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JOB AIDS FOR QUALITY CONTROL IN THE MANUFACTURING OF THE AID HAND PUMP

WASH FIELD REPORT NO. 124

MAY 1984

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Prepared for:
Office of Health
Bureau for Science and Technology
U.S. Agency for International Development
Order of Technical Direction No. 82

June 7, 1984 T-82

Dear Colleague:

I am pleased to send you two sets of job aids that WASH has recently developed. One is for the installation and repair of the AID handpump. The other is for quality control in the manufacturing of the AID handpump.

Although these job aids have been designed for the AID handpump, they could be adapted for other handpumps. In addition, they represent an example of the kind of materials that need to be put in the hands of the end users -- in this case the installers and repair teams and foundry and machine shop personnel.

Please contact me if you have any comments or questions.

Sincerely,

Fred Rosensweig

Fred Rosensweig,
Associate Director/
Human Resources Development

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Prepared for the Office of Health, Bureau for Science and Technology
U.S. Agency for International Development
Under Order of Technical Direction No. 82

Prepared by

Alan Pashkevich

with the assistance of
Rebecca Birch

May 1984

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PREFACE

Over the past few years AID has sponsored local manufacturing programs of the AID hand pump in a number of countries. In the Ecuador program under Order of Technical Direction No. 82, AID requested WASH to develop training aids that would be used for quality control by the manufacturer. WASH in turn requested Georgia Institute of Technology to develop these training aids as part of its work under the Ecuador hand pump program. This request resulted in the development of Job Aids for the Quality Control in the Manufacturing of the AID Hand Pump. Job aids for the installation, maintennace, and repair of the aid handpump are also available (see WASH Field Report No. 125).

These job aids provide guidance in the performance of the tasks needed to do effective quality control in the factory. They are meant to be left with the manufacturer when the technical assistance is finished. They are a supplement to the training that was done during the assistance phase.

Although they were developed under the Ecuador program, the job aids are generic in that they can be used by any manufacturer of the AID hand pump. Because they are specifically for quality control through the use of gages and not for the whole manufacturing process, which varies greatly from country to country, they are transferable to other settings. It is also likely that similar job aids could be developed for other local manufacturing efforts of other pumps or devices.

For cost and ease of distribution, these job aids appear in the form of a report. When used in a foundry, the job aids should be in a ring binder and each page should be plasticized for long lasting use.

AID HAND PUMP

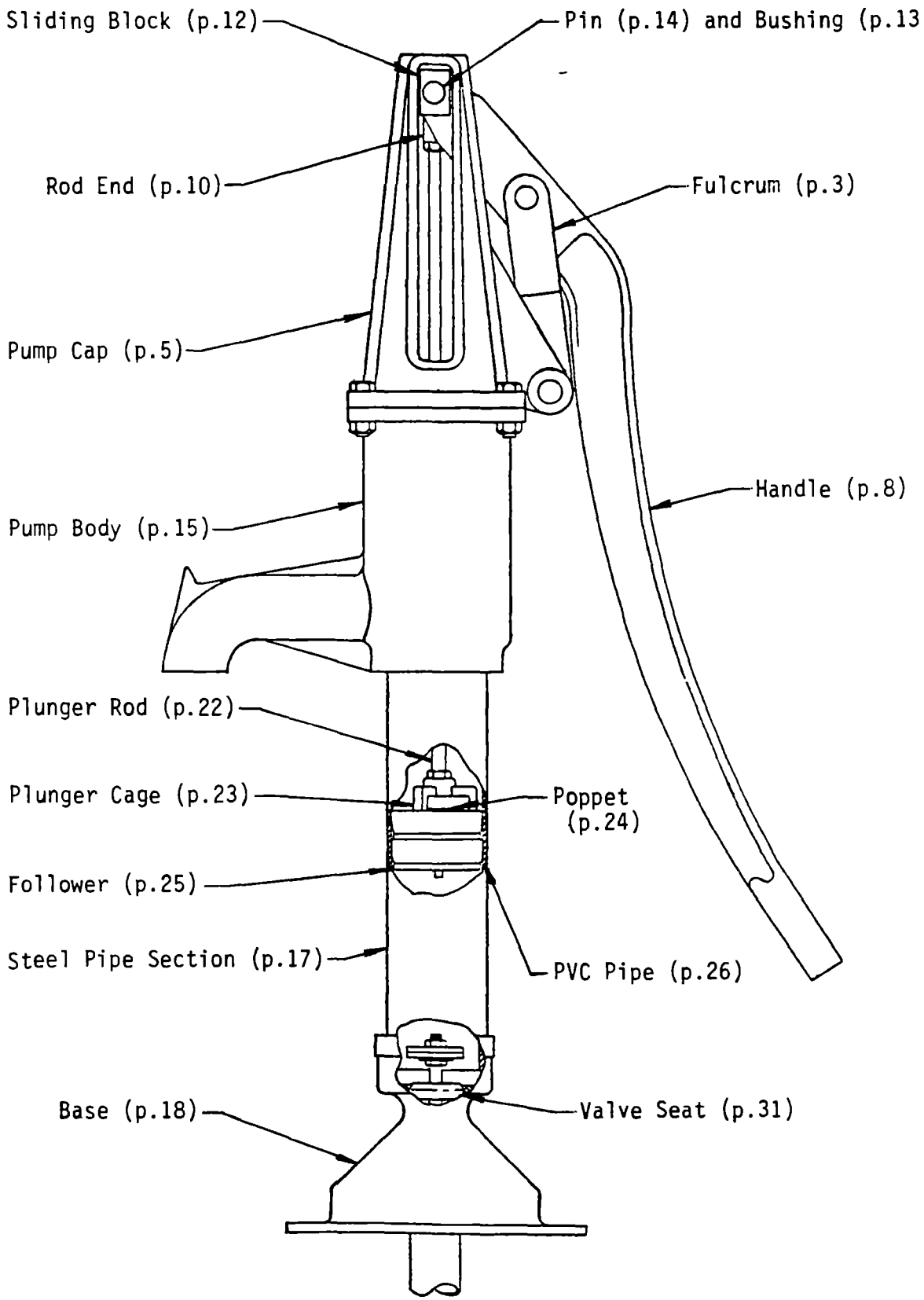
Quality Control Job Aids for Manufacturing

Introduction

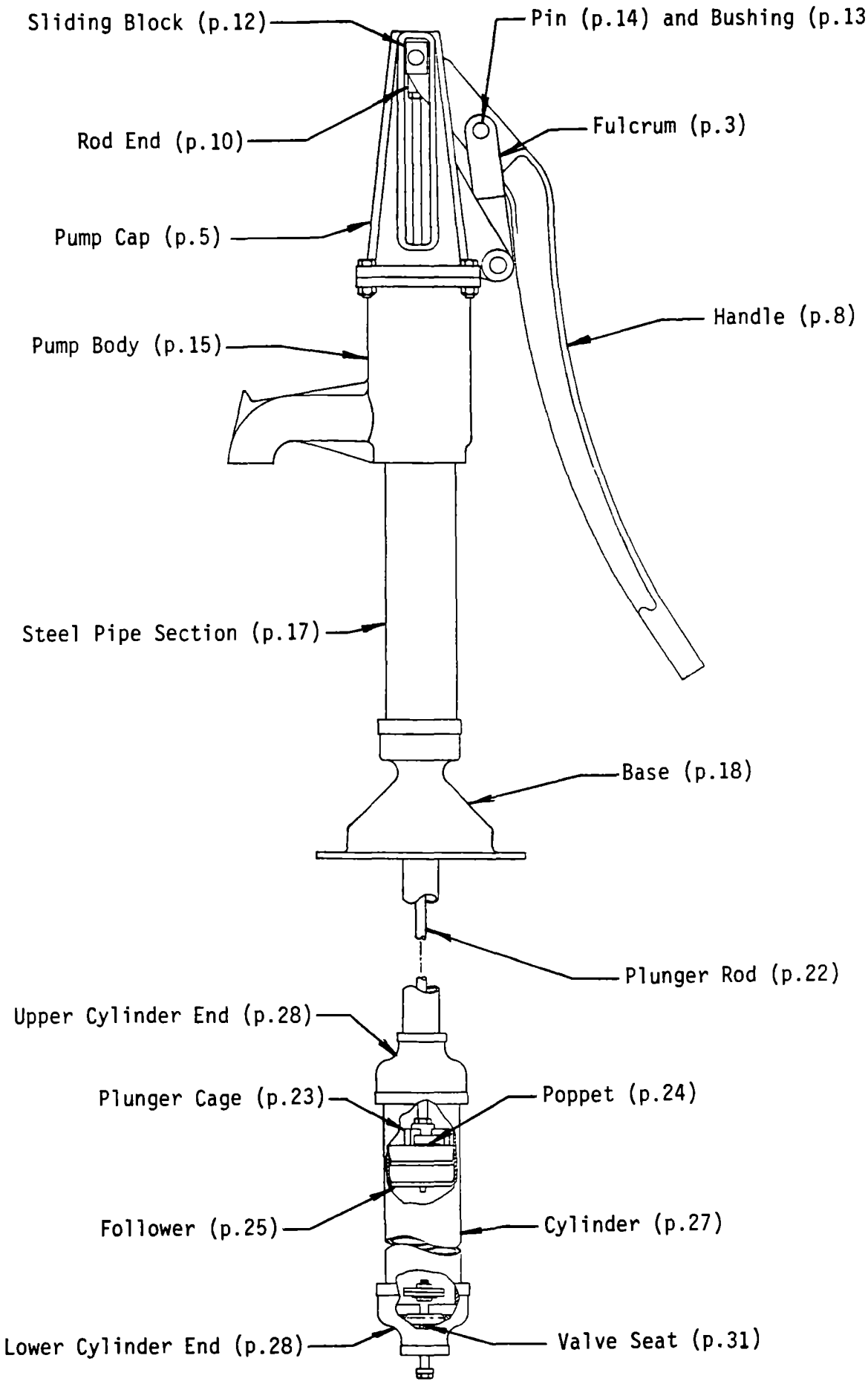
These job aids are intended to be used by people who manufacture and perform quality assurance for the AID hand pump.

These job aids serve as memory joggers for factory personnel and acceptance testers who have already received training in the quality control tasks required to produce a high-quality AID hand pump.

The appendix contains all the graphics for each inspection that requires gages. The graphics are enlarged and limited to one operation per page so only the pertinent ones can be distributed to workers who may be responsible for only a limited number of machining operations.

