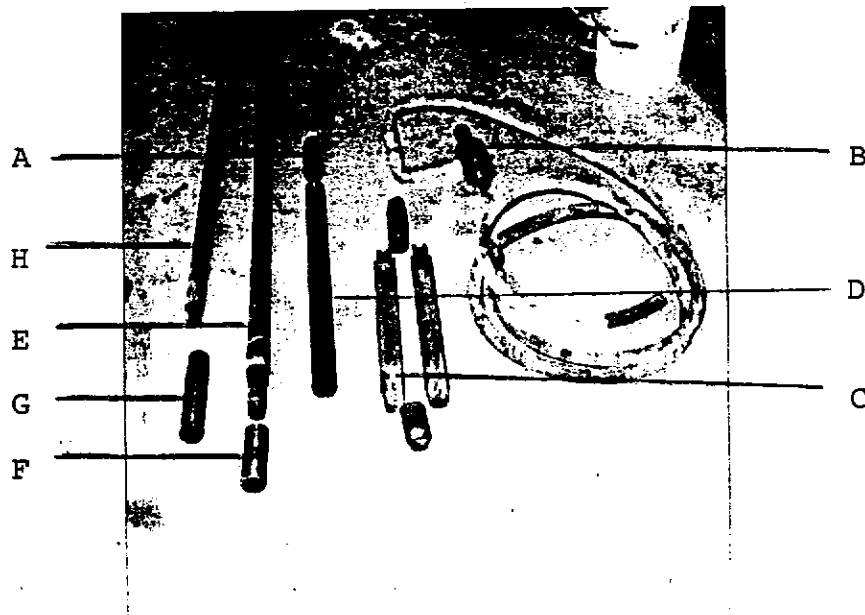
- A - Mud Mixer
- B - Spill 'T' for Auger String
- C - Fishtail Drag Bit
- D - 2 Cone Rock Roller Bit
- E - A-rod Pulling Plug
- F - Suction Hose with Foot Valve
- G - A-rod Slips
- H - Casing Insert Slip Holder

FIGURE 5. Mud Pump and Connectors



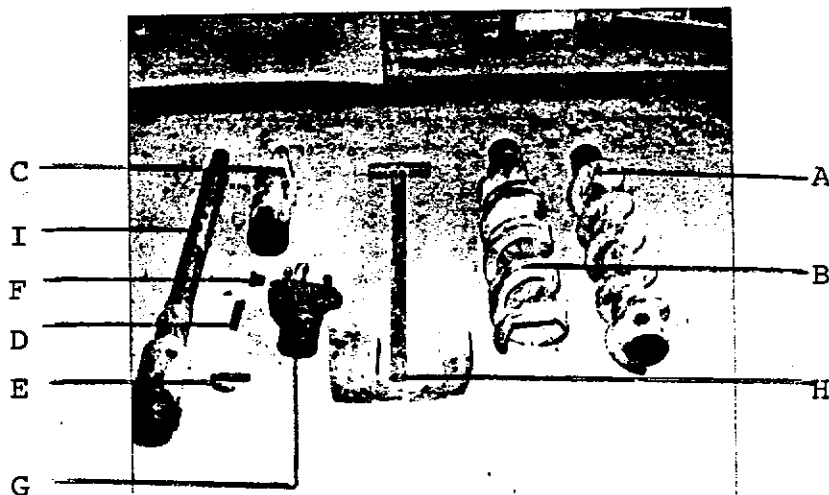
- A - Mud Mixer Connection (1.5 inch hose)
 - B - Suction Hose Inlet (1.5 inch hose)
 - C - Main Tank Inlet Valve
 - D - Standard Hose Valve
 - E - Hydraulic Filter
 - F - Hydraulic Tank
 - G - Main Tank Inlet Hose
 - H - Moyno Hydraulically Driven Pump
- (Closer observation of pump yields several drain plugs for cold weather use, and lube fittings for the pump).

FIGURE 6. Sampling Devices and Water Swivel



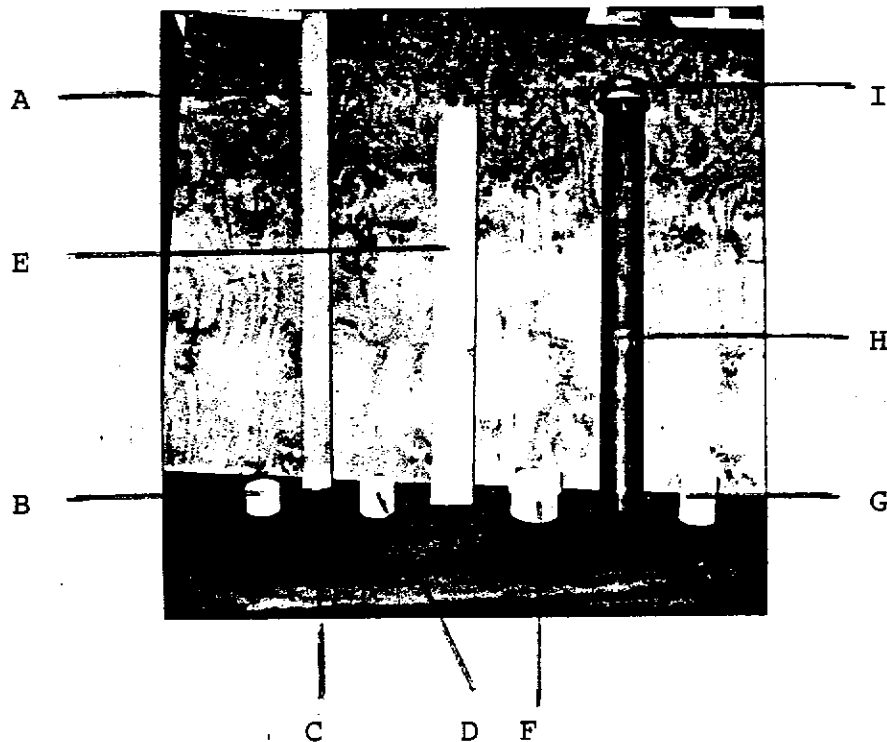
- A - Shelby Tube Adaptor
- B - Water Swivel (Note: Lube fitting on side of swivel)
- C - Disassembled 18-inch Split Spoon
- D - Shelby Tube
- E - Coring Barrel with Inner Barrel and Core Catcher uncovered.
- F - Diamond Coring Bit
- G - Carbide Reaming Shell and Coring Bit
- H - A-rod

FIGURE 7. Augering Equipment



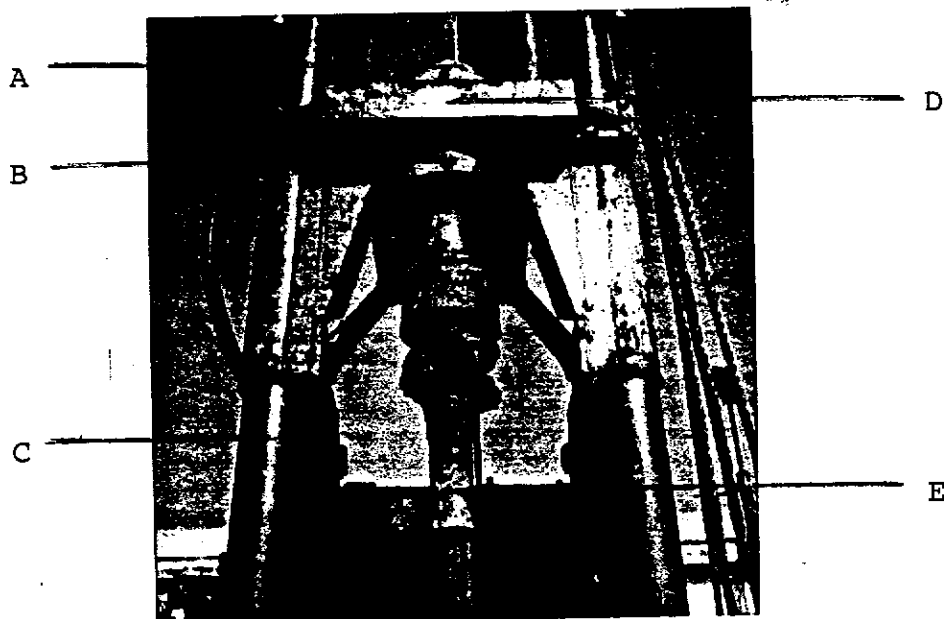
- A - Hollow Stem Auger
- B - Auger Fishing Tool
- C - Auger Hoisting Socket
- D - Replaceable Tooth for Auger Drilling Head
- E - Drive Pin
- F - Auger Retaining Screw
- G - Auger Drilling Head with removable center plug
- H - Fork
- I - Auger Drilling Adaptor

FIGURE 8. Examples of Casing, Screen, and Misc. Parts



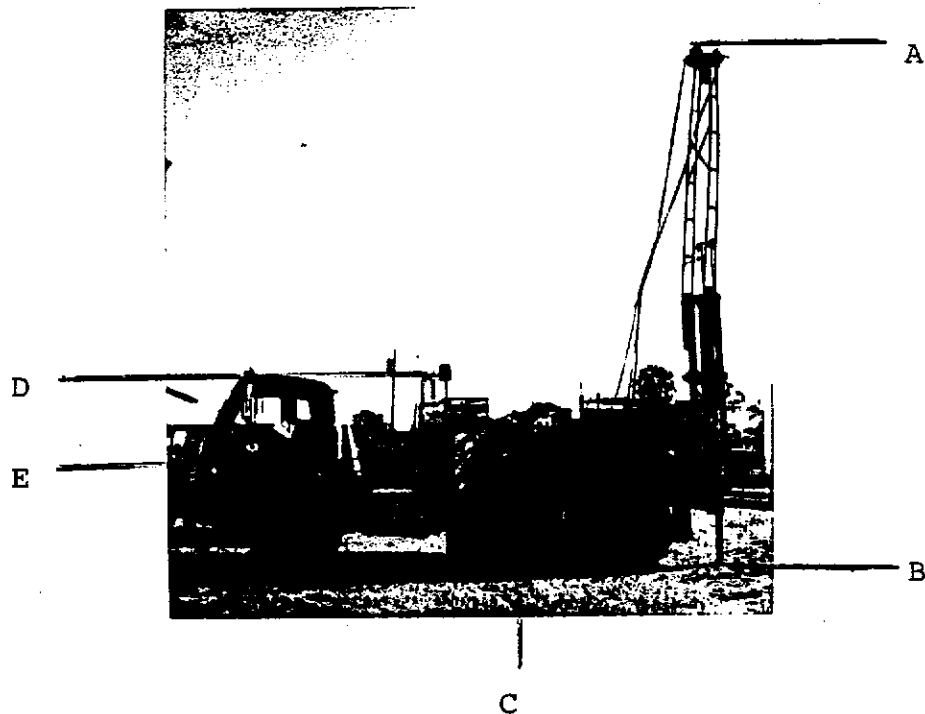
- A - PVC Slotted Well Screen (I.D. 1")
- B - PVC Cap (for 1" pipe or screen)
- C - PVC Push or Drive Point (for 1" pipe or screen)
- D - Shallow PVC Coupling (for 1" pipe or screen)
- E - PVC Pipe (schedule 40, 2" I.D.)
- F - PVC to 2" Threaded Stock Adaptor
- G - PVC Deep Coupling (for 1.5" I.D. pipe or screen)
- H - 2" Threaded, Galvanized Steel Casing
- I - 2" Threaded, Galvanized Steel Cap

FIGURE 9. Rotary Table



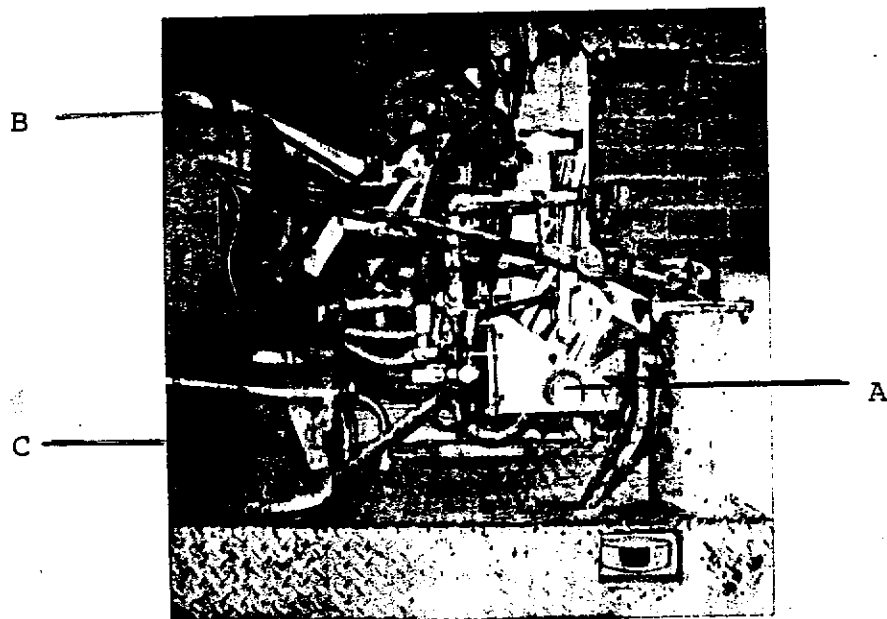
- A - Rotary Table Bearing-Lube Zerk Fittings
- B - On back side of Rotary Table Slide Tubes: Bushing-Lube Zerk Fittings
- C - Rotary Table Slides (These have about a 6 foot run length)
- D - Rotary Table
- E - Hex Socket for Auger and A-rod Drive

FIGURE 10. Rig Side View

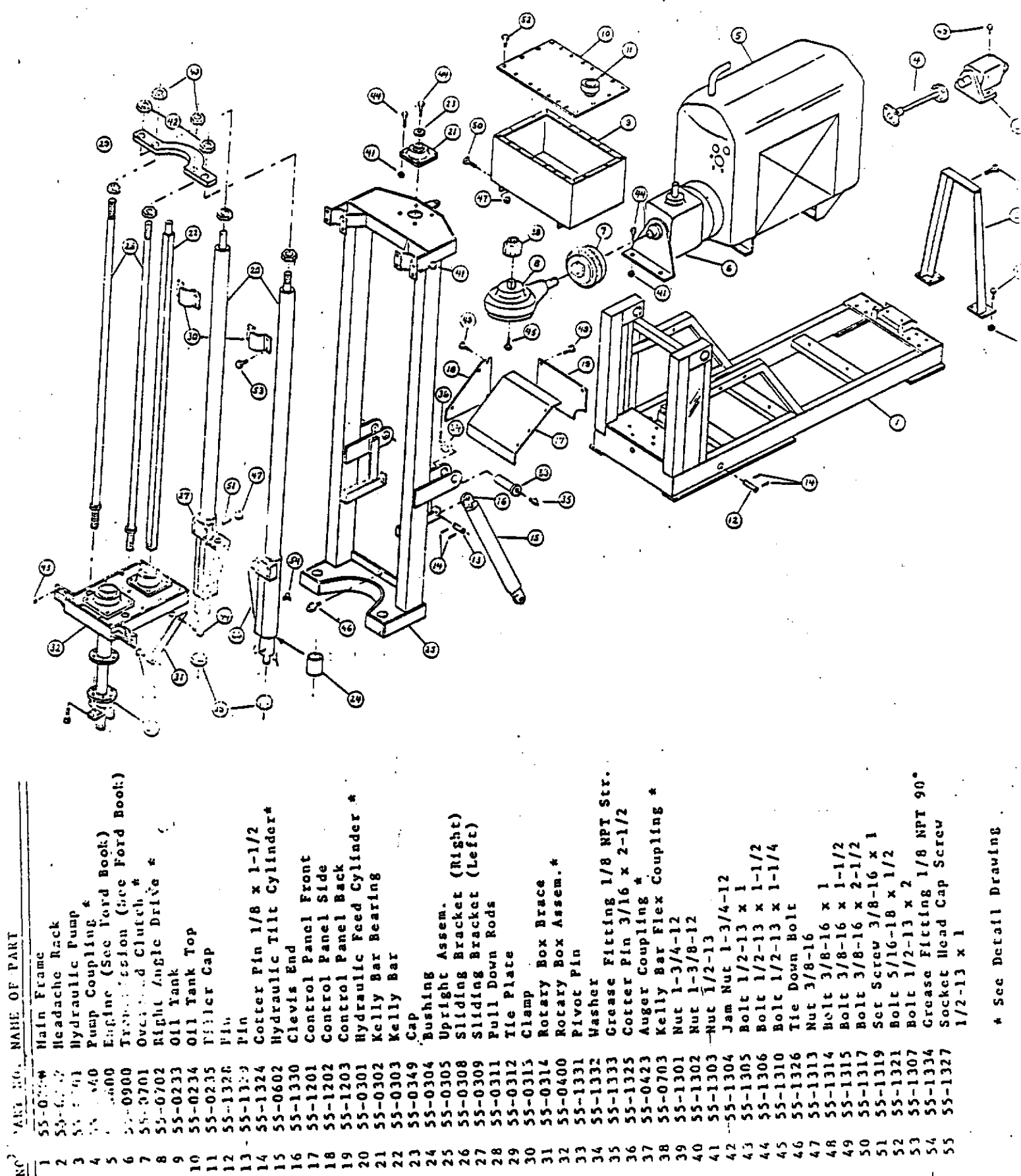


- A - Drill Rig Mast Height: About 25 feet when elevated which allows the cathead or sandline to pull 20 feet of augers or A-rods.
About 12 feet with mast in travelling mode.
- B - Leveling Jack
- C - Tool Boxes
- D - Warning Light (Connect Large Alligator Clip to (+) Positive Battery Terminal for Operation)
- E - Water Tanks

FIGURE 11. Console Side View

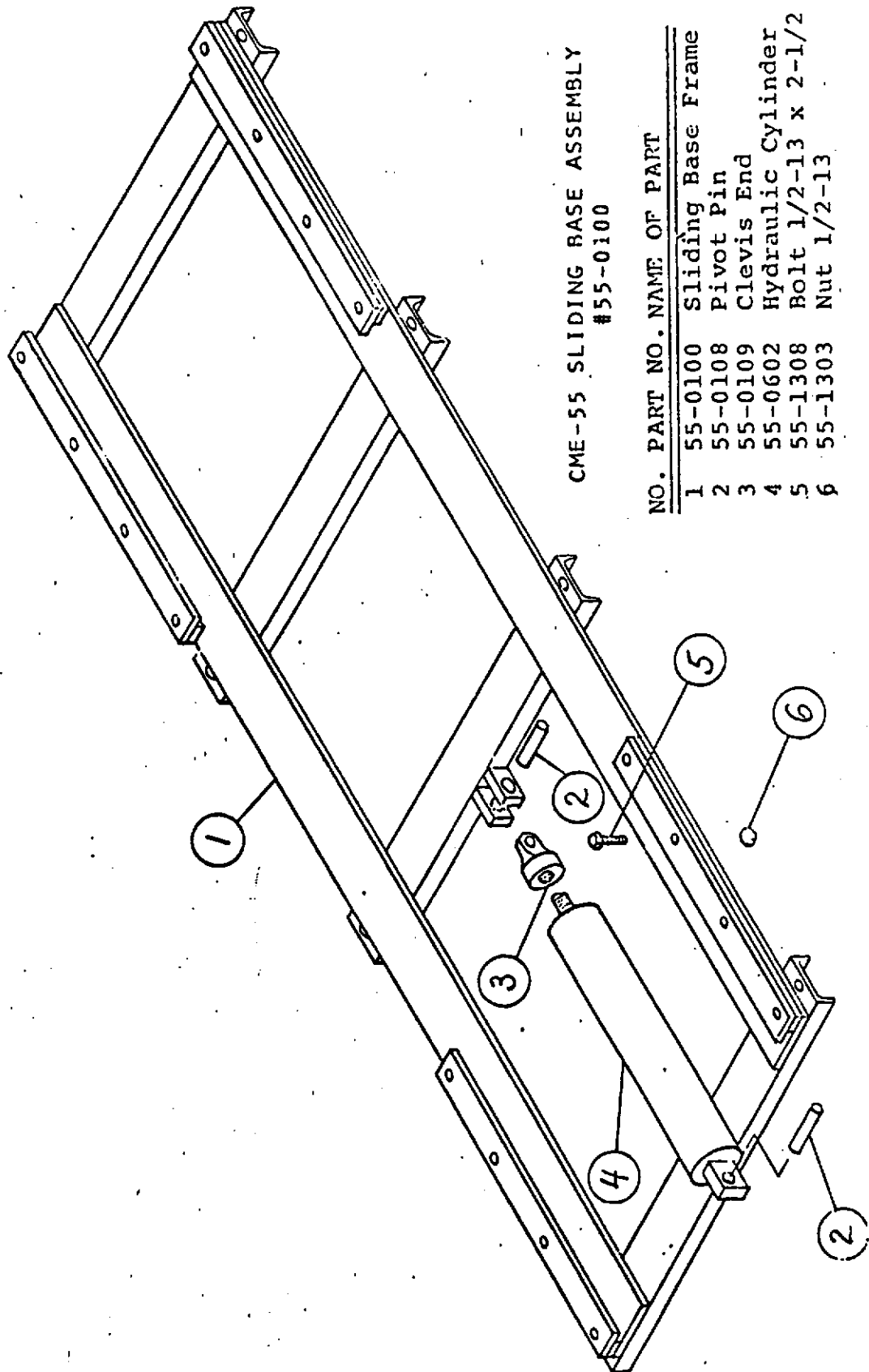


- A - Hour Meter for Rig Operation (This should be read at the end of each day, along with the odometer in the truck cab).
- B - Wireline Hoist (Sandline) - note the lube fitting.
- C - Extra Fuel Can (5 gallons).