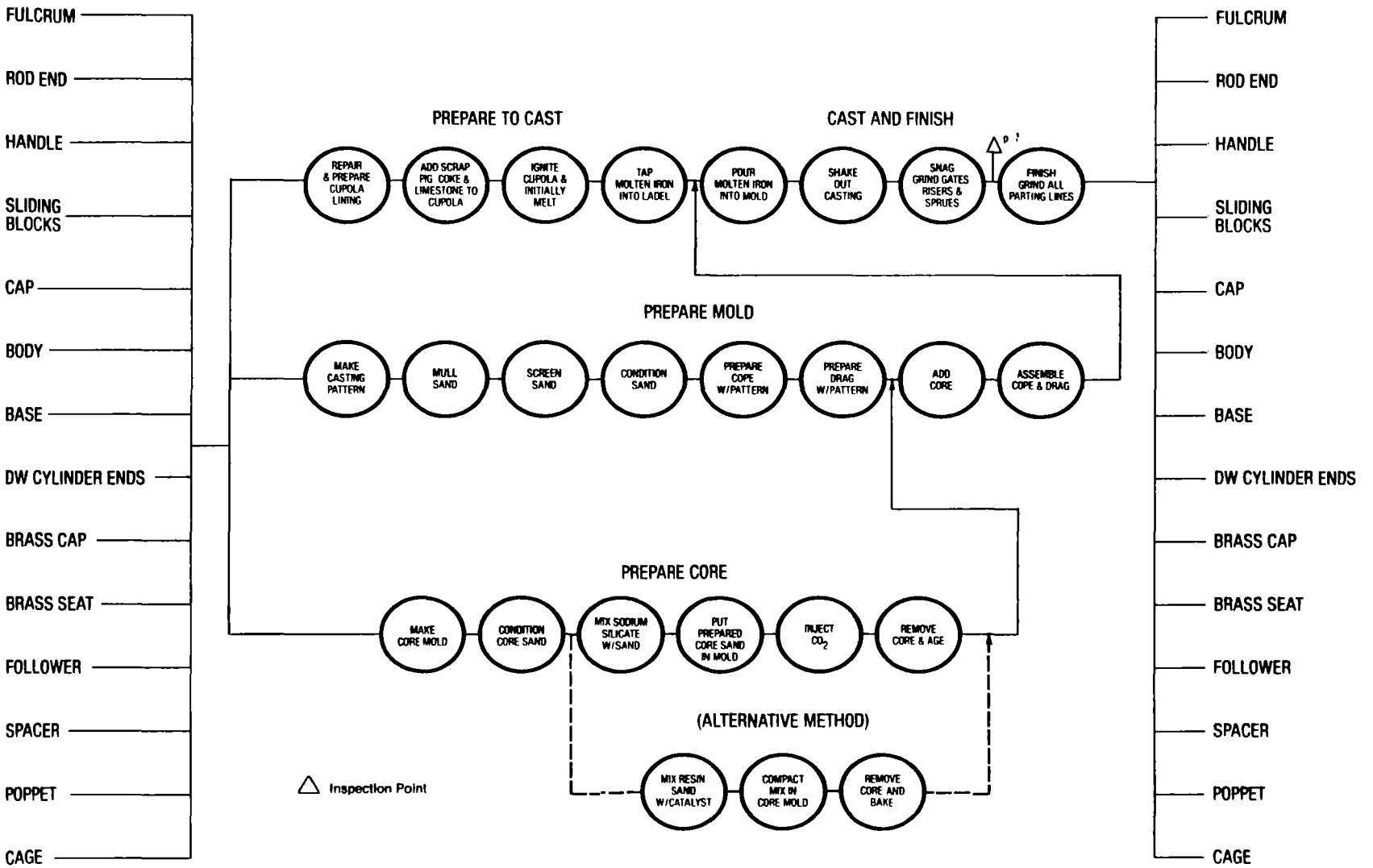


SHALLOW WELL PUMP



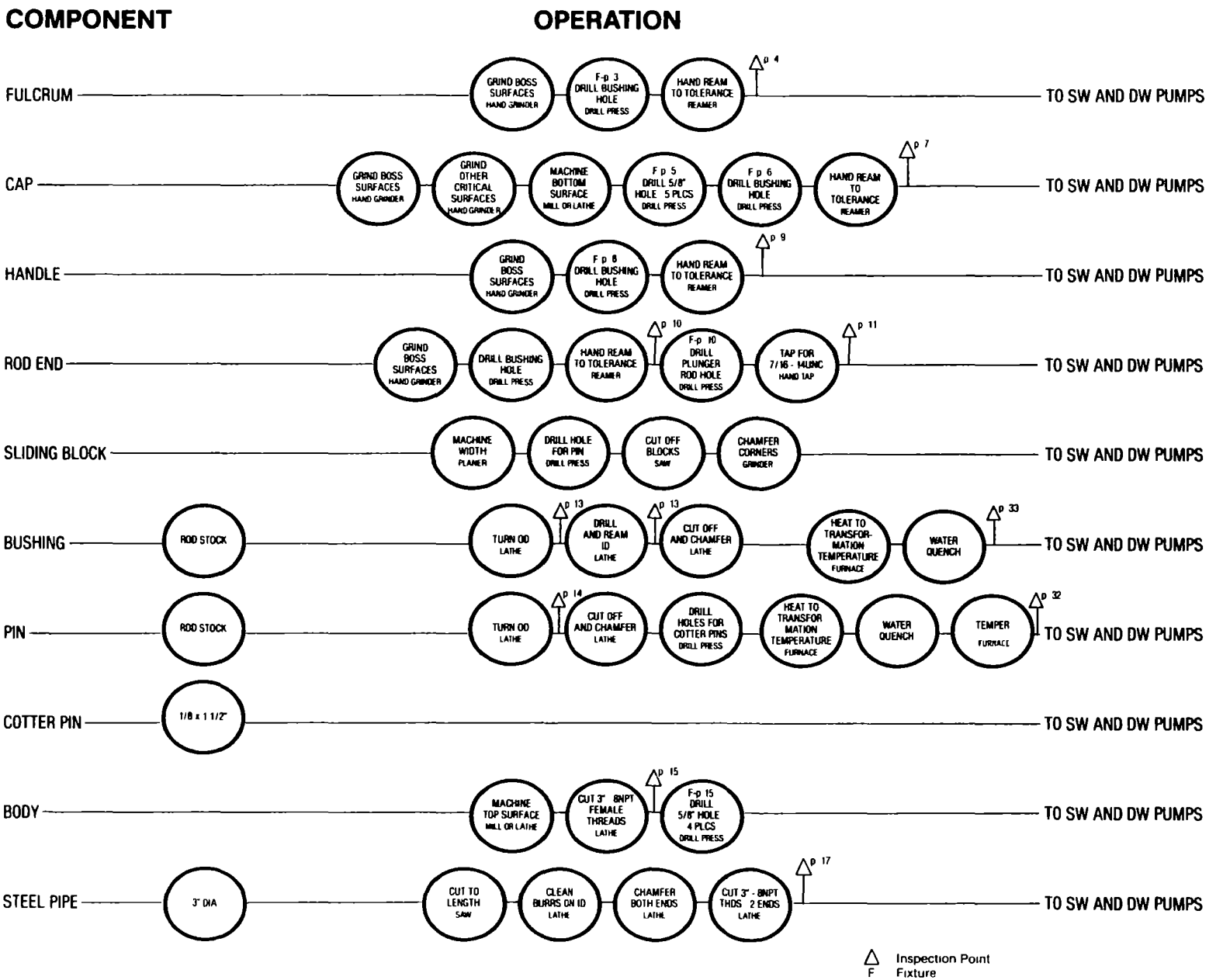
DEEP WELL PUMP

CASTING FLOW CHART



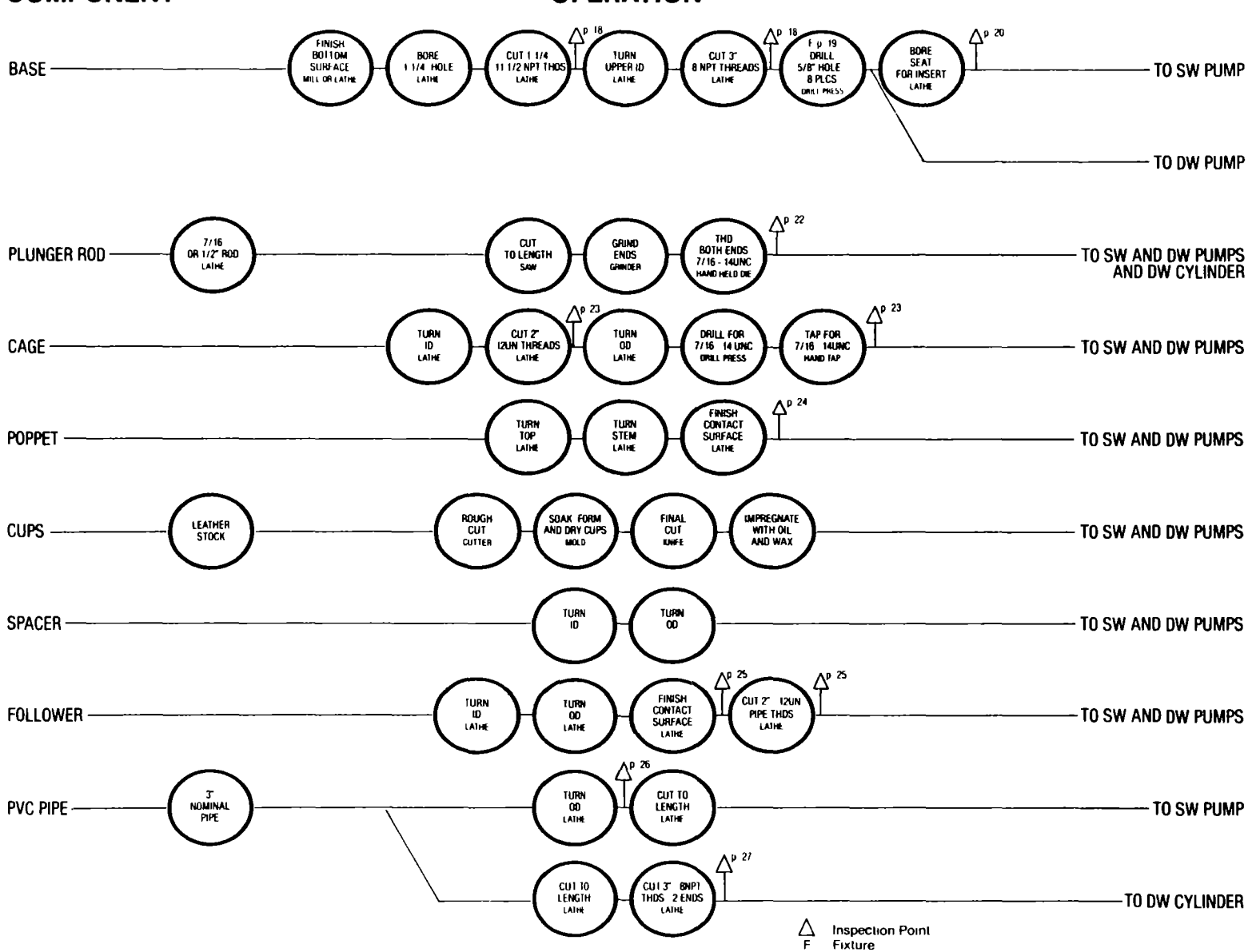
MACHINING AND HEAT TREATING FLOW CHART

SHEET 1



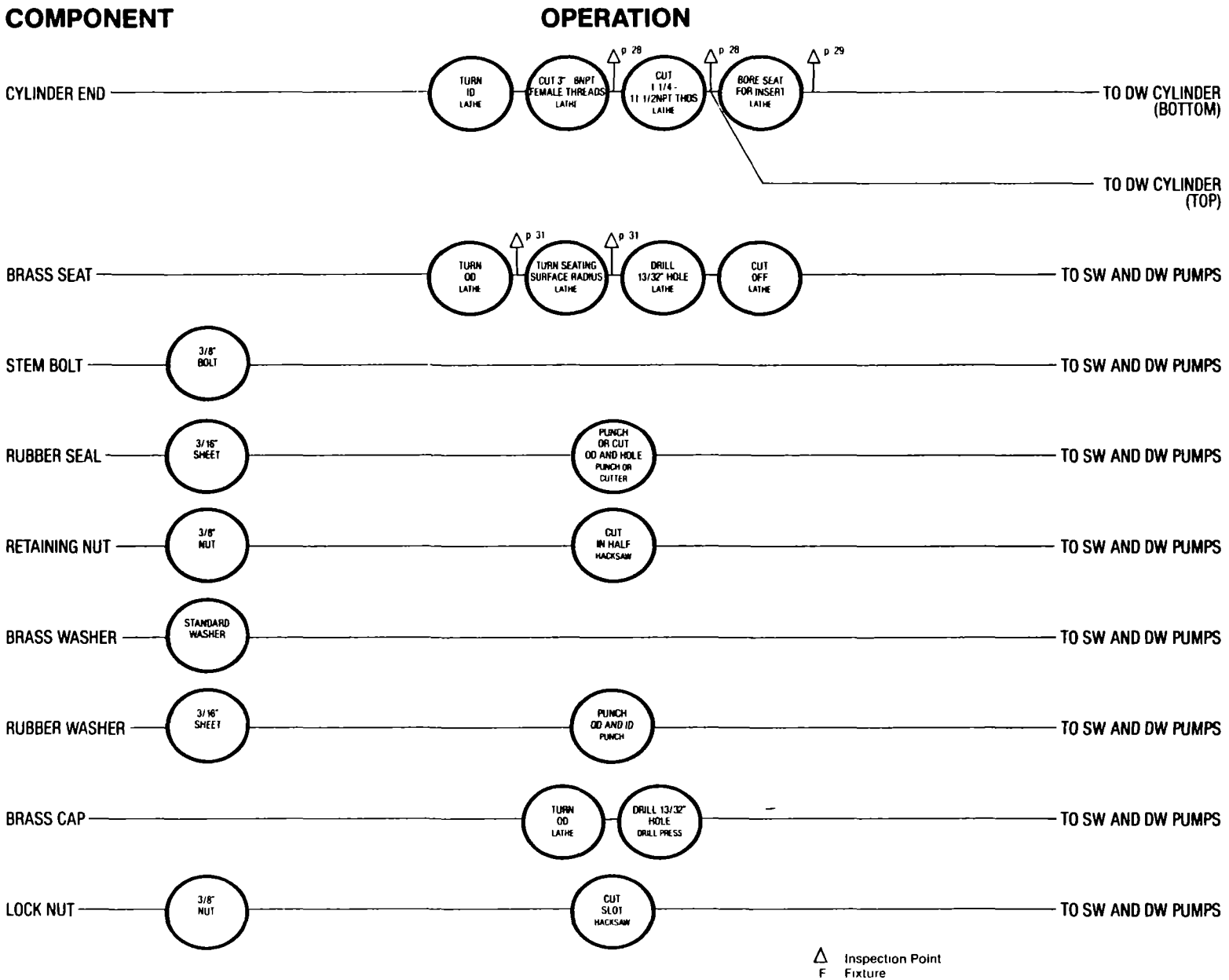
MACHINING AND HEAT TREATING FLOW CHART

SHEET 2



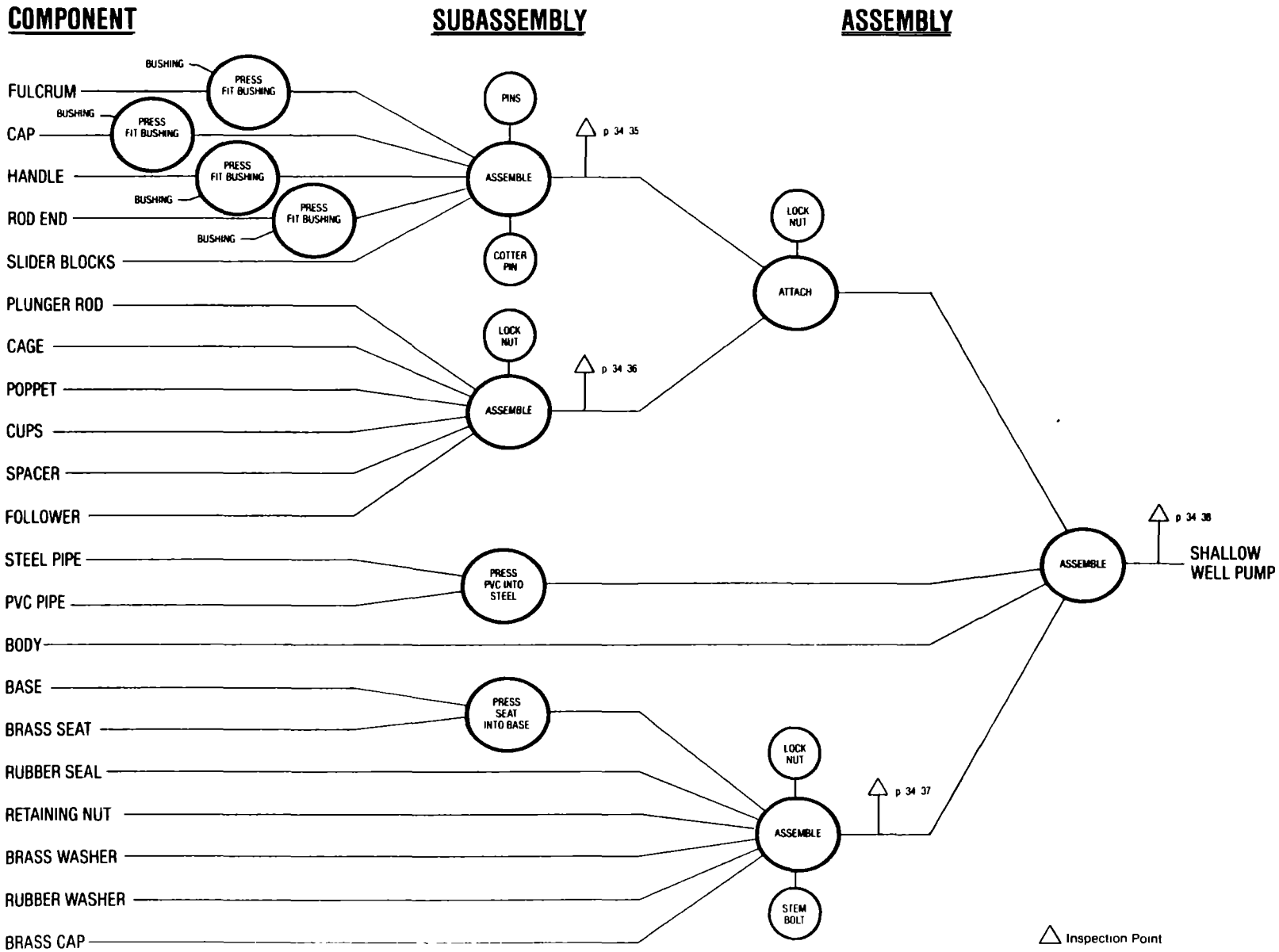
MACHINING AND HEAT TREATING FLOW CHART

SHEET 3



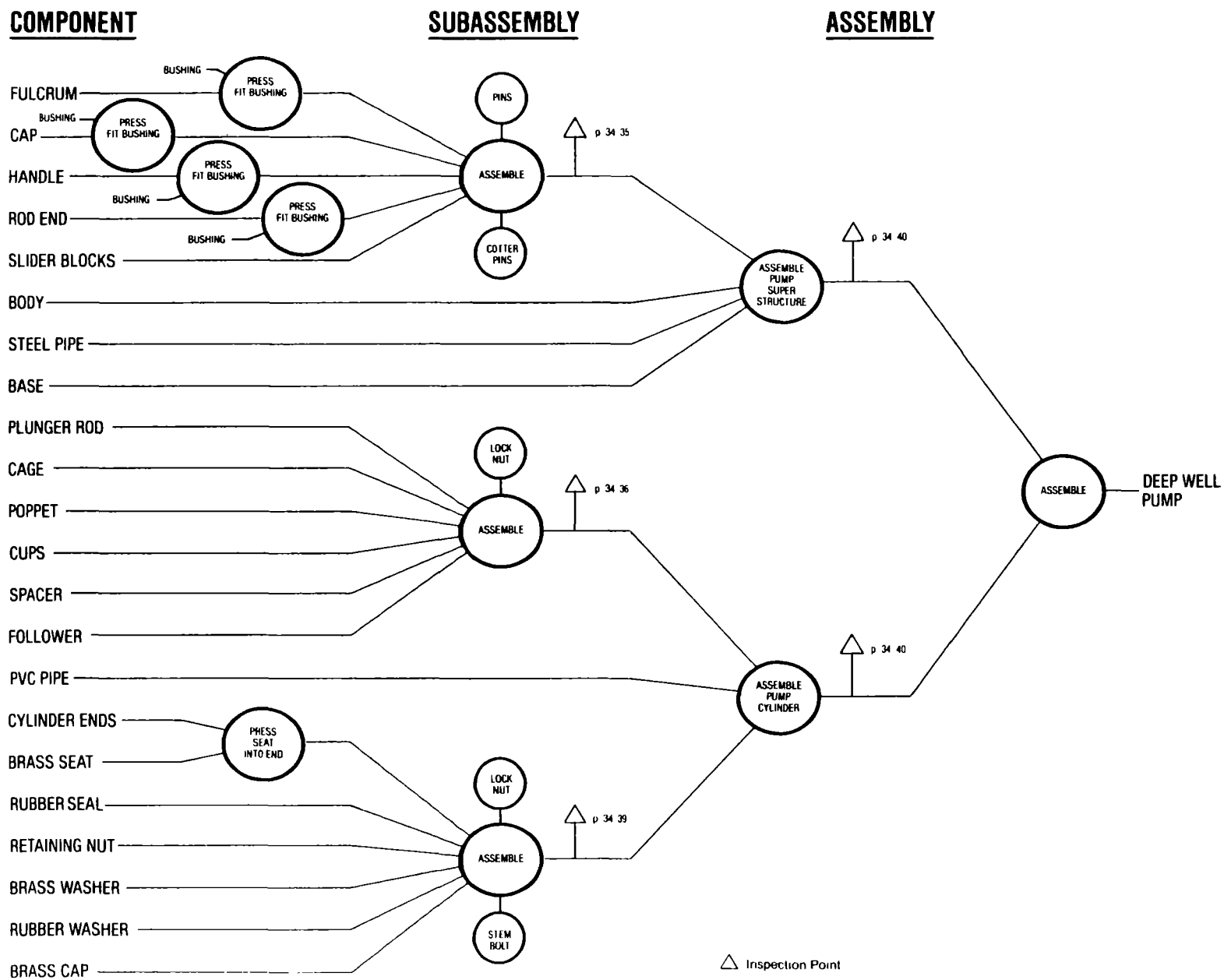
ASSEMBLY FLOW CHART

SHALLOW WELL PUMP



ASSEMBLY FLOW CHART

DEEP WELL PUMP



List of Gages

Below is a list of the seventeen gages used in the job aids. The gages are referenced by machining operation and page number. They can be identified by the dark shading in the drawings.

Gage Number	Inspection	Machining Operation	Page
G-1	Fulcrum	A-2a	4
	Pump Cap	B-4	7
	Handle	C-2a	9
	Rod End	D-2	10
G-2	Fulcrum	A-2b	4
G-3	Handle	C-2b	9
G-4	Rod End	D-3	11
	Plunger Rod	K-3	22
	Plunger Cage	L-3	23
G-5	Bushings	F-1	13
G-6	Bushings	F-2	13
G-7	Pins	G-1	14
G-8	Pump Body	H-2	15
	Pump Base	J-3	18
	Deep Well Cylinder Ends	P-2	28
G-9	Steel Pipe Section	I-4	17
	PVC Pipe	O-2	27
G-10	Pump Base	5-2	18
	Deep Well Cylinder Ends	P-3	28
G-11	Pump Base	J-5a	20
	Deep Well Cylinder Ends	P-4a	29

Gage Number	Inspection	Machining Operation	Page
G-12	Pump Base	J-5c	21
	Deep Well Cylinder Ends	P-4c	30
G-13	Plunger Gage	L-1	23
	Follower	N-4	25
G-14	PVC Pipe	O-1	26
G-15	Valve Seat	Q-1	31
G-16	Valve Seat	Q-2	31
G-17	Pins	A-2b	32

Operation: Cast pump components

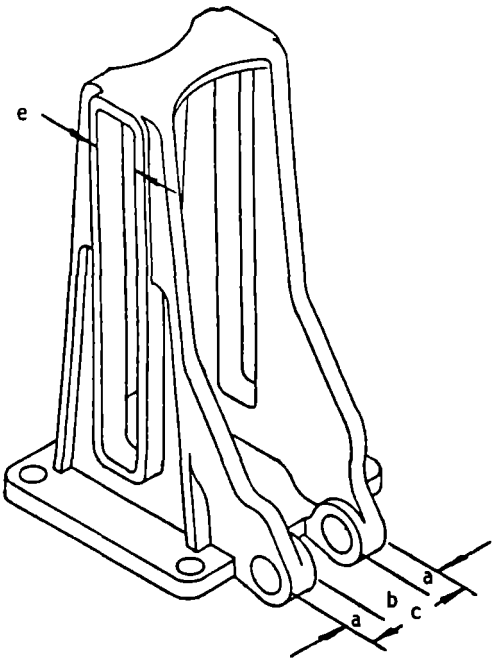
Quality Characteristics:

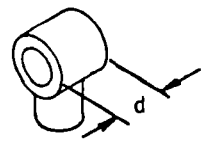
a) casting large enough to meet final specified dimensions
b) casting without excessive porosity in critical areas
c) casting without excessive voids or other surface imperfections

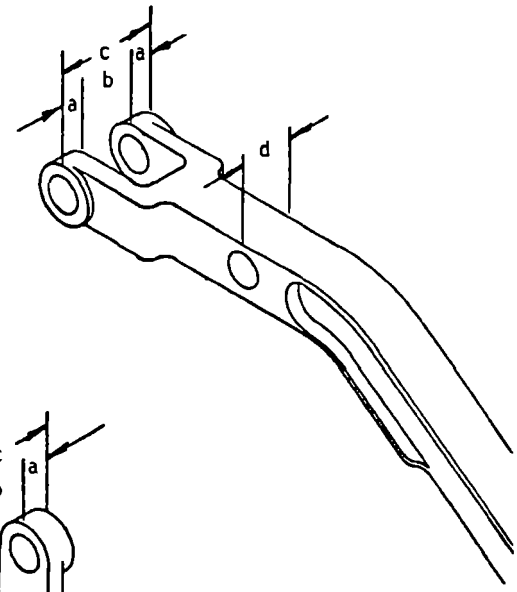
Inspection 1a. Measure and compare to provided drawings the first casting produced when any change has been made to a pattern. Changes include:
a) new patterns
b) repaired patterns
c) otherwise modified patterns

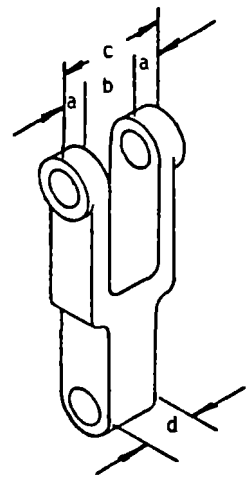
Inspection 1b. Measure the following critical dimensions every 100 casting for wood patterns or every 1000 castings for metal patterns:

a) width of each fork of fulcrum, handle and cap
b) distance between forks of fulcrum, handle and cap
c) overall width of forks of fulcrum, handle and cap
d) width of rod end, bottom of fulcrum, neck of handle
e) width of slider block tracks of cap









Inspection 2. Visually inspect all castings for excessive porosity using the following criteria:

Acceptable:

holes less than 1 mm diameter
and
greater than 1 cm from each other

Not Acceptable:

1) In critical areas holes greater than 1 mm diameter but less than 3 mm diameter
and
more than 4 holes per square centimeter

2) In critical areas holes greater than 3 mm diameter

3) Any holes in threads

4) Any holes in valve seat

Critical Areas:

1) areas around every bushing
2) neck of base
3) forks of handle and fulcrum
4) tapering section of handle

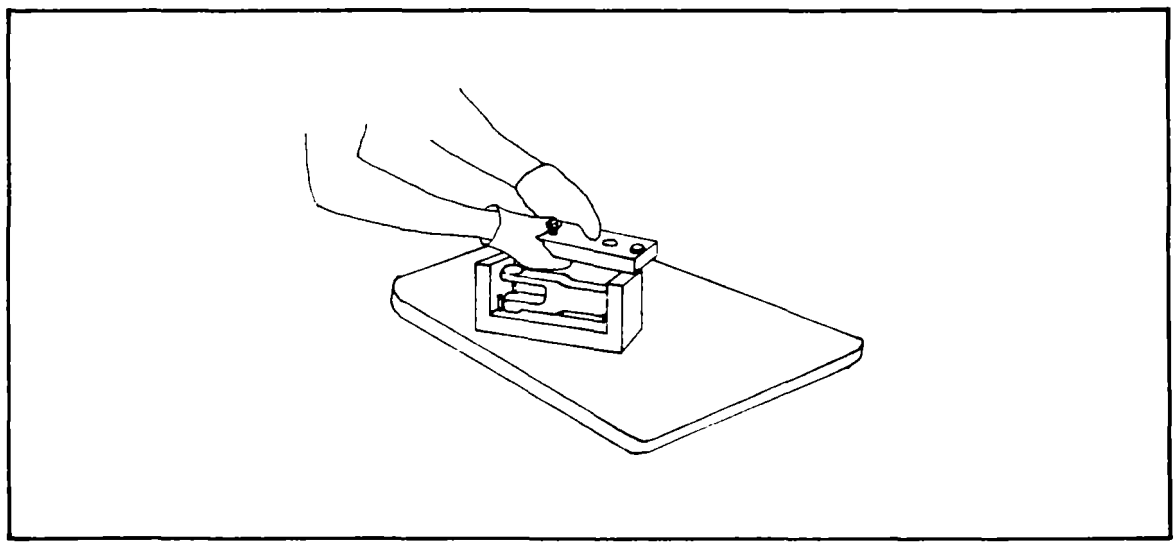
Inspection 3. Compare all castings to samples provided by purchaser for acceptable surface finish.

A. Fulcrum

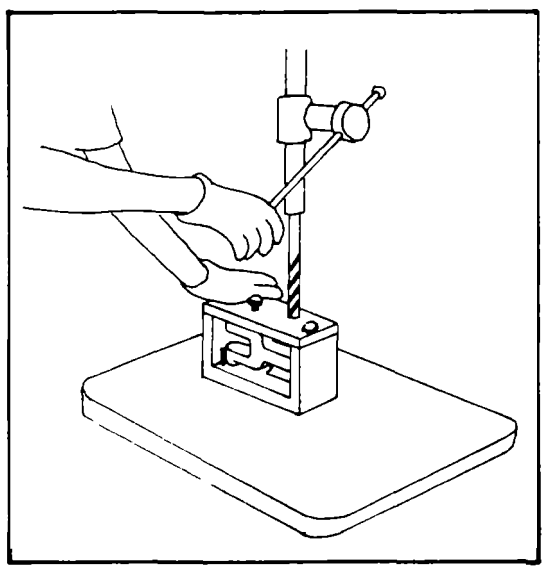
Operation 1. Grind boss surfaces.

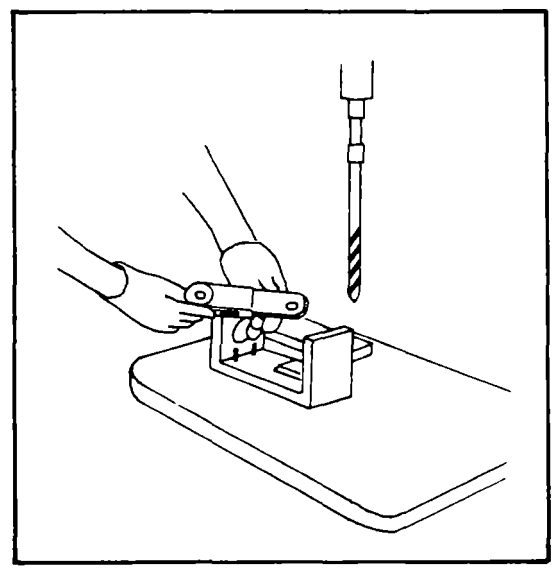
Operation 2. Drill and ream bushing holes.

Operation 2a. Place fulcrum in fixture.

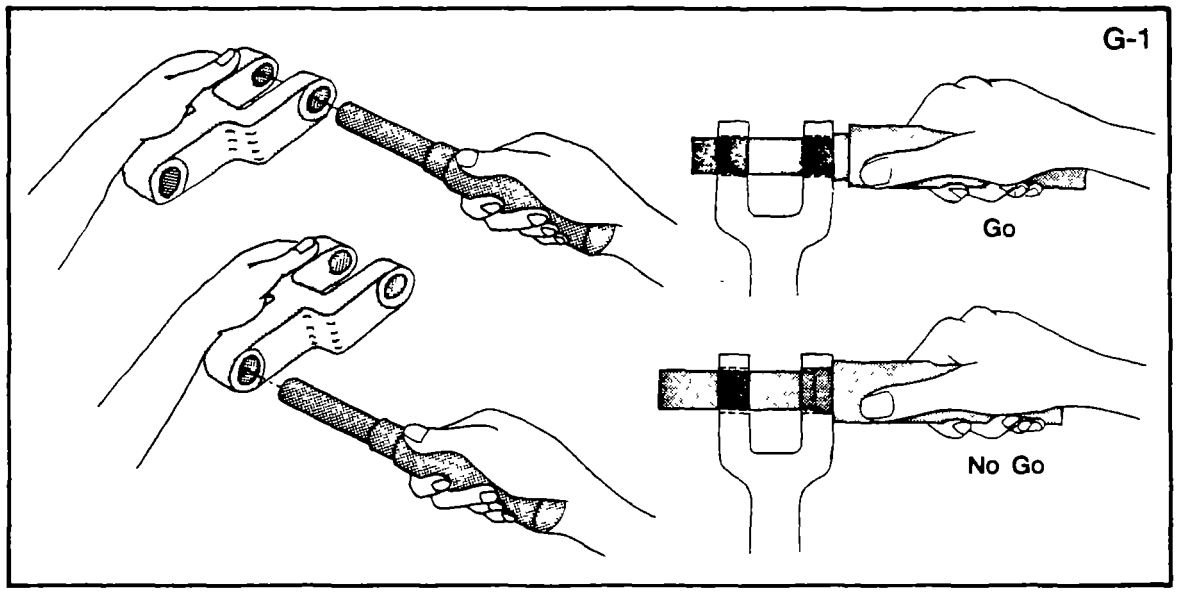


Operation 2b. Drill two holes in fulcrum; ream both holes.

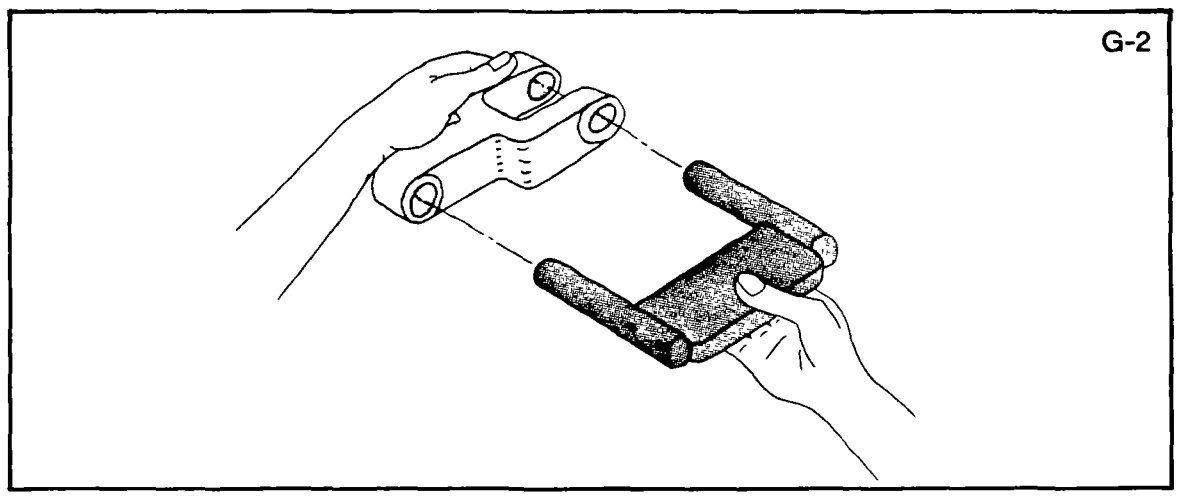




Inspection 2a. Measure reamed hole diameter with gage; smaller diameter of gage must fit hole but larger diameter must not.



Inspection 2b. Measure distance between holes; gage must fit through holes.



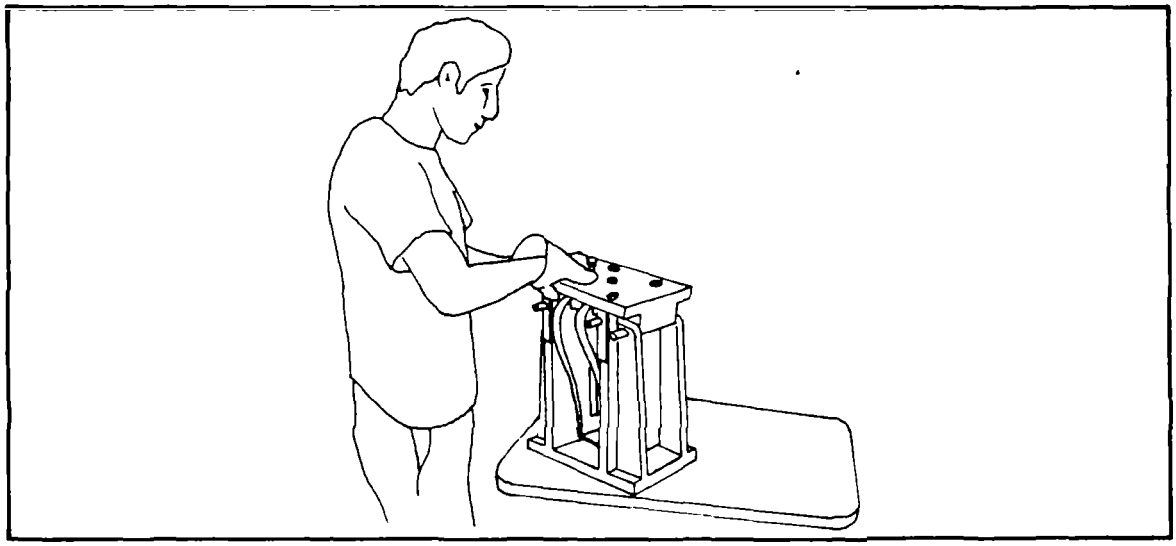
B. Pump Cap

Operation 1. Grind boss surfaces and slider block tracks.

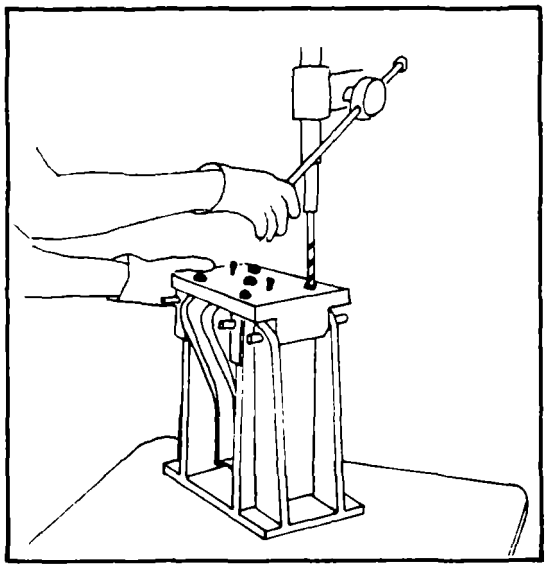
Operation 2. Machine bottom surface of pump cap.

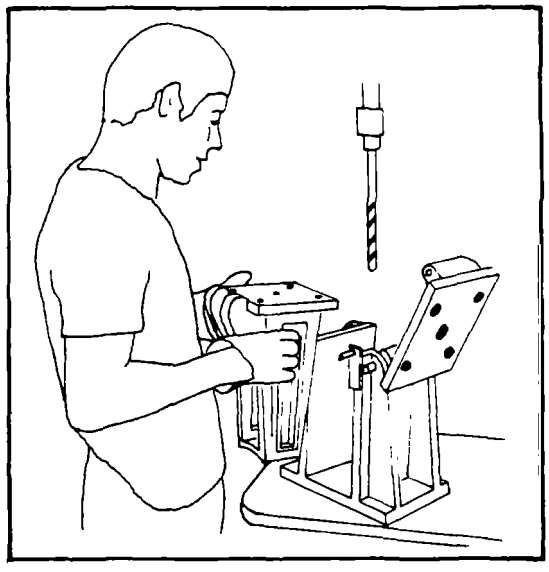
Operation 3. Drill five holes using fixture.

Operation 3a. Place cap in fixture.



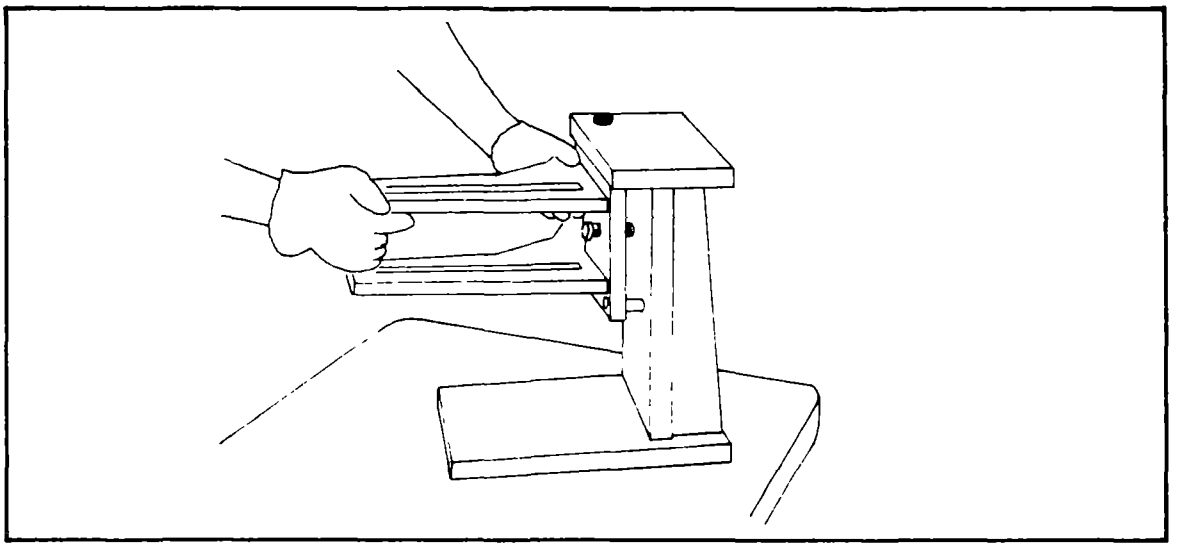
Operation 3b. Drill holes.



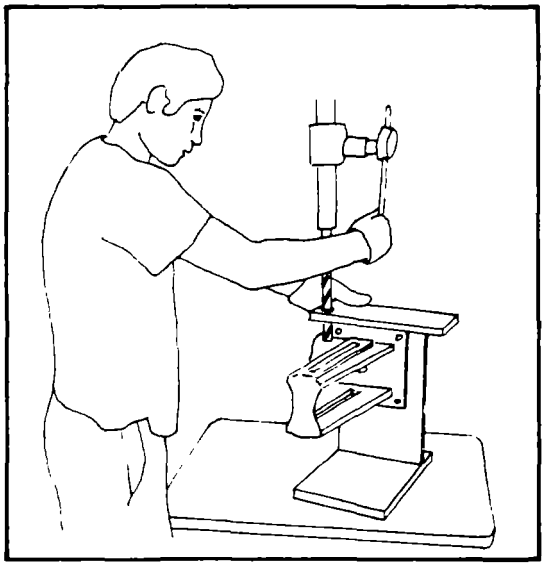


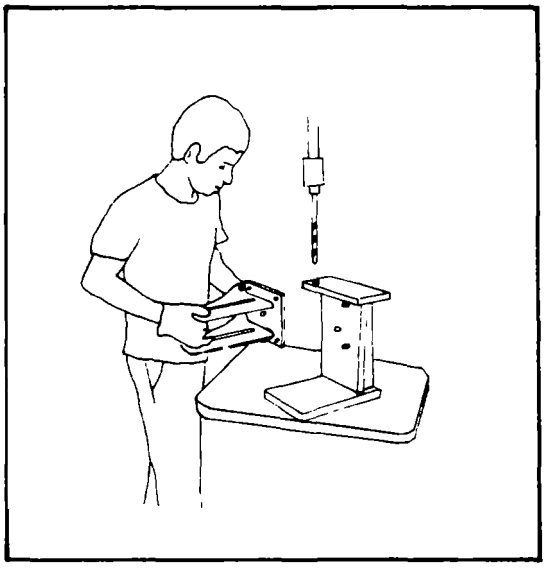
Operation 4. Drill and ream bushing holes.

Operation 4a. Place cap in fixture.

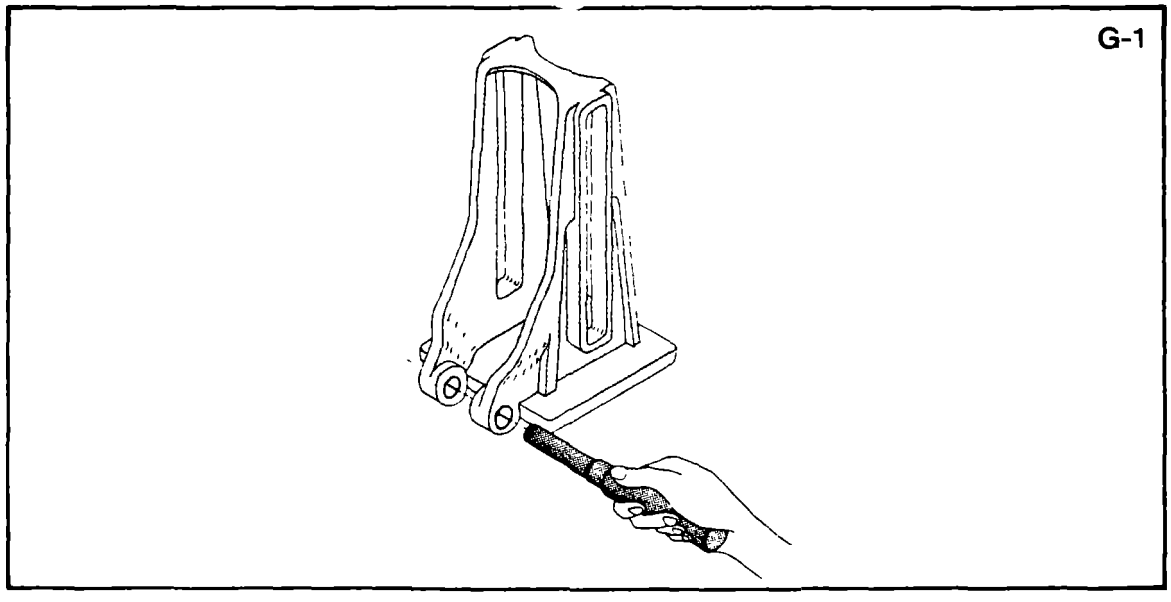


Operation 4b. Drill bushing holes.





Inspection 4. Measure reamed holes; small end of gage must fit holes, large end must not

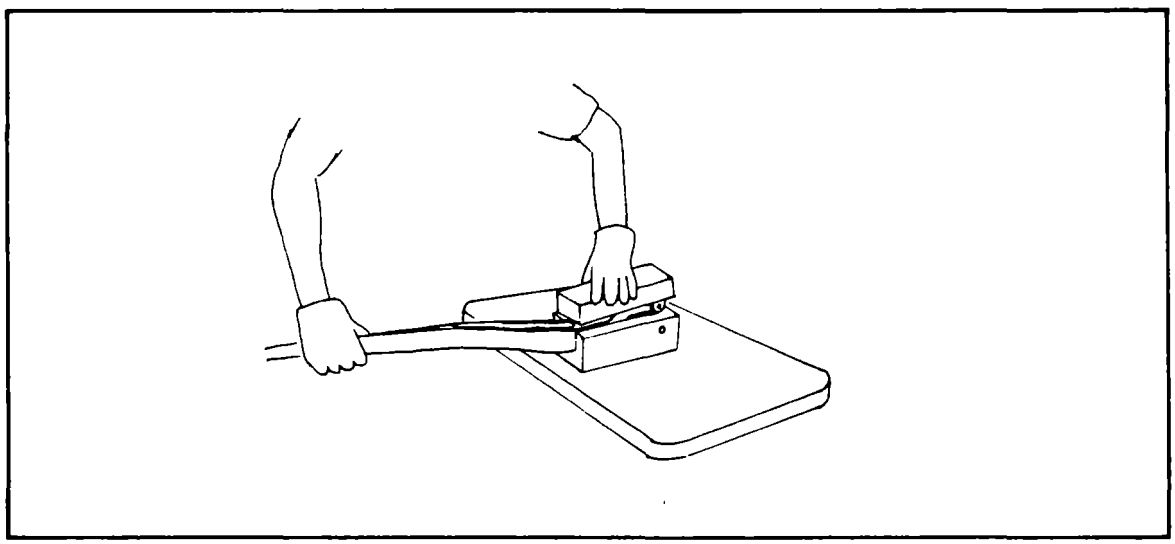


C. Handle

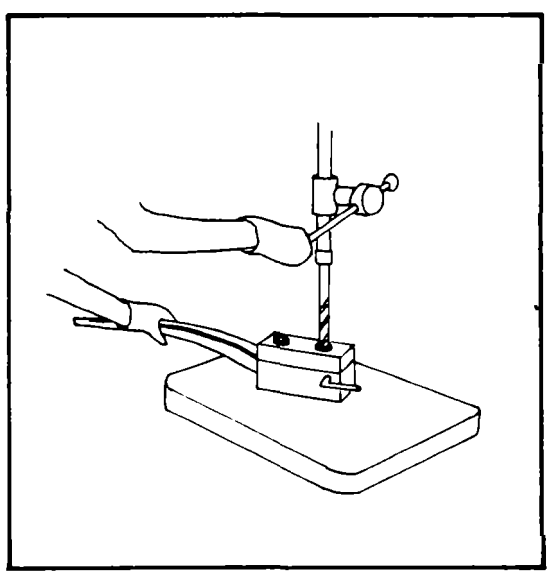
Operation 1. Grind boss surfaces.

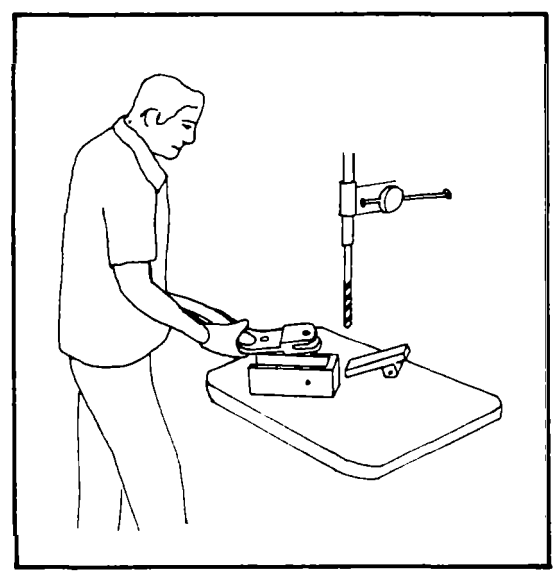
Operation 2. Drill and ream bushing holes.

Operation 2a. Place handle in fixture.

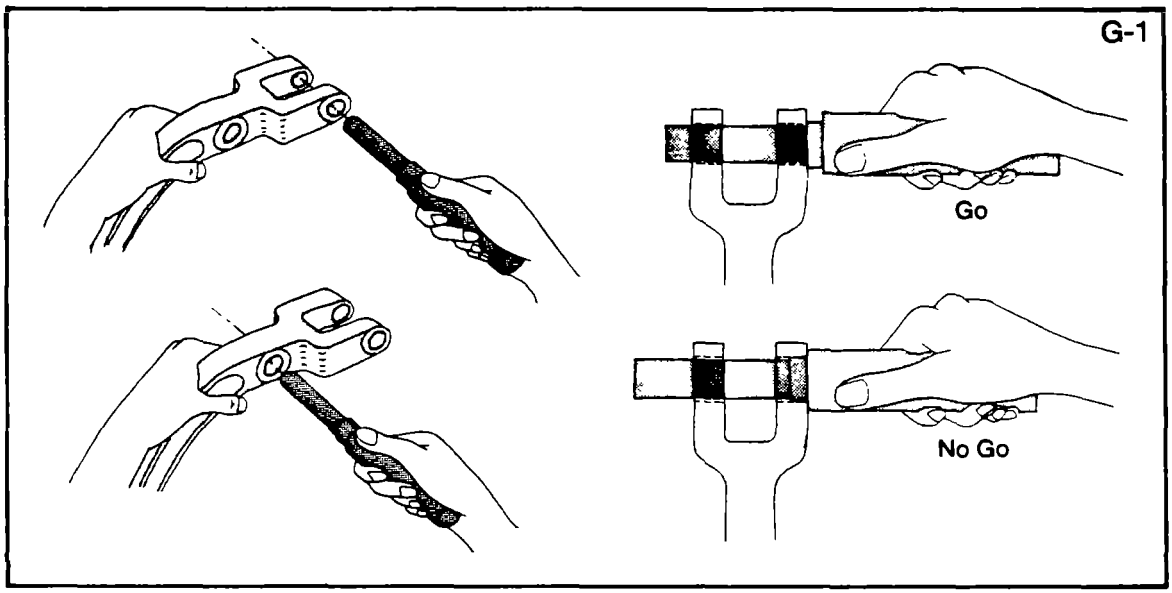


Operation 2b. Drill two holes in handle.

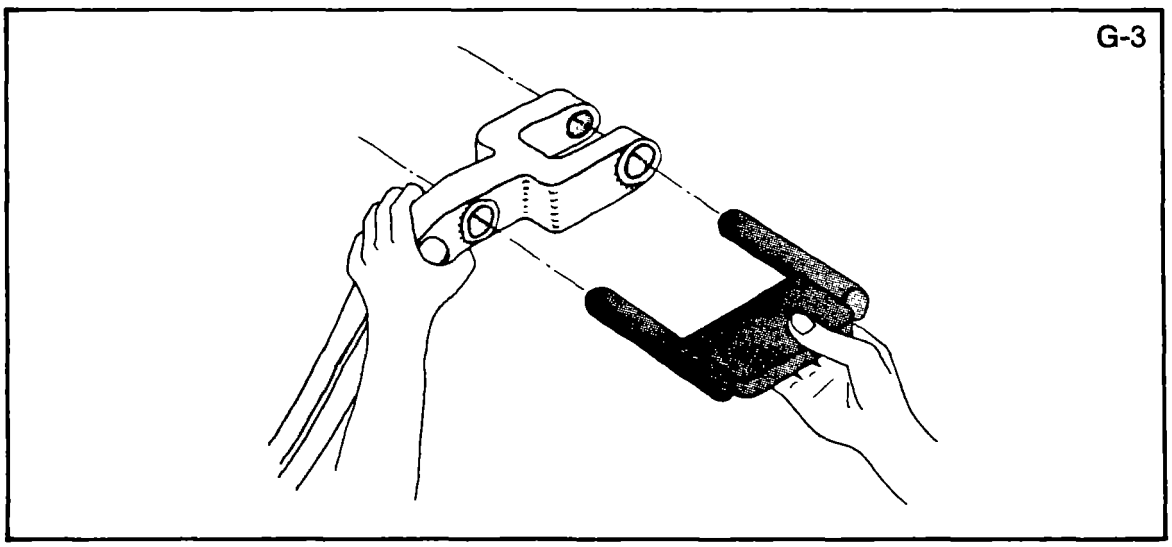




Inspection 2a. Measure reamed hole diameter with gage; smaller diameter of gage must fit hole but larger diameter must not.



Inspection 2b. Measure distance between holes; gage must fit through holes.



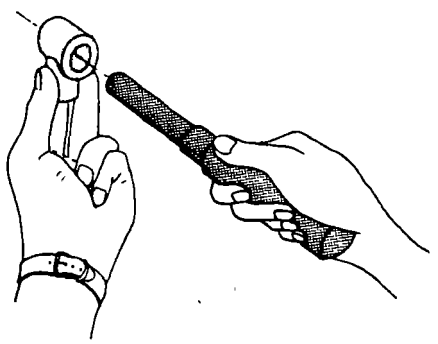
D. Rod End

Operation 1. Grind boss surface.

Operation 2. Drill and ream bushing hole.

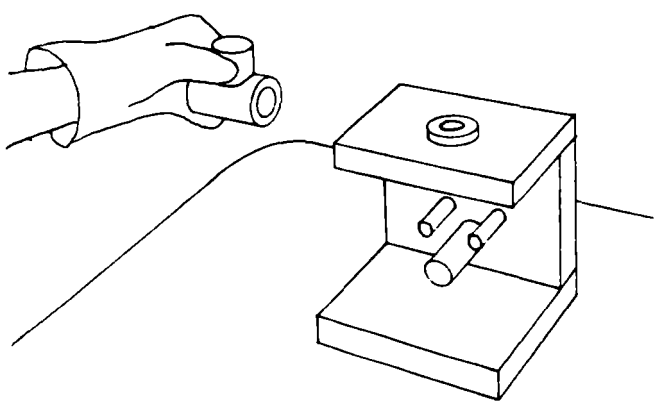
Inspection 2. Measure reamed hole diameter with gage; small diameter must fit hole but larger diameter must not.

G-1

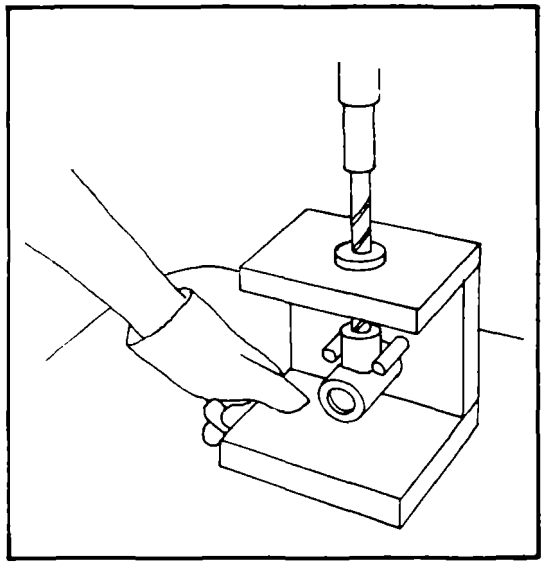


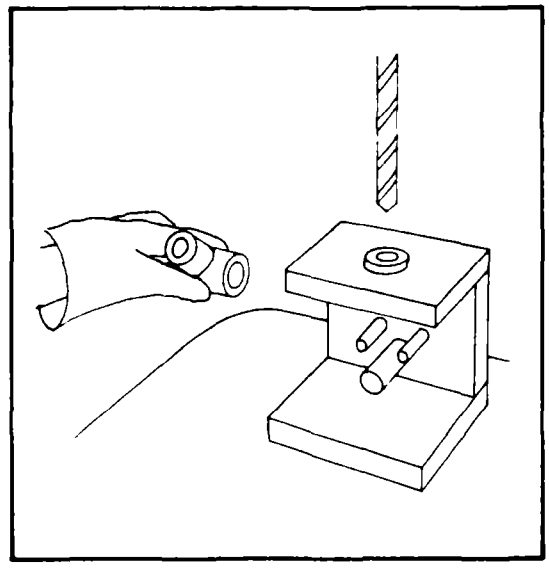
Operation 3. Drill and tap hole for plunger rod.

Operation 3a. Place rod end in fixture.



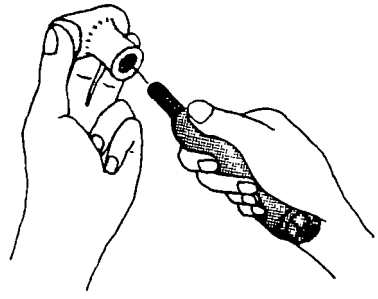
Operation 3b. Drill hole for plunger rod; thread hole.





Inspection 3. Tapped hole must fit gage.

G-4



E. Sliding Block

Operation 1. Machine sliding block stock to correct width.

Operation 2. Drill hole for pin.

Operation 3. Cut block to correct length.

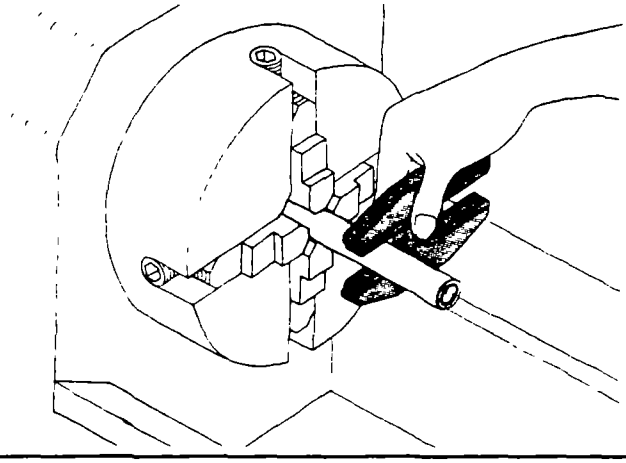
Operation 4. Chamfer corners.

F. Bushings

Operation 1. Turn outside diameter.

Inspection 1. Measure outside diameter; bushing must fit "go" part of gage but not "no go" part.

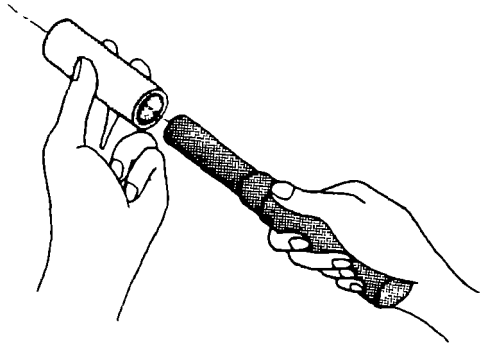
G-5



Operation 2. Drill and ream inside diameter.

Inspection 2. Measure inside diameter; smaller diameter of gage must fit inside diameter of bushing, larger diameter must not.

G-6

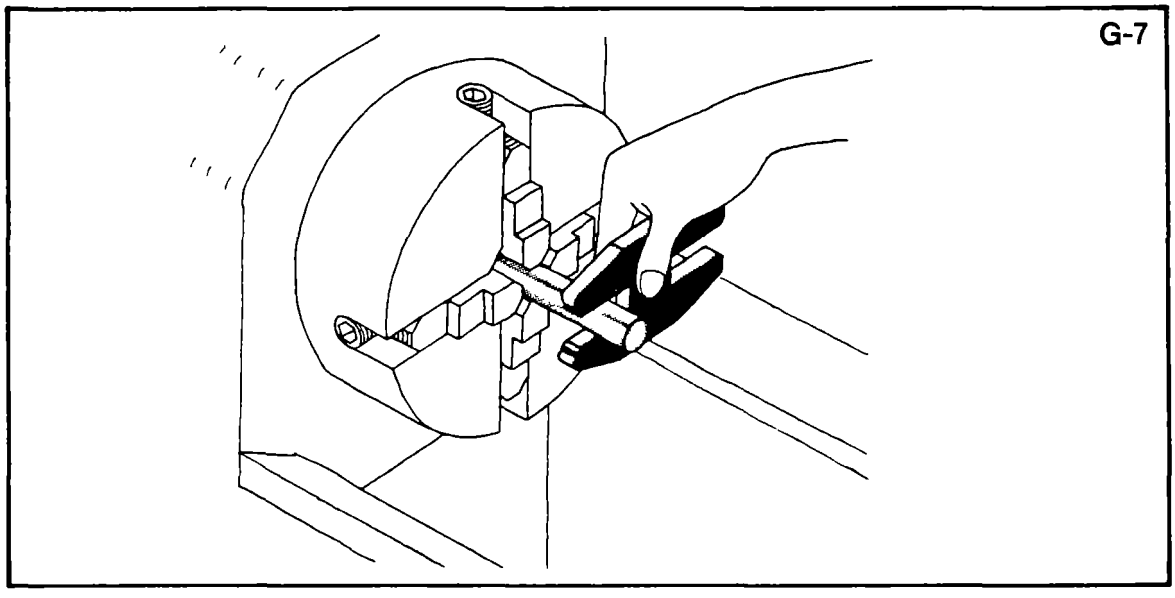


Operation 3. Cut off and chamfer bushings.

G. Pins

Operation 1. Turn outside diameter.

Inspection 1. Measure outside diameter; diameter must fit "go" part of gage but not "no go" part.



Operation 2. Cut off and chamfer pin.

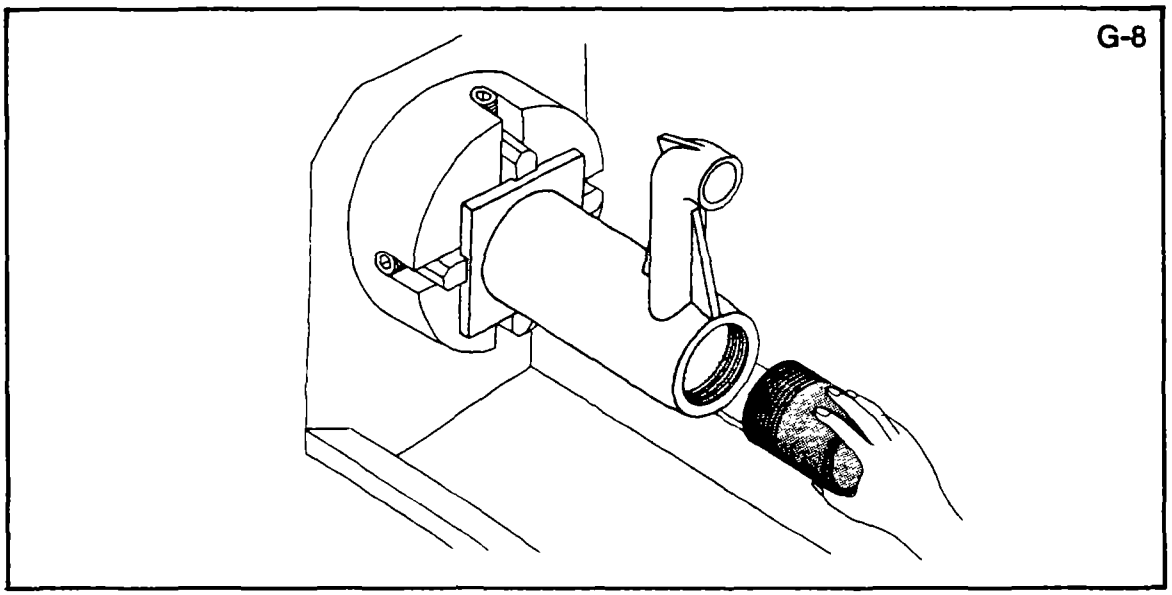
Operation 3. Drill holes in ends of pin for small retaining pin.

H. Pump Body

Operation 1. Machine top surface of pump body.

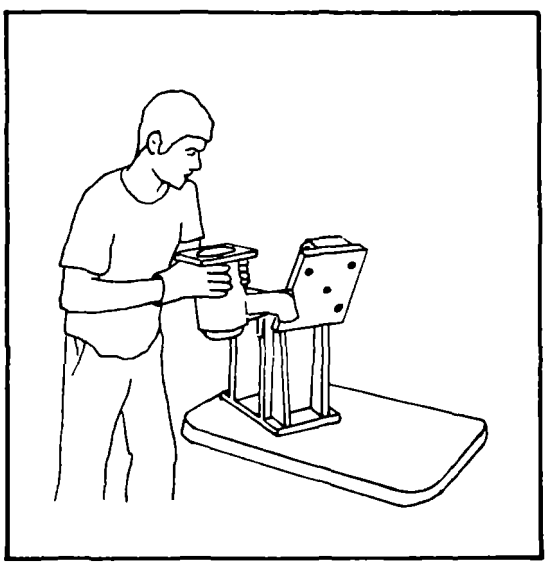
Operation 2. Cut threads on bottom of pump body.

Inspection 2. Measure threads; gage must engage at least four but not more than eight threads in body when tightened by hand.

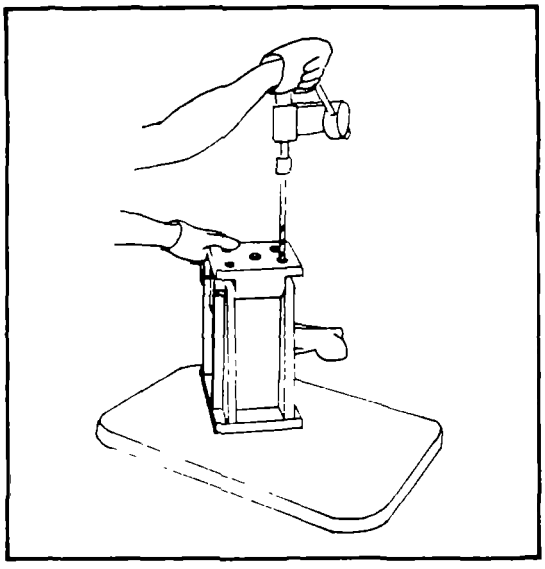


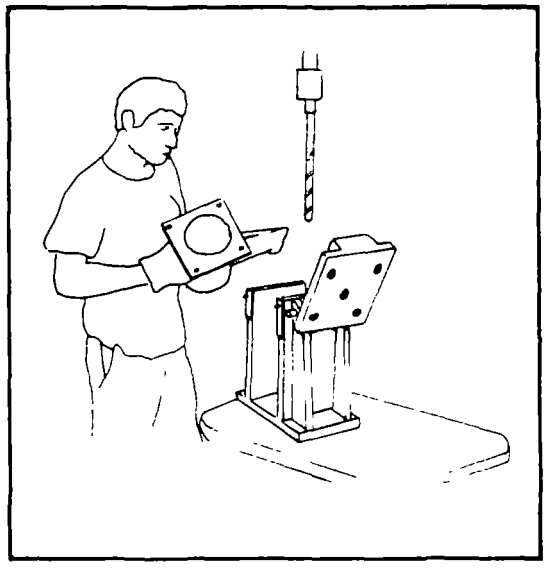
Operation 3. Drill four holes using fixture.