| NO. | PART NO. | NAME OF PART |
|-----|----------|----------------------------------|
| 1 | 55-0000 | Main Frame |
| 2 | 55-0001 | Headache Rack |
| 3 | 55-0002 | Hydraulic Pump |
| 4 | 55-0003 | Pump Coupling * |
| 5 | 55-0004 | Engine (See Ford Book) |
| 6 | 55-0005 | Transmission (See Ford Book) |
| 7 | 55-0701 | Overhaul Clutch * |
| 8 | 55-0702 | Right Angle Drive * |
| 9 | 55-0233 | Oil Tank |
| 10 | 55-0234 | Oil Tank Top |
| 11 | 55-0235 | Filler Cap |
| 12 | 55-1328 | Pin |
| 13 | 55-1329 | Pin |
| 14 | 55-1324 | Cotter Pin 1/8 x 1-1/2 |
| 15 | 55-0602 | Hydraulic Tilt Cylinder* |
| 16 | 55-1330 | Clevis End |
| 17 | 55-1201 | Control Panel Front |
| 18 | 55-1202 | Control Panel Side |
| 19 | 55-1203 | Control Panel Back |
| 20 | 55-0301 | Hydraulic Feed Cylinder * |
| 21 | 55-0302 | Kelly Bar Bearing |
| 22 | 55-0303 | Kelly Bar |
| 23 | 55-0349 | Cap |
| 24 | 55-0304 | Bushing |
| 25 | 55-0305 | Upright Assem. |
| 26 | 55-0308 | Sliding Bracket (Right) |
| 27 | 55-0309 | Sliding Bracket (Left) |
| 28 | 55-0311 | Pull Down Rods |
| 29 | 55-0312 | Tie Plate |
| 30 | 55-0315 | Clamp |
| 31 | 55-0314 | Rotary Box Brace |
| 32 | 55-0400 | Rotary Box Assem. * |
| 33 | 55-1331 | Pivot Pin |
| 34 | 55-1332 | Washer |
| 35 | 55-1333 | Grease Fitting 1/8 NPT Str. |
| 36 | 55-1325 | Cotter Pin 3/16 x 2-1/2 |
| 37 | 55-0423 | Auger Coupling * |
| 38 | 55-0703 | Kelly Bar Flex Coupling * |
| 39 | 55-1301 | Nut 1-3/4-12 |
| 40 | 55-1302 | Nut 1-3/8-12 |
| 41 | 55-1303 | Nut 1/2-13 |
| 42 | 55-1304 | Jam Nut 1-3/4-12 |
| 43 | 55-1305 | Bolt 1/2-13 x 1 |
| 44 | 55-1306 | Bolt 1/2-13 x 1-1/2 |
| 45 | 55-1310 | Bolt 1/2-13 x 1-1/4 |
| 46 | 55-1326 | Tie Down Bolt |
| 47 | 55-1313 | Nut 3/8-16 |
| 48 | 55-1314 | Bolt 3/8-16 x 1 |
| 49 | 55-1315 | Bolt 3/8-16 x 1-1/2 |
| 50 | 55-1317 | Bolt 3/8-16 x 2-1/2 |
| 51 | 55-1319 | Set Screw 3/8-16 x 1 |
| 52 | 55-1321 | Bolt 5/16-18 x 1/2 |
| 53 | 55-1307 | Bolt 1/2-13 x 2 |
| 54 | 55-1334 | Grease Fitting 1/8 NPT 90° |
| 55 | 55-1327 | Socket Head Cap Screw 1/2-13 x 1 |

* See Detail Drawing

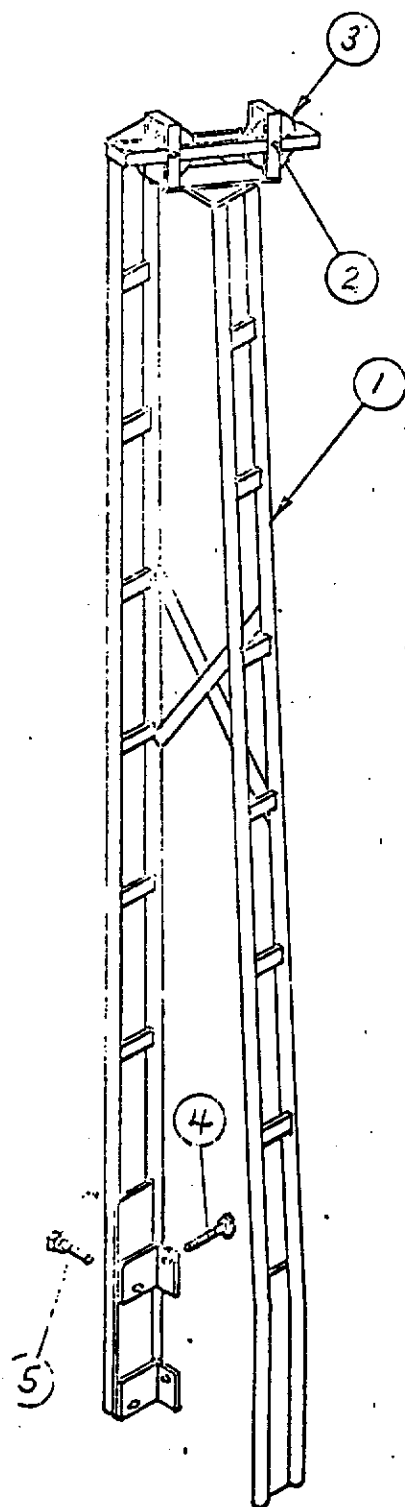


CME-55 SLIDING BASE ASSEMBLY
#55-0100

NO. PART NO. NAME OF PART

| | | |
|---|---------|---------------------|
| 1 | 55-0100 | Sliding Base Frame |
| 2 | 55-0108 | Pivot Pin |
| 3 | 55-0109 | Clevis End |
| 4 | 55-0602 | Hydraulic Cylinder |
| 5 | 55-1308 | Bolt 1/2-13 x 2-1/2 |
| 6 | 55-1303 | Nut 1/2-13 |

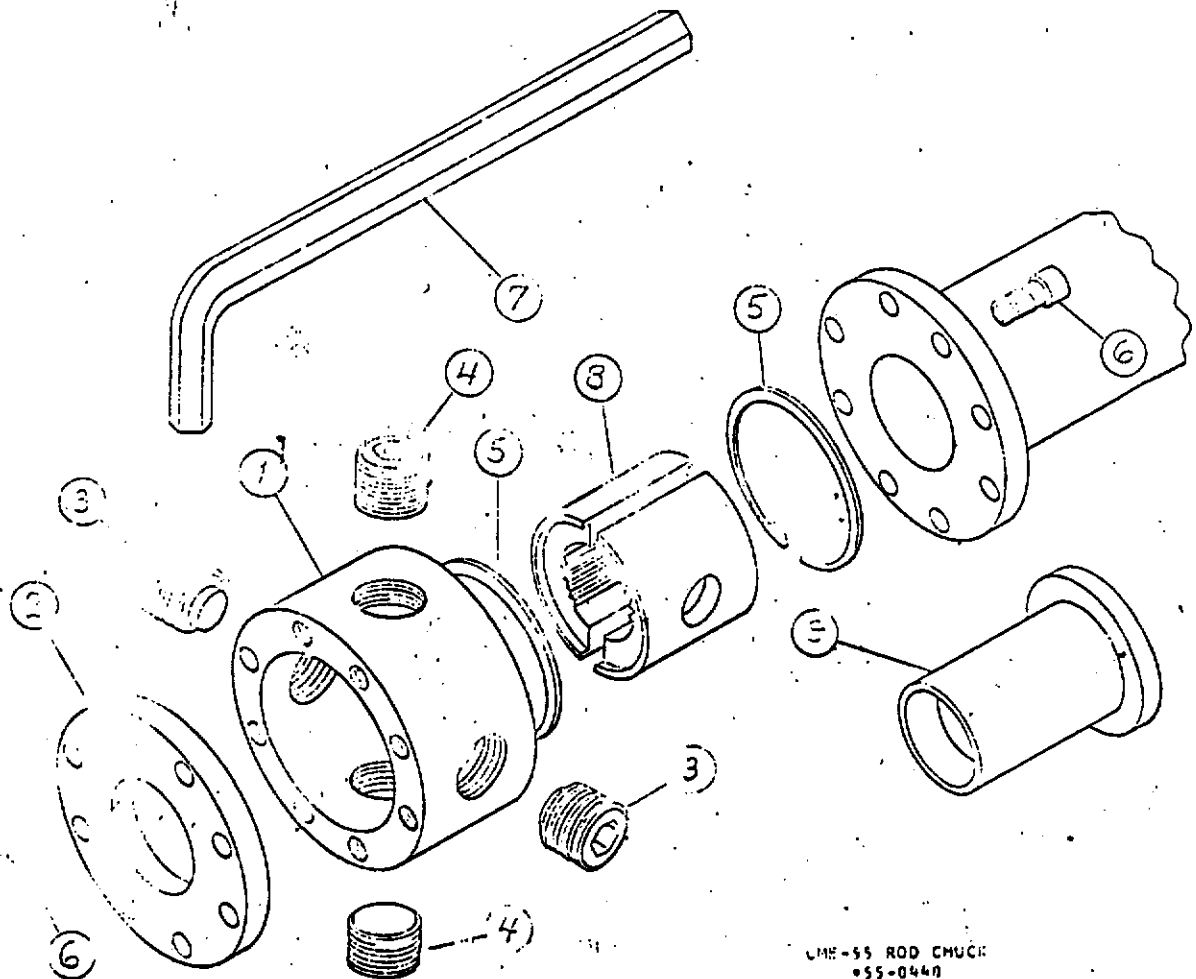
Specify Drill Model & Serial Number When Ordering Parts



CME-55 TOWER ASSEMBLY
#55-0350

| NO. | PART NO. | NAME OF PART |
|-----|----------|----------------------|
| 1 | 55-0351 | Tower Weld Assem. |
| 2 | 55-0352 | Sheave Pin |
| 3 | 55-0353 | Sheave (Rope) |
| 3 | 55-0355 | Sheave (Wire) |
| 4 | 55-1311 | 1/2-13 x 6 Bolts |
| 5 | 55-1309 | 1/2-13 x 4-1/2 Bolts |

Specify Drill Model & Serial Number When Ordering Parts

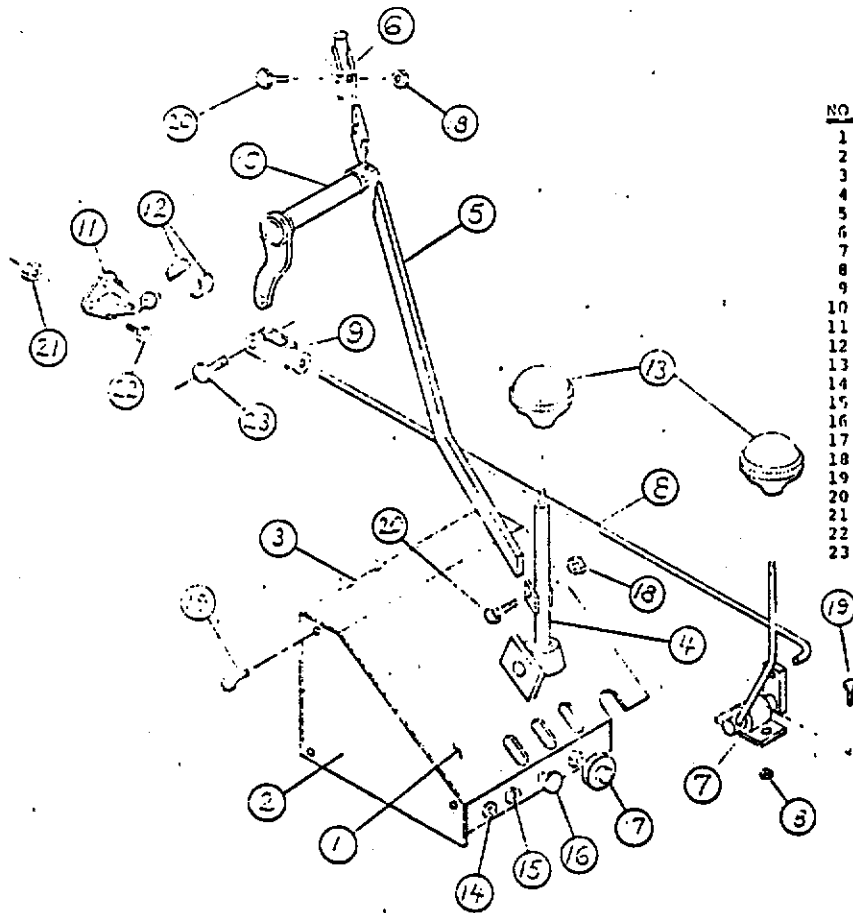


LME-55 ROD CHUCK
•55-0440

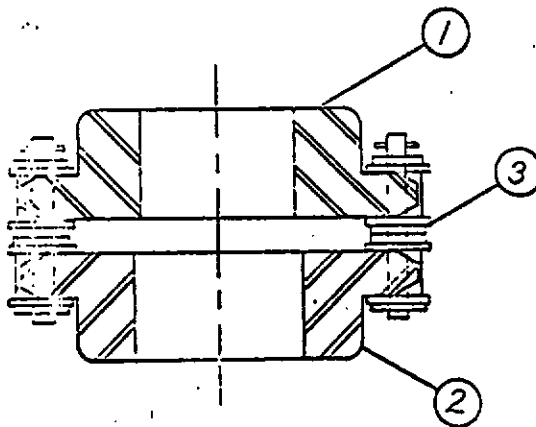
| NO. | PART NO. | NAME OF PART |
|-----|----------|----------------------|
| 1 | 55-0441 | Body |
| 2 | 55-0442 | End Plate |
| 3 | 55-0443 | Adjusting Screw |
| 4 | 55-0444 | Centering Screw |
| 5 | 55-0445 | Shao Ring |
| 6 | 55-1327 | Socket Hd. Cap Screw |
| 7 | 55-0446 | Socket Wrench |
| 8 | 55-0447 | Jaw Set "E" Rod |
| 8 | 55-0448 | Jaw Set "EM" Rod |
| 8 | 55-0449 | Jaw Set "A" Rod |
| 8 | 55-0450 | Jaw Set "AM" Rod |
| 8 | 55-0451 | Jaw Set "B" Rod |
| 8 | 55-0452 | Jaw Set "BM" Rod |
| 8 | 55-0453 | Jaw Set "N" Rod |
| 8 | 55-0454 | Jaw Set "NM" Rod |
| 9 | 55-0455 | Bushing "E" Rod |
| 9 | 55-0456 | Bushing "EM" Rod |
| 9 | 55-0457 | Bushing "A" Rod |
| 9 | 55-0458 | Bushing "AM" Rod |
| 9 | 55-0459 | Bushing "B" Rod |
| 9 | 55-0460 | Bushing "BM" Rod |
| 9 | 55-0461 | Bushing "N" Rod |
| 9 | 55-0462 | Bushing "NM" Rod |

Specify Drill Model & Serial Number When Ordering Parts

CME-55 CONTROL PANEL #55-1200



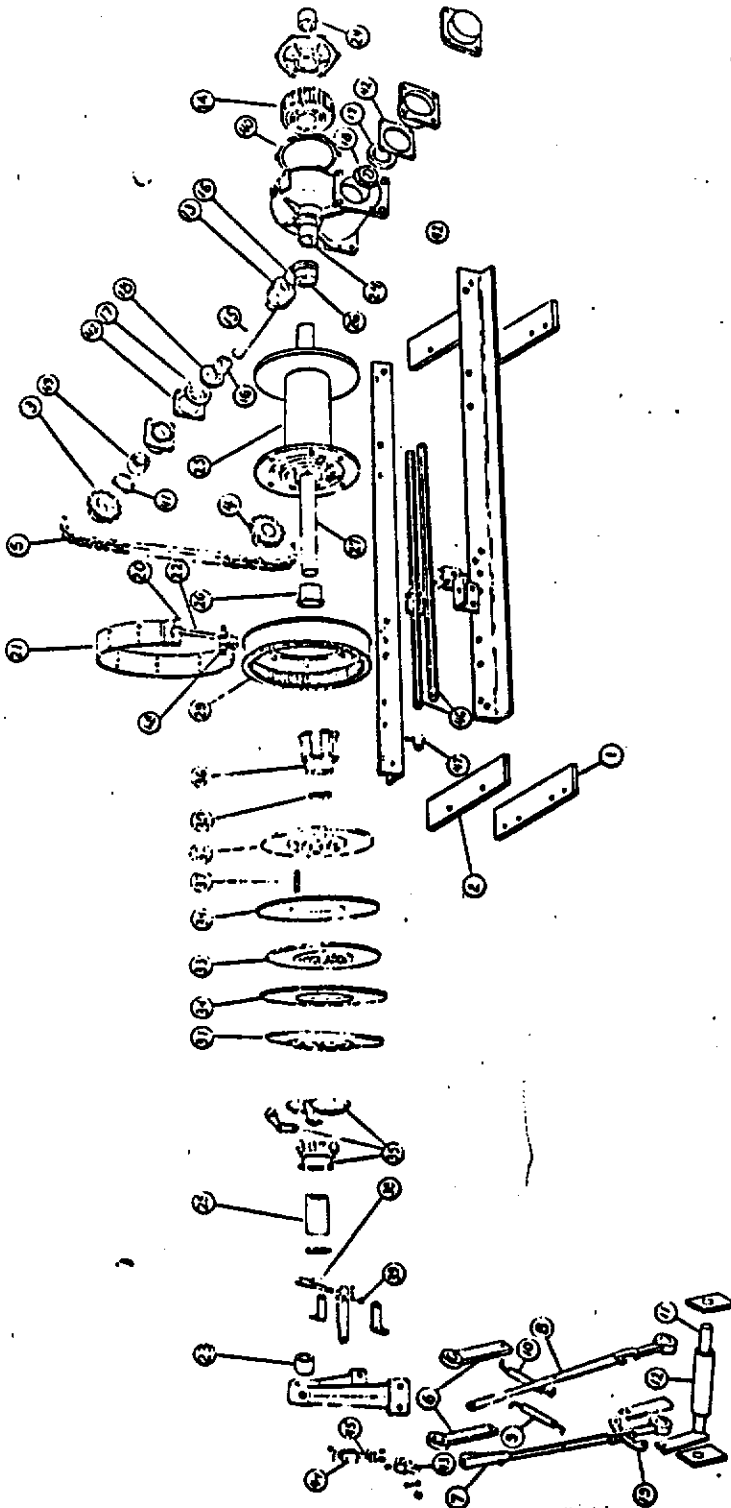
| NO. | PART NO. | NAME OF PART |
|-----|----------|------------------------|
| 1 | 55-1201 | Control Panel Front |
| 2 | 55-1202 | Control Panel Side |
| 3 | 55-1203 | Control Panel Back |
| 4 | 55-1204 | Shift Lever Assem. |
| 5 | 55-1205 | Shift Linkage Rod |
| 6 | 55-1206 | Shift Rod |
| 7 | 55-1207 | Clutch Lever Assem. |
| 8 | 55-1208 | Clutch Linkage Rod |
| 9 | 55-1209 | Clevis End |
| 10 | 55-1210 | Clutch Arm |
| 11 | 55-1211 | Clutch Arm Bracket |
| 12 | 55-1212 | Split Bushing |
| 13 | 55-1213 | Knob |
| 14 | 55-1214 | Starter Button |
| 15 | 55-1215 | Ignition Switch |
| 16 | 55-1216 | Choke Control |
| 17 | 55-1217 | Throttle Control |
| 18 | 55-1313 | Nut 3/8-16 |
| 19 | 55-1314 | Bolt 3/8-16 x 1 |
| 20 | 55-1316 | Bolt 3/8-16 x 1-3/4 |
| 21 | 55-1320 | Nut 5/16-18 |
| 22 | 55-1322 | Bolt 5/16-18 x 1 |
| 23 | 55-1335 | Pivot Pin w/Cotter Key |



CME-55 KELLY BAR FLEXIBLE COUPLING #55-0703

| NO. | PART NO. | NAME OF PART |
|-----|----------|-----------------|
| 1 | 55-0735 | Top Sprocket |
| 2 | 55-0736 | Bottom Sprocket |
| 3 | 55-0737 | Chain |