Operation 3a. Place body in fixture.



Operation 3b. Drill four holes.





I. Steel Pipe Section

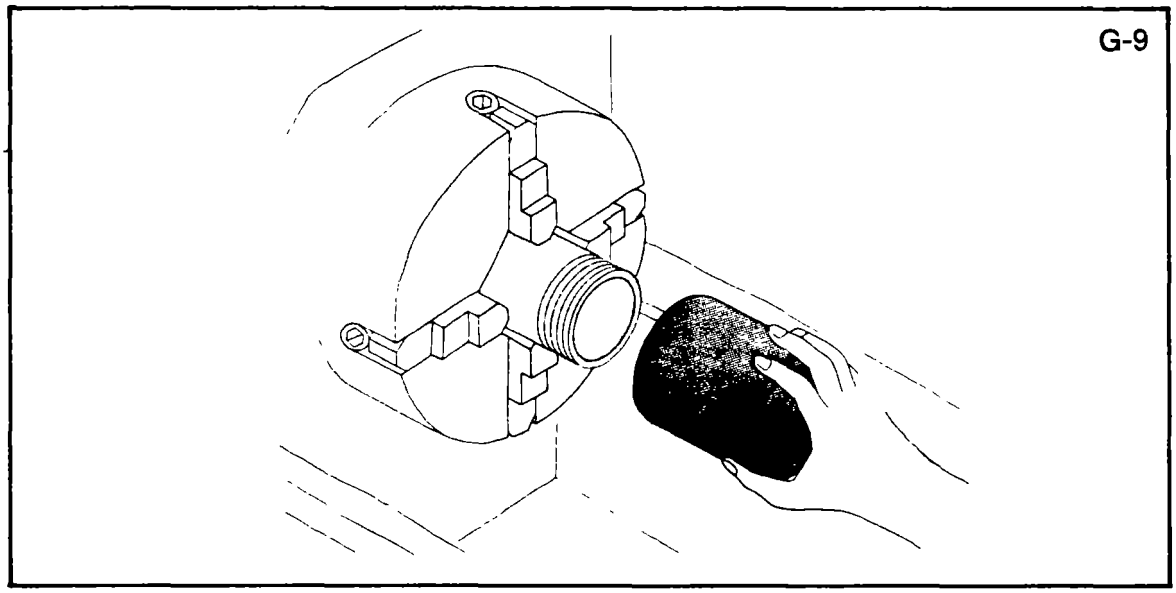
Operation 1. Cut to length.

Operation 2. Clean burrs on inside diameter.

Operation 3. Chamfer both ends.

Operation 4. Cut threads on both ends.

Inspection 4. Measure threads; gage must engage at least four but not more than eight threads on pipe section when tightened by hand.

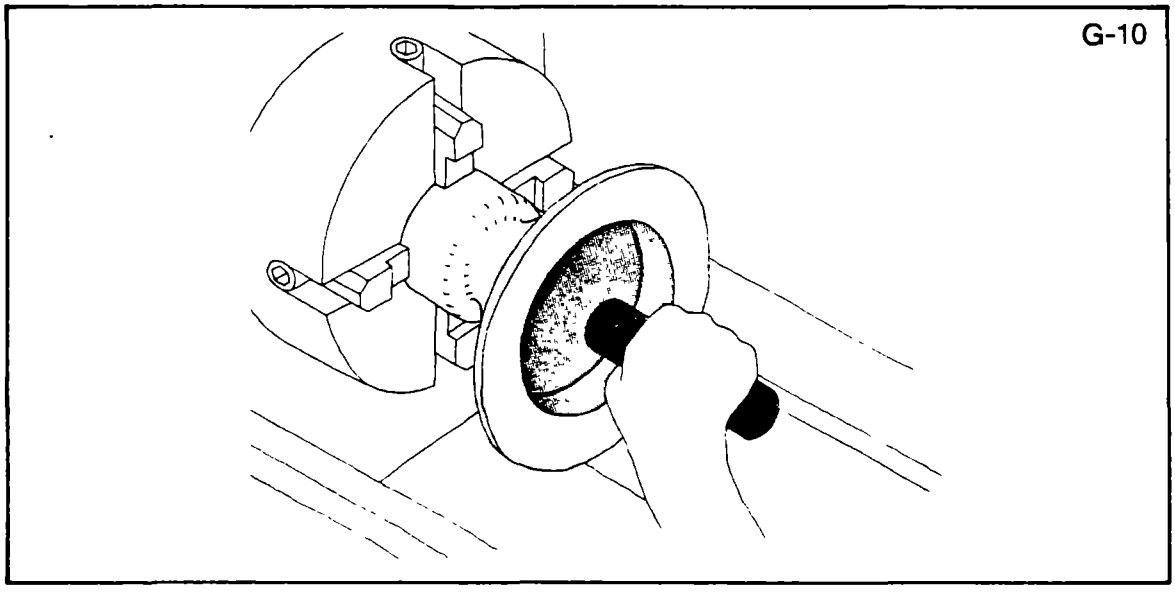


J. Pump Base

Operation 1. Machine bottom surface of pump base.

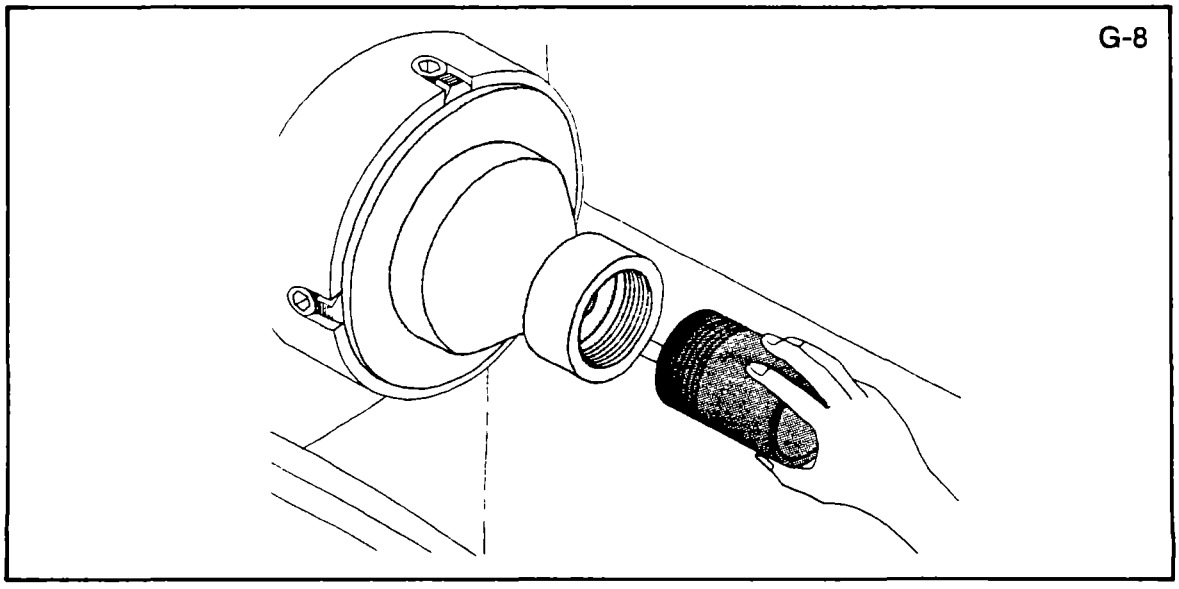
Operation 2. Bore and thread for drop pipe.

Inspection 2. Measure threads; gage must engage at least four but not more than eight threads on pipe section when tightened by hand.



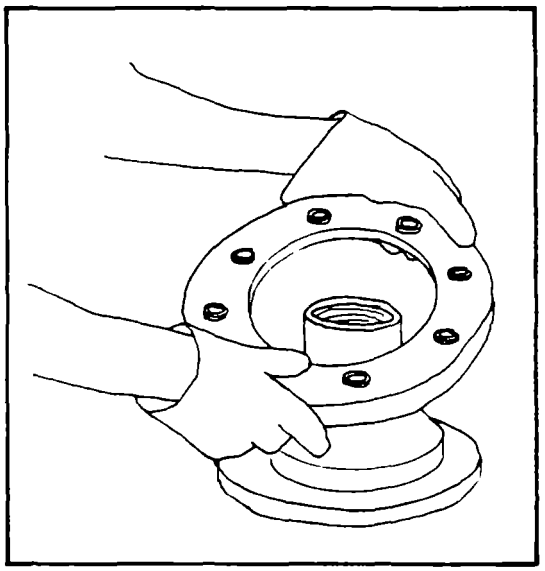
Operation 3. Cut pipe threads in upper pump base.

Inspection 3. Measure threads; gage must engage at least four but not more than eight threads in base when tightened by hand.

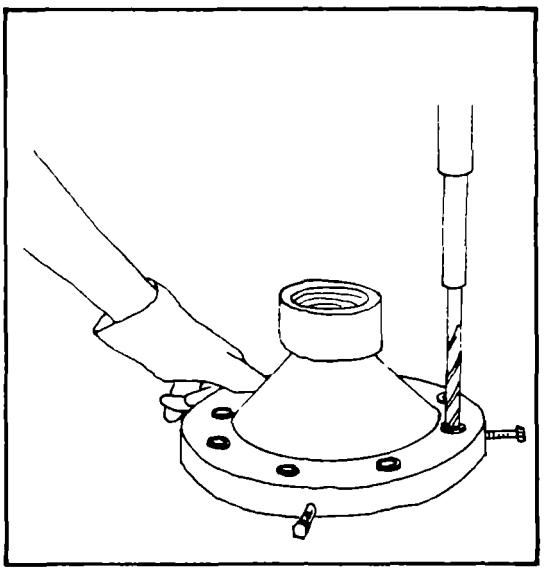


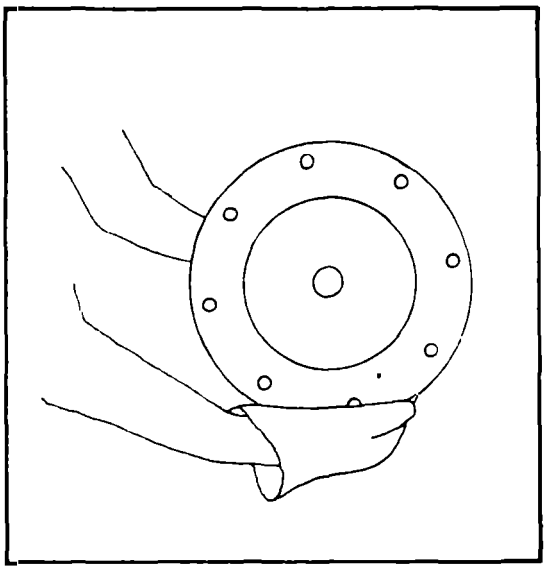
Operation 4. Drill eight holes for anchor bolts using jig.

Operation 4a. Place jig on base.



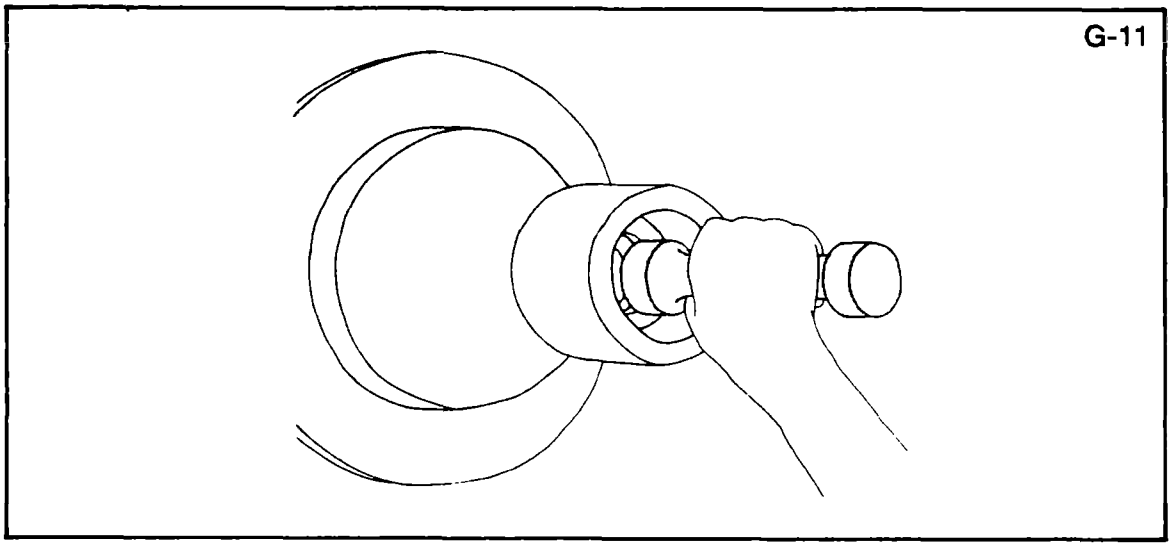
Operation 4b. Drill eight holes.



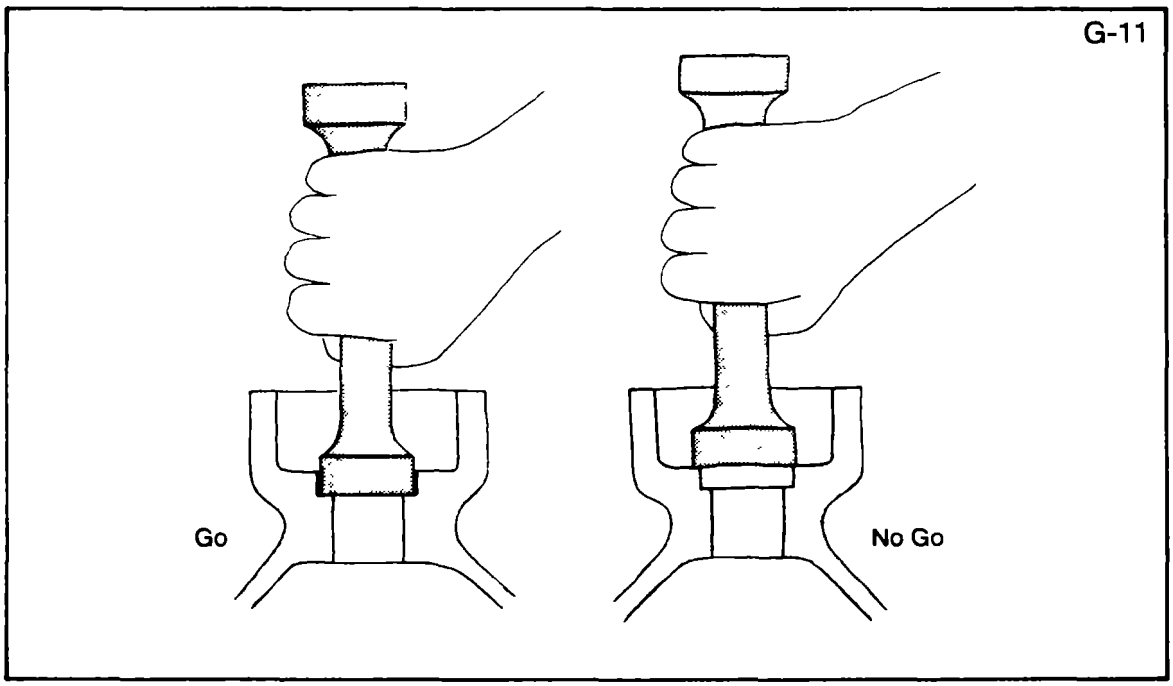


Operation 5. Bore seating surface for valve seat (shallow well pumps only).

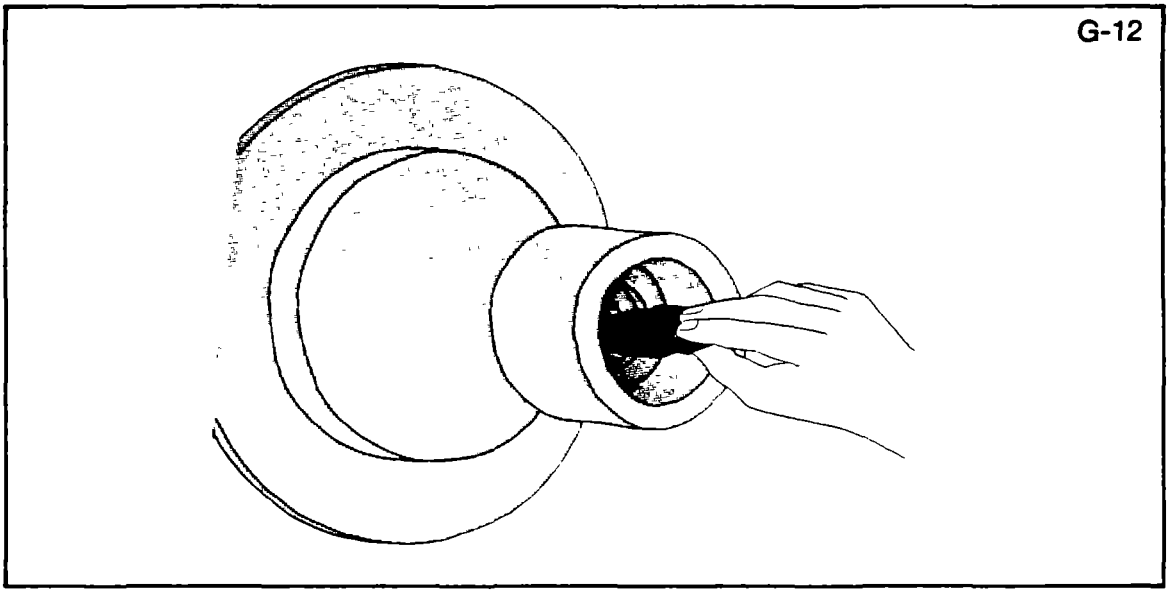
Inspection 5a. Measure width of seating surface.



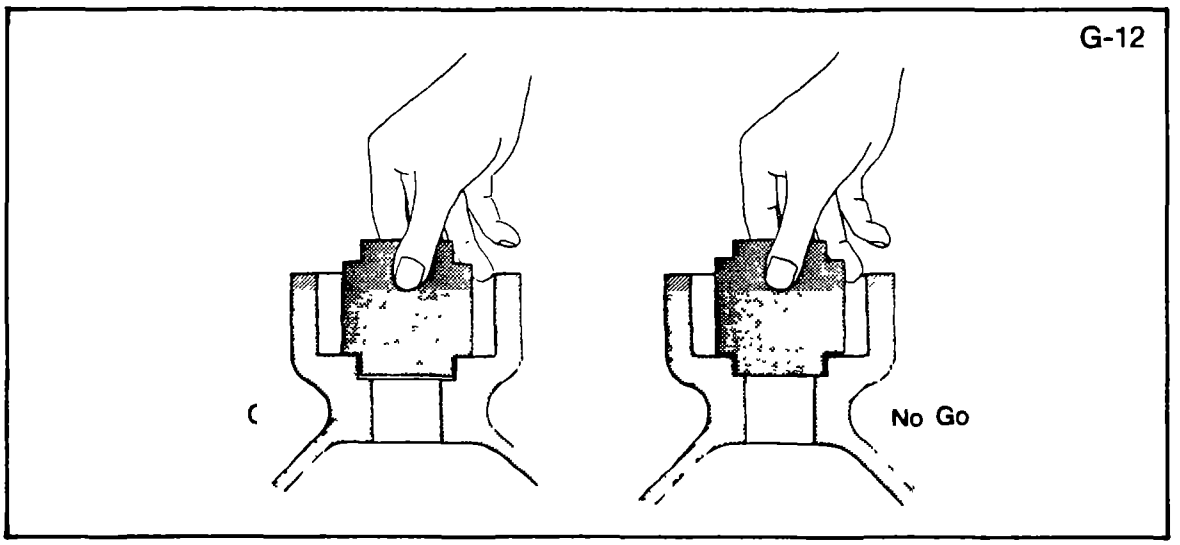
Inspection 5b. "Go" part width gage must fit into seating surface; "no go" part must not fit into seating surface.



Inspection 5c. Measure depth of seating surface.



Inspection 5d. "Go" part of depth gage must not touch seating surface; "no go" part of depth gage must touch seating surface.



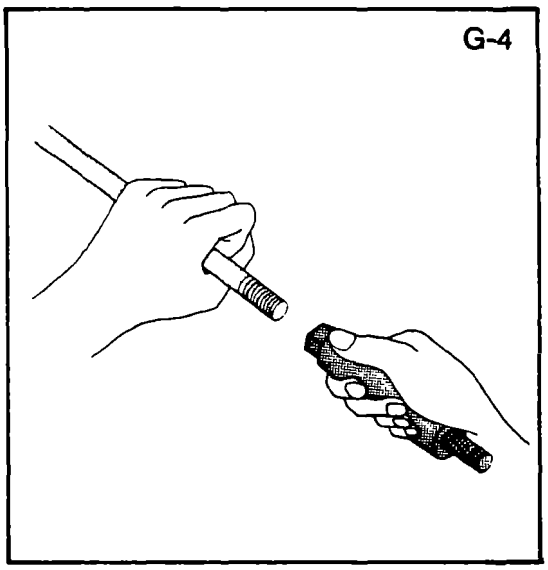
K. Plunger Rod

Operation 1. Cut rod to length.

Operation 2. Grind ends.

Operation 3. Thread both ends.

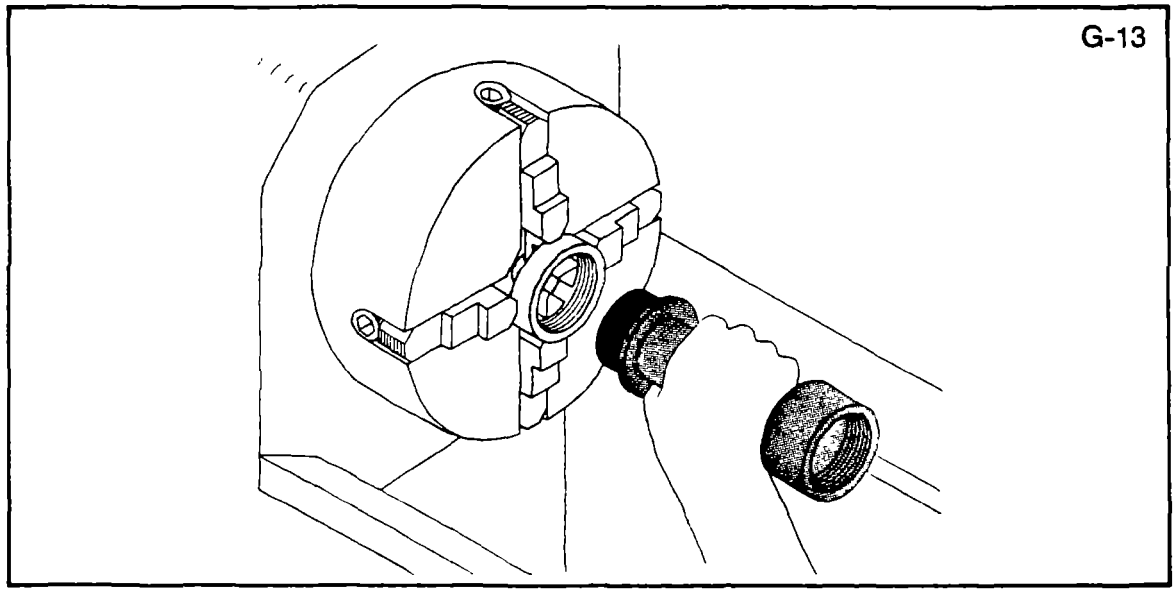
Inspection 3. Measure threads; thread gage must freely engage threaded portion of plunger rod.



L. Plunger Cage

Operation 1. Clean inside diameter and cut threads.

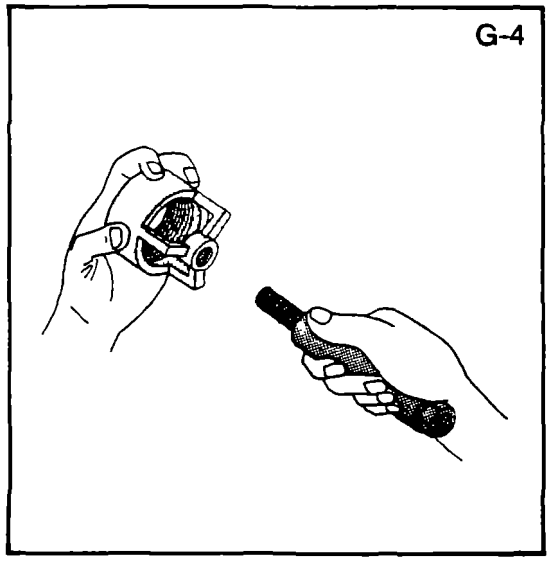
Inspection 1. Measure threads; thread gage must freely engage threaded portion of plunger cage.



Operation 2. Clean outside diameter.

Operation 3. Drill and tap plunger rod hole.

Inspection 3. Measure threads; thread gage must freely engage threaded plunger rod hole.



M. Poppet

Operation 1. Turn top of poppet.

Operation 2. Turn stem.

Operation 3. Finish contact surface.

Inspection 3. Contact surface must be free of all voids, burrs and other imperfections Must equal or surpass quality of sample provided by purchaser.

N. Follower

Operation 1. Turn inside diameter.

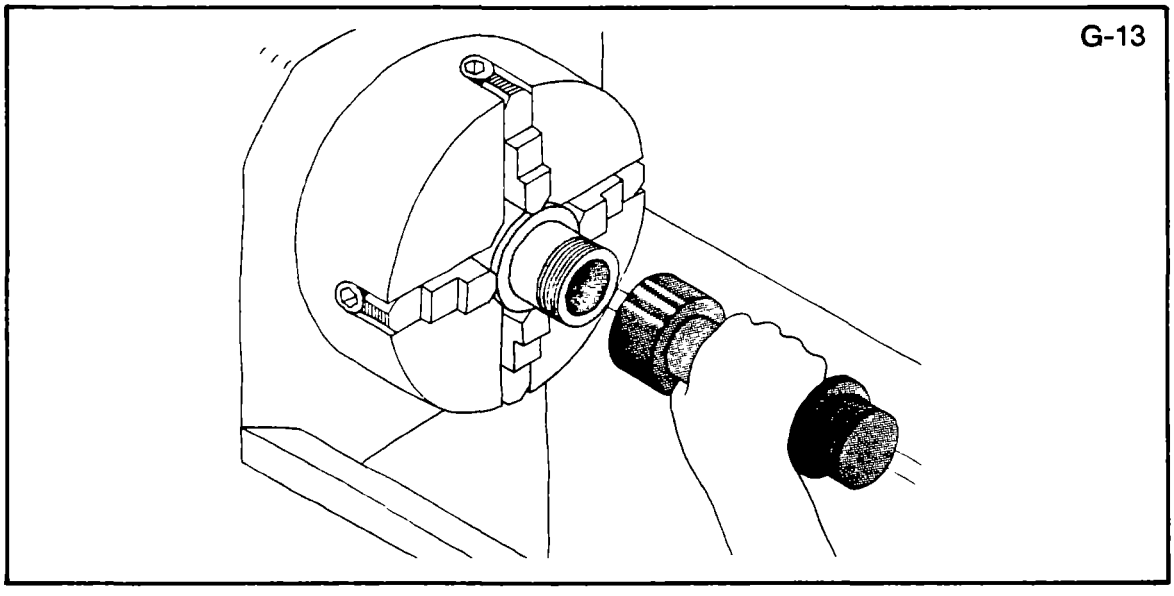
Operation 2. Turn outside diameter.

Operation 3. Finish top contact surface.

Inspection 3. Contact surface must be free of all voids, burrs and other imperfections. Must equal or surpass quality of sample provided by purchaser.

Operation 4. Cut pipe threads.

Inspection 4. Measure threads; thread gage must freely engage threads on follower.

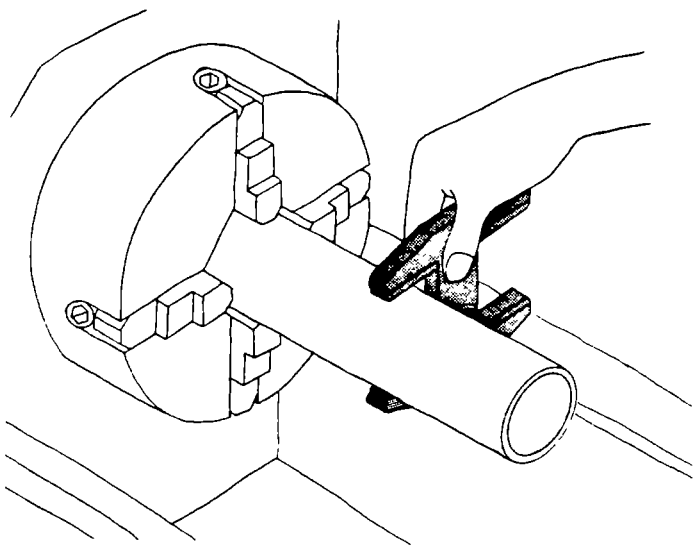


O. **PVC Pipe** (for press fit in steel pipe)

Operation 1. Turn outside diameter.

Inspection 1. Measure outside diameter; outside diameter must fit "go" part of gage but not "no go" part.

G-14



Operation 2. Cut to length.

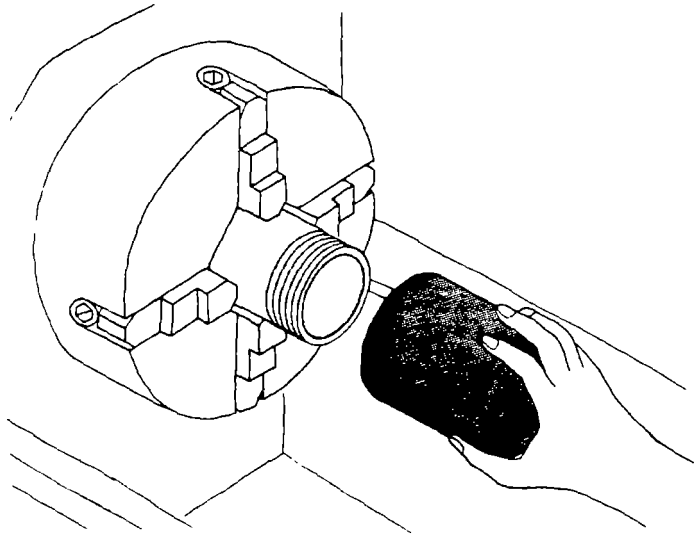
O. **PVC Pipe** (for deep well cylinder)

Operation 1. Cut to length.

Operation 2. Cut threads on both ends.

Inspection 2. Measure threads; gage must engage at least four but not more than eight threads on pipe section when tightened by hand.

G-9

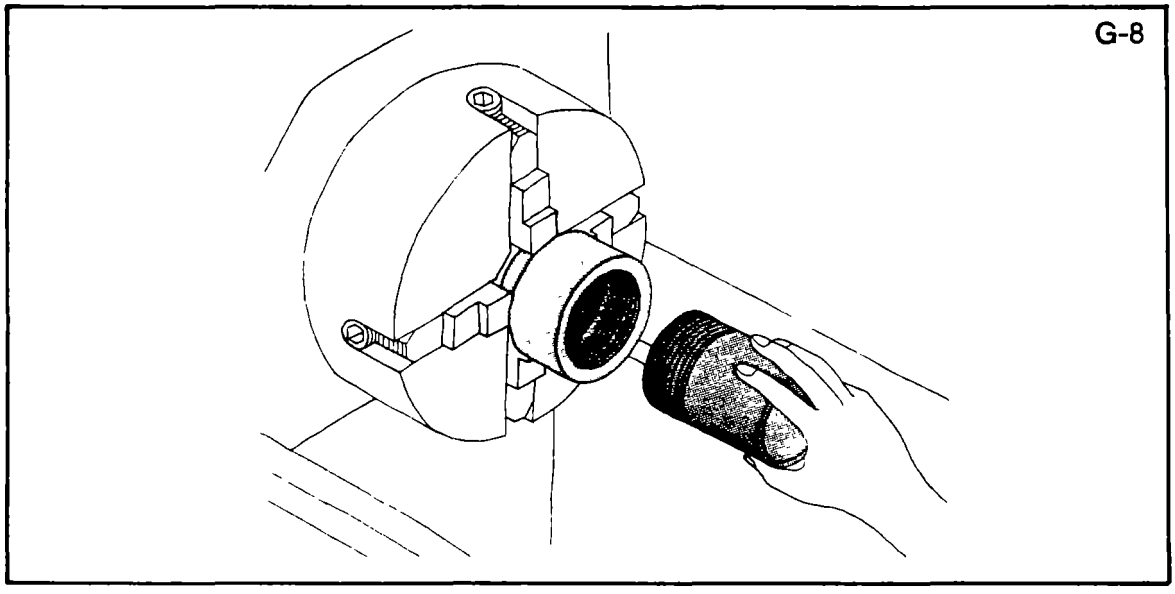


P. Deep Well Cylinder Ends

Operation 1. Turn inside diameter.

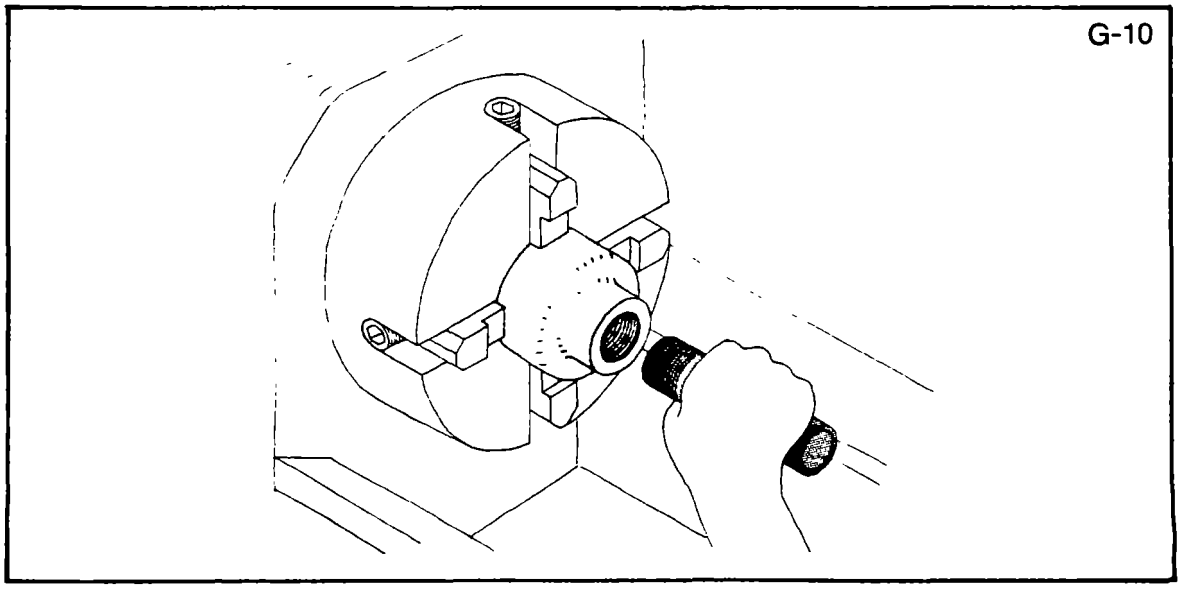
Operation 2. Cut large pipe threads.

Inspection 2. Measure threads; gage must engage at least four threads but not more than eight threads in cylinder end when tightened by hand.



Operation 3. Cut small pipe threads.

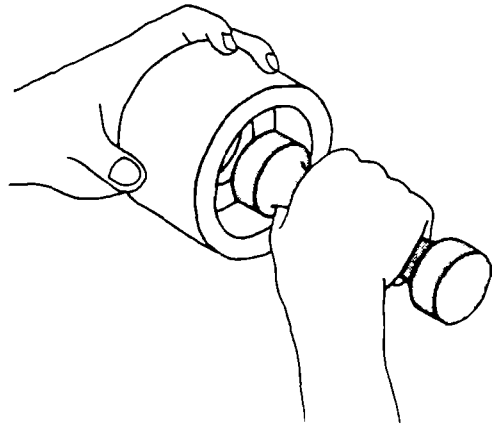
Inspection 3. Measure threads; gage must engage at least four threads but not more than eight threads in cylinder end when tightened by hand.



Operation 4. Bore seating surface for valve seat (lower cylinder end only).

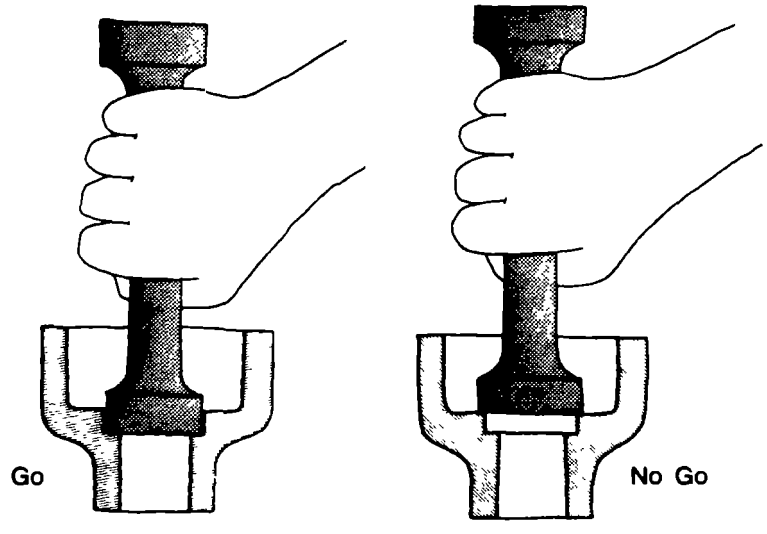
Inspection 4a. Measure width and depth of seating surface.

G-11

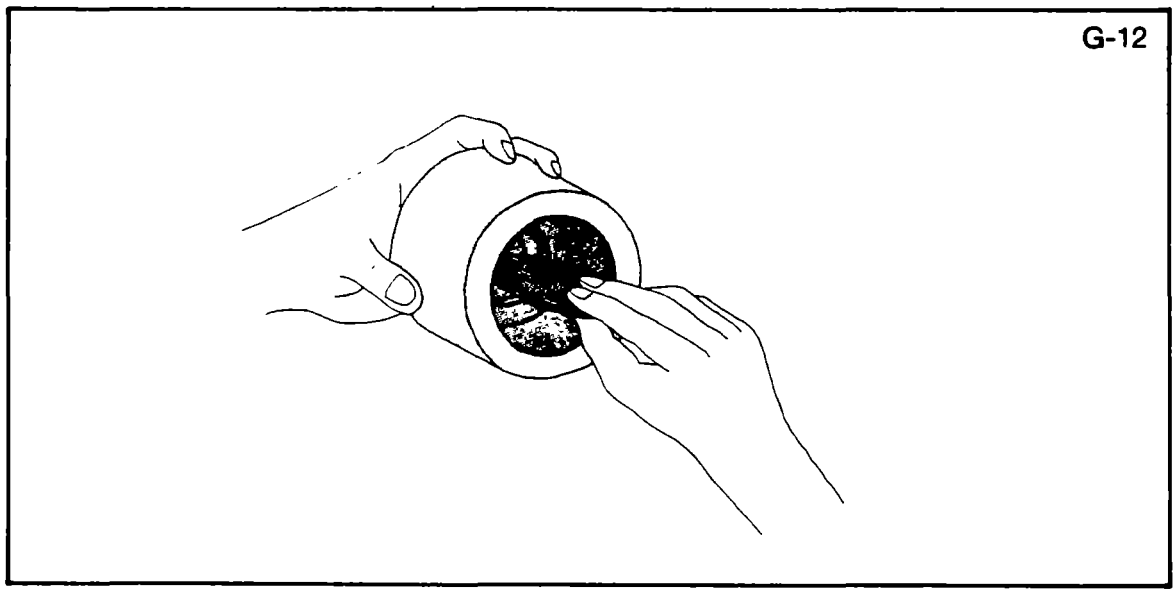


Inspection 4b. "Go" part of width gage must fit into seating surface; "no go" part must not fit into seating surface.

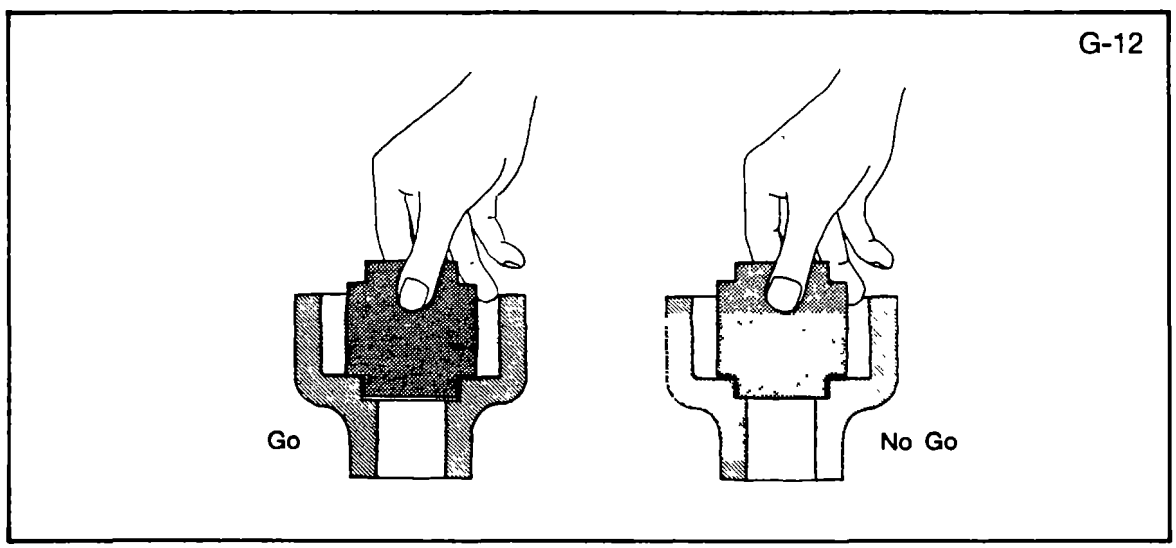
G-11



Inspection 4c. Measure depth of seating surface



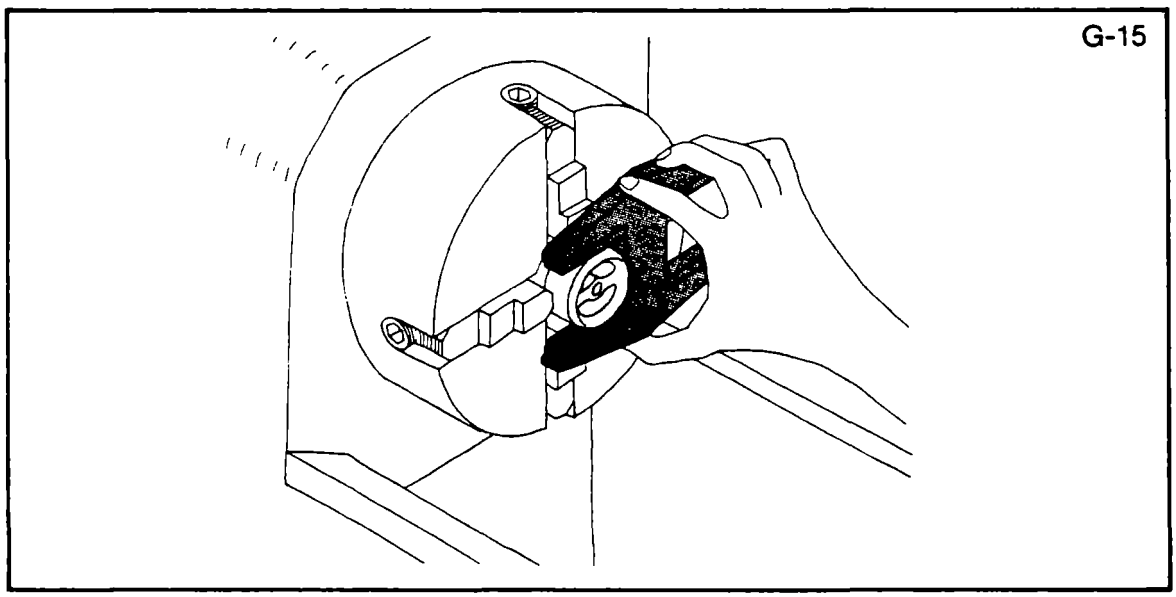
Inspection 4d. "Go" part of depth gage must not touch seating surface; "no go" part of depth gage must touch seating surface.



Q. Valve Seat.

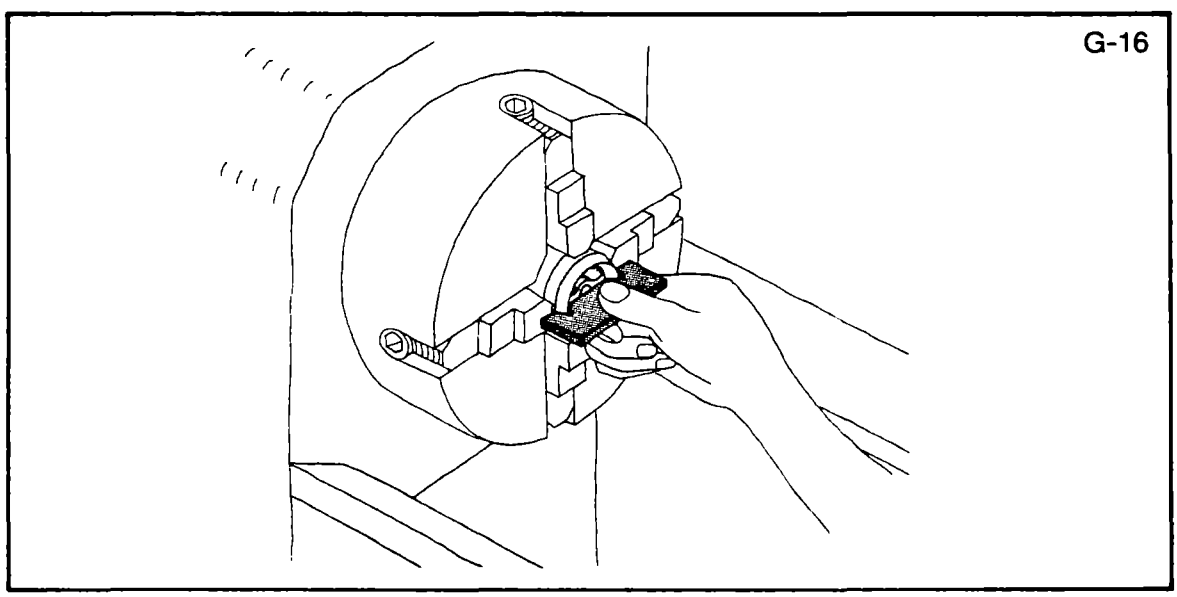
Operation 1. Turn outside diameter.

Inspection 1. Measure outside diameter; diameter must fit "go" part of gage but not "no go" part.



Operation 2. Turn seating surface radius.

Inspection 2. Measure seating surface; seating surface must conform to diameter and contour of gage.



Operation 3. Drill hole for stem.

Operation 4. Cut valve seat to length.

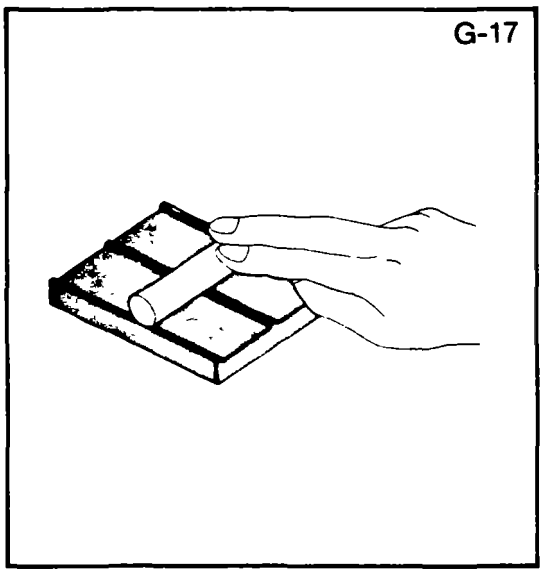
A. Pin

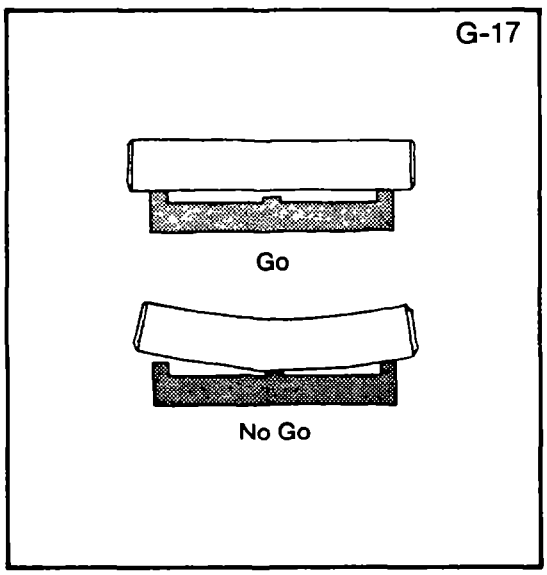
Operation 1. Harden pin

Operation 2. Temper pin

Inspection 2a. Check hardness tester. Pin must be R_C 40-45.

Inspection 2b. Examine pin for warpage; pin should not touch middle leg of gage.





B. Bushing

Operation. Harden bushing

Inspection. Check hardness with hardness tester. Bushing must be R_C 60-65.