Specify Drill Model & Serial Number When Ordering Parts



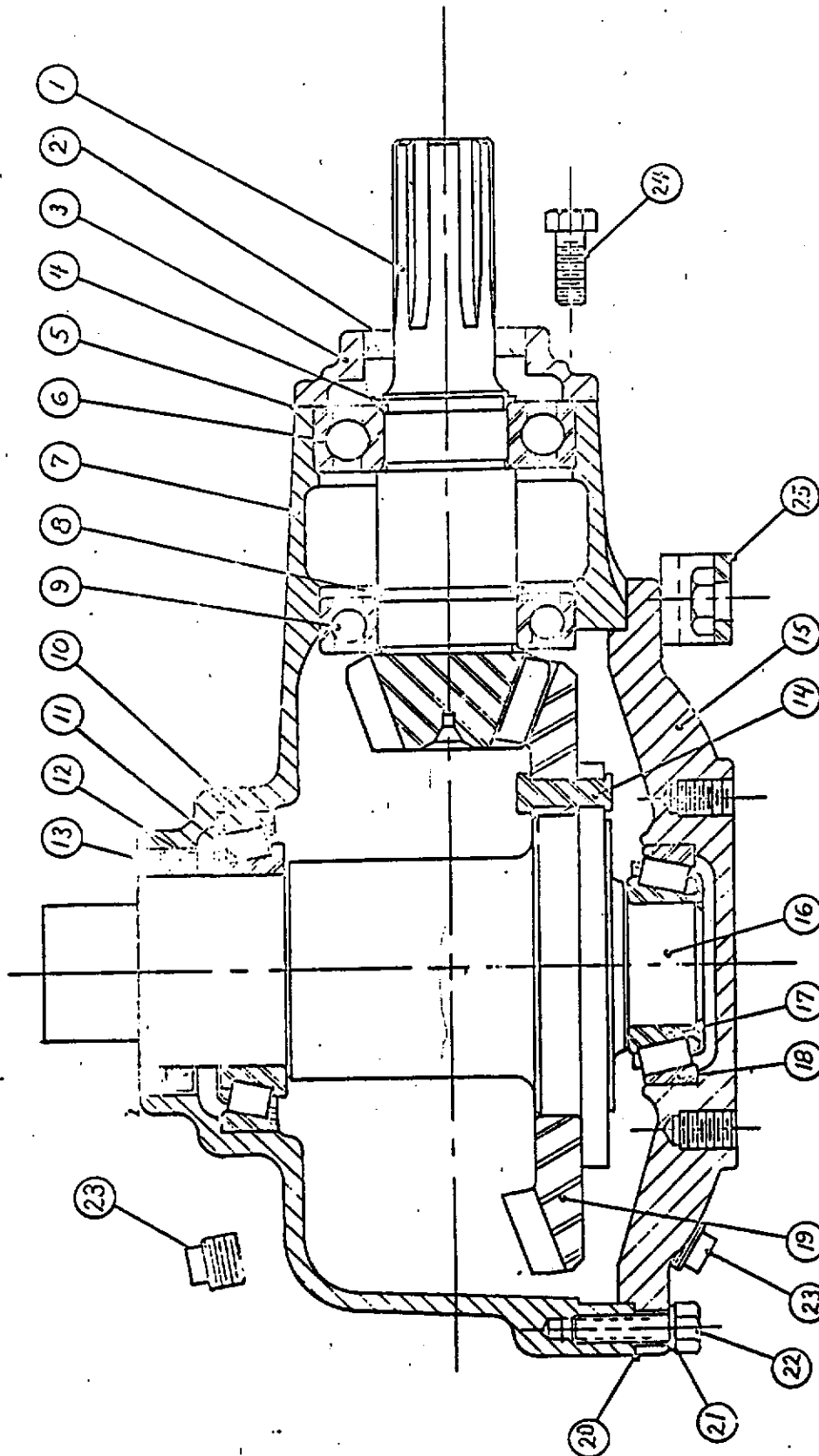
CME-55 FRICTION CLUTCH SHAFTLINE
555-1100

| NO. | PART NO. | NAME OF PART |
|-----|----------|------------------------|
| 1 | 55-1101 | Base Plate |
| 2 | 55-1102 | Mounting Plate |
| 3 | 55-1103 | Sprocket Driven |
| 4 | 55-1104 | Sprocket Driving |
| 5 | 55-1107 | Chain Assembly |
| 6 | 55-1108 | Lever |
| 7 | 55-1109 | Brake Control Lever |
| 8 | 55-1110 | Clutch Control Lever |
| 9 | 55-1111 | Brake Control Linkage |
| 10 | 55-1112 | Clutch Control Linkage |
| 11 | 55-1115 | Lever Pivot Shaft |
| 12 | 55-1116 | Pivot Shaft Spacer |
| 13 | 55-1118 | Norm Gear |
| 14 | 55-1120 | Norm Shaft |
| 15 | 55-1121 | Norm Spacer |

| NO. | PART NO. | NAME OF PART |
|-----|----------|-------------------------|
| 17 | 55-1122 | Norm Bearing Cup |
| 18 | 55-1123 | Norm Bearing Cone |
| 19 | 55-1124 | Lever Quadrant Hatchet |
| 20 | 55-1125 | Brake Pin |
| 21 | 55-1126 | Brake Band |
| 22 | 55-1127 | Brake Band Link |
| 23 | 55-1128 | Bearing Leg Bushing |
| 24 | 55-1129 | Norm Housing Bushing |
| 25 | 55-1130 | Cable Drum |
| 26 | 55-1131 | Cable Drum Bushing |
| 27 | 55-1132 | Cable Drum Shaft |
| 28 | 55-1133 | Cable Drum Shaft Sleeve |
| 29 | 55-1134 | Clutch Bell Housing |
| 30 | 55-1135 | Retaining Ring |
| 31 | 55-1136 | Clutch Pressure Plate |
| 32 | 55-1137 | Clutch Back-up Plate |
| 33 | 55-1138 | Clutch Pressure Plate |

| NO. | PART NO. | NAME OF PART |
|-----|----------|---------------------------|
| 34 | 55-1139 | Clutch Drive Plate |
| 35 | 55-1140 | Clutch Collar Assembly |
| 36 | 55-1141 | Clutch Hub |
| 37 | 55-1142 | Clutch Release Spring |
| 38 | 55-1143 | Shifter Fork |
| 39 | 55-1144 | Shifter Fork Pin |
| 40 | 55-1145 | Norm Housing Cover Gasket |
| 41 | 55-1146 | Grease Seal |
| 42 | 55-1147 | Clutch Lever |
| 43 | 55-1148 | Clutch Lever |
| 44 | 55-1149 | Clevis Link |
| 45 | 55-1150 | Clevis Link |
| 46 | 55-1151 | Control Shaft |
| 47 | 55-1152 | Thrust Collar |
| 48 | 55-1153 | Brake Control Lever |
| 49 | 55-1154 | Bearing Container Bushing |

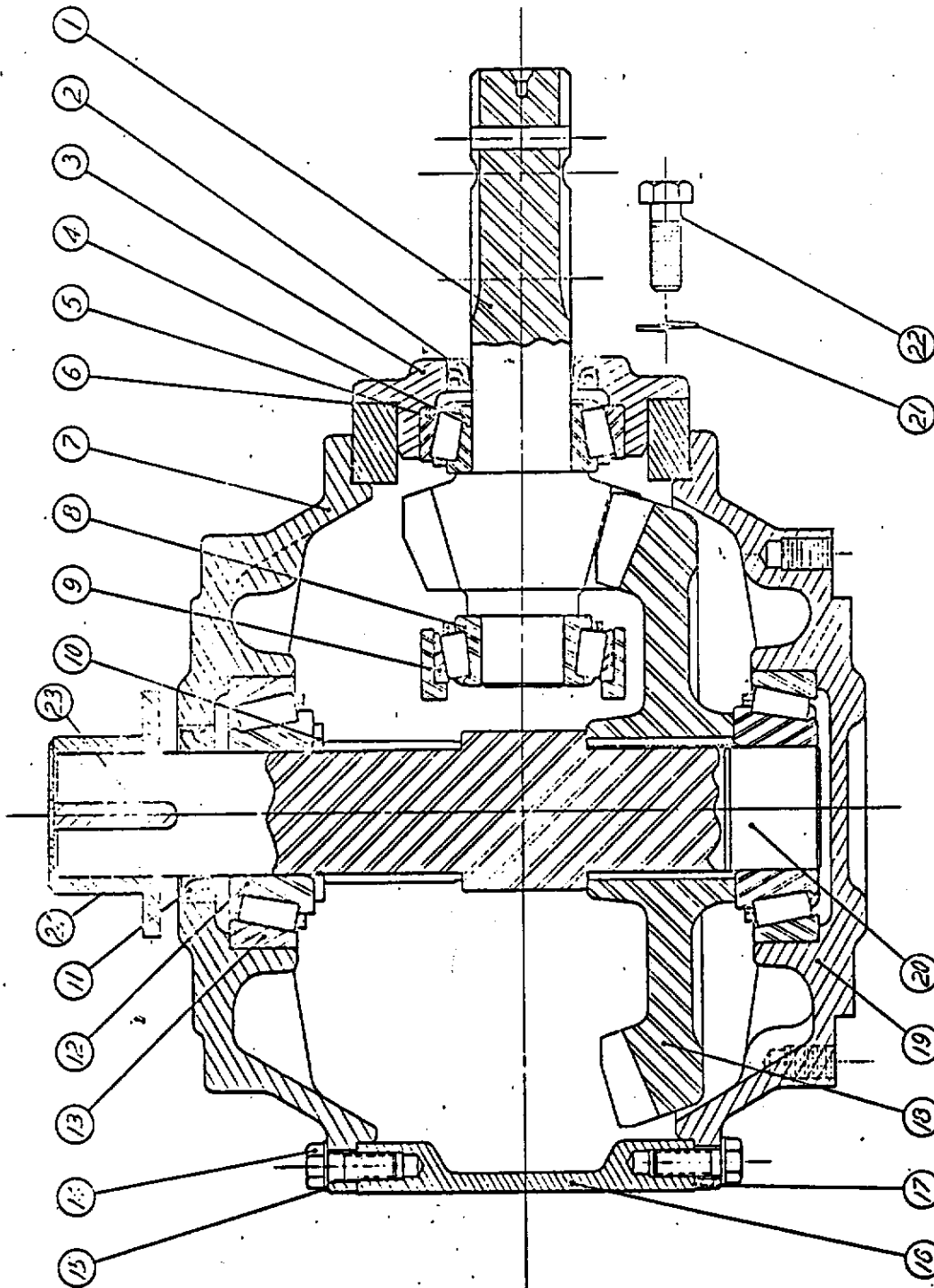
Specify Drill Model & Serial Number When Ordering Parts



CME-55 RIGHT ANGLE DRIVE ASSEMBLY
#55-0702

| NO. PART NO. | NAME OF PART | NO. PART NO. | NAME OF PART | NO. PART NO. | NAME OF PART |
|--------------|---------------------------|--------------|------------------------|--------------|-----------------------------|
| 1 | 55-0714 Pinion, Driving | 9 | 55-0722 Bearing, Ball | 18 | 55-0731 Bearing Cup |
| 2 | 55-0715 Seal, Oil | 10 | 55-0723 Bearing Cup | 19 | 55-0732 Gear, Driven |
| 3 | 55-0716 Retainer, Bearing | 11 | 55-0724 Bearing Cone | 20 | 55-0733 Shim |
| 4 | 55-0717 Ring Retainer | 12 | 55-0725 Seal, Oil | 21 | 55-1338 Lock Washer, 3/8 |
| 5 | 55-0718 Gasket | 13 | 55-0726 Seal, Oil | 22 | 55-1337 Bolt 3/8-16 x 1-1/4 |
| 6 | 55-0719 Bearing, Ball | 14 | 55-0727 Rivet | 23 | 55-1339 Plug 1/2 NPT |
| 7 | 55-0720 Housing, Main | 15 | 55-0728 Cap, Retaining | 24 | 55-1314 Bolt 3/8-16 x 1 |
| 8 | 55-0721 Ring, Retaining | 16 | 55-0729 Shaft, Output | 25 | 55-0734 Gear Box Clip |
| | | 17 | 55-0730 Bearing Cone | | |

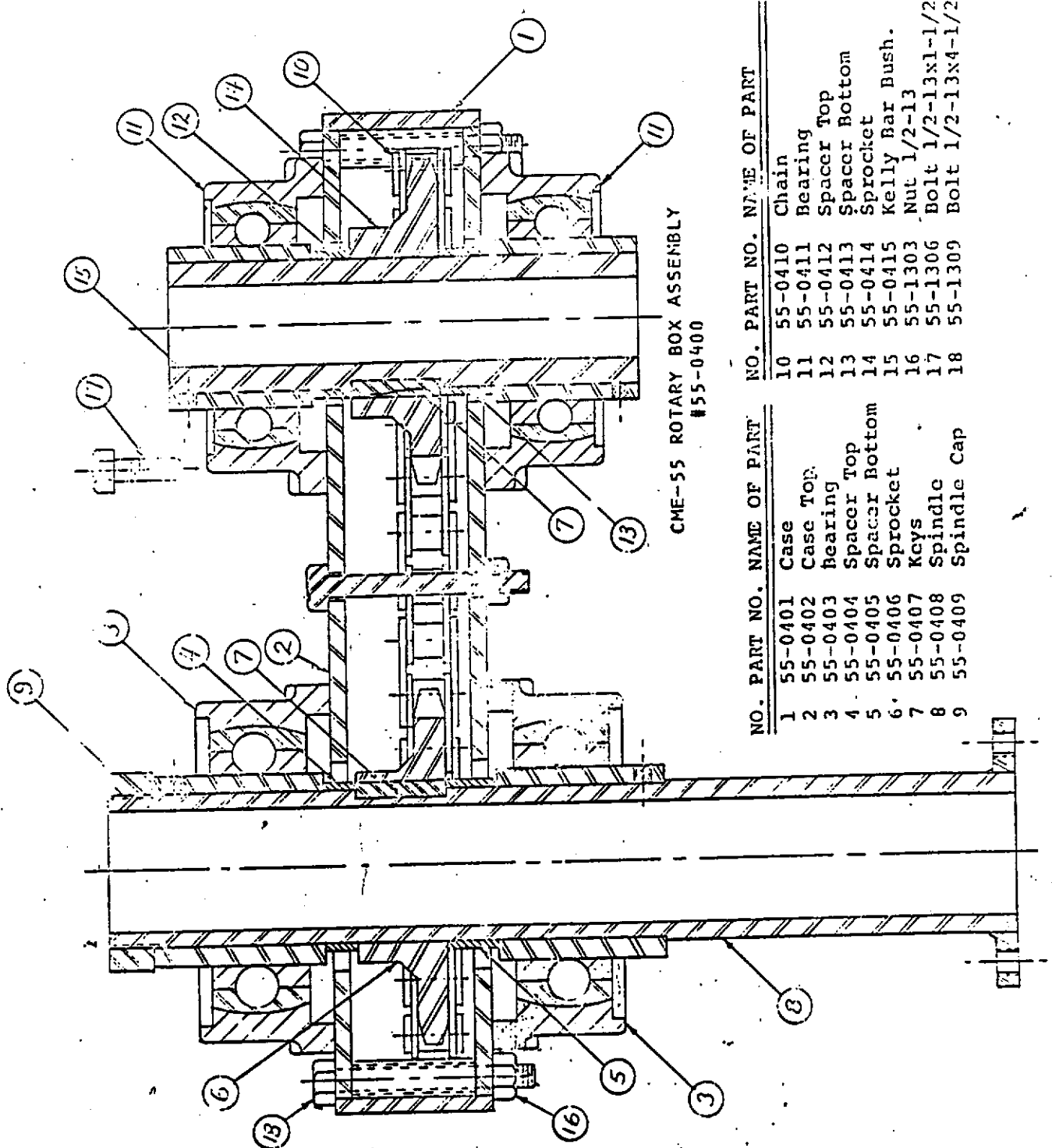
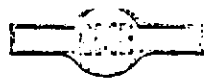
Specify Drill Model & Serial Number When Ordering Parts



CHE-55 RIGHT ANGLE DRIVE ASSEMBLY
#55-0750

| NO. PART NO. NAME OF PART | NO. PART NO. NAME OF PART | NO. PART NO. NAME OF PART |
|---------------------------------|--|--|
| 1 55-0751 Pinion, Driving | 9 55-0759 Cup. Bearing | 17 55-0767 Shim |
| 2 55-0752 Oil Seal | 10 55-0760 Spacer | 18 55-0768 Gear, Output |
| 3 55-0753 Cap. Bearing (Petain) | 11 55-0761 Oil Seal | 19 55-0769 Cover, Bottom |
| 4 55-0754 Cup. Bearing | 12 55-0762 Cone, Bearing | 20 55-0770 Shaft, Output |
| 5 55-0755 Cup. Bearing | 13 55-0763 Cup. Bearing | 21 55-0771 Lockwasher (7/16) |
| 6 55-0756 Shim | 14 55-0764 Bolt, Hex Head (3/8-16 x 1) | 22 55-0772 Bolt Hex Head (7/16-14 x 1-1/4) |
| 7 55-0757 Cover, Top | 15 55-0765 Lockwasher 3/8 | 23 55-0773 Key |
| 8 55-0758 Cone, Bearing | 16 55-0766 Housing, Main | 24 55-2019 Kelly Bar Adaptor |

Specify Drill Model and Serial Number When Ordering Parts



CME-55 ROTARY BOX ASSEMBLY
#55-0400

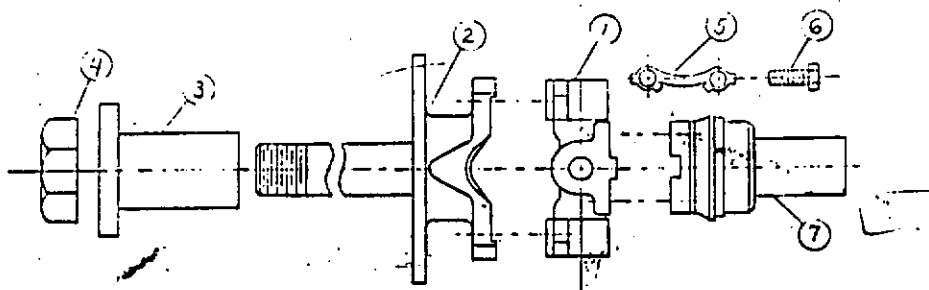
| NO. PART NO. | NAME OF PART | NO. PART NO. | NAME OF PART |
|--------------|-----------------------|--------------|---------------------------|
| 1 | 55-0401 Case Top | 10 | 55-0410 Chain |
| 2 | 55-0402 Case Bottom | 11 | 55-0411 Bearing |
| 3 | 55-0403 Bearing | 12 | 55-0412 Spacer Top |
| 4 | 55-0404 Spacer Top | 13 | 55-0413 Spacer Bottom |
| 5 | 55-0405 Spacer Bottom | 14 | 55-0414 Sprocket |
| 6 | 55-0406 Sprocket | 15 | 55-0415 Kelly Bar Bush. |
| 7 | 55-0407 Keys | 16 | 55-1303 Nut 1/2-13 |
| 8 | 55-0408 Spindle Cap | 17 | 55-1306 Bolt 1/2-13x1-1/2 |
| 9 | 55-0409 Spindle | 18 | 55-1309 Bolt 1/2-13x4-1/2 |

Specify Drill Model & Serial Number When Ordering Parts



CENTRAL MINE EQUIPMENT COMPANY

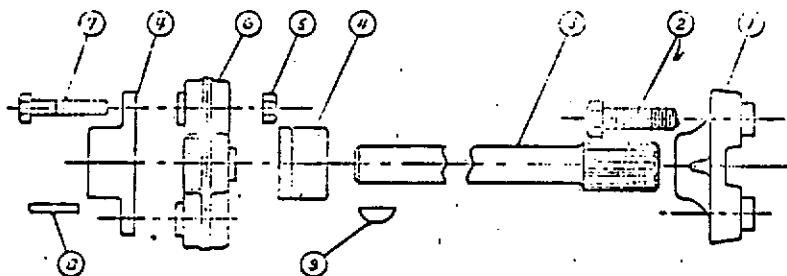
CME-55 AUGER COUPLING ASSEMBLY #55-0423



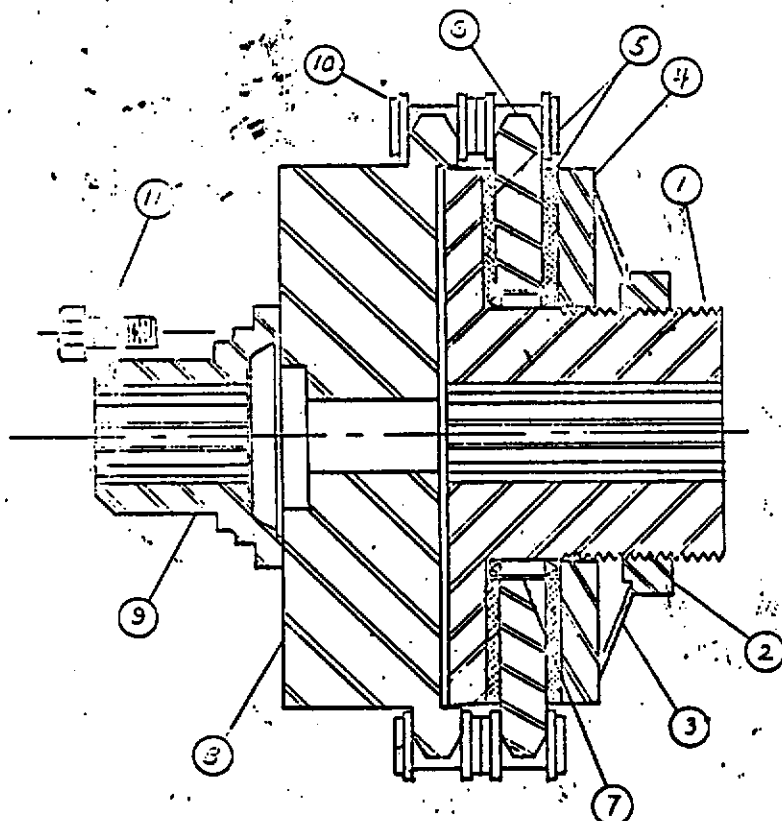
| NO. | PART NO. | NAME OF PART |
|-----|----------|-----------------------|
| 1 | 55-0424 | Universal Joint |
| 2 | 55-0425 | Flange & Shaft Assem. |
| 3 | 55-0426 | Spacer Bushing |
| 4 | 55-1302 | Nut 1-3/8-12 |
| 5 | 55-1350 | Locking Tab |
| 6 | 55-1351 | 3/8-24 N.P. x 1" Bolt |
| 7 | 55-0427 | Socket Assem. 13/16" |
| 7 | 55-0428 | " " 1-1/8" |
| 7 | 55-0429 | " " 1-5/8" |
| 7 | 55-0430 | " " 1-1/2" |

Specify Socket Size When Ordering Complete Assem.