“

Operation 1. Assemble subassemblies:

a. head assembly
b. piston assembly
c. foot valve assembly

Inspection 1. Inspect all subassemblies for the following:

a. all parts assembled in correct order
b. no cracks in press fit parts
c. foot valve must not appear to leak over 5-minute period

Operation 2. Assemble pump

Inspection 2. Inspect all pumps for the following:

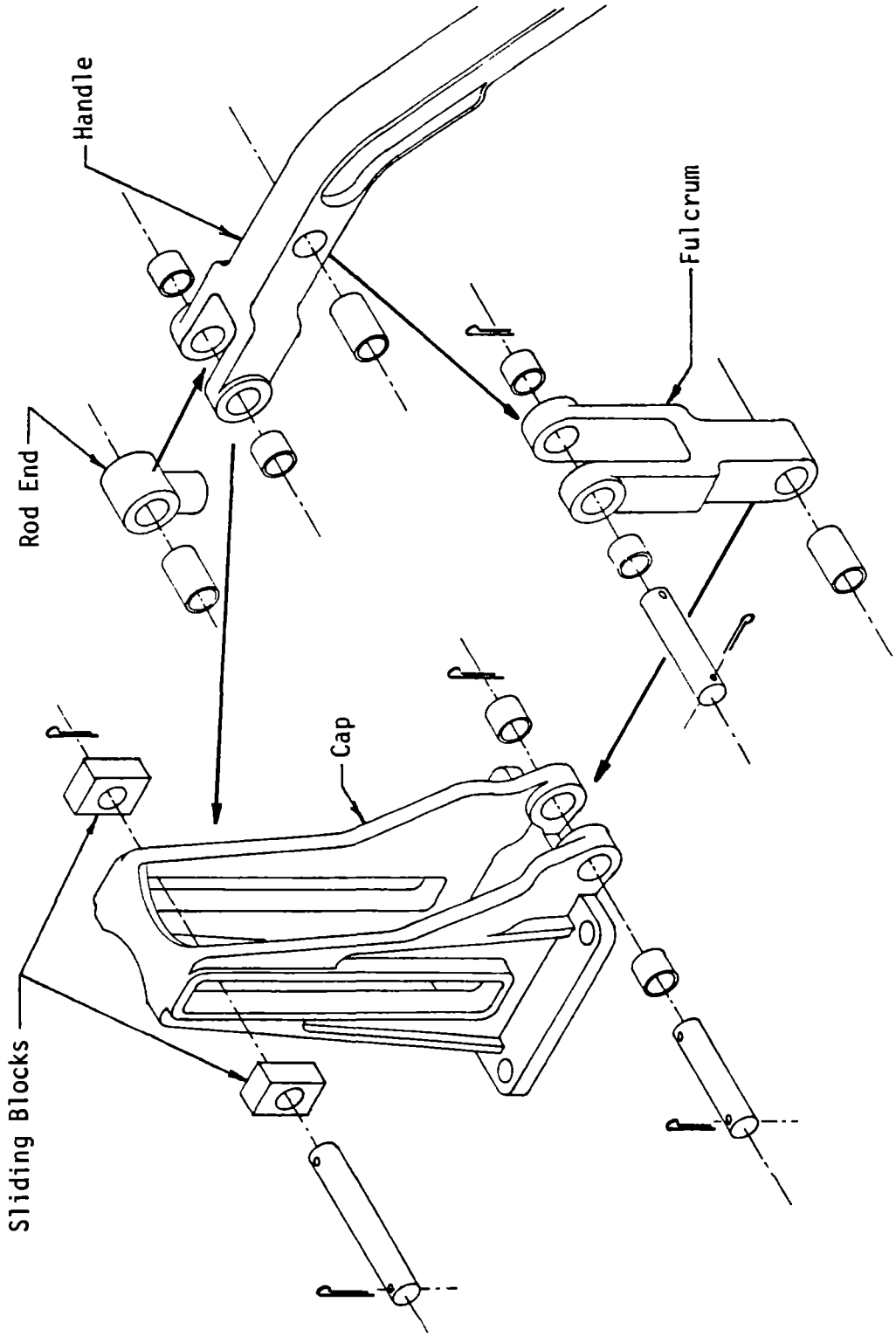
a. handle to move smoothly through entire travel
b. fulcrum to limit travel of handle

Inspection 3. Wet test 5% of the pumps and/or cylinders

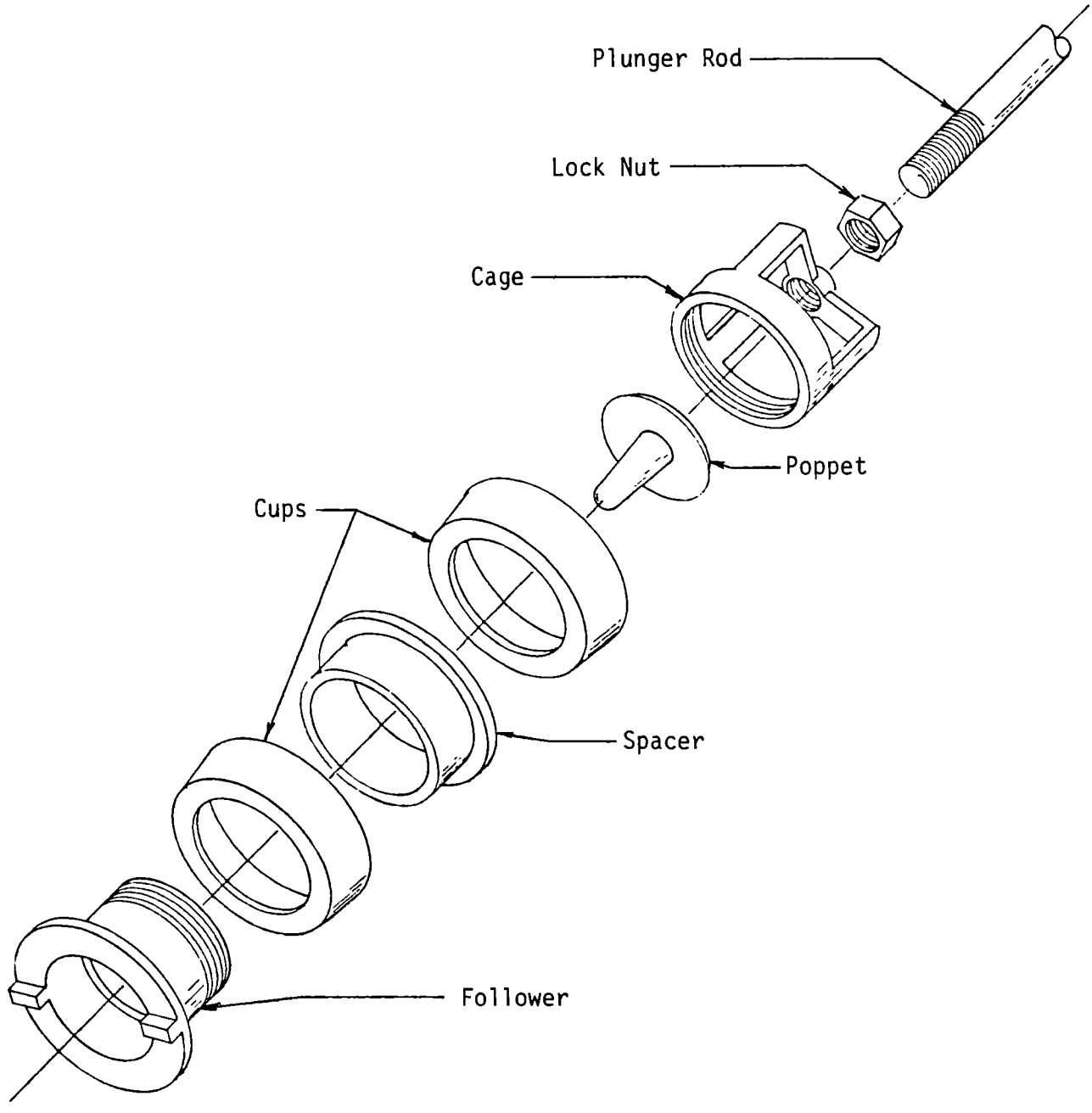
a. pump or cylinder must pump water
b. no leaks apparent at base/stand/body connections

Note: If one of the pumps or cylinders in the 5% sample does not pump water or leaks a 20% sample should be tested. If another substandard pump or cylinder is found the entire production lot should be tested. All substandard pumps and cylinders should be retested after the problem has been corrected.

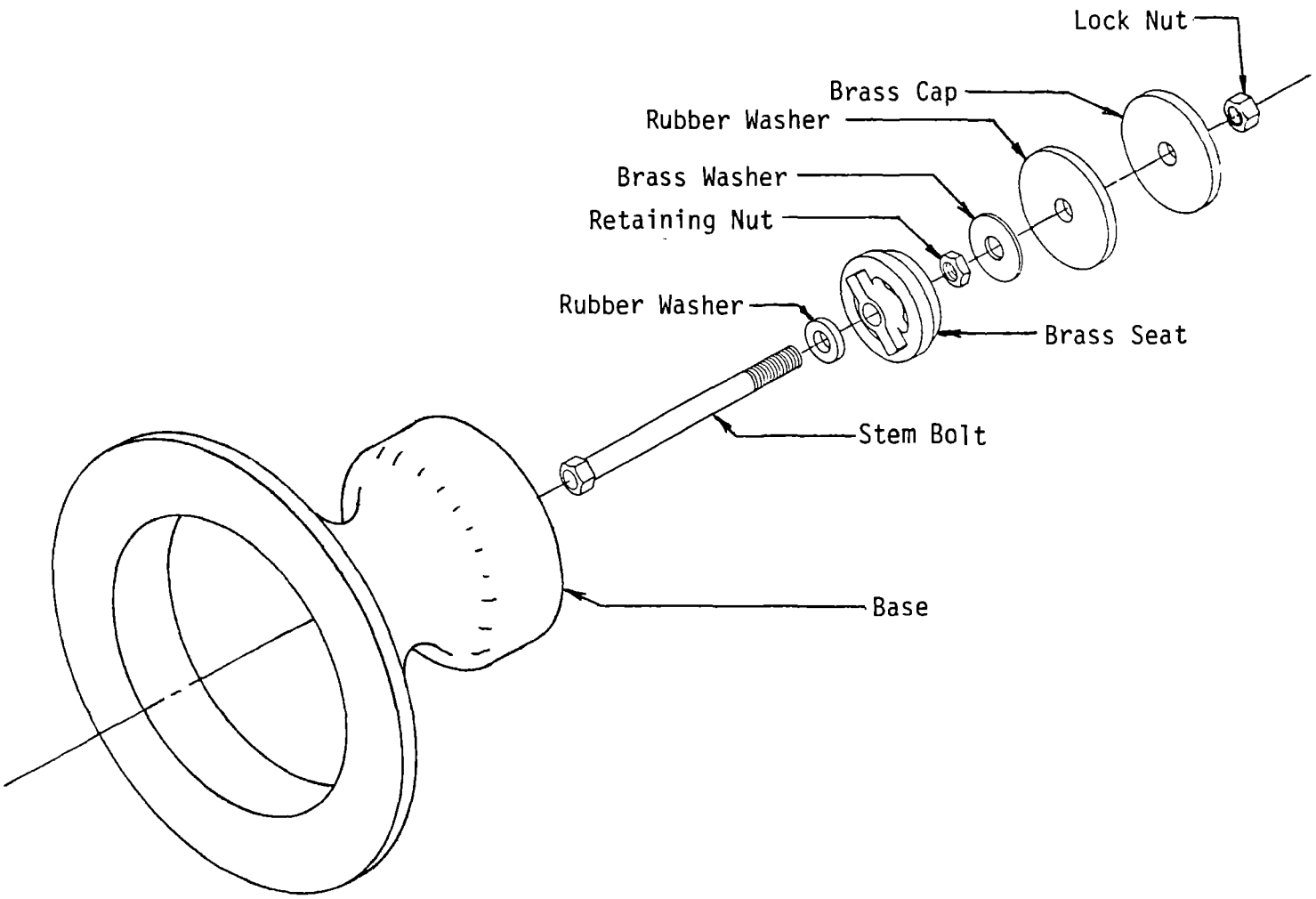
Cap Assembly



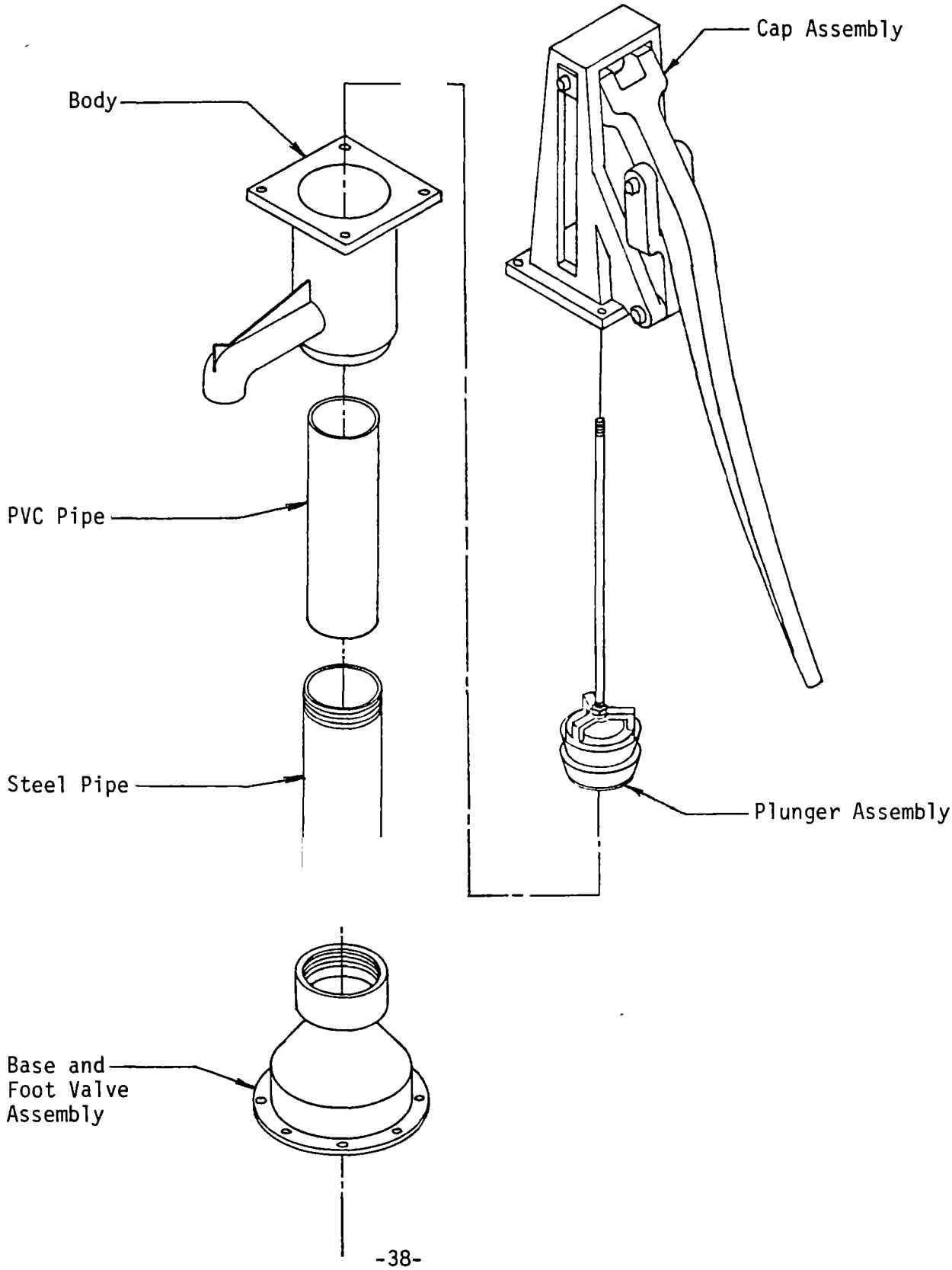
Plunger Assembly



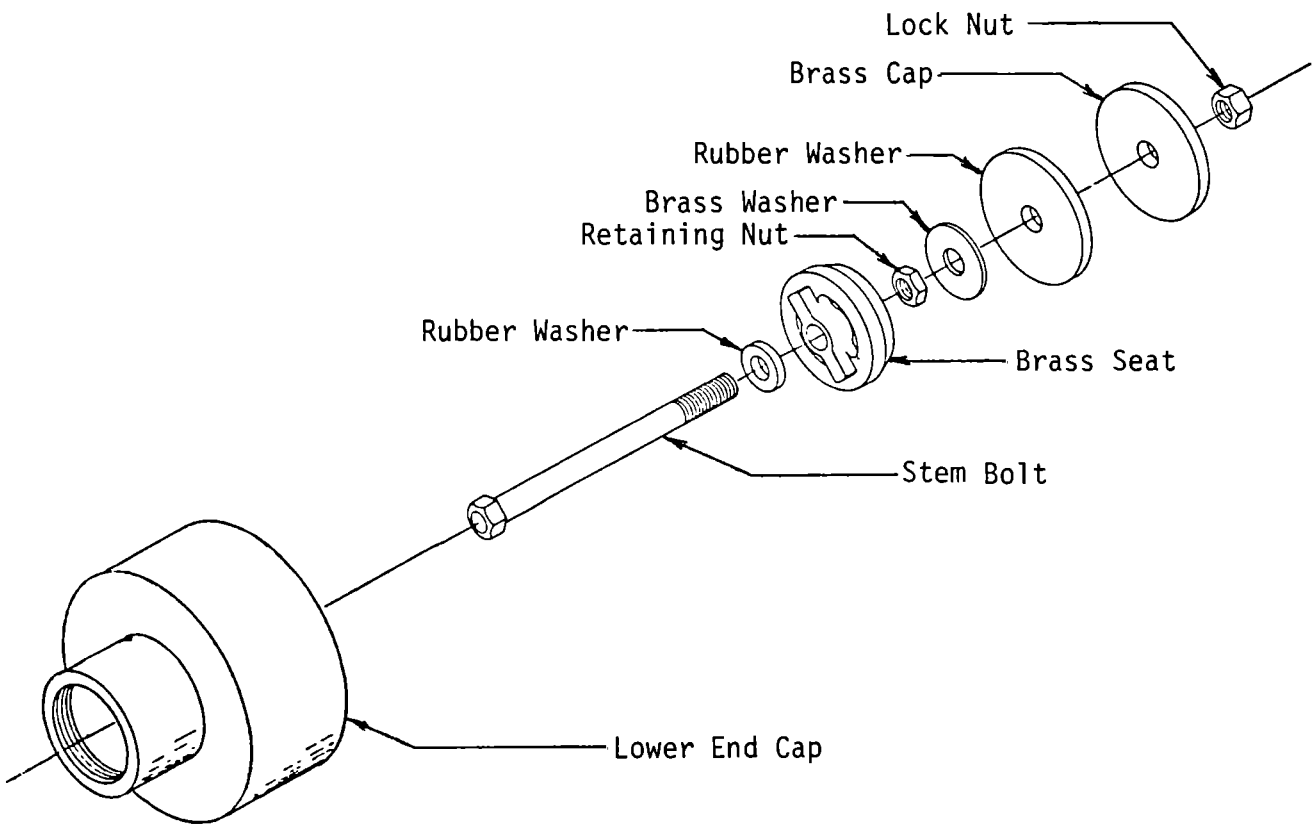
Foot Valve Assembly for Shallow Well Pumps



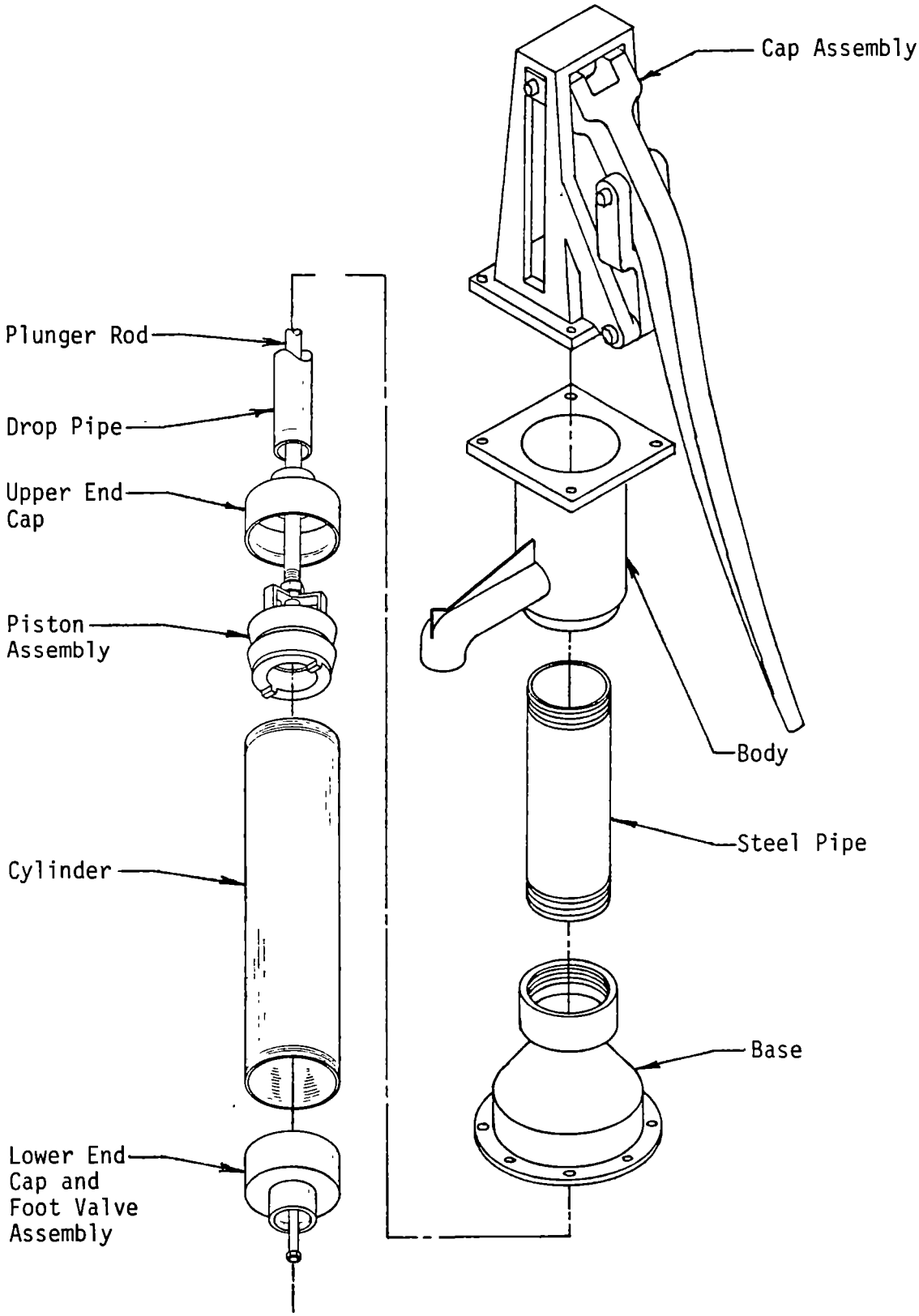
Shallow Well Pump Assembly



Foot Valve Assembly for Deep Well Pumps



Deep Well Pump Assembly



A. Randomly select 20% of pumps and cylinders to be received.

B. Inspect the following quality characteristics:

Inspection	Quality Characteristic
1. Examine motion of handle/fulcrum assembly.	a. Smooth motion, no catching on burrs, etc. b. Fulcrum to limit motion of handle so that rod end does not contact cap.
2. Examine surface finish of external parts and piston assembly.	a. No burned sand adhering to casting, relatively smooth surface. b. Parting line flash removed. c. No obvious distortion of parts.
3. Examine threads in base, body and cylinder ends.	a. No voids or broken threads in threaded area. b. No putty or filler evident. c. 3" pipe section and 1-1/4" drop pipe must have 4 threads showing when hand-tightened into base, body, or cylinder.
4. Rotate cap on body to check hole spacing.	Cap must fit in all four positions.
5. Check dimensions on anchor bolt holes in base.	Using a standard base or a template, line up base holes.
6. Inspect for porosity in critical areas.	Must meet porosity criteria of casting criteria sheet.

7. Inspect pins and bushings.	a. Pins and bushings must be to hardness of 40-45 and 60-65 R_C respectively. Note: Measure hardness of one pin and one bushing from 1% of the pumps to be received.
	b. Bushings must be press fit in cast iron part; must not move in pump components.
	c. Measure pin and bushing dimensions and pin warpage with gages.
	d. Cotter pins must be easily removed from pins; cotter pins not to drag on cast iron parts.
8. Inspect cylinder.	a. No putty, voids, sealer in threads.
	b. Cylinder ID smooth and without excessive ripple.
9. Compare plunger assembly with sample provided by purchaser.	a. No holes, voids or excessive porosity on valve contact surface of follower or underside of poppet valve.
	b. No holes or excess porosity in plunger cage; no machined sharp corners inside cage.
	c. All flash removed from brass parts.
	d. Leather cups not ragged, torn or stretched; ID to just fit over follower.
	e. Piston fits snugly into cylinder.
	f. Plunger rod threads not misthreaded and do not protrude into cage.

10. Compare foot valve with sample provided by purchaser.	a. Valve seat has no holes or imperfections. b. Rubber or leather on valve must be smooth.
11. Wet test pump.	a. Pump must pump water. b. No leaks at base/stand/body connections. c. Foot valve must not appear to leak over 5 minute period.

C. If any of the pumps in the 20% sample has one of the quality characteristics fail, that entire pump will be rejected and that quality characteristic inspected on every pump in the entire lot. The inspector has sole authority to determine whether to repair or scrap the failed part.

D. Each pump in the lot will be numbered. All pumps in the lot to be inspected will have no paint or thread sealer or putty of any kind in evidence when inspected. After the lot has been accepted, each pump will be painted and the pump number painted or stenciled on in a contrasting color on the pump body.

APPENDIX

Enlarged Drawings for Gage Inspection

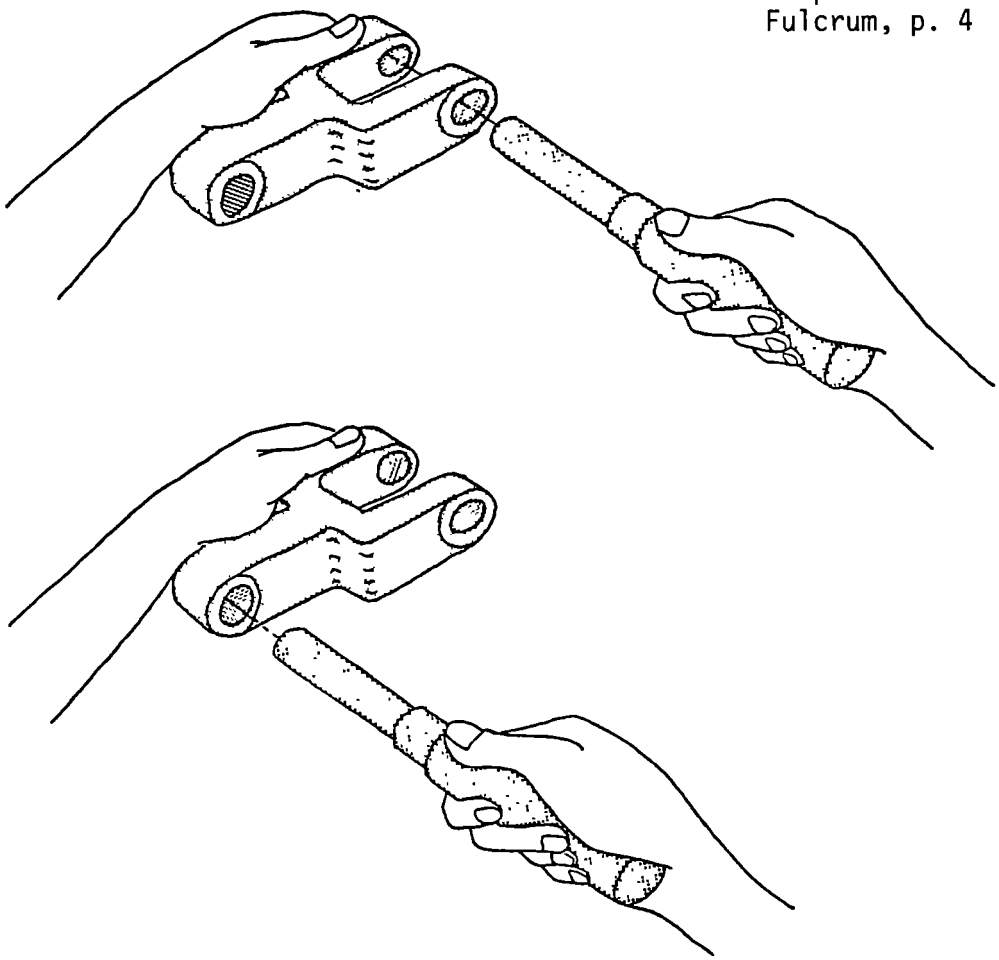
The Appendix contains all the graphics for each inspection that requires gages. It contains enlarged drawings from the main body. These enlarged drawings are included so they can be more easily distributed to workers who may be responsible for only a limited number of machining operations. In this way the shop foreman can pass out only those drawings that are needed.

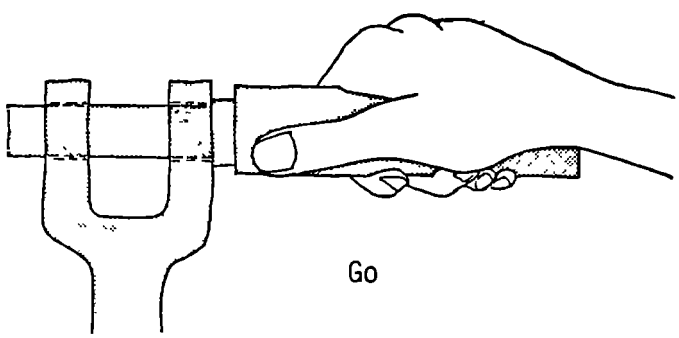
The drawings are indexed by the gage number used in the main body. An example is on page 45:

G-1

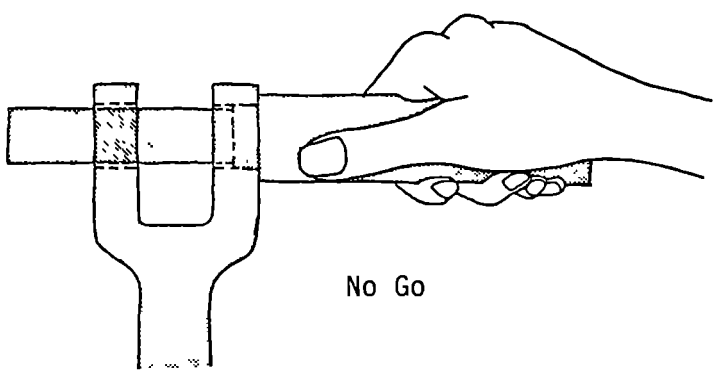
Inspection A-2a
Fulcrum, p. 4

G-1 refers to Gage 1, Inspection 2a (for the fulcrum), on page 4. Since gage 1 is used for four inspections, there are four pages of G-1 drawings. In all, there are 17 gages. Some of the gages are only used for one or two inspections.