CME-55 ENGINE TO HYDRAULIC PUMP DR. #55-1340



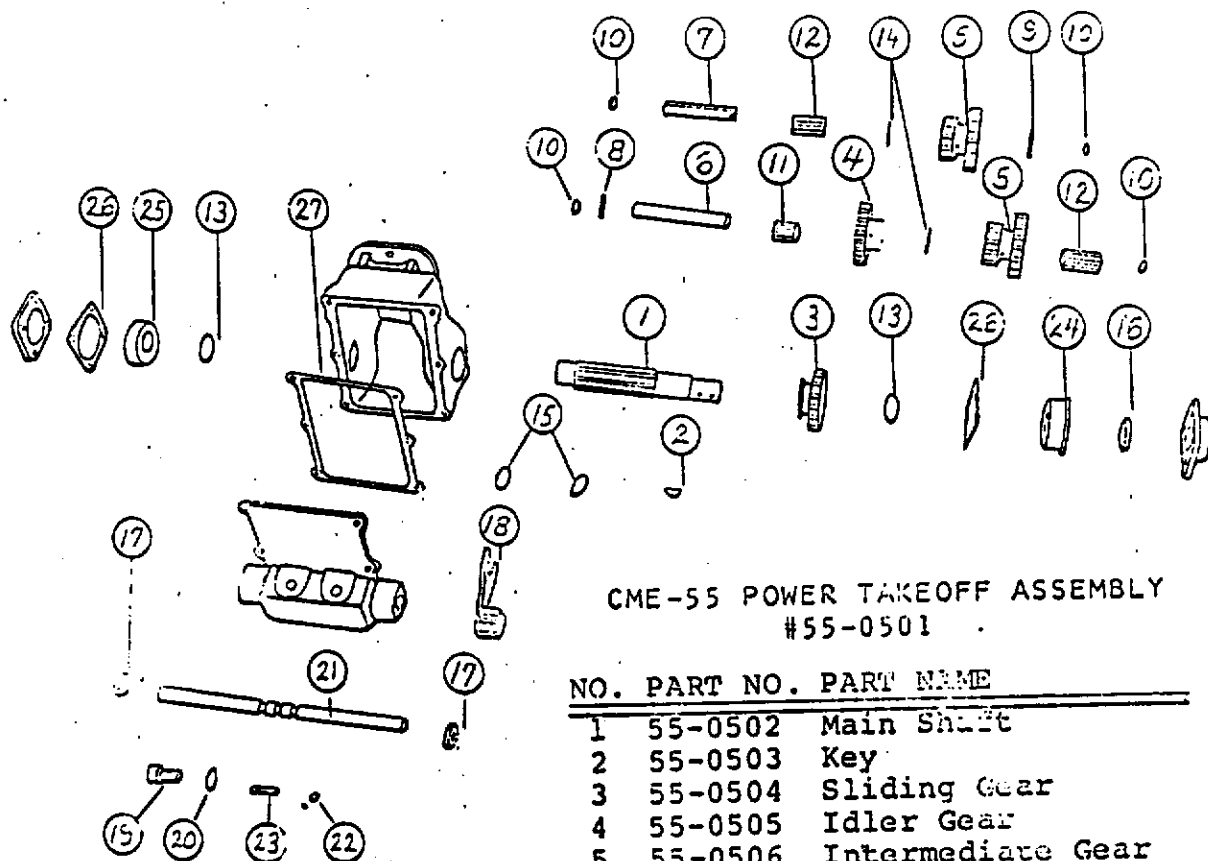
| NO. | PART NO. | NAME OF PART |
|-----|----------|-----------------------|
| 1 | 55-1341 | Engine Pulley Adapter |
| 2 | 55-1342 | Bolt |
| 3 | 55-1343 | Shaft |
| 4 | 55-1344 | Adapter Flange |
| 5 | 55-1345 | Nut |
| 6 | 55-1346 | Flex. Coupling |
| 7 | 55-1347 | Bolt |
| 8 | 55-1348 | Straight Key 3/16 sq |
| 9 | 55-1349 | Woodruff Key |



CME-55 SLIP CLUTCH #55-0701

| NO. | PART NO. | NAME OF PART |
|-----|----------|-----------------------------------|
| 1 | 55-0704 | Hub |
| 2 | 55-0705 | Nut |
| 3 | 55-0706 | Spring |
| 4 | 55-0707 | Pressure Plate |
| 5 | 55-0708 | Fibre Disc |
| 6 | 55-0709 | Sprocket |
| 7 | 55-0710 | Bearing |
| 8 | 55-0711 | Coupling Half |
| 9 | 55-0712 | Spline Flange |
| 10 | 55-0713 | Coupling Chain |
| 11 | 55-1336 | Bolts 7/16 x 1" Std. Hex. Head |

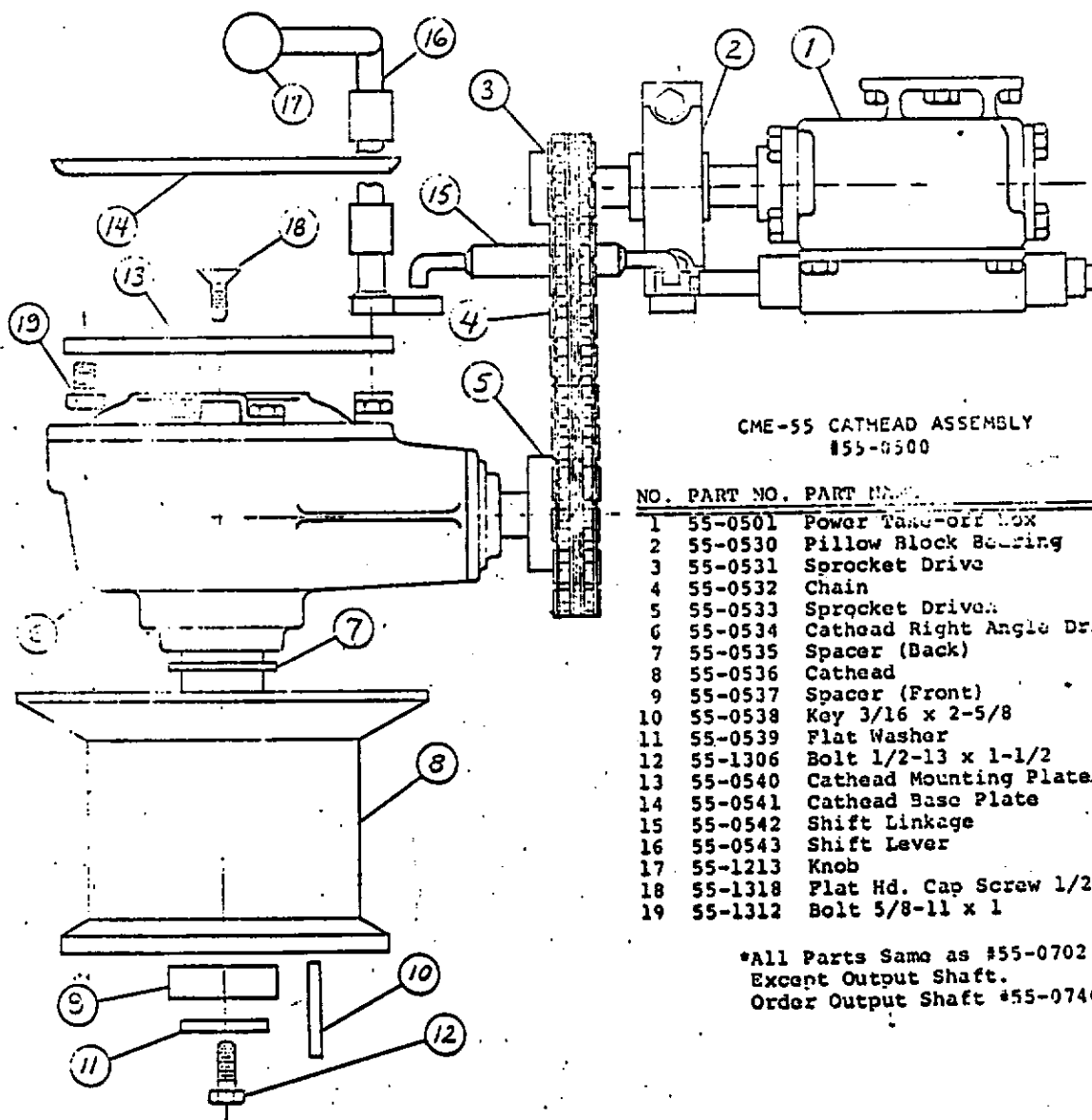
Specify Drill Model & Serial Number When Ordering Parts



CME-55 POWER TAKEOFF ASSEMBLY
#55-0501

| NO. | PART NO. | PART NAME |
|-----|----------|----------------------|
| 1 | 55-0502 | Main Shaft |
| 2 | 55-0503 | Key |
| 3 | 55-0504 | Sliding Gear |
| 4 | 55-0505 | Idler Gear |
| 5 | 55-0506 | Intermediate Gear |
| 6 | 55-0507 | Idler Shaft |
| 7 | 55-0508 | Reverse Idler Shaft |
| 8 | 55-0509 | Taper Pin #8 x 1-3/4 |
| 9 | 55-0510 | Taper Pin #8 x 1-1/2 |
| 10 | 55-0511 | Welsh Plug |
| 11 | 55-0512 | Bearing |
| 12 | 55-0513 | Bearing |
| 13 | 55-0514 | Gear Spacer (Steel) |
| 14 | 55-0515 | Gear Spacer (Bronze) |
| 15 | 55-0516 | Snap Ring |
| 16 | 55-0517 | Grease Seal |
| 17 | 55-0518 | Grease Seal |
| 18 | 55-0519 | Shifter Fork |
| 19 | 55-0520 | Poppet Retainer |
| 20 | 55-0521 | Poppet Washer |
| 21 | 55-0522 | Shift Shaft |
| 22 | 55-0523 | Poppet |
| 23 | 55-0524 | Poppet Spring |
| 24 | 55-0525 | Bearing |
| 25 | 55-0526 | Bearing |
| 26 | 55-0527 | Gasket |
| 27 | 55-0528 | Cover Gasket |

Specify Drill Model & Serial Number When Ordering Parts

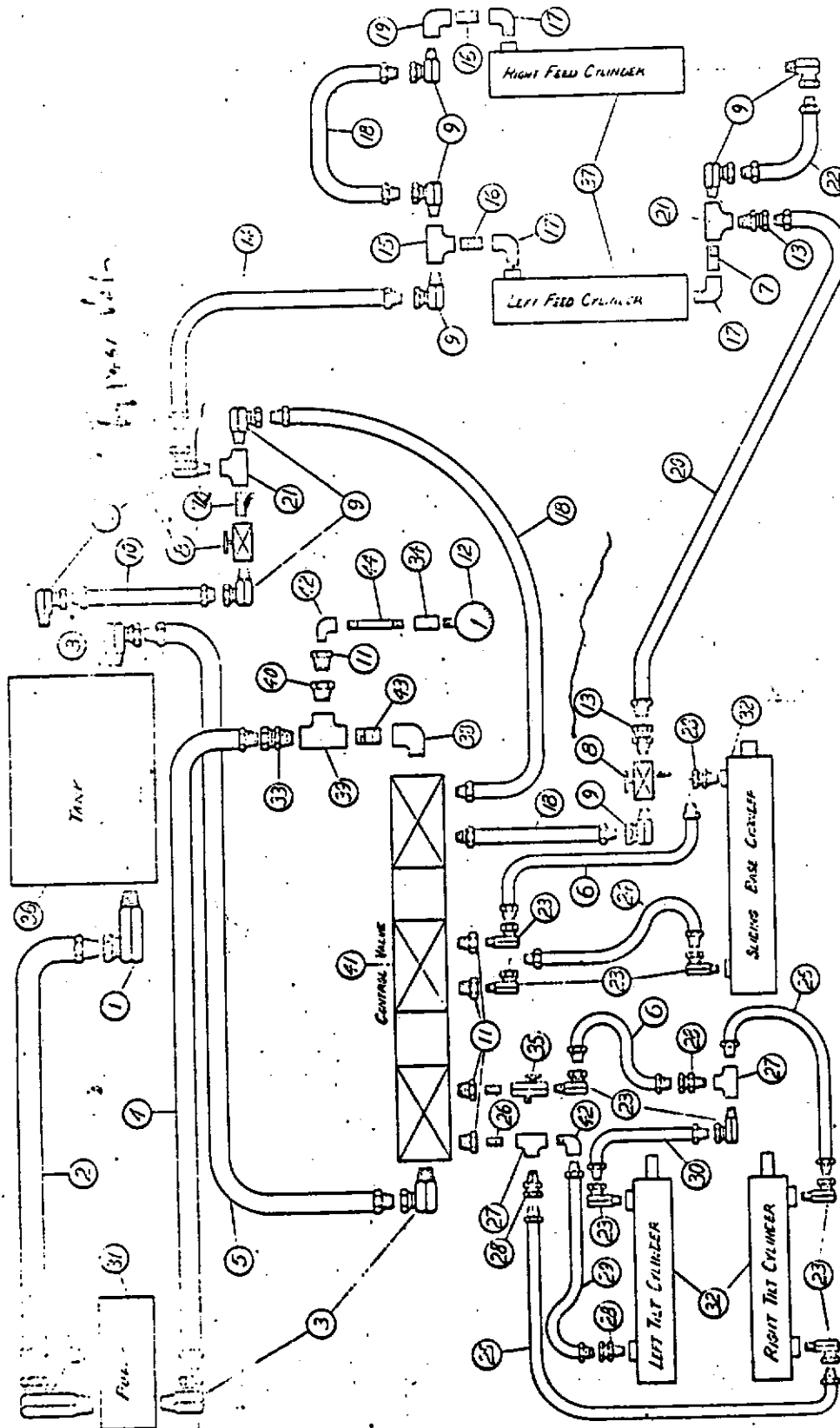


CME-55 CATHEAD ASSEMBLY
#55-0500

| NO. | PART NO. | PART NAME |
|-----|----------|-------------------------------|
| 1 | 55-0501 | Power Take-off Box |
| 2 | 55-0530 | Pillow Block Bearing |
| 3 | 55-0531 | Sprocket Drive |
| 4 | 55-0532 | Chain |
| 5 | 55-0533 | Sprocket Driven |
| 6 | 55-0534 | Cathead Right Angle Drive |
| 7 | 55-0535 | Spacer (Back) |
| 8 | 55-0536 | Cathead |
| 9 | 55-0537 | Spacer (Front) |
| 10 | 55-0538 | Key 3/16 x 2-5/8 |
| 11 | 55-0539 | Flat Washer |
| 12 | 55-1306 | Bolt 1/2-13 x 1-1/2 |
| 13 | 55-0540 | Cathead Mounting Plate |
| 14 | 55-0541 | Cathead Base Plate |
| 15 | 55-0542 | Shift Linkage |
| 16 | 55-0543 | Shift Lever |
| 17 | 55-1213 | Knob |
| 18 | 55-1318 | Flat Hd. Cap Screw 1/2-13 x 1 |
| 19 | 55-1312 | Bolt 5/8-11 x 1 |

*All Parts Same as #55-0702
Except Output Shaft.
Order Output Shaft #55-0740.

Specify Drill Model & Serial Number When Ordering Parts



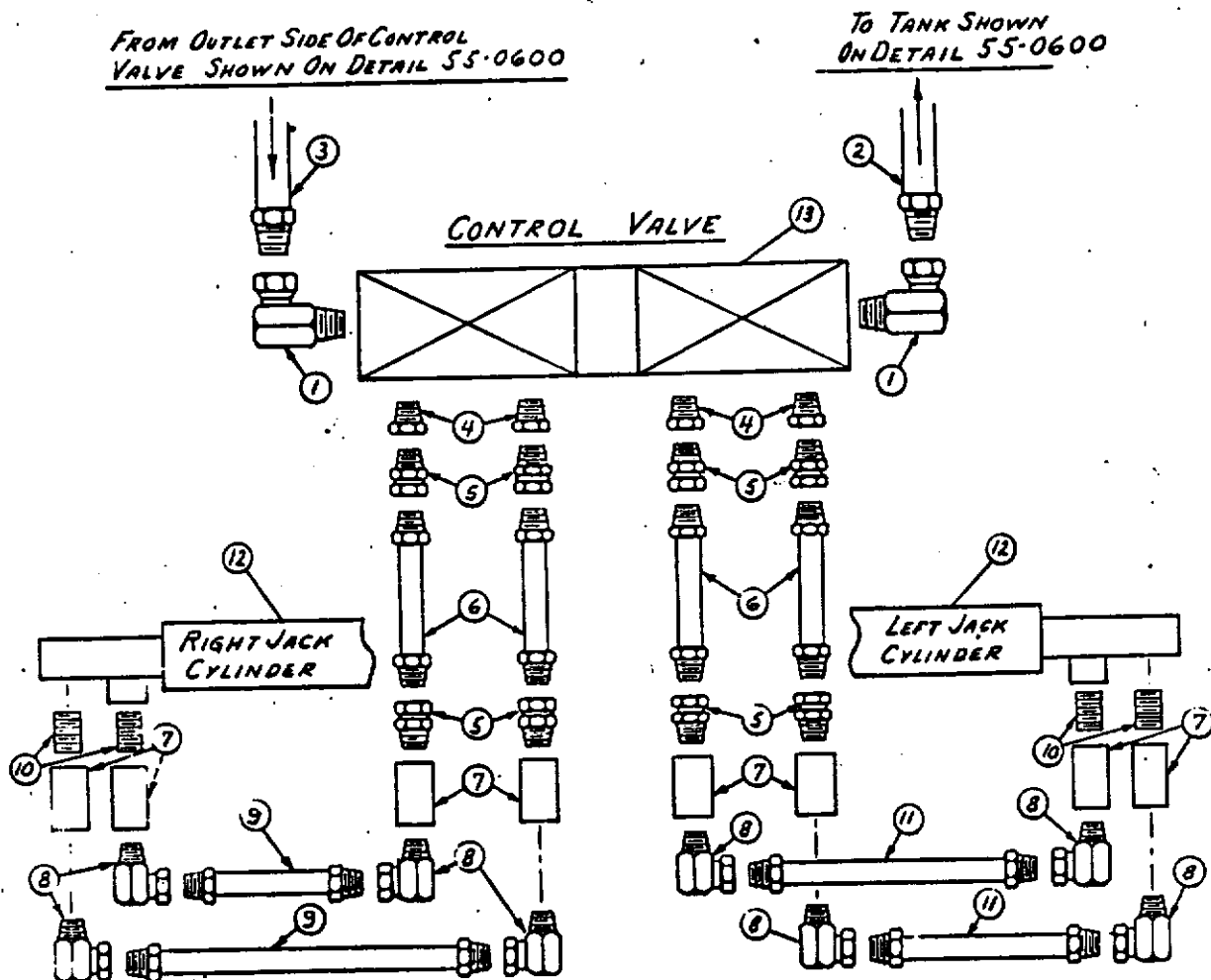
CMP-55 HYDRAULIC SYSTEM
55-0606

| NO. PART NO. | NAME OF PART | NO. PART NO. | NAME OF PART | NO. PART NO. | NAME OF PART |
|--------------|-----------------------------------|--------------|-----------------------------------|--------------|--------------------------------|
| 1 | 55-0630 1"-90° Male Adapt. Union | 23 | 55-0653 1/4-90° Male Adapt. Union | 34 | 55-0691 1/4 Coupling |
| 2 | 55-0631 3/4-90° Male Adapt. Union | 24 | 55-0654 Hose | 35 | 55-0692 1/4 Flow Control Valve |
| 3 | 55-0632 1/2-90° Male Adapt. Union | 25 | 55-0655 1/4 Close W nipple | 36 | 55-0693 Tank |
| 4 | 55-0633 Hose | 26 | 55-0656 1/4 Tee | 37 | 55-0694 Feed Cylinder |
| 5 | 55-0634 Hose | 27 | 55-0657 1/4 Tee | 38 | 45-0326 3/4-90° Street Elbow |
| 6 | 55-0635 1/2 x 3/4 Tee | 28 | 55-0658 1/4 Male Adapt. Union | 39 | 45-0326 3/4 Tee |
| 7 | 55-0636 1/2 x 1-1/2 Tee | 29 | 55-0659 Hose | 40 | 52-1626 3/4 x 1/2 Bushing |
| 8 | 55-0637 Valve, Sp. Pass. | 30 | 55-0660 1/2 Elbow | 41 | 55-0695 3 Speed Valve |
| 9 | 55-0638 1/2-90° Male Adapt. Union | 31 | 55-0661 Hose | 42 | 55-0696 1/4-90° Street Elbow |
| 10 | 55-0639 1/2-90° Male Adapt. Union | 32 | 55-0662 1/2 Tee | 43 | 55-0697 1/4 x 1-1/2 Nipple |
| 11 | 55-0640 1/2 x 1/2 Tee | 33 | 55-0663 Hose | 44 | 55-0698 1/4 x 3" Nipple |