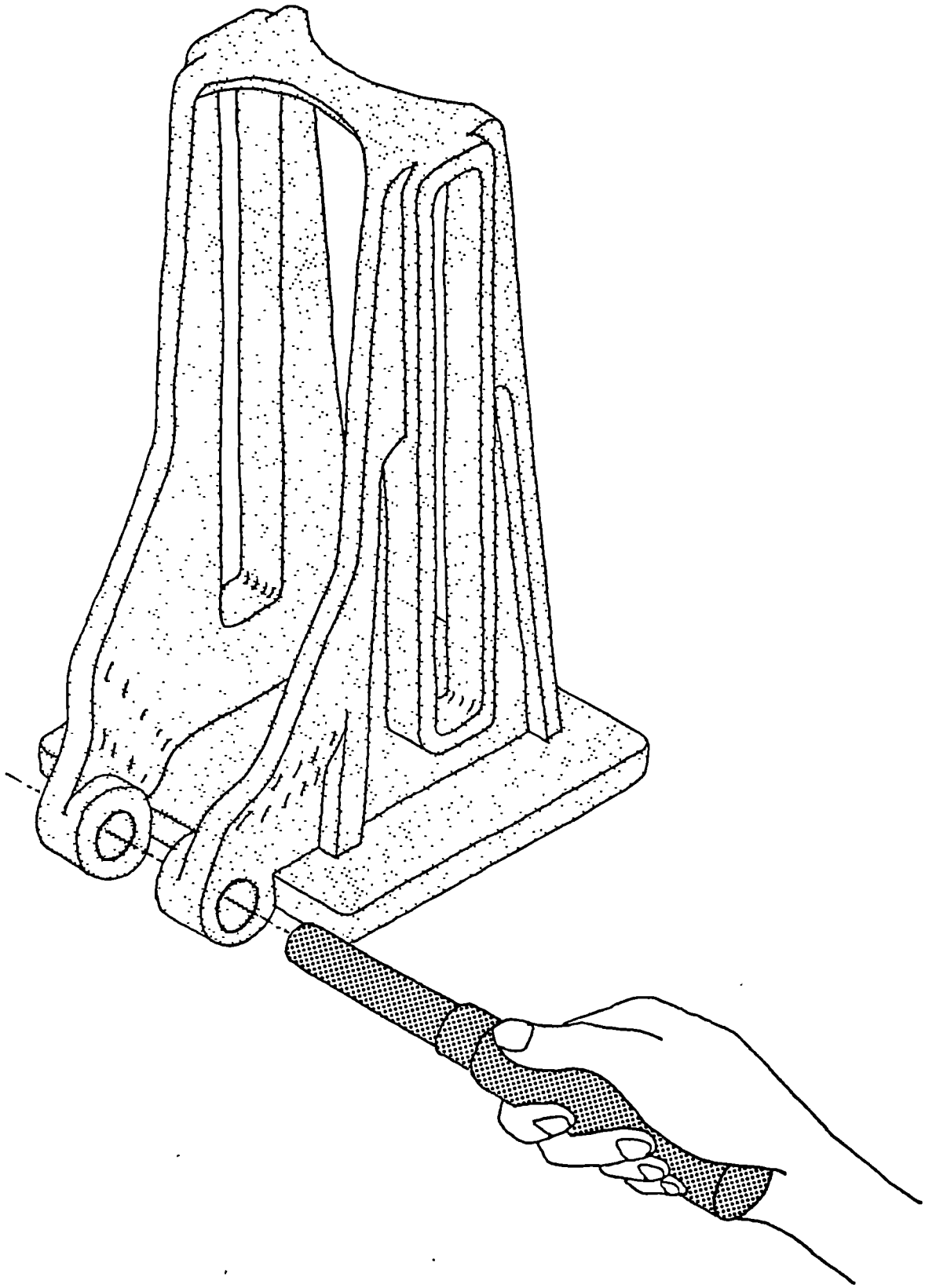




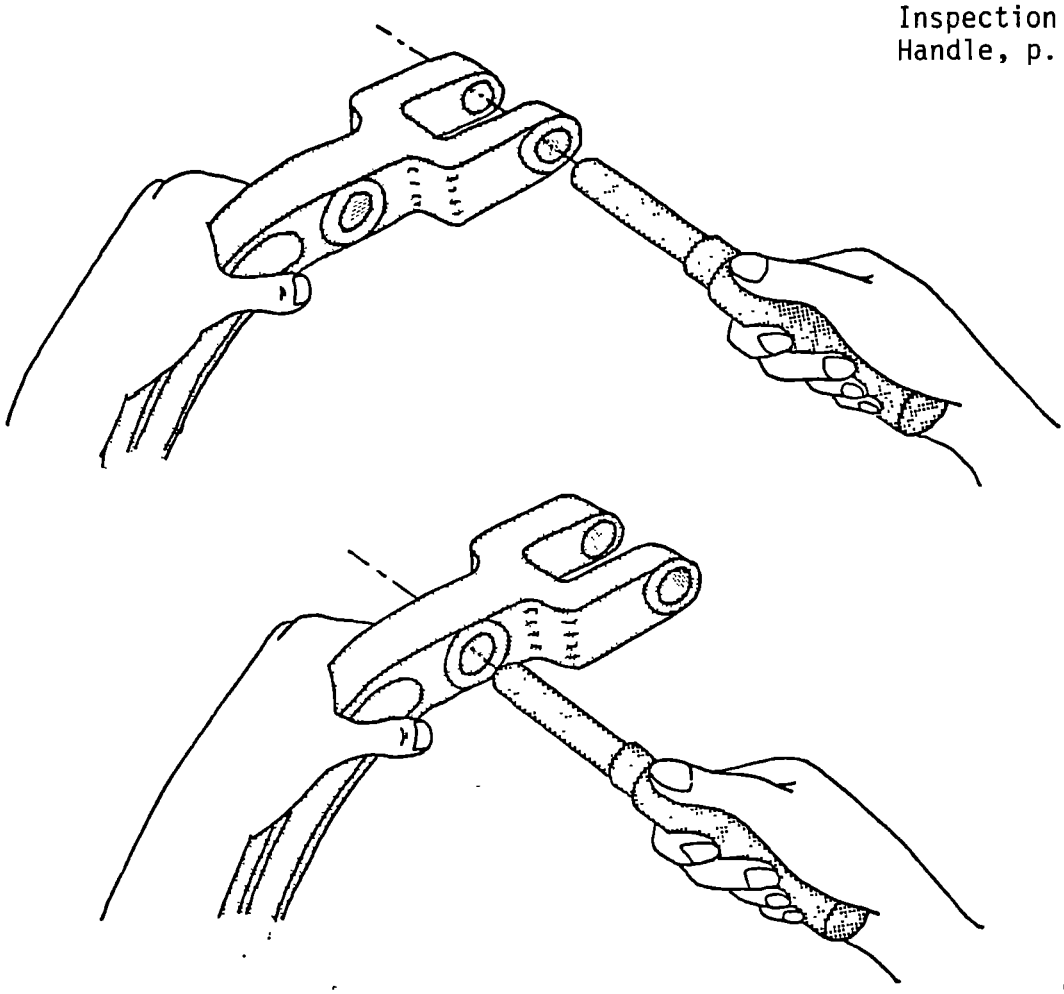
Go

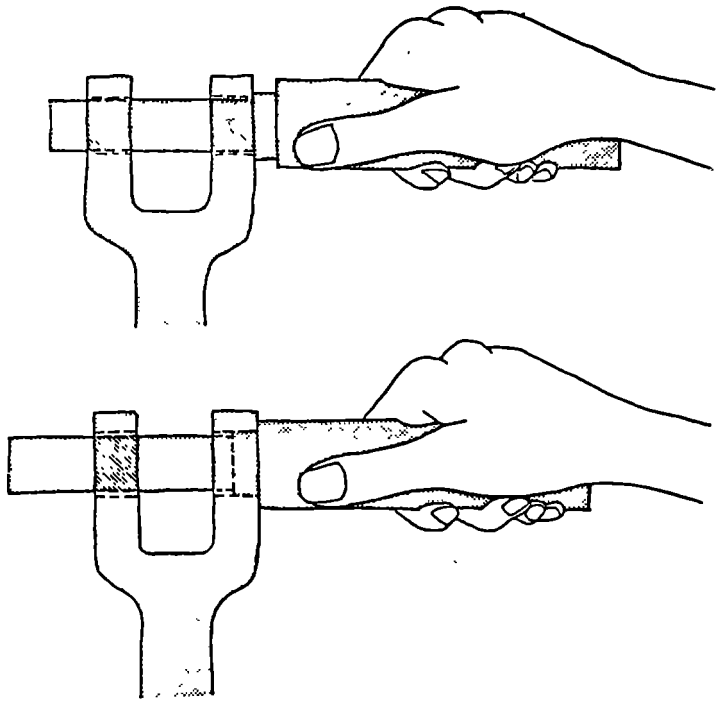


No Go

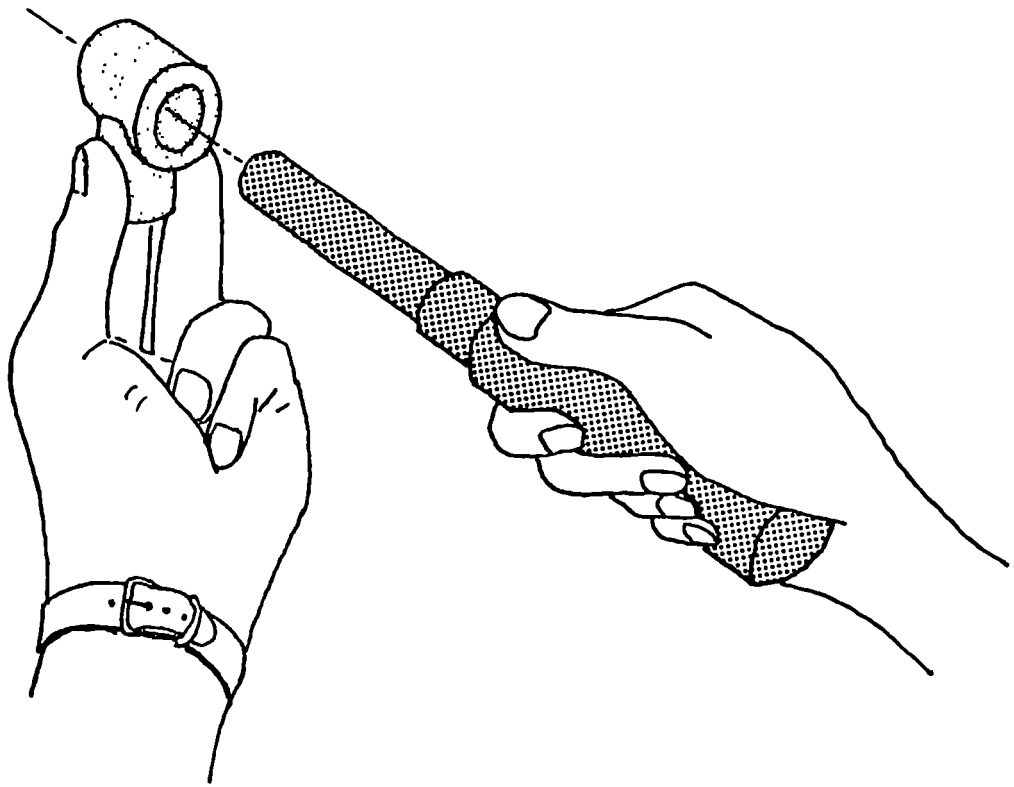


Inspection C-2a
Handle, p. 9



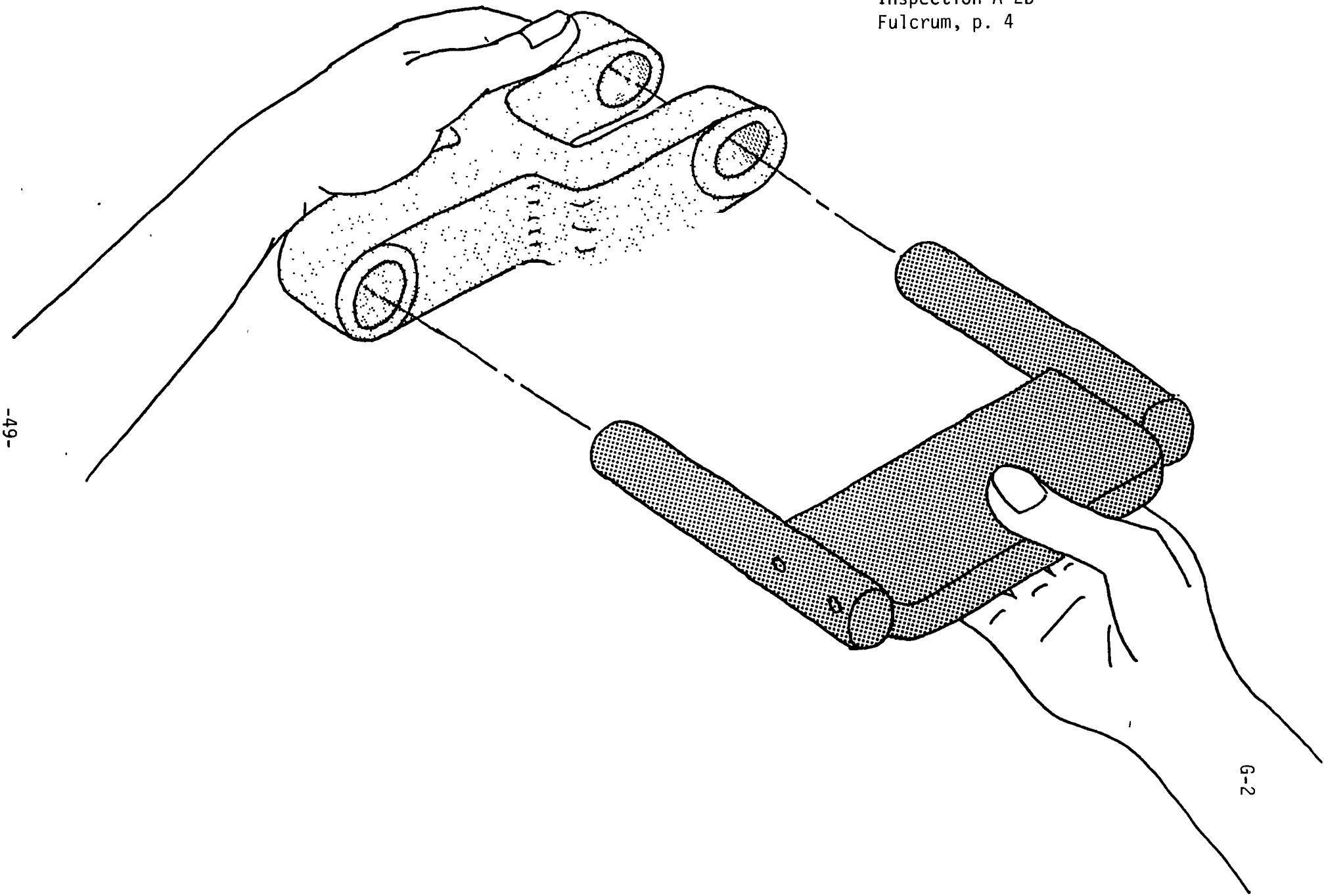


Inspection D-2
Rod End, p. 10



G-2

Inspection A-2b
Fulcrum, p. 4



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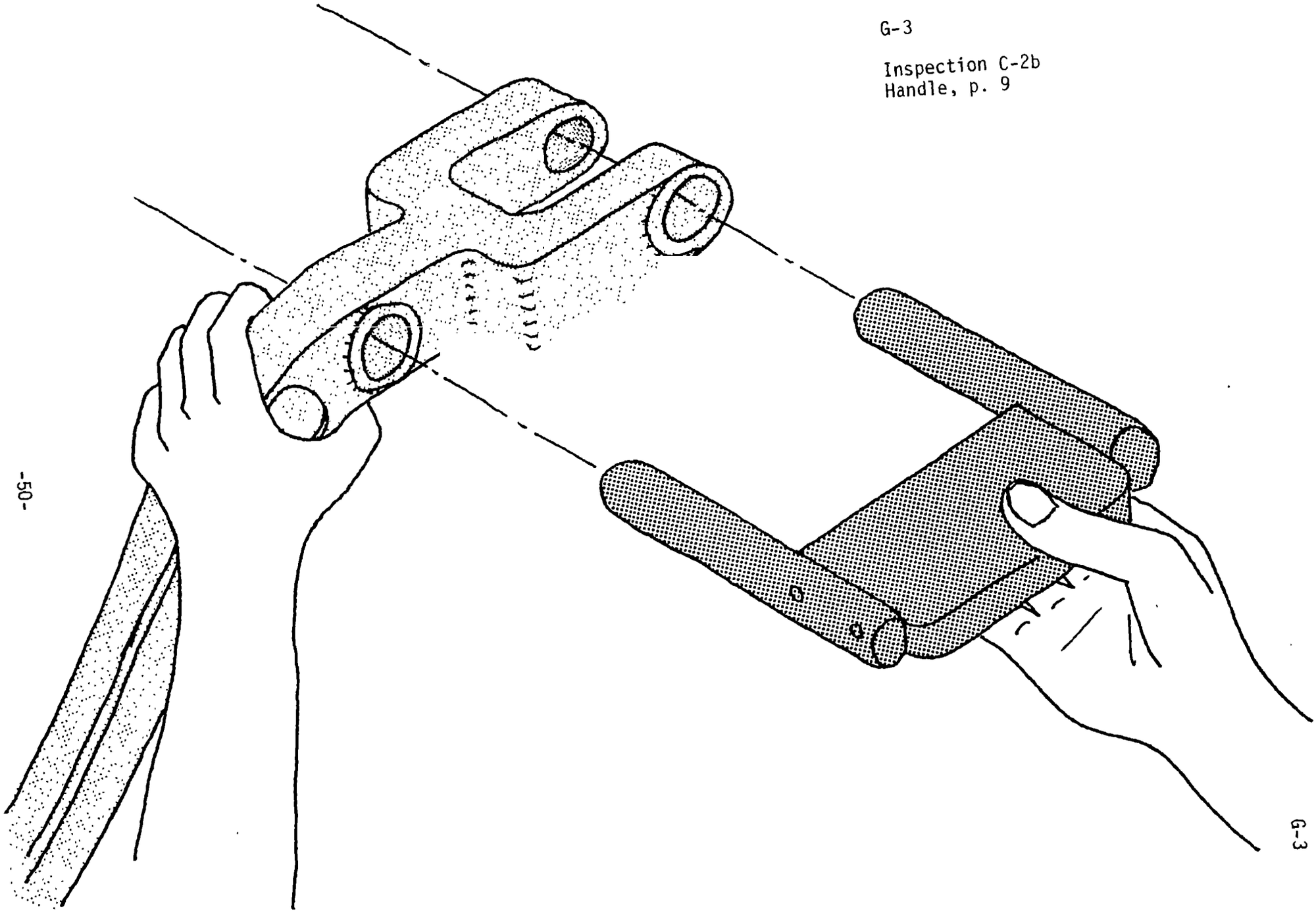
Inspection C-2b
Handle, p. 9



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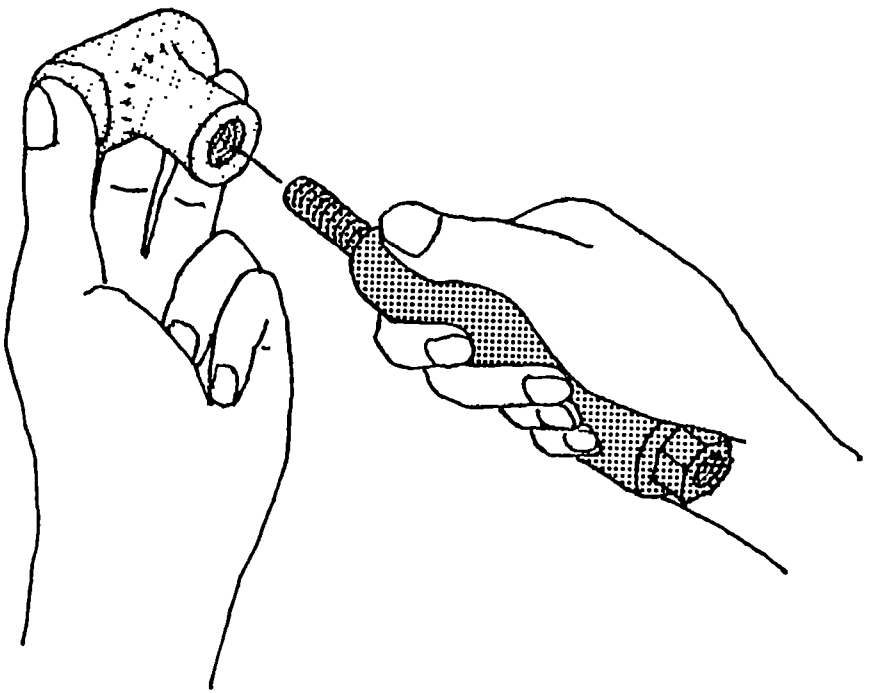
Inspection D-3
Rod End, p. 11



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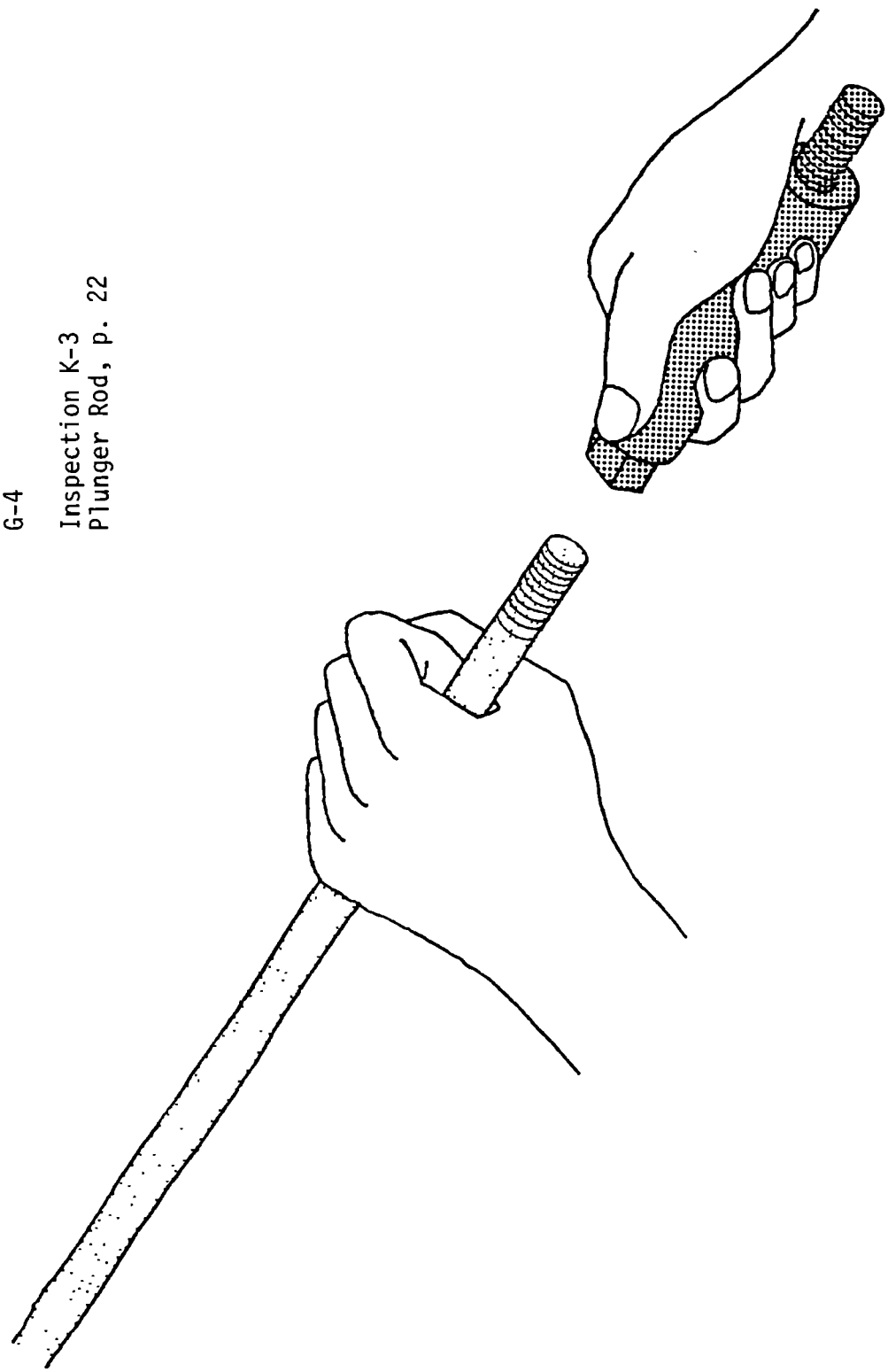
Inspection K-3
Plunger Rod, p. 22



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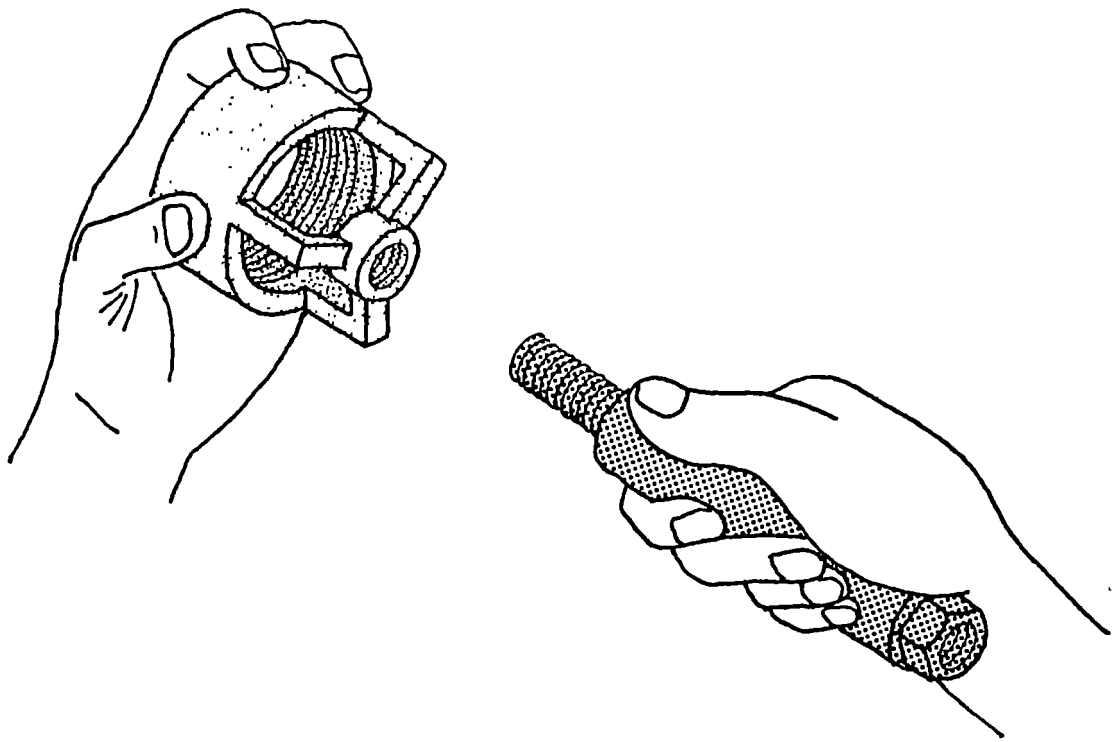
Inspection L-3
Plunger Cage, p. 23