Specify Drill Model and Serial Number When Ordering Parts



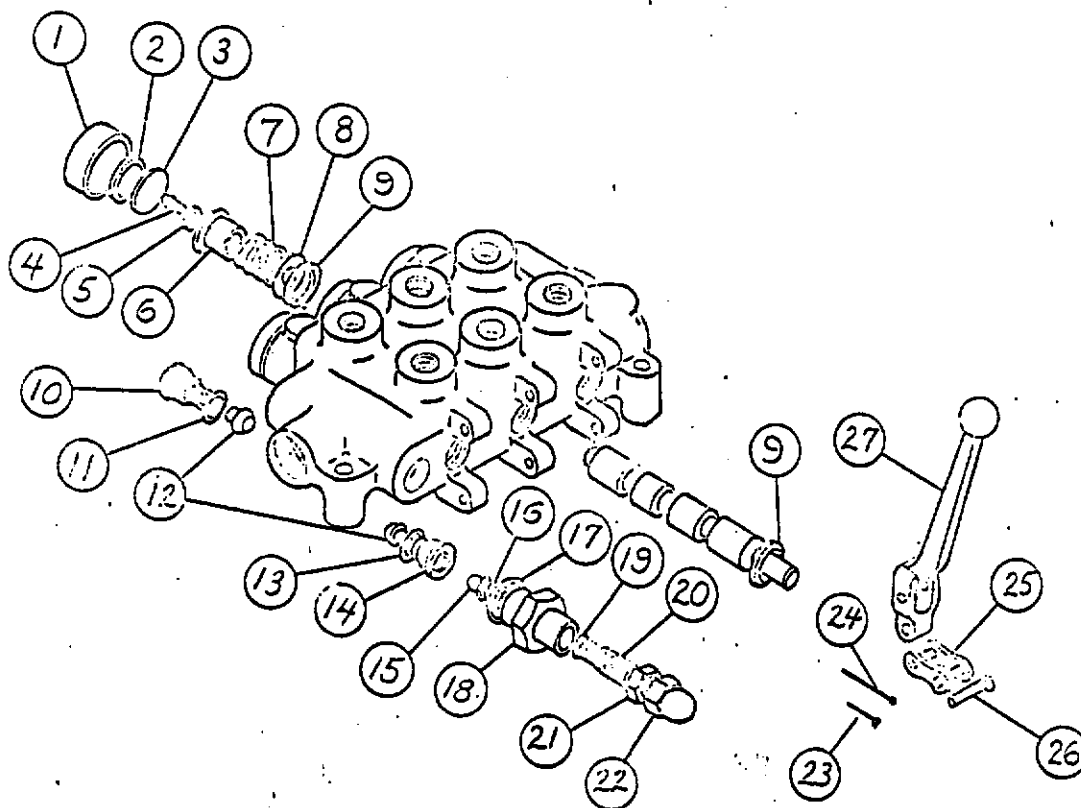
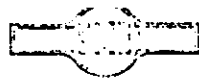
CENTRAL MINE EQUIPMENT COMPANY



CME-55 HYDRAULIC JACK SYSTEM
#55-0660

| NO. | PART NO. | NAME OF PART |
|-----|----------|-------------------------|
| 1 | 55-0632 | 3/4 90° Male Adap.Union |
| 2 | 55-0677 | Hose |
| 3 | 55-0678 | Hose |
| 4 | 55-0679 | 1/2 x 3/8 Bushing |
| 5 | 55-0680 | 3/8 Male Adapter Union |
| 6 | 55-0681 | Hose |
| 7 | 55-0682 | 3/8 Coupling |
| 8 | 55-0683 | 3/8 90° Male Adap.Union |
| 9 | 55-0684 | Hose |
| 10 | 55-0685 | 3/8 x 1 Pipe Nipple |
| 11 | 55-0686 | Hose |
| 12 | 55-0661 | Jack Cylinders |
| 13 | 55-1250 | 2-Spool Valve |

Specify Drill Model & Serial Number When Ordering Parts

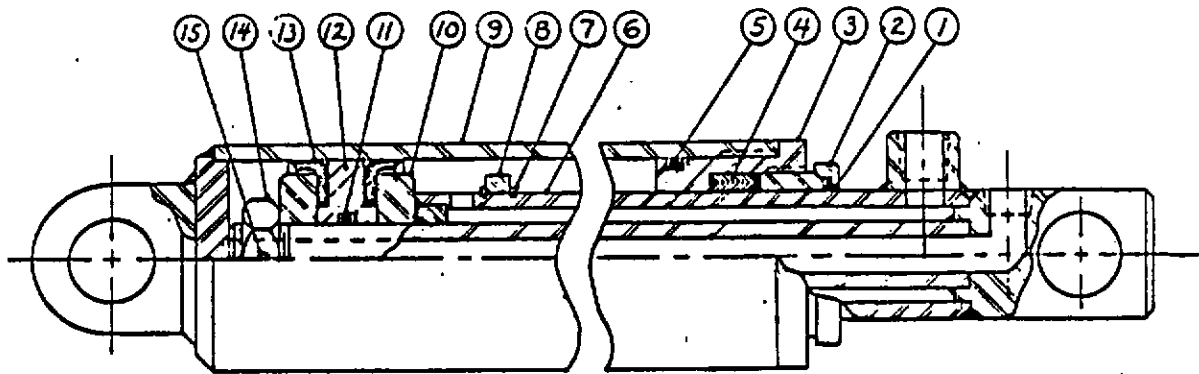


CME-55 CONTROL VALVE
#55-1220

| NO. | PART NO. | NAME OF PART |
|-----|----------|----------------------------|
| 1 | 55-1221 | Rubber Bonnet |
| 2 | 55-1222 | Stop Disc Snap Ring |
| 3 | 55-1223 | Stop Disc |
| 4 | 55-1224 | Spring Assembly Bolt |
| 5 | 55-1225 | Center Spring Lock Washer |
| 6 | 55-1226 | Stop Collar |
| 7 | 55-1227 | Centering Spring |
| 8 | 55-1228 | Stop Washer |
| 9 | 55-1229 | Spool Seal ✓ |
| 10 | 55-1230 | Check Plug |
| 11 | 55-1231 | Check Plug "O" Ring |
| 12 | 55-1232 | Check Poppet |
| 13 | 55-1233 | Relief Valve Seat "O" Ring |
| 14 | 55-1234 | Relief Valve Seat |

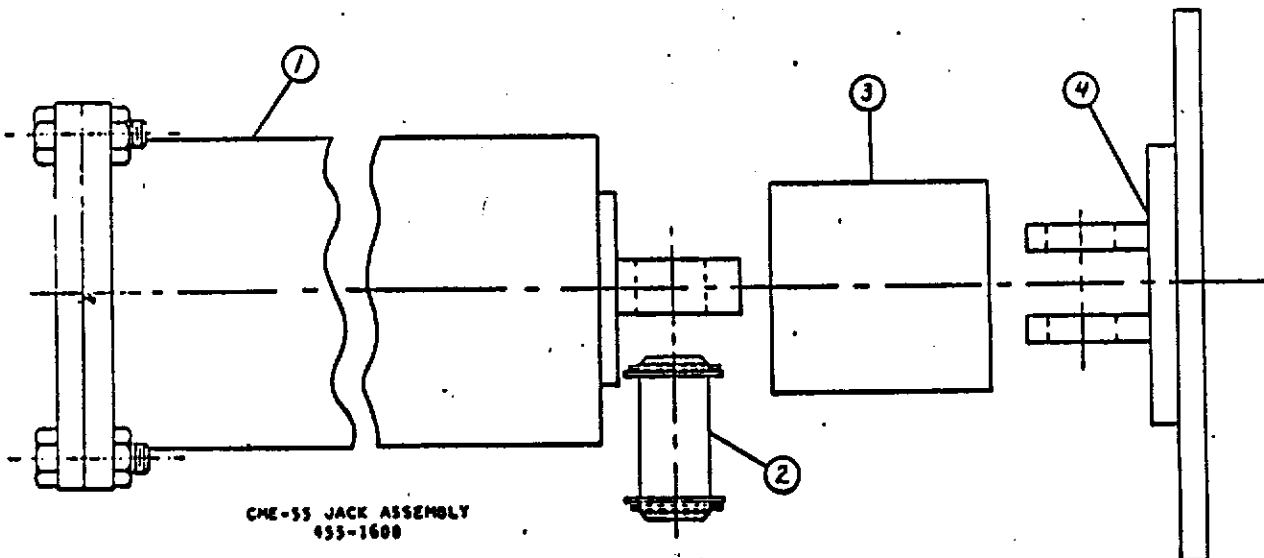
| NO. | PART NO. | NAME OF PART |
|-----|----------|--------------------------|
| 15 | 55-1235 | Relief Valve Bolt |
| 16 | 55-1236 | Relief Spring |
| 17 | 55-1237 | Relief Body Gasket |
| 18 | 55-1238 | Relief Body |
| 19 | 55-1239 | Adjusting Screw "O" Ring |
| 20 | 55-1240 | Adjusting Screw |
| 21 | 55-1241 | Adjusting Screw Jam Nut |
| 22 | 55-1242 | Acorn Cap |
| 23 | 55-1243 | Handle Cotter Pin |
| 24 | 55-1244 | Handle Link Cotter Pin |
| 25 | 55-1245 | Handle Link Assembly |
| 26 | 55-1246 | Handle Pin |
| 27 | 55-1247 | Handle |

Specify Drill Model & Serial Number When Ordering Parts



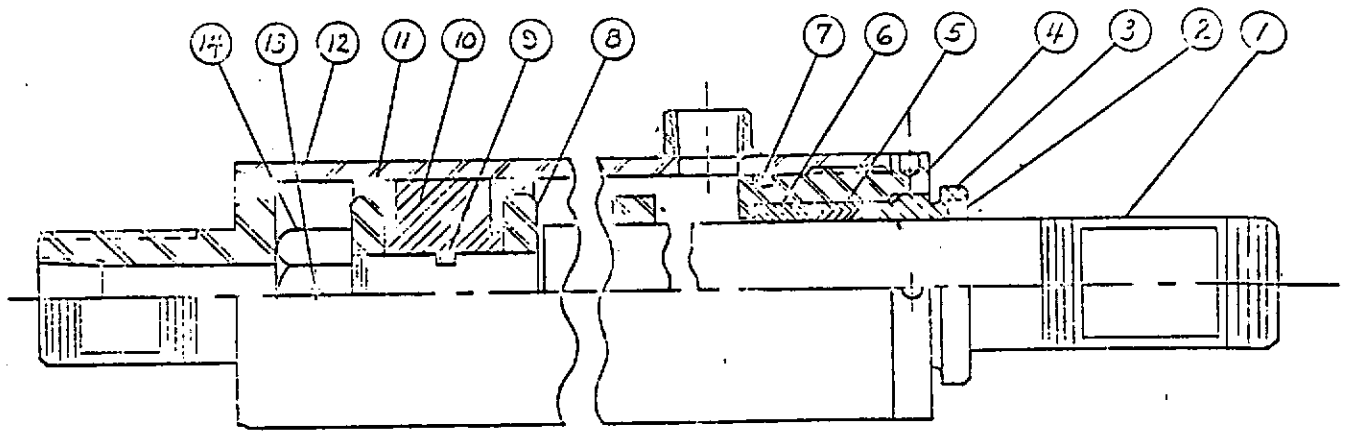
CME-55 HYDRAULIC JACK CYLINDERS
855-0661

| NO. | PART NO. | NAME OF PART |
|-----|----------|------------------|
| 1 | 55-0662 | Wiper |
| 2 | 55-0663 | Pack Gland |
| 3 | 55-0664 | Stuff Box |
| 4 | 55-0665 | Pack Set |
| 5 | 55-0666 | "O" Ring |
| 6 | 55-0667 | Plunger Assembly |
| 7 | 55-0668 | Retainer Ring |
| 8 | 55-0669 | Stop |
| 9 | 55-0670 | Cyl. Tube Assem. |
| 10 | 55-0671 | Cup Follower |
| 11 | 55-0672 | "O" Ring |
| 12 | 55-0673 | Piston |
| 13 | 55-0674 | Cup |
| 14 | 55-0675 | Rod Nut |
| 15 | 55-0676 | Cotter Pin |



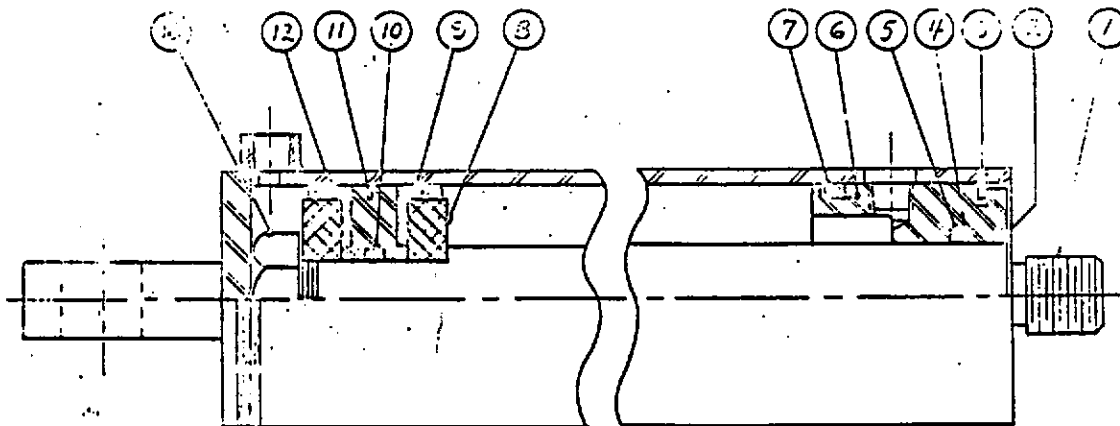
CME-55 JACK ASSEMBLY
455-1600

| NO. | PART NO. | NAME OF PART |
|-----|----------|----------------|
| 1 | 55-1601 | Tube Assembly |
| 2 | 55-1602 | Pin Assembly |
| 3 | 55-0304 | Bushing Bronze |
| 4 | 55-1603 | Foot Assembly |



CME-55 HYDRAULIC FEED CYLINDERS
#55-0301

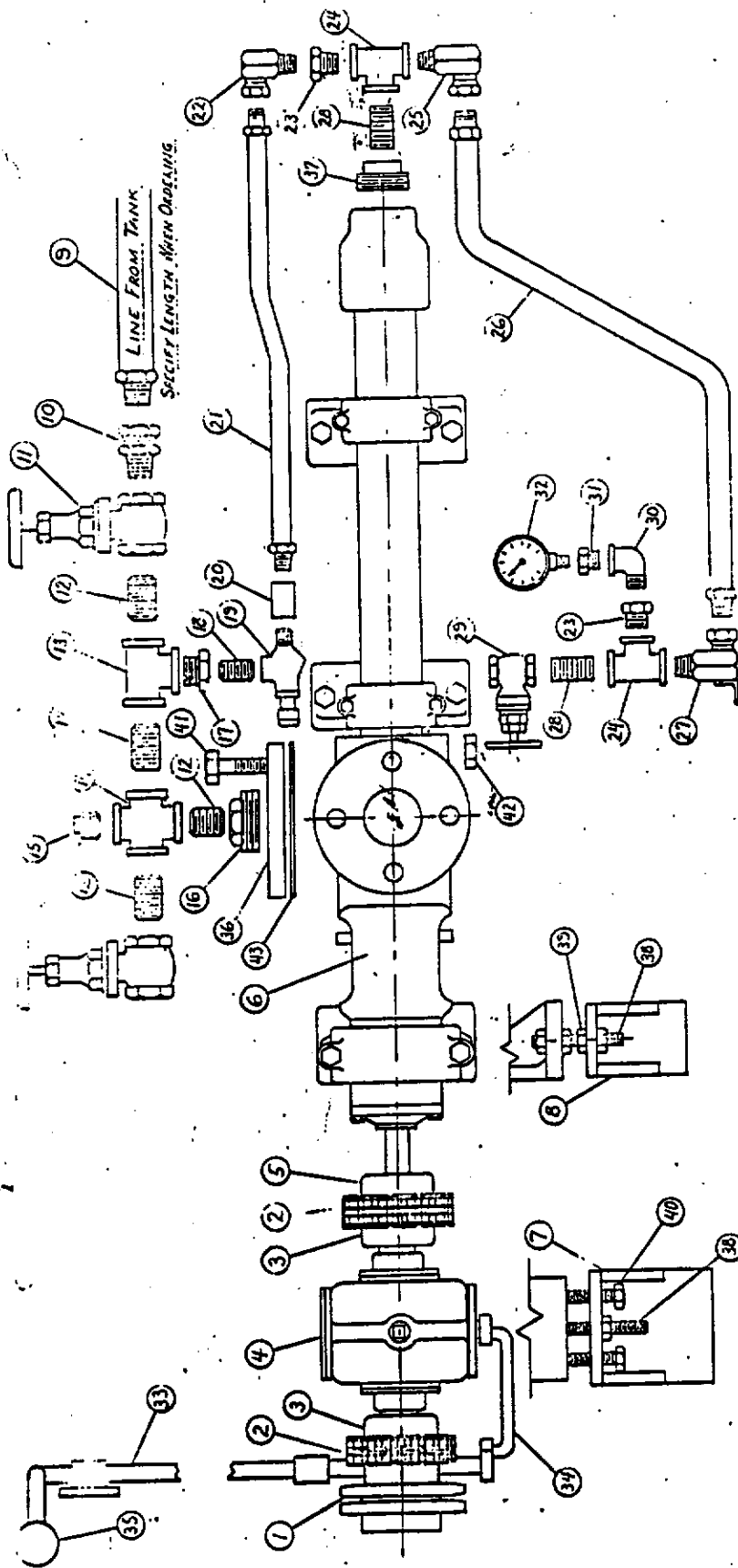
| NO. | PART NO. | NAME OF PART | NO. | PART NO. | NAME OF PART |
|-----|----------|-------------------|-----|----------|------------------|
| 1 | 55-0616 | Piston Rod Assem. | 8 | 55-0623 | Cup Follower |
| 2 | 55-0617 | Wiper | 9 | 55-0624 | "O" Ring |
| 3 | 55-0618 | Packing Gland | 10 | 55-0625 | Piston |
| 4 | 55-0619 | Stuffing Box | 11 | 55-0626 | Piston Cup |
| 5 | 55-0620 | Packing Set | 12 | 55-0627 | Cyl. Tube Assem. |
| 6 | 55-0621 | Bushing | 13 | 55-0628 | Roll Pin |
| 7 | 55-0622 | "O" Ring | 14 | 55-0629 | Rod Nut |



CME-55 TILT & SLIDING BASE CYLINDER
#55-0602

| NO. | PART NO. | NAME OF PART | NO. | PART NO. | NAME OF PART |
|-----|----------|------------------|-----|----------|--------------------|
| 1 | 55-0603 | Piston Rod | 8 | 55-0610 | Follower Plate |
| 2 | 55-0604 | Wiper | 9 | 55-0611 | Butt & Tube Assem. |
| 3 | 55-0605 | Truarc Snap Ring | 10 | 55-0612 | "O" Ring |
| 4 | 55-0606 | Backup Washer | 11 | 55-0613 | Piston |
| 5 | 55-0607 | "O" Ring | 12 | 55-0614 | Cup |
| 6 | 55-0608 | Gland | 13 | 55-0615 | Jam Nut |
| 7 | 55-0609 | "O" Ring | | | |

Specify Drill Model & Serial Number When Ordering Parts



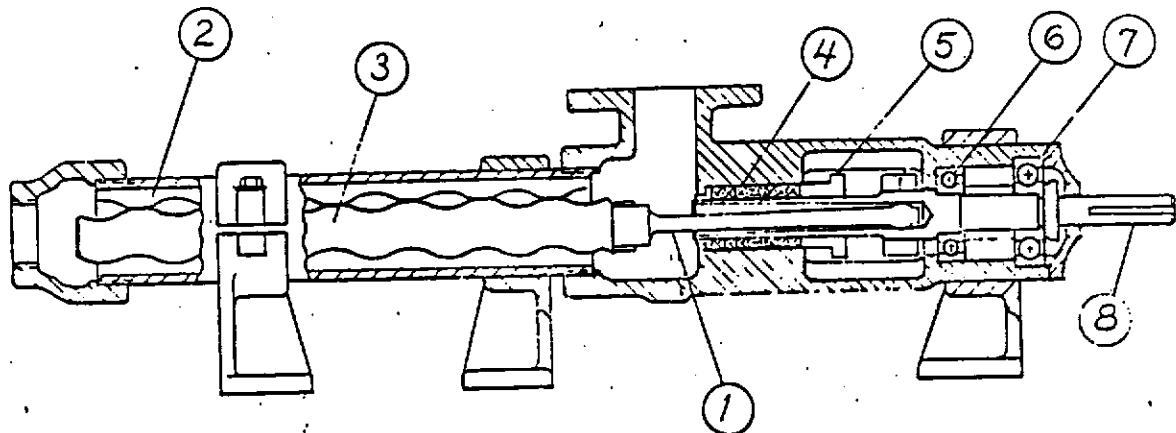
CME-55 WATER PUMP ASSEMBLY
855-1970

| NO. | PART NO. | NAME OF PART |
|-----|----------|------------------------------|
| 1 | 55-1010 | Coupling Half w/Drive Surft. |
| 2 | 55-1011 | Chain |
| 3 | 55-1012 | Coupling Half |
| 4 | 55-1013 | Water Pump Gear Box |
| 5 | 55-1014 | Coupling Half |
| 6 | 55-1015 | Water Pump |
| 7 | 55-1016 | Gear Box Bracket |
| 8 | 55-1017 | Water Pump Bracket |
| 9 | 55-1018 | Inlet Line Adan. Union |
| 10 | 55-1019 | Gate Valve, 1-1/4" |
| 11 | 55-1020 | Gate Valve, 1-1/4" |
| 12 | 55-1021 | 1-1/4" Tee |
| 13 | 55-1022 | 1-1/4" Cross |

| NO. | PART NO. | NAME OF PART |
|-----|----------|-----------------------------|
| 14 | 55-1023 | 1-1/4" Prize Plug |
| 15 | 55-1024 | 2-1/2" x 1-1/4" Bushing |
| 16 | 55-1025 | 1-1/4" x 1-1/2" Bushing |
| 17 | 55-1026 | 1-1/4" Nipple |
| 18 | 55-1027 | Pressure Relief Valve |
| 19 | 55-1028 | 1/2" Coupling |
| 20 | 55-1029 | 1/2" Tee |
| 21 | 55-1030 | 1/2" x 90° Male Adan. Union |
| 22 | 55-1031 | 1/2" x 1/2" Bushing |
| 23 | 55-1032 | 3/4" Tee |
| 24 | 55-1033 | 3/4" x 90° Male Adan. Union |
| 25 | 55-1034 | 1/2" x 1/2" Tee |
| 26 | 55-1035 | 1/2" x 1/2" Tee |
| 27 | 55-1036 | 1/2" x 1/2" Tee |
| 28 | 55-1037 | 1/2" x 1/2" Tee |
| 29 | 55-1038 | 1/2" x 1/2" Tee |

| NO. | PART NO. | NAME OF PART |
|-----|----------|--------------------------|
| 30 | 55-1039 | 1/2" Street L |
| 31 | 55-1040 | 1/2" x 1/4" Bushing |
| 32 | 55-1041 | Gauge |
| 33 | 55-1042 | Shift Lever |
| 34 | 55-1043 | Shift Linkage |
| 35 | 55-1044 | Knob |
| 36 | 55-1045 | Adaptor Flange |
| 37 | 55-1046 | 2" x 1/4" Bushing |
| 38 | 55-1047 | 1/2" x 1/2" Threaded Rod |
| 39 | 55-1048 | 1/2" x 1/2" Nut |
| 40 | 55-1049 | 1/2" x 2-1/2" Bolt |
| 41 | 55-1050 | 5/8" x 2-1/2" Bolt |
| 42 | 55-1051 | 5/8" x 2-1/2" Nut |
| 43 | 55-1052 | Gasket |

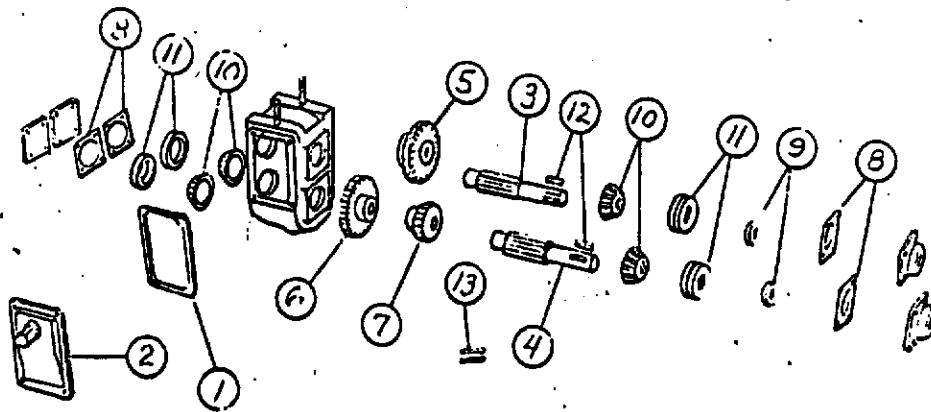
Specify Drill Model & Serial Number When Ordering Parts



CME-55 WATER PUMP
#55-1001

| NO. | PART NO. | NAME OF PART |
|-----|----------|-----------------|
| 1 | 55-1002 | Connecting Rod |
| 2 | 55-1003 | Stator Assembly |
| 3 | 55-1004 | Rotor |
| 4 | 55-1005 | Packing Set |

| NO. | PART NO. | NAME OF PART |
|-----|----------|------------------|
| 5 | 55-1006 | Packing Gland |
| 6 | 55-1007 | Radial Ball Brg. |
| 7 | 55-1008 | Thrust Ball Brg. |
| 8 | 55-1009 | Drive Shaft |

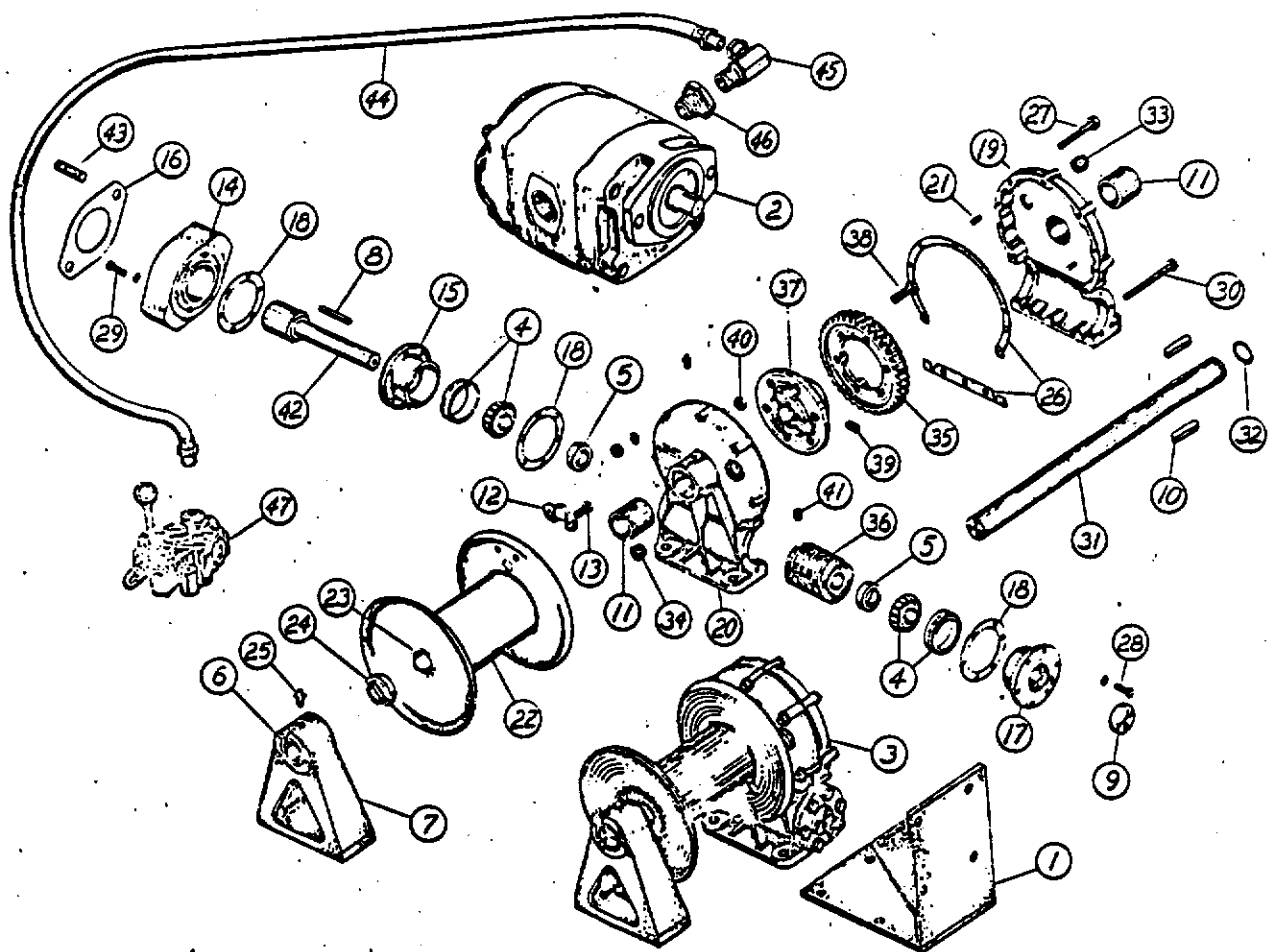


CME-55 WATER PUMP GEAR BOX
#55-1030

| NO. | PART NO. | NAME OF PART |
|-----|----------|---------------------------|
| 1 | 55-1031 | Gear Housing Cover Gasket |
| 2 | 55-1032 | Complete Cover Assembly |
| 3 | 55-1033 | Main Shaft |
| 4 | 55-1034 | Drive Shaft |
| 5 | 55-1035 | Sliding Gear |
| 6 | 55-1036 | High Speed Drive Gear |
| 7 | 55-1037 | Low Speed Drive Gear |

| NO. | PART NO. | NAME OF PART |
|-----|----------|-------------------------|
| 8 | 55-1038 | Bearing Retainer Gasket |
| 9 | 55-1039 | Main Shaft Grease Seal |
| 10 | 55-1040 | Main Bearing Cone |
| 11 | 55-1041 | Main Bearing Cup |
| 12 | 55-1042 | Main Shaft Key |
| 13 | 55-1043 | Drive Gear Pin |

Specify Drill Model & Serial Number When Ordering Parts



CME 55 HYDRAULIC WINCH ASSEMBLY
55-1700

| NO. | PART NO. | NAME OF PART |
|-----|----------|-------------------------------|
| 1 | 55-1701 | Mounting Adaptor Assem. Plate |
| 2 | 55-1703 | Hydraulic Motor |
| 3 | 55-1704 | Winch Assembly |
| 4 | 55-1706 | Timken Bearing |
| 5 | 55-1707 | Bearing Spacer |
| 6 | 55-1708 | Bushing |
| 7 | 55-1709 | Bracket With Bushing |
| 8 | 55-1710 | Worm Key |
| 9 | 55-1711 | Plug |
| 10 | 55-1712 | Spider Key |
| 11 | 55-1713 | Bushing |
| 12 | 55-1714 | Cable Clamp |
| 13 | 55-1715 | Cable Clamp Bolt |
| 14 | 55-1716 | Motor Adaptor |
| 15 | 55-1717 | Bearing Holder with Bushing |
| 16 | 55-1718 | Gasket |
| 17 | 55-1719 | Bearing Holder with Bushing |
| 18 | 55-1720 | Gasket |
| 19 | 55-1721 | Housing Half |
| 20 | 55-1722 | Housing Half (Tapped) |
| 21 | 55-1723 | Dowel Pin |
| 22 | 55-1724 | Drum with Bushings |
| 23 | 55-1725 | Bushing |
| 24 | 55-1726 | Drum Set Collar |

| NO. | PART NO. | NAME OF PART |
|-----|----------|----------------------------|
| 25 | 55-1727 | Grease Fitting |
| 26 | 55-1728 | Gasket (2 pieces) |
| 27 | 55-1729 | Housing Bolt |
| 28 | 55-1730 | Bearing Holder Bolt |
| 29 | 55-1731 | Socket Bearing Holder Bolt |
| 30 | 55-1732 | Allen Head Cap Screw |
| 31 | 55-1733 | Drum Shaft With Keys |
| 32 | 55-1734 | "O" Ring |
| 33 | 55-1735 | Grease Filler Plug |
| 34 | 55-1736 | Countersunk Grease Plug |
| 35 | 55-1737 | Gear |
| 36 | 55-1738 | Worm |
| 37 | 55-1739 | Spider |
| 38 | 55-1740 | Bolt |
| 39 | 55-1741 | Set Screw For Spider |
| 40 | 55-1742 | Lock Nut |
| 41 | 55-1743 | Set Screws for Worm |
| 42 | 55-1744 | Worm Shaft |
| 43 | 55-1746 | Motor Stud |
| 44 | 55-1747 | Hose |
| 45 | 55-0639 | 1/2 x 90° Adaptor Union |
| 46 | 55-1026 | Reducer Bushing |
| 47 | 55-1251 | Single Spool Valve |

Specify Drill Model and Serial Number When Ordering Parts

Moyno[®] Progressing Cavity Pump

SERVICE MANUAL

“L6” Drive End

(Frame Sizes 1L6, 2L6, 3L6, 3M4, 6M4, 3P3, 6P3, 9P3)

**IRROBBINS
IMYERS**

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SERVICE MANUAL "L6" DRIVE END

(FRAME SIZES 1L6, 2L6, 3L6, 3M4, 6M4, 3P3, 6P3, 9P3)

1-1. INTRODUCTION

1-2. GENERAL

The Robbins & Myers Moyno® Pump is one of the most versatile pumps available. It has been proven in thousands of applications over the past 45 years. It is backed by the experience gained over these years, both in application and manufacturing know-how.

The Moyno® Pump is a progressing cavity pump. The pumping action is created by a single helical rotor rolling eccentrically in the double threaded helix of the stator. In its revolution, the rotor forms in conjunction with the stator a series of sealed cavities 180 degrees apart. As the rotor turns, the cavities progress from the suction to the discharge. As one cavity diminishes, the opposing cavity is increasing at exactly the same rate. Thus the sum of the two discharges is a constant volume. The result is a pulsation-less positive displacement flow with no valves.

1-3. NAMEPLATE DATA

The pump nameplate, located on the bearing housing, carries the Serial Number, Frame Size, Type Designation, and Trim Code. All are extremely important and must be used when ordering spare parts.

Record the nameplate data of your pump in the spaces provided at paragraph 4-33.

1-4. Frame Size. The pump frame designation is essentially an indication of size. It consists of a number, a letter, and a number (i.e. 2L6). The first number indicates the number of stages in the pumping elements. The letter indicates the model. The final number indicates the size of the rotor-stator pumping elements. A frame 2L6 pump, therefore, has two stages of size-6 pumping elements.

The "L" in the frame size indicates a standard relationship between the housing, bearings, and drive shaft, and the size of the pumping elements. Many variations may be made by adapting smaller element sizes to a larger drive end size. This may be necessary due to the severity of a specific pumping application. In cases where the drive end (housing, bearings, and drive shaft) is one size larger than the element size normally used, the pump is referred to as an "M" frame pump (i.e. 3M4). If the drive end is two sizes larger than the element size, the pump

is referred to as a "P" frame. Thus, a frame 3L6, 3M4, and 3P3 would all use a common drive end.

1-5. Type Designation is a series of letters which identify the "Materials of Construction" in component groups of parts. The usual type designation will consist of three letters (i.e. CDQ).

The first letter identifies the material of the suction housing casting or the body casting where the bearing housing is a part of the suction housing.

The second letter indicates the material used in the drive shaft, pins, connecting rod, rotor, and other minor metallic parts in contact with the material being pumped.

The third letter determines the material of the stator. It identifies only the stator material and not that of the tube in which the stator is placed. The tube is either carbon steel or stainless steel, depending on Type Designation.

A typical type designation such as CDQ would result in the following:

C = Cast Iron Suction Housing

D = Tool Steel Internals including drive shaft, pins, connecting rod, rotor and other minor metallic parts in contact with the material being pumped.

Q = Buna N Synthetic Rubber Stator (70 durometer)

The following letters identify some of the actual materials that are used in standard construction:

B = EPDM

Q = Buna N (70 durometer)

C = Cast Iron

R = Natural Rubber (55 durometer)

D = Tool Steel

S = Stainless Steel, type #316

F = Viton

T = Teflon (glass impregnated)

G = Stainless Steel, type #416

1-6. Trim Code. Also included on the nameplate is the three-character trim code designation. This only appears on pumps which have semi-standard or special construction. The first letter identifies sealing variations, the second character identifies internal variations, and the third letter identifies rotor variations.

1-7. Variations of Standard Parts. Refer to paragraphs 4-34 thru 4-36 for variations available for modifying pumps to meet specialized pumping conditions. If the trim code of your pump is other than "AAA", contact your nearest Moyno® representative for clarification. Do not use any variation unless you have determined that it is compatible with your application.

2.1. INSTALLATION

2.2. GENERAL

Moyno® pumps are lubricated and tested at the factory prior to shipment and require minimum pre-start up maintenance.

Accessibility to the pump and adequate clearance should be a prime consideration in any installation. Enough space should surround the unit so that maintenance can be carried out with ease.

2.3. PIPING

2.4. Suction piping should be as short as possible. Normally, the suction line should be the same size as the pump suction; however, conditions, such as high viscosity or required minimum flow velocities, may dictate otherwise. Long-sweep 90 degree elbows or 45 degree elbows should be used instead of the standard elbow. Suction piping loops which trap air should be avoided.

2.5. Discharge piping diameter should generally be as large as the pump ports unless fluids conditions indicate otherwise.

An easily removable section of piping between 1-2 times longer than the stator should be mated to the discharge port. This will allow the rotor and stator to be removed without having to remove the complete pump from the base.

2.6. FOUNDATION

For maximum pump-driver unit life, each unit should be mounted on a strong, fabricated-steel base plate which can be ordered from Robbins & Myers. The base plates should be mounted on a concrete foundation built on a solid base. The foundation should be approximately 4" to 8" longer and wider than the base for which it is built. See figure 2-1. Anchor bolts for the base plate should be located in the foundation.

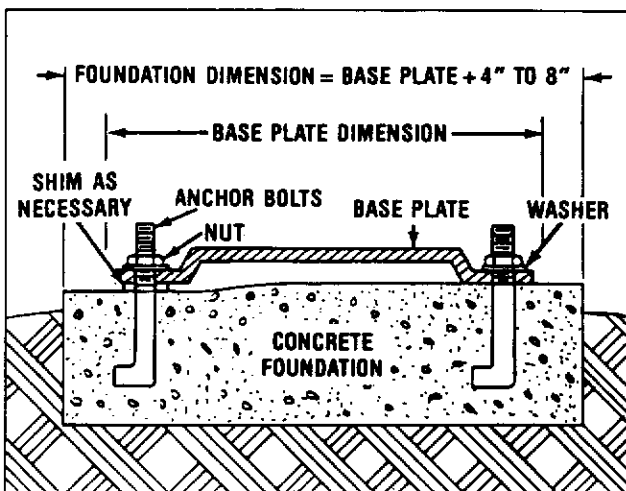


Figure 2-1. Typical Foundation Example

Check the base plate surface with a carpenter's level and place shims under the base plate at the places nec-

essary to make it level. Then check the pump and driver shafts and the pump ports. Complete base mounted units supplied by Robbins & Myers including pump and driver are leveled with respect to the base at the factory. Shifting may occur during shipment. The pump and driver should be realigned. Care should be exercised to ensure that all components are level and mounted in a direct line.

For maximum rigidity and lower noise levels the base plate should be grouted to the foundation after the anchor bolts have been evenly tightened. A good grade of non-shrink grout is recommended. The spaces between the base plate and the foundation around the shims and inside the bushings for the anchor bolts should also be filled with grout. Allow the grout to dry according to manufacturer's instructions, then fully tighten the anchor bolts.

2.7. SHAFT ALIGNMENT

Although the base mounted units supplied by Robbins & Myers are leveled with respect to the base before shipping, most of the larger pump and driver units are shipped with the flexible coupling disconnected.

After the base has been bolted down to the foundation, check the following conditions:

2.8. On coupling connected units, be sure that the pump and driver shafts are realigned before the coupling is connected. Care should be exercised to ensure that all components are level and mounted in a direct line.

Check gap between coupling halves (refer to coupling manufacturers recommendations). Adjustment can usually be accomplished by loosening the mounting bolts on either the pump or driver and moving the loosened component into alignment with the fixed component. Do not use a hammer! On couplings with equal diameter hubs, it may be helpful to lay a straight edge axially across the coupling halves to check alignment.

2.9. On belt drive units, check to ensure that sheaves or sprockets are in alignment. Check belts for proper tension. Tension requirements will vary with type of belt, center distances, and belt speeds. Consult belt manufacturer for specific recommendation.

2.10. WATER FLUSH OF PACKING

The packing may be either grease lubricated through a grease fitting in the stuffing box or have plumbing connected to the housing to allow a water flush.

When the material being pumped is abrasive in nature, it may be advantageous to flush the packing to prevent leakage under packing and excessive shaft wear.

Clean water can be injected through a 1/8" NPT tapped hole that normally houses the grease fitting for lubricating the packing. The water can be permitted to leak axially along the shaft in either direction or can be removed from the second tapped hole in the stuffing box. In both cases, the discharge from the stuffing box should be throttled slightly to maintain 10-15 PSI higher pressure in the stuffing box than is present in the suction housing. See figure 2-2.

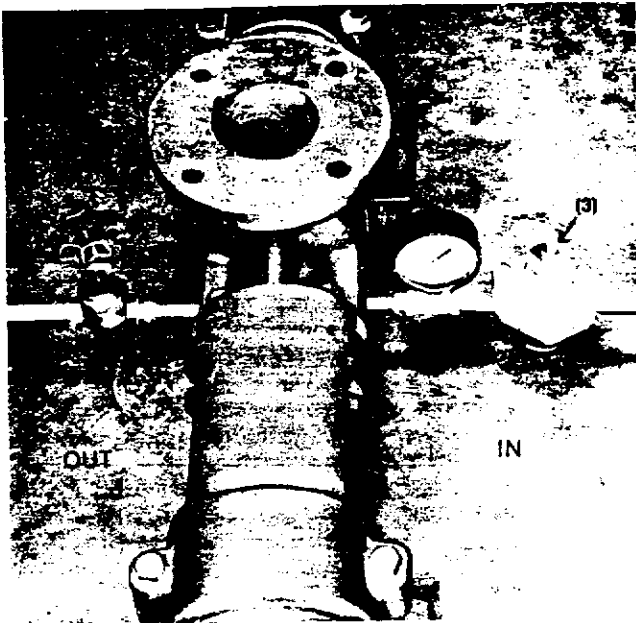


Figure 2-2. Typical Water Flush to Packing includes a (1) Throttling Valve, (2) Pressure Gauge, and (3) Pressure Regulating Valve. This is a basic arrangement; other variations can be used.

3.1. OPERATION

3.2. INITIAL CHECK

Before putting the pump into operation, the following items should be checked to ensure that each piece of equipment is installed correctly:

- Pump, driver, coupling or sheave alignment.
- Electrical connections.
- Gauges and other instruments.
- Water flush connection to the stuffing box.
- Pump rotation. Normal rotation is indicated on the pump drive end.
- Belt tension on belt driven units. There should be no appreciable deflection when first starting up.
- All valves should be open on both suction and discharge sides of pump.

CAUTION: This is a positive displacement pump. Do not operate it against a closed valve.

3.3. START-UP

CAUTION: DRY OPERATION IS HARMFUL TO THE PUMP! Never allow the pump to operate without liquid, as dry operation will cause premature wear of the stator and possible damage. The stator is lubricated by the liquid which is pumped.

1. Before operating the pump for the first time, fill it with liquid (the pipe plug tap on the suction housing may be used for filling). If the liquid to be pumped is highly viscous, dilute it before filling the pump. The liquid fill-up will lubricate the stator for the initial start-up.

Note: If the pump is shut down temporarily, enough liquid will remain in the system to provide lubrication upon restarting. It is advisable to maintain the suction piping at a higher elevation than the

centerline of the pump in order to contain some liquid in the pump at time of shutdown.

2. Once the pump has been filled with liquid, check for direction of pump rotation by momentarily starting and stopping the drive. See pump drive end for correct rotation.

3. In suction lift applications, when water flush is not utilized, replace the zerk fitting at the stuffing box (in suction housing) with a pipe plug. This will prevent loss of prime due to air leakage.

4. If applicable, turn on the seal water to packing.

5. Start pump.

3.4. PACKING LEAKAGE

The packed stuffing box is designed to control leakage, not to stop it completely. Leakage is necessary to reduce friction and to dissipate heat.

1. Upon initial start up of the pump, be sure that the packing gland nuts are only finger-tight and evenly adjusted. See figure 3-1.

2. Adjust the gland nuts for a leakage rate of 50-100 drops per minute until the packing has seated and adjusted to the operating temperature (approximately 10-15 minutes).

3. If excessive leakage is present after 15 minutes of operation, tighten the gland nuts 1/6 of a turn.

4. Tighten the gland nuts 1/6 of a turn after an additional 15 minutes if necessary, and repeat until desired leakage of 1-2 drops per minute is obtained.

CAUTION: Do not tighten until zero leakage is obtained. Over-tightening of the packing gland may result in accelerated wear on the packing and damage to the shaft.

5. When new packing is placed in the stuffing box, often all but one ring will fit, until pump operation compacts them. In such cases, a single packing ring is included in a small bag attached to the packing gland nut. After the pump has run, and the packing has compressed, the final packing ring can be added.

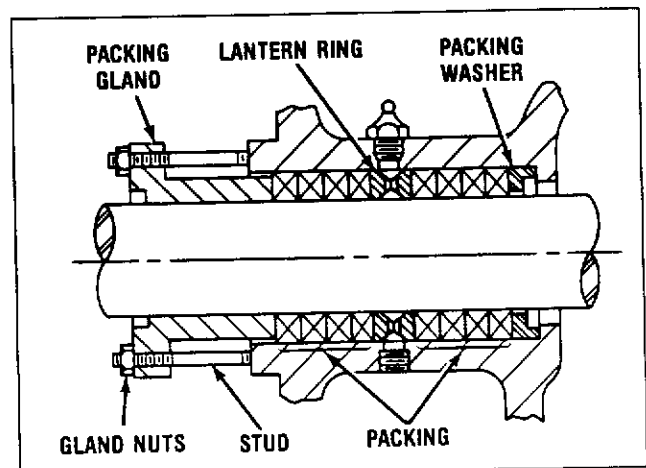


Figure 3-1. Cross Section of Stuffing Box

4-1. MAINTENANCE

4-2. GENERAL

The Moyno pump has been designed for a minimum of maintenance, the extent of which is routine lubrication and adjustment of packing, and infrequent lubrication of the bearings. The pump is one of the easiest to work on in that the main elements are very accessible and require few tools to disassemble.

4-3. PACKING LUBRICATION

The zerk fitting on the side of the suction housing leads to the lantern ring halves in the mid-section of the packings. At least once a week, inject a small quantity of good quality grease, such as Mobil Temp Grease (Mobil Chemical Co.), or equivalent, into the zerk fitting to lubricate the packings.

4-4. PACKING ADJUSTMENT

Packing gland attaching nuts should be evenly adjusted so they are little more than finger tight. Over-tightening of the packing gland may result in premature packing failure and possible damage to the shaft and gland.

When the packing is new, frequent minor adjustments are recommended for the first few hours of operation in order to compress and seat the packing.

When leakage can no longer be regulated by tightening the gland nuts, remove and replace the packings in accordance with the DISASSEMBLY and REASSEMBLY instructions. The entire pump need not be disassembled to replace the packings. Briefly, replace as follows:

1. Remove gland nuts, and slide gland along drive shaft.
2. Use a packing puller tool to remove four packing rings, lantern ring halves, and four additional packing rings.
3. Inspect surface of drive shaft for excessive wear or grooves due to packing rub. If shaft is worn, disassemble pump drive to replace drive shaft.
4. If drive shaft is not worn, install four packing rings, the lantern ring halves, and four more packing rings. Be sure to stagger the packing ring joints at 90° increments.
5. When installing the new packing, it may be found that all but one ring will go on the drive shaft. When the pump has run for a short time and the new packing is compressed, this final ring can be installed.

CAUTION: Always use a proper packing tamper tool to install packings. Do not use a pointed or sharp tool, as damage to the packing material or drive shaft could result. To assure proper shaft lubrication, never use a one-piece spiral wrap packing.

4-5. BEARING LUBRICATION

The bearings are lubricated at the factory and do not need additional lubrication for at least 15,000 hours of normal operation.

1. Remove the drive shaft and bearing assembly in accordance with the DISASSEMBLY instructions.
2. Clean bearings and shaft assembly to remove all old grease.
3. Use a good grade of EP (Extreme Pressure) Lithium soap-base grease such as Mobilux EP2 Grease (Mobil Chemical Co.), or equivalent, to lubricate bearings.
4. Reassemble in accordance with the REASSEMBLY instructions.

Note: It is normal for bearings to run warm to the touch for the first few hours of operation.

4-6. DISASSEMBLY

4-7. Disconnect Pump.

1. Disconnect the power source.
2. Close the suction and discharge valves to isolate the pump from the line.
3. Turn off flush water to packing if used.
4. Remove drain plug in bottom of suction housing to drain away any fluid remaining in pump.
5. Place a support block under suction housing in area of drain plug. Wooden blocks are sufficient. The purpose is to prevent undue stress on pump support when pump is disassembled.
6. Disconnect piping from stator end of pump.

4-8. Stator Removal.

1. With pipe wrench or strap wrench, remove discharge reducer (31).
2. Remove cap of stator support (30).

Note: On most "M" and "P" frame pumps, a two-piece bushing (28) will be installed around stator (27) at support (30). On the 3P3 frame pump, a second two-piece bushing (29) is used.

3. With strap wrench or pipe wrench, unscrew stator (27) from suction housing. Pull stator off the rotor.

4-9. Rotor Removal.

1. At shaft collar (12), remove two retaining screws (10).
2. Use a small punch or drift pin to drive pin (13) from shaft (8).

3. Slide shaft collar (12) toward packing gland (14) and remove a washer (11) from each side of shaft (8).

4. Pull rotor and connecting rod unit (22 thru 26) from pump.

4-10. Rotor Disassembly.

1. Use a vise to clamp the mid-section of connecting rod (23).

2. Use a drift pin to carefully drive pin retainer (24) from end of rotor (26).

3. Remove rotor pin (25), and separate connecting rod (23) from rotor (26).

4. If present, remove washers (22).

5. On most "M" and "P" frame pumps, a detachable rotor head (33) is present. Drive off the second pin retainer (24) to remove head pin (32).

6. On 9P3 frame pumps, remove O-ring (34).

4-11. Packing Removal.

1. Remove two nuts (D) and packing gland (14).

2. If packing is to be removed without further disassembly of pump, use a packing puller tool to remove packing (15).

3. Carefully work out lantern ring halves (16).

Note: If pump is to be disassembled, remove packings **AFTER** removal of the suction from the bearing housing assembly. Refer to paragraph 4-12, step 5.

4-12. Drive Shaft and Bearing Removal.

1. Remove stator and rotor per paragraphs 4-8 and 4-9.

2. Remove two nuts (D) and packing gland (14).

3. Remove four screws and lock washers (A). Pull cover plate (2) from drive shaft.

4. Insert a bar or rod into the hollow end of drive shaft (8), and tap the rod to force the shaft unit (3 thru 8) out of the pump.

5. If the packing was not previously removed, use a small rod through stator port of suction housing (20) to tap on packing washer (17). Carefully drive packings (15), lantern ring halves (16), and packing washer (17) out of suction housing (20).

6. To disassemble drive shaft and bearing unit, remove nut (3) and washer (4). Use an arbor press on inner race of radial bearing (7) to press radial bearing (7), spacer (6), and thrust bearing (5) from shaft.

Note: If replacing drive shaft or bearings, it is recommended that both grease seals (1 and 9) also be replaced.

7. Drive seal (1) out of plate (2). Drive seal (9) out of bearing housing (19).

4-13. CLEANING

Clean all parts in a suitable cleaning solvent. Be sure to clean stuffing box cavity in suction housing (20).

4-14. INSPECTION

4-15. Bearings. After cleaning, rotate bearings very slowly under hand pressure to feel for smooth and even action. Never spin a dry bearing. Check for cracks, galling, pitting, burrs, etc. Replace bearing if there is any doubt concerning complete serviceability.

4-16. Drive Shaft. Inspect drive shaft for scoring, burrs, cracks, damaged threads, etc. Replace as necessary.

4-17. Seals. It is sound practice to always replace seals whenever bearings and drive shaft are removed.

4-18. Packing. It is sound practice to always replace packing whenever the pump drive end is disassembled. However, examine old packings as an indication of operating conditions.

4-19. Rotor.

1. To check for excessive rotor wear, measure the rotor crest-to-crest diameter and compare with the following chart:

| Frame Size | Standard Crest-to-Crest Dia. (in.) |
|------------|------------------------------------|
| L6 | 2.281 ± 0.003 |
| M4 | 1.888 ± 0.003 |
| P3 | 1.415 ± 0.003 |

2. If the measured crest-to-crest diameter is within 0.010" of the standard value, the rotor is re-usable.

3. Rotors with crest-to-crest diameters of 0.011 to 0.050 inch under the standard value should be replaced. These rotors can be renewed by chrome plating to standard dimensions provided that:

- the rotor pin holes are not excessively worn.
- the rotor surface is not cracked, pitted or deeply grooved (1/32" or more).
- the base metal surface is not pitted or corroded.

4. Rotors may be sent to Robbins & Myers or any other competent plating shop. Surface should be buffed, replated to standard dimensions, then polished.

4-20. Stator. A stator is worn and in need of replacement if its surface is pitted and gouged. However, even a smooth surface may be worn. Performance is the best measure of rotor to stator fit. Suspected stator wear can be evaluated by a Robbins & Myers' sales or factory representative.

4-21. All Other Parts. Check for cracks, excessive wear, damage to threaded holes, burrs, etc. Replace as necessary. Replace O-ring (34) at each disassembly.

4-22. ASSEMBLY

4-23. Grease Seals.

1. Use an arbor press to install grease seal (1) in cover plate (2). Be sure lip of seal is directed toward interior of cover plate (pump interior).
2. Use an arbor press to install grease seal (9) in bearing housing (19) so that lip of seal is directed toward bearing cavity.
3. Apply a few drops of oil to ID of seals just before further assembly.

4-24. Drive Shaft, Bearings, and Packing.

1. Use an arbor press to install radial bearing (7), spacer (6), and thrust bearing (5) on drive shaft (8). Press only on inner race of bearings. Be sure radial bearing (7) is seated on shaft shoulder.
2. Install lock washer (4) and nut (3), and tighten nut securely. Bend one tab of lock washer against flat of nut.
3. Lubricate bearings per paragraph 4-5.
4. Carefully and slowly insert hollow end of drive shaft (8) through seal (9) in bearing housing (19). As the shaft emerges from the seal, slip the following parts, in order, over the shaft:
 - a. Shaft collar (12).
 - b. Packing gland (14).

Note: If the packing set consists of hard foil rings and soft asbestos plastic rings, install the rings alternately; first a hard, then a soft, etc.

- c. Four or three packing rings (15) with their joints staggered 90° on adjacent rings.

Note: When installing new packing, it may be found that all but one ring will go on the drive shaft. When the pump has run for a short time and the new packing is compressed, this final ring can be installed. Remember, for proper lubrication, FOUR rings must ALWAYS be installed between washer (17) and lantern ring halves (16).

- d. Two lantern ring halves (16) with their flat faces against the packing.
- e. Four packing rings (15) with joints staggered 90°.
- f. Packing washer (17) with its flat face against packing.

5. Push drive shaft through suction housing (20). Carefully install cover plate assembly (1,2), and attach with four screws and lock washers (A). Tighten screws evenly and alternately.

6. Push packing (15) and packing gland (14) into stuffing box of suction housing (20). Attach gland to studs (F) with two nuts (D) finger tight. Final gland adjustment should be done during the next start up.

4-25. Rotor.

1. Slip connecting rod (23) and one washer (22) (if used) into rotor (26). Align pin holes, and install pin (25).

2. On "M" and "P" frame pumps, attach rotor to rotor head (33) with pin (32). Secure pin (32) with retainer (24).

Note: On 9P3 frame pumps, install O-ring (34).

3. Insert connecting rod (23) with washer (22) (if used) into hollow drive shaft (8). Align hole in end of rod (23) with hole in shaft (8) and hole in collar (12).

4. Insert shaft pin (13) through collar, shaft, and rod. Retain with a washer (11) and retaining screw (10) on each end of shaft pin (13).

Note: Be sure that the hollow end of retaining screw (10) fits over end of shaft pin (13) to ensure a tight fit. Retaining screws must seat on washers (11) and not on pin (13).

4-26. Stator.

1. If the stator (27) has a stainless steel tube, apply Teflon™ tape or a similar sealing material to its threads. If the stator has a carbon steel sleeve, apply pipe dope to its threads.

2. Just before installation of stator, lubricate the rotor with water or glycerine to allow stator to slip on easier.

Note: Be sure to use a lubricant that is compatible with the stator material. Grease or oil is not compatible with type R or B stators.

3. Slip stator over rotor, and screw into the suction housing. Tighten with a pipe wrench as close to the suction housing as possible.

4. Secure stator in stator support(s) (30) with support cap and screws (C).

Note: For frames 3M4, 3P3, and 6P3, install bushing (28) at each support (30). For frame 3P3, install an extra smaller bushing (29) under the bushing (28).

4-27. Pump Connections.

1. Connect piping to stator end of pump.
2. Check complete pump installation per INSTALLATION instructions.
3. Perform INITIAL CHECK and START-UP operations per paragraphs 3-2 and 3-3.

4-28. STORAGE

4-29. Short Term Storage. Storage of 6 months or less will not damage the pump. However, to ensure the best possible protection, the following is advised:

1. Store pump inside whenever possible or cover with some type of protective covering. Do not allow moisture to collect around pump.

2. Remove drain plug to allow the suction housing to drain and dry completely.

3. Loosen the packing gland and inject a liberal amount of grease into the stuffing box. Tighten the gland nut only hand tight. When water flush systems are to be used, do not use grease. A small amount of light oil is recommended.

4. See manufacturer's instructions for motor and/or

5. Every 2 or 3 weeks, rotate the pump manually a few revolutions to avoid a "set" condition of rotor in stator elastomer. This will prevent hard starting and excessive torque requirements when pump is again put in operation.

6. See OPERATION paragraphs 3-1 thru 3-4 before start-up.

4-30. Long Term Storage. If pump is to be in storage for more than 6 months, perform the above short term storage procedures. Then do the following:

1. Apply rust inhibitor.
2. Remove drive belts.

Note: If storage is for more than 6 months, and the pump will be unattended, remove the stator to avoid a "set" condition of rotor in stator elastomer.

4-31. STANDARD HARDWARE

| REF. NO | DESCRIPTION | SIZE | QTY |
|---------|--------------------|--|-----|
| A | Screw, Hex head | $\frac{3}{8}$ -16 x 1 | 4 |
| | Lock Washer | $\frac{3}{8}$ | 4 |
| B | Key, Square | $\frac{1}{4}$ x $\frac{1}{4}$ x 2- $\frac{1}{2}$ | 1 |
| C | Screw, Hex head: | | |
| | 1L6, 2L6, 3M4, 3P3 | $\frac{1}{2}$ -13 x 1- $\frac{1}{2}$ | 4 |
| | 3L6, 6M4, 6P3, 9P3 | $\frac{1}{2}$ -13 x 1- $\frac{1}{2}$ | 6 |
| D | Nut, Hex | $\frac{7}{16}$ -14 | 2 |
| E | Plug, Pipe | $\frac{1}{8}$ NPT | 2 |
| F | Stud | $\frac{7}{16}$ -14 x 3- $\frac{3}{8}$ | 2 |
| G | Fitting, Grease | $\frac{1}{8}$ NPT | 1 |
| H | Plug, Pipe | $\frac{1}{2}$ NPT | 3 |
| J | Screw, Hex head | $\frac{1}{2}$ -13 x $\frac{1}{2}$ | 4 |
| | Lock Washer | $\frac{1}{2}$ | 4 |

4-32. RECOMMENDED SPARE PARTS

The Moyno® pump has been designed and built with all wearable parts replaceable. A recommended inventory of spare parts is dependent upon the application and importance of continued operation.

For the shortest possible down time, we recommend the following parts be stocked:

- 1 - Rotor
- 1 - Stator
- 1 - Connecting Rod Kit
- 1 - Packing Set

The above is only a suggested list. For further assistance in determining what you'll need for your application, contact your Moyno® representative.

4-33. NAMEPLATE DATA



| |
|------------------|
| FRAME NO |
| TYPE NO |
| FORM NO |
| RPM |
| MFG SERIAL NO |
| BRANCH SERIAL NO |

MFD by ROBBINS & MYERS, INC.
Springfield, Ohio, U.S.A.

**ROBBINS
& MYERS**

4-34. VARIATIONS OF STANDARD PARTS

Below are variations available for modifying pumps to meet specialized pumping conditions. If the trim code of your pump is other than "AAA", contact your nearest Moyno® representative for clarification. Do not use any variation unless you have determined that it is compatible with your application.

4-35. Rotors identified on parts listing are standard size with hard chrome plated surface. Other variations of rotor size and finish may be ordered by selecting the standard rotor part number and changing the last digit of the rotor number as follows:

- 2 = Standard size, non-plated
- 3 = Undersize, chrome-plated
- 4 = Undersize, non-plated
- 5 = Oversize, chrome-plated

Do not change rotor sizes without consulting your local Moyno® Sales Office. These variations are used for certain specialized pumping conditions only.

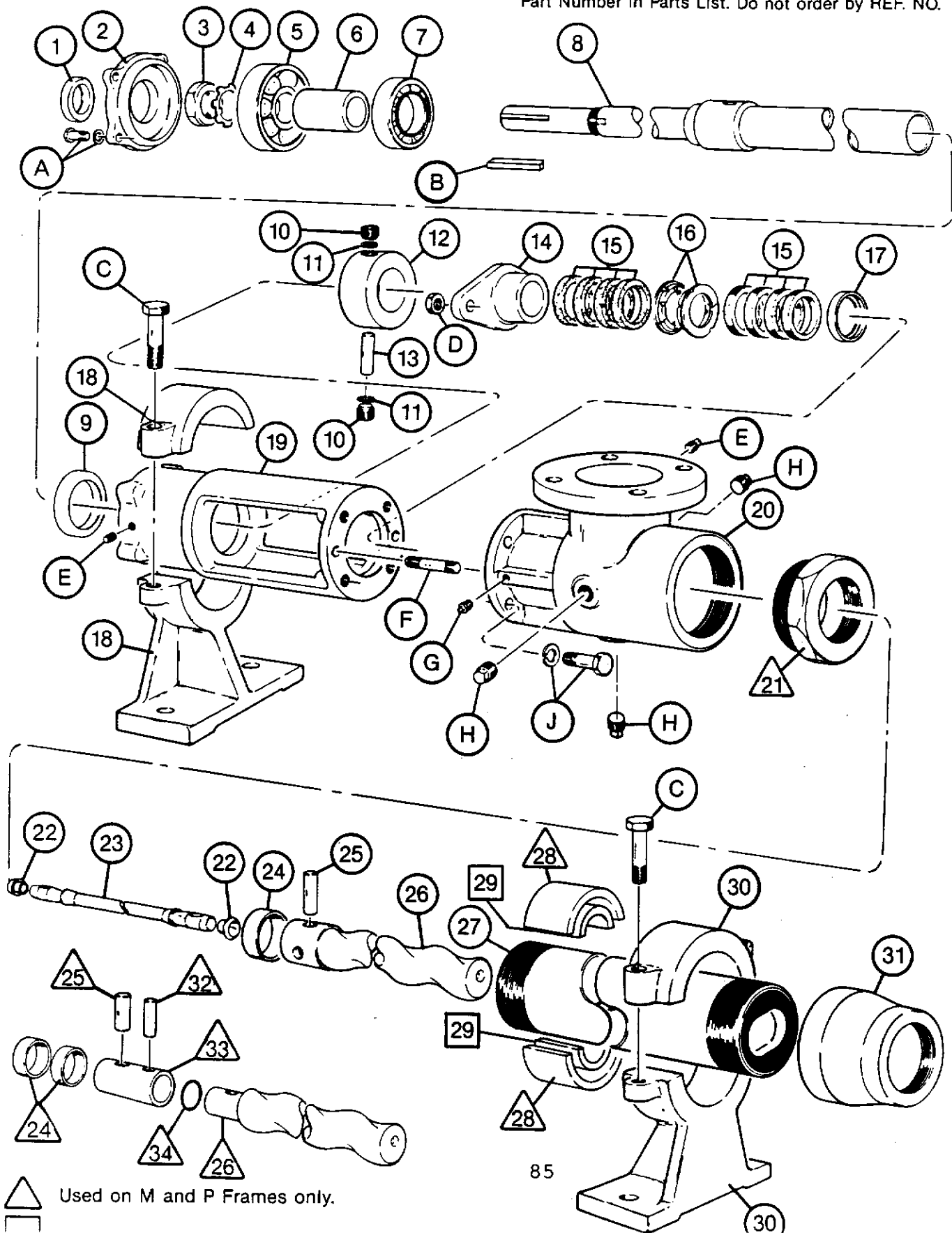
4-36. Drive Shafts shown have hard-chrome plating on the packing wear area. If non-plated drive shafts are required, select the standard part number and change the last digit to next higher number. Example: B06261 to B06262.

4-37. PACKING

The last digit of the packing part number is listed below according to the pump Type Designation.

| PUMP TYPE DESIGNATION | PACKING PART NO. LAST DIGIT | PACKING MATERIAL |
|---------------------------------------|-----------------------------|--|
| CDB,CDD,CDF CDG,CDQ,CDT | 1 | Alternate die molded rings of lead foil wrapped asbestos, and rings of dura-plastic asbestos fiber and lead shreads. |
| CDR,CSR,SSR | 3 | Die molded dura-plastic consisting of pure, long asbestos fiber and lead shreads lubricated throughout. |
| CSB,CSD,CSG CSQ,SSB,SSG SSQ,CSF | 5 | Die molded dura-plastic consisting of pure, long asbestos fiber and aluminum shreads lubricated throughout. |
| CST,SSF SST | 7 | Flexible braided Polytetrafluoroethylene. |

Select Type Designation column in Parts List according to Type No. on nameplate. Refer to Frame No. to select proper rotor and stator and other related parts. Order by Part Number in Parts List. Do not order by REF. NO.



4-38. PARTS LIST

PUMP TYPE DESIGNATIONS

| REF. NO. | DESCRIPTION | CDQ CDR CDB CDF | CDD CDG CDT | CSQ CSR CSB CSF | CSD CSG CST | SSQ SSR SSB SSF | SSG SST |
|-------------|--|--------------------------|-------------------|--------------------------|-------------------|--------------------------|------------|
| | Bearing Kit (See note A) | K06291 | K06291 | K06291 | K06291 | K06291 | K06291 |
| | Rod Kit, Connecting (See Note B): | | | | | | |
| | All but Type F | K0625D | K0625D | K0625S | K0625S | K0625S | K0625S |
| | Rod Kit, Connecting (See Note B): | | | | | | |
| | CDF, CSF, SSF | KF625D | ----- | KF625D | ----- | KF625D | ----- |
| 1 | Seal, Grease (Thrust) | A06621 | A06621 | A06621 | A06621 | A06621 | A06621 |
| 2 | Plate, Bearing Cover | A06341 | A06341 | A06341 | A06341 | A06341 | A06341 |
| 3 | Nut, Bearing Lock | A06581 | A06581 | A06581 | A06581 | A06581 | A06581 |
| 4 | Washer, Bearing Lock | A06591 | A06591 | A06591 | A06591 | A06591 | A06591 |
| 5 | Bearing, Ball (Thrust) | A06301 | A06301 | A06301 | A06301 | A06301 | A06301 |
| 6 | Spacer, Bearing | A06331 | A06331 | A06331 | A06331 | A06331 | A06331 |
| 7 | Bearing, Ball (Radial) | A06291 | A06291 | A06291 | A06291 | A06291 | A06291 |
| 8 | Shaft, Drive | B06261* | B06261* | B06266* | B06266* | B06266* | B06266* |
| 9 | Seal, Grease (Radial) | A06611 | A06611 | A06611 | A06611 | A06611 | A06611 |
| 10 | Screw, Drive Pin Retaining (2) | B0654D | B0654D | B0654S | B0654S | B0654S | B0654S |
| 11 | Washer, Retaining Screw (2) | A06731 | A06731 | A06731 | A06731 | A06731 | A06731 |
| 12 | Collar, Shaft | A06491 | A06491 | A06491 | A06491 | A06491 | A06491 |
| 13 | Pin, Shaft | B0646D | B0646D | B0646S | B0646S | B0646S | B0646S |
| 14 | Gland, Packing | B0641D | B0641D | B0641D | B0641S | B0641S | B0641S |
| 15 | Packing Set | B0642# | B0642# | B0642# | B0642# | B0642# | B0642# |
| 16 | Ring Half, Lantern (2) | A06571 | A06571 | A06571 | A06571 | A06571 | A06571 |
| 17 | Washer, Packing | B0665D | B0665D | B0665D | B0665S | B0665S | B0665S |
| 18 | Support with Cap, Pump | A06371 | A06371 | A06371 | A06371 | A06371 | A06371 |
| 19 | Housing, Bearing | A06051 | A06051 | A06051 | A06051 | A06051 | A06051 |
| 20 | Housing, Suction | B06021 | B06021 | B06021 | B06021 | B06026 | B06026 |
| 21 | Bushing, Adapter: 3M4, 6P3 only | B06511 | B06512 | B06511 | B06512 | B06516 | B06517 |
| | 3P3 only | B06513 | B06511 | B06513 | B06511 | B06518 | B06516 |
| | 9P3 only | B06512 | ----- | B06512 | ----- | B06517 | ----- |
| 22 | Washer, Connecting Rod: | | | | | | |
| | All but Type F | A0653Q | ----- | A0653Q | ----- | A0653Q | ----- |
| | Washer, Connecting Rod: | | | | | | |
| | CDF, CSF, SSF | A0653F | ----- | A0653F | ----- | A0653F | ----- |
| 23 | Rod, Connecting | B0625D | B0625D | B0625S | B0625S | B0625S | B0625S |
| 24 | Retainer, Pin | A06501 | A06501 | A06501 | A06501 | A06501 | A06501 |
| 25 | Pin, Rotor | B0645D | B0645D | B0645S | B0645S | B0645S | B0645S |
| 26 | Rotor: 1L6 | C71061* | C71061* | C81061* | C81061* | C81061* | C81061* |
| | 2L6 | C72061* | C72061* | C82061* | C82061* | C82061* | C82061* |
| | 3L6 | C73061* | C73061* | C83061* | C83061* | C83061* | C83061* |
| | 3M4 | C73041* | C73041* | C83041* | C83041* | C83041* | C83041* |
| | 6M4 | C76041* | C76041* | C86041* | C86041* | C86041* | C86041* |
| | 3P3 | C73031* | C73031* | C83031* | C83031* | C83031* | C83031* |
| | 6P3 | C76031* | C76031* | C86031* | C86031* | C86031* | C86031* |
| | 9P3 | C79031* | C79031* | C89031* | C89031* | C89031* | C89031* |
| 27 | Stator: 1L6 | C4106 + | C4106 + | C4106 + | C4106 + | C5106 + | C5106 + |
| | 2L6 | C4206 + | C4206 + | C4206 + | C4206 + | C5206 + | C5206 + |
| | 3L6 | C4306 + | C4306 + | C4306 + | C4306 + | C5306 + | C5306 + |
| | 3M4 | C4304 + | C4304 + | C4304 + | C4304 + | C5304 + | C5304 + |
| | 6M4 | C4604 + | C4604 + | C4604 + | C4604 + | C5604 + | C5604 + |
| | 3P3 | C4303 + | C4303 + | C4303 + | C4303 + | C5303 + | C5303 + |
| | 6P3 | C4603 + | C4603 + | C4603 + | C4603 + | C5603 + | C5603 + |
| | 9P3 | C4903 + | C4903 + | C4903 + | C4903 + | C5903 + | C5903 + |
| 28 | Bushing, Support: 3M4, 3P3, 6P3 only .. | A06711 | A06711 | A06711 | A06711 | A06711 | A06711 |
| 29 | Bushing, Support: 3P3 only | A04711 | A04711 | A04711 | A04711 | A04711 | A04711 |
| 30 | Support with Cap, Stator: All but 9P3 .. | A06381 | A06381 | A06381 | A06381 | A06381 | A06381 |
| | 9P3 | A06382 | ----- | A06382 | ----- | A06382 | ----- |
| 31 | Reducer: 1L6, 2L6, 3L6, 6M4 | B06091 | B06091 | B06091 | B06091 | B06096 | B06096 |
| | 3M4, 6P3 | B04091 | B04092 | B04091 | B04092 | B04096 | B04097 |
| | 3P3 | B03091 | B04091 | B03091 | B03092 | B03096 | B03097 |
| | 9P3 | B04092 | ----- | A04092 | ----- | B04097 | ----- |
| 32 | Pin, Rotor Head: 3P3 only | B06471 | B06471 | B06472 | B06472 | B06472 | B06472 |
| | 3M4, 6P3 only | B06473 | B06473 | B06474 | B06474 | B06474 | B06474 |
| | 9P3 only | B0645D | ----- | B0645S | ----- | B0645S | ----- |
| 33 | Head, Rotor: 3M4, 6P3 only | B06321 | B06321 | B06322 | B06322 | B06322 | B06322 |
| | 3P3 only | B06323 | B06323 | B06324 | B06324 | B06324 | B06324 |
| | 9P3 only | B06325 | B06325 | B06326 | B06326 | B06326 | B06326 |
| 34 | O-Ring: 9P3 only | A06111 | A06111 | A06111 | A06111 | A06111 | A06111 |

Note A - Bearing Kit includes items 1, 3 thru 7, and 9.

Note B - Connecting Rod Kit includes items 10, 11, 13, 22, 23, and 25.

* See paragraph 4-34, VARIATIONS OF STANDARD PARTS, for part numbers of special applications.

+ Add third letter of Type Designation to complete part number; i.e., for Type CDQ, add Q to basic number of stator.

See PACKING, paragraph 4-37, for last digit of part number and packing material.

NOTE: See paragraph 4-31 for STANDARD HARDWARE.

4-39. TROUBLE SHOOTING CHART

PUMP PROBLEMS

Pump does not rotate.

Pump does not discharge.

Discharge output low.

Discharge output fluctuates.

Pump drive overloaded.

Pump noisy.

Stator wears too fast.

PROBABLE CAUSE AND REMEDY

Incorrect power supply; drive not properly wired. *Check motor nameplate data; test voltage, phase, & frequency.*

Foreign matter in pump. *Remove foreign matter.*

If pump or stator is new, too much static friction. *Fill with liquid, and hand turn. If still tight, lubricate stator with glycerine.*

Stator swells due to chemical attack. *Change stator material.*

Stator swells due to high liquid temp. *Reduce liquid temp. or use an undersized rotor.*

Blockage due to solids in liquid. *Decrease solids-to-liquid ratio.*

Liquid settles and hardens after pump shut down. *Clean and rinse pump after each use.*

Suction pipe not submerged. *Reposition suction pipe.*

Air in suction pipe. *Tighten connections to stop leaks.*

Pump speed too low. *Increase drive speed.*

Suction lift too high (cavitation). *Reduce suction losses; move pump to lower elevation.*

Pump running dry; no prime. *Fill pump with liquid; relocate suction piping.*

Stator worn excessively. *Replace stator.*

Rotor worn excessively. *Replace rotor.*

Wrong direction of rotation. *Reverse drive motor polarity.*

Discharge pressure too high. *Open discharge valve; reduce discharge pipe length; remove obstruction.*

Suction pipe leaks. *Tighten pipe connections.*

Shaft packing leaks. *Tighten packing gland; replace packing.*

Stator material brittle. *Replace stator.*

Pump speed too high. *Reduce drive speed.*

Liquid viscosity or specific gravity too high. *Measure and compare with specification.*

Packing too tight. *Loosen gland nuts.*

Bent drive shaft. *Replace drive shaft.*

Drive and pump misaligned. *Re-align drive and pump.*

Flexible drive coupling worn. *Repair or replace coupling.*

Drive shaft bearings worn. *Replace bearings.*

Incorrect packing. *Change packing material.*

Packing too loose. *Tighten gland nuts.*

ASSEMBLY AND USE OF LONGYEAR CORE BARREL

Pertinent Data

L.O.A. - 12 ft.
Core Dimension - 1 3/16"
Assembly No. - 22610
Outer Tube O. D. - 1 13/16"
Length - 10 ft.

Longyear Company
Board Road
York, PA 17402

STEPS FOR ASSEMBLY & USE

Refer to drawing for assembly

1. Attach diamond reaming shell to outer barrel using strap wrenches to prevent crushing of the barrels.
2. Thread A rod adapter and water jacket to inner barrel; slide through outer barrel and thread.
3. Insert Core retainer into retainer basket and thread into inner barrel.
4. Slide bit over retainer basket assembly and thread onto reaming shell. This completes assembly. Remember: keep all thread joints clean and grease to prevent binding of threads and crushing of barrel during take down.
5. Extruding the core is the reverse process of assembly.

CARE & USE OF LONGYEAR CORE BARREL ASSEMBLY

The 10 ft. double tube core barrel in our possession is a relatively durable unit to be used for hard rock coring only. The following is a list of items to be concerned with when using.

1. The core barrel should be used in 300-600 rpm range. Slow speeds are inefficient while too great a speed could cause heat buildup on the bit and scouring or plucking of the diamonds.
2. Constant water circulation to the diamond bit is imperative to prevent overheating and possible damage to the bit or bridging of the entire barrel. It has been found that, due to the slow drilling through hard rock, it is desirable to recirculate water through the CME mud pump.

3. A suggested procedure for hardrock core drilling using the University's CME rig is as follows:

Use Augers to drill to the top of the weathered basement. Later, clean the insides of the Auger if an aluminum plug is installed at the auger bit.

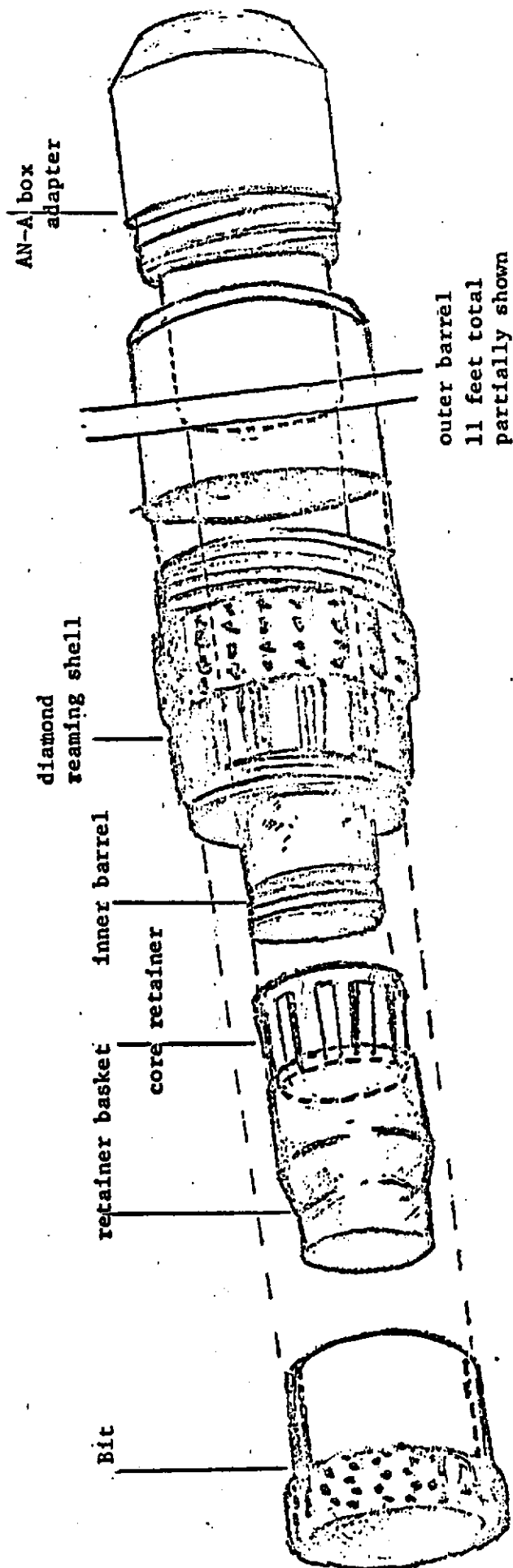
If weathered basement is full of clay voids and regolith, it would be best to rotary drill down through the augers using the three wing drag bit and A rod until certain that solid rock has been struck.

Pull up and remove the drag bit and attach the core barrel. (Check all A rods to be sure they're clear.)

Attach the recirculation tee to the top of the augers and begin drilling.

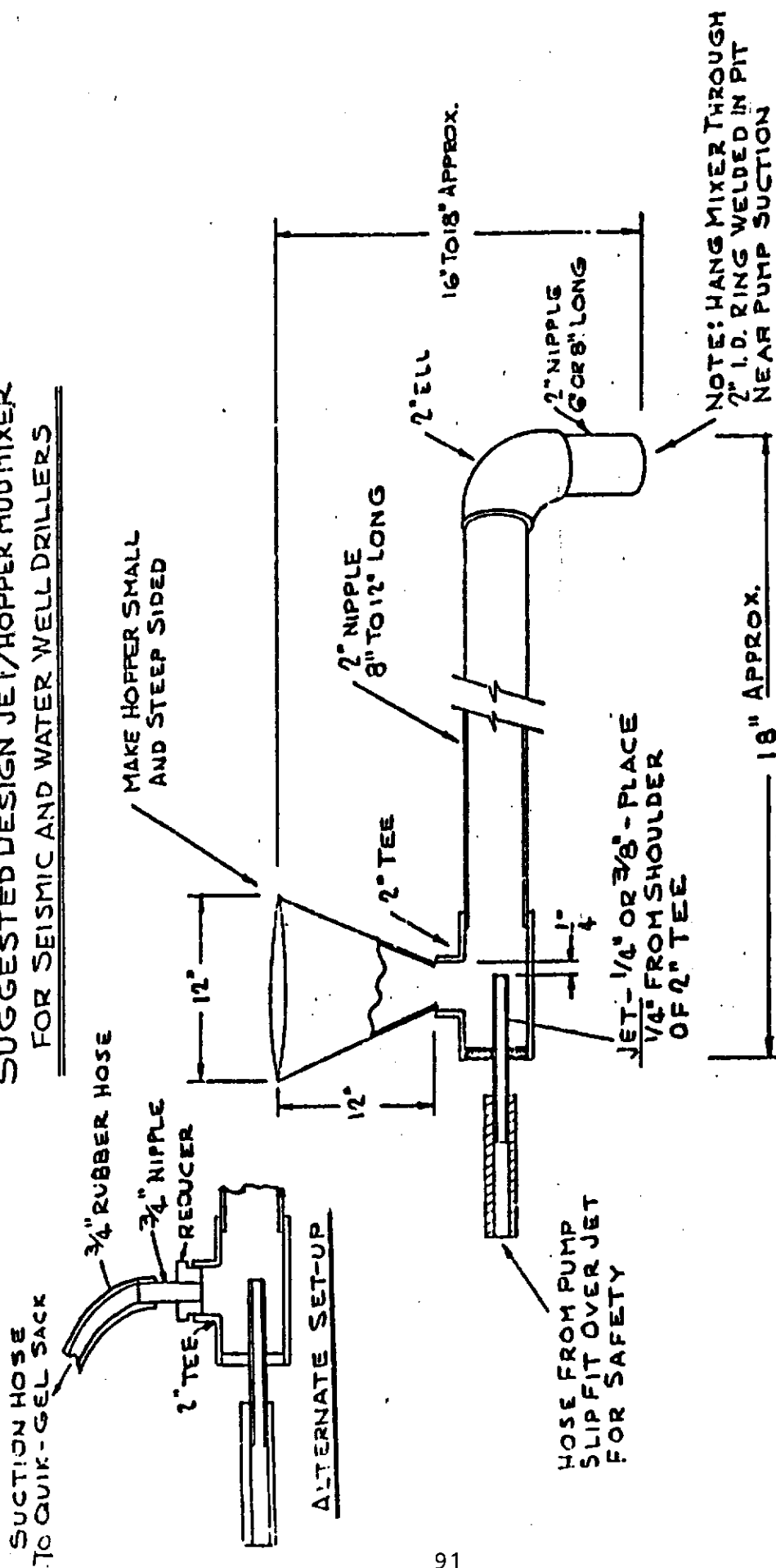
Always, always be sure of water pressure; if no water is pumped out do not assume that you've hit a void, especially if the hydraulics pressure valve starts climbing.

EXPLODED VIEW OF LONGYEAR CORE BARREL



BAROID DIVISION
NATIONAL LEAD COMPANY

SUGGESTED DESIGN JET/HOPPER MUD MIXER
FOR SEISMIC AND WATER WELL DRILLERS



NOTE: TO MIX, GET ALL THE PRESSURE POSSIBLE
ON JET - UNTIL YOU HEAR CRACKLING
SOUND IN HOPPER/JET - THEN POUR
IN QUIK GEL SLOWLY