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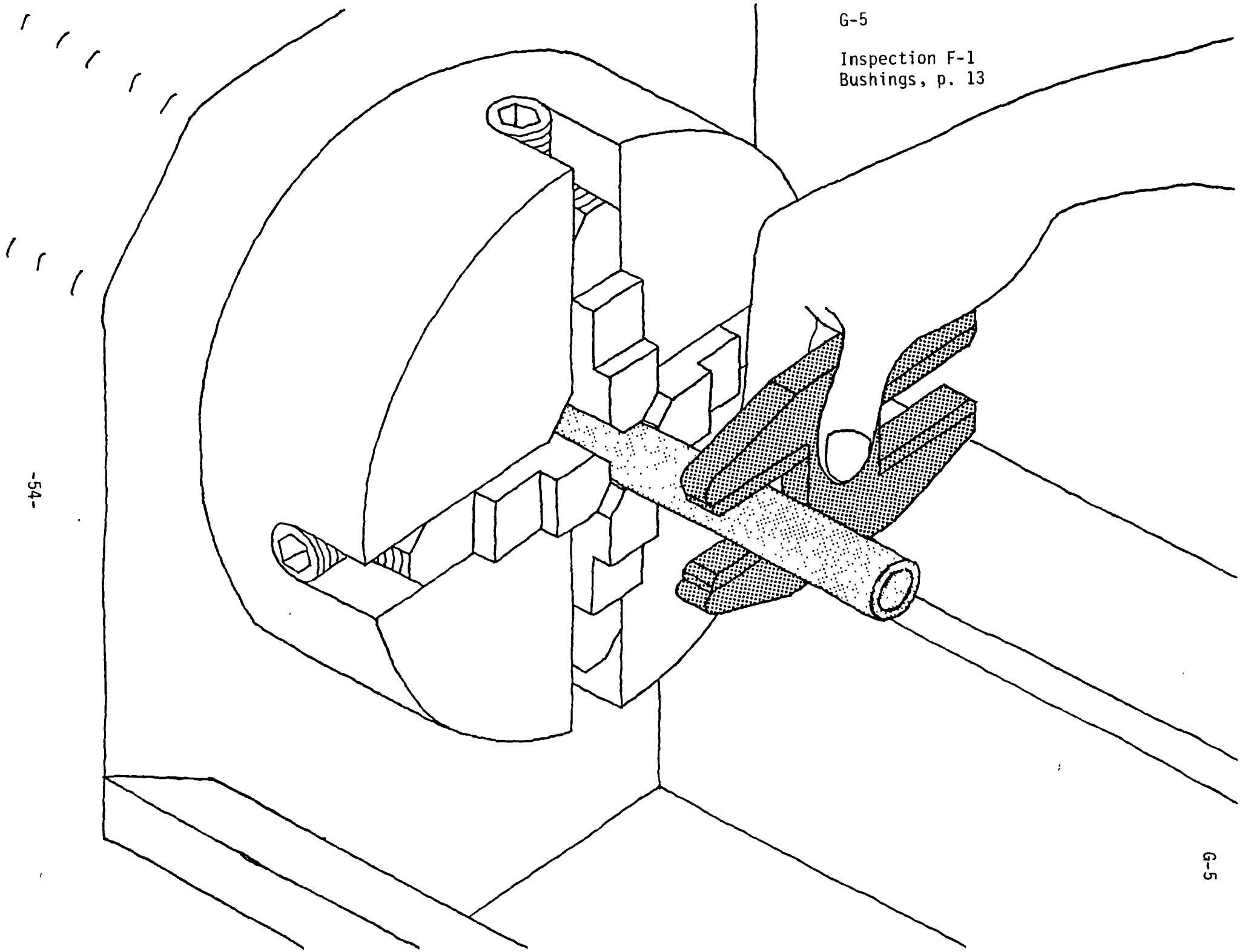
Inspection F-1
Bushings, p. 13



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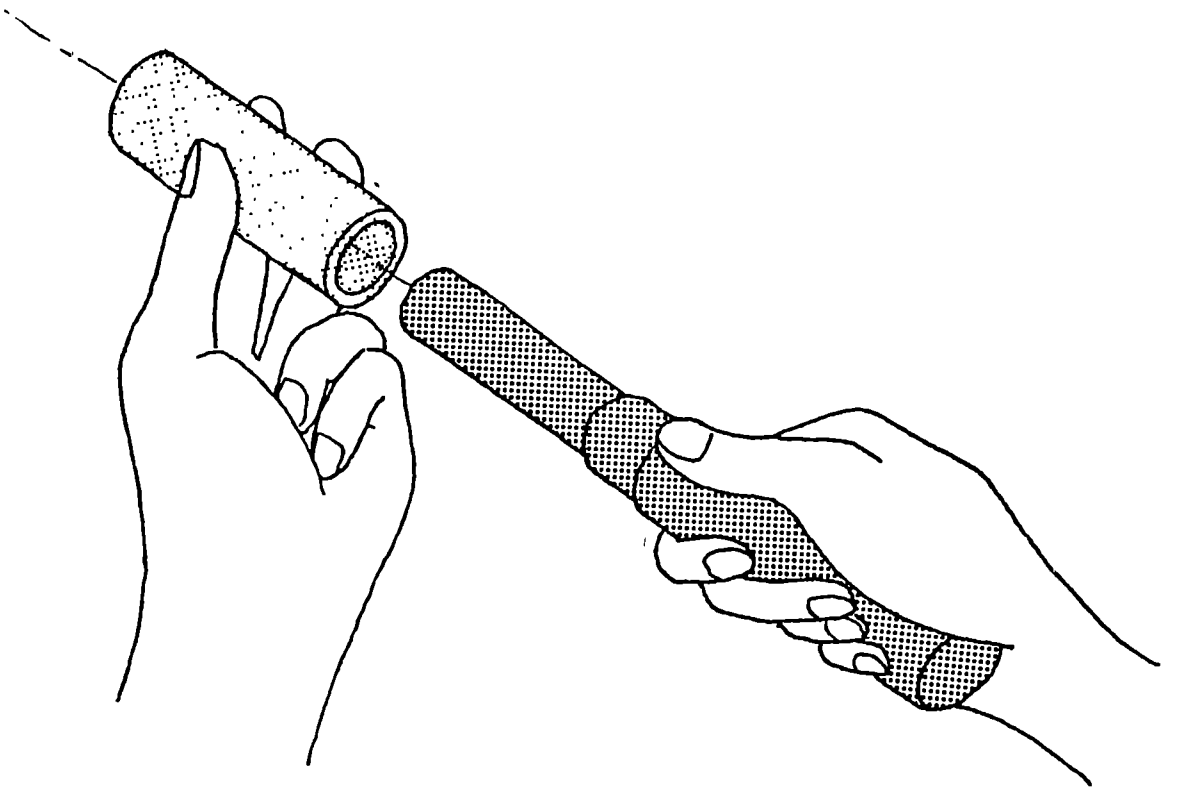
Inspection F-2
Busihgs, p. 13



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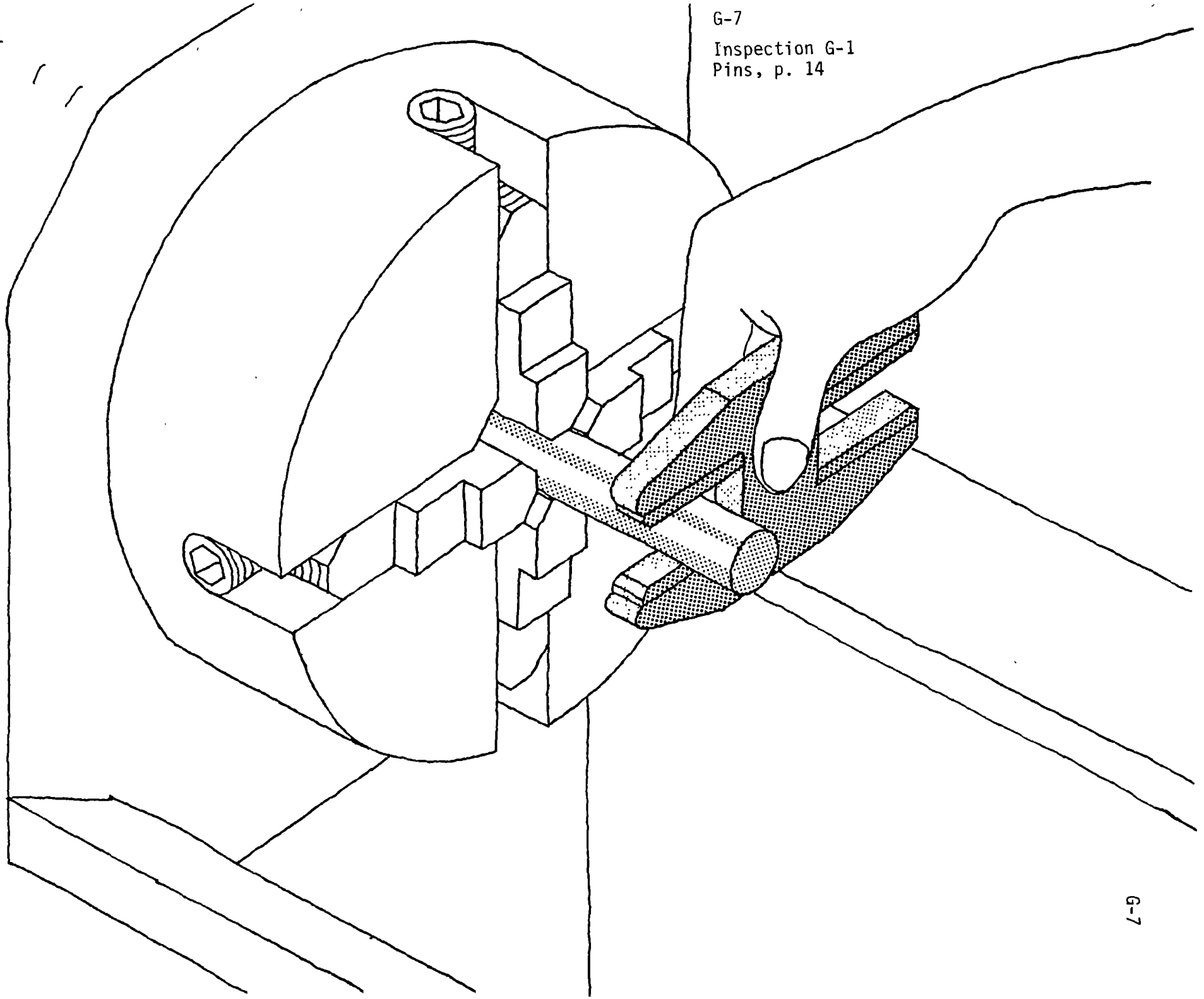
Inspection G-1
Pins, p. 14



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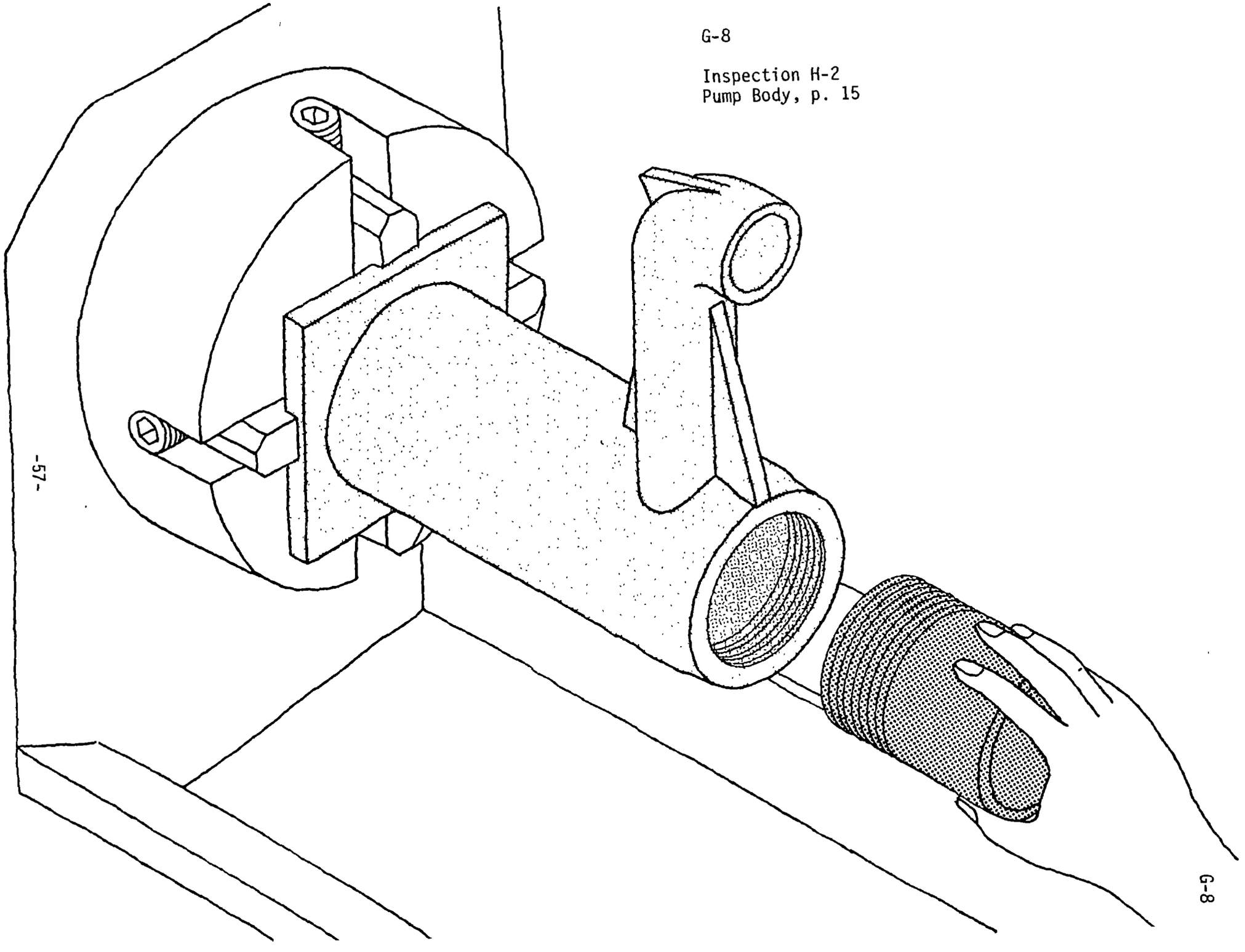
Inspection H-2
Pump Body, p. 15



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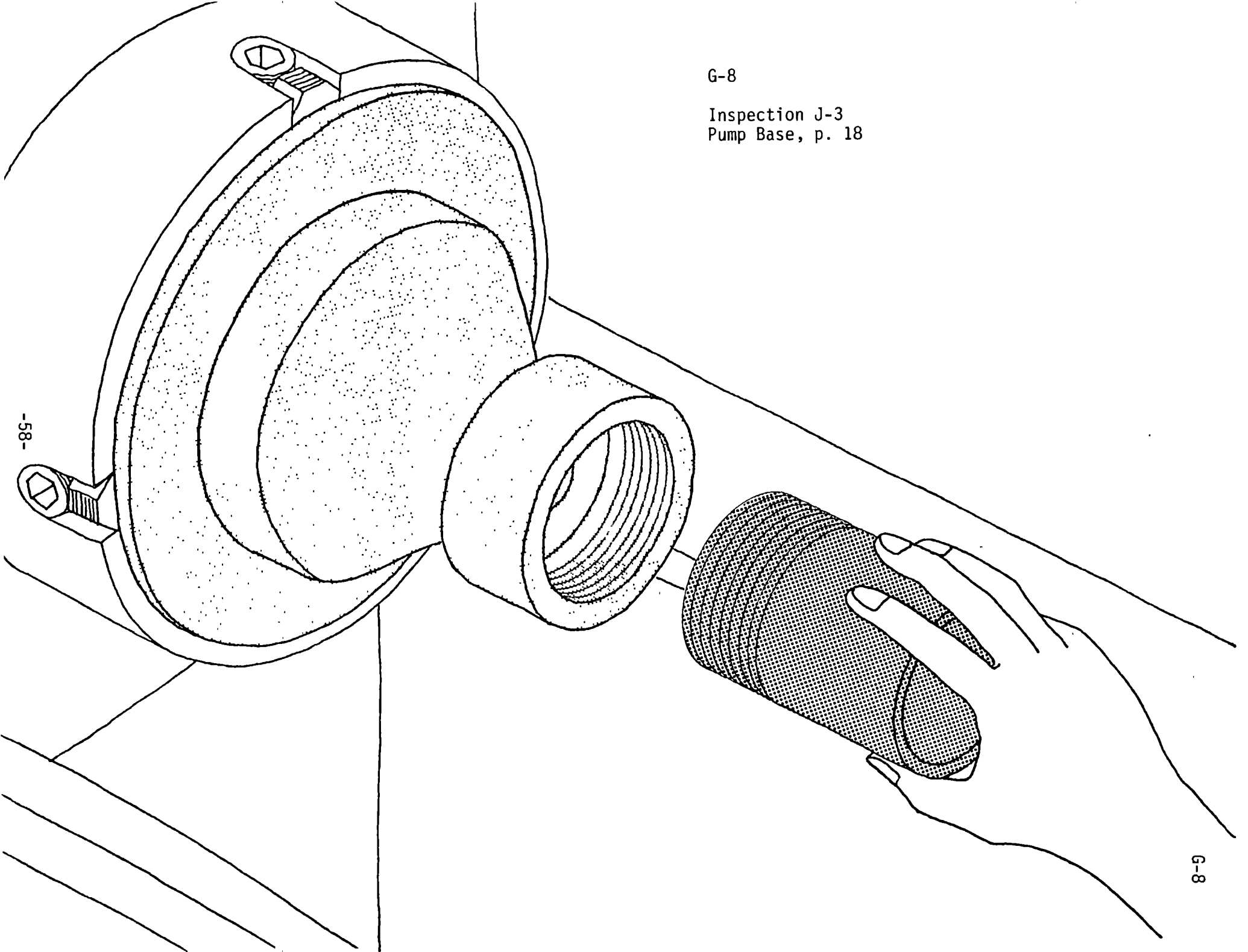
Inspection J-3
Pump Base, p. 18



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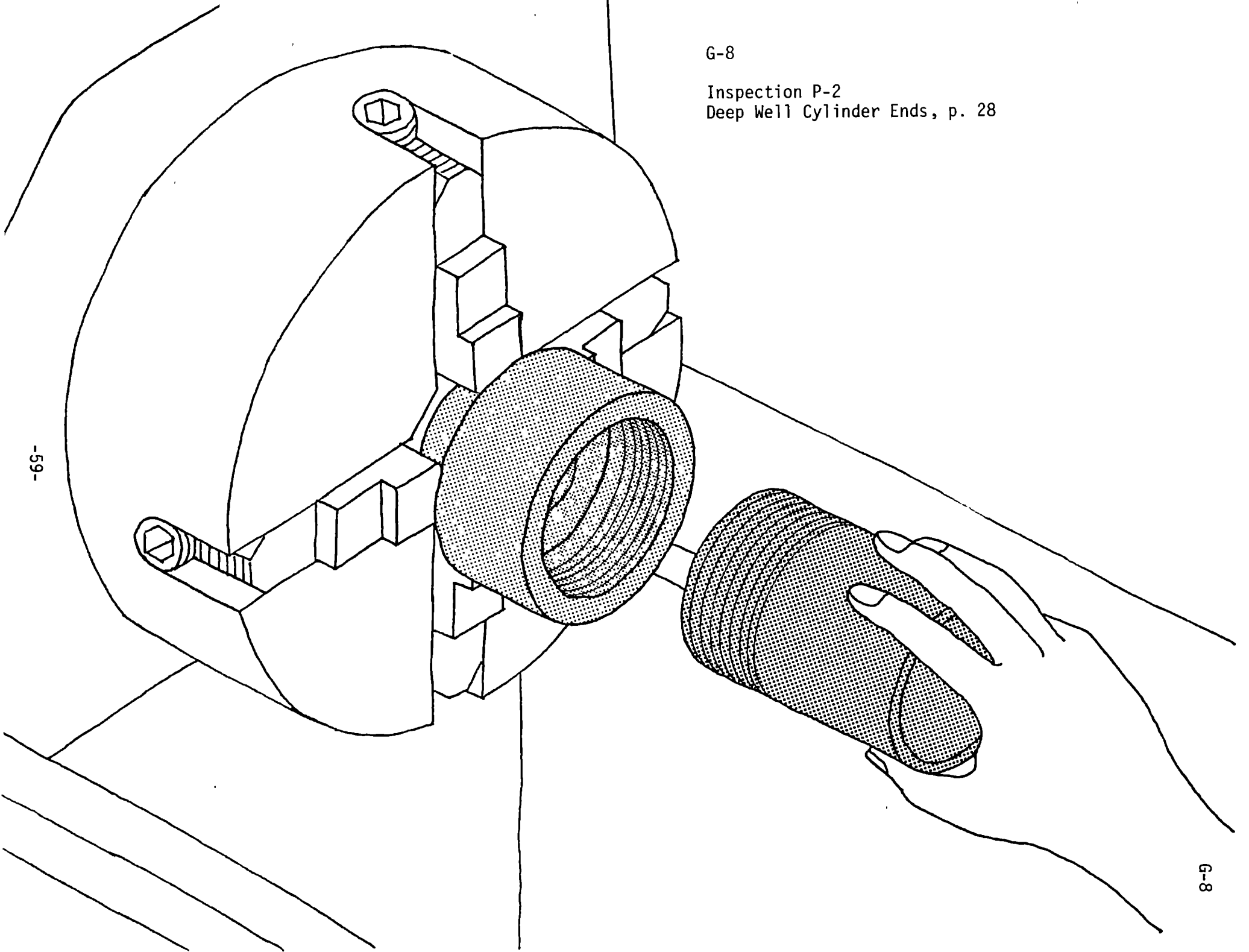
Inspection P-2
Deep Well Cylinder Ends, p. 28



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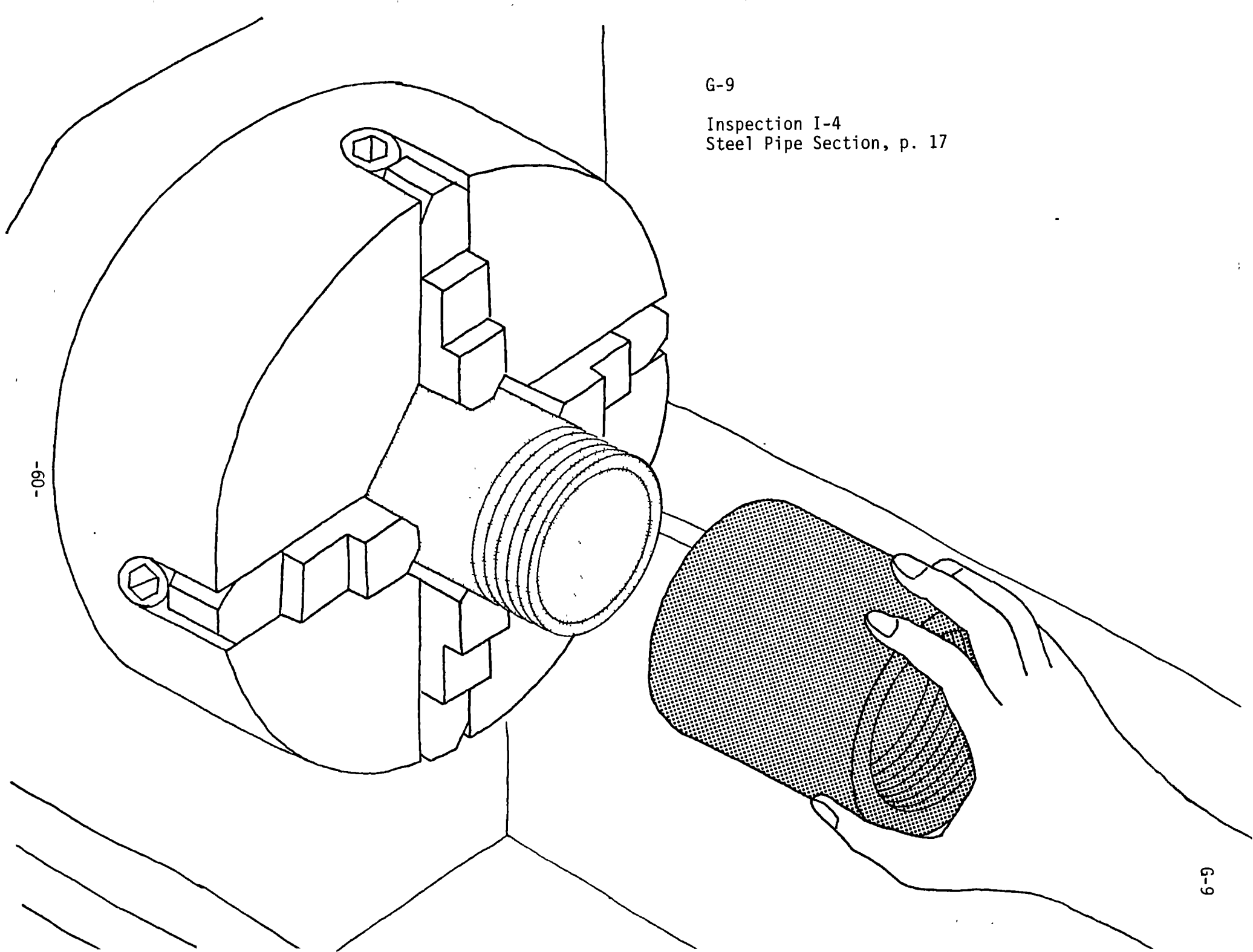
Inspection I-4
Steel Pipe Section, p. 17



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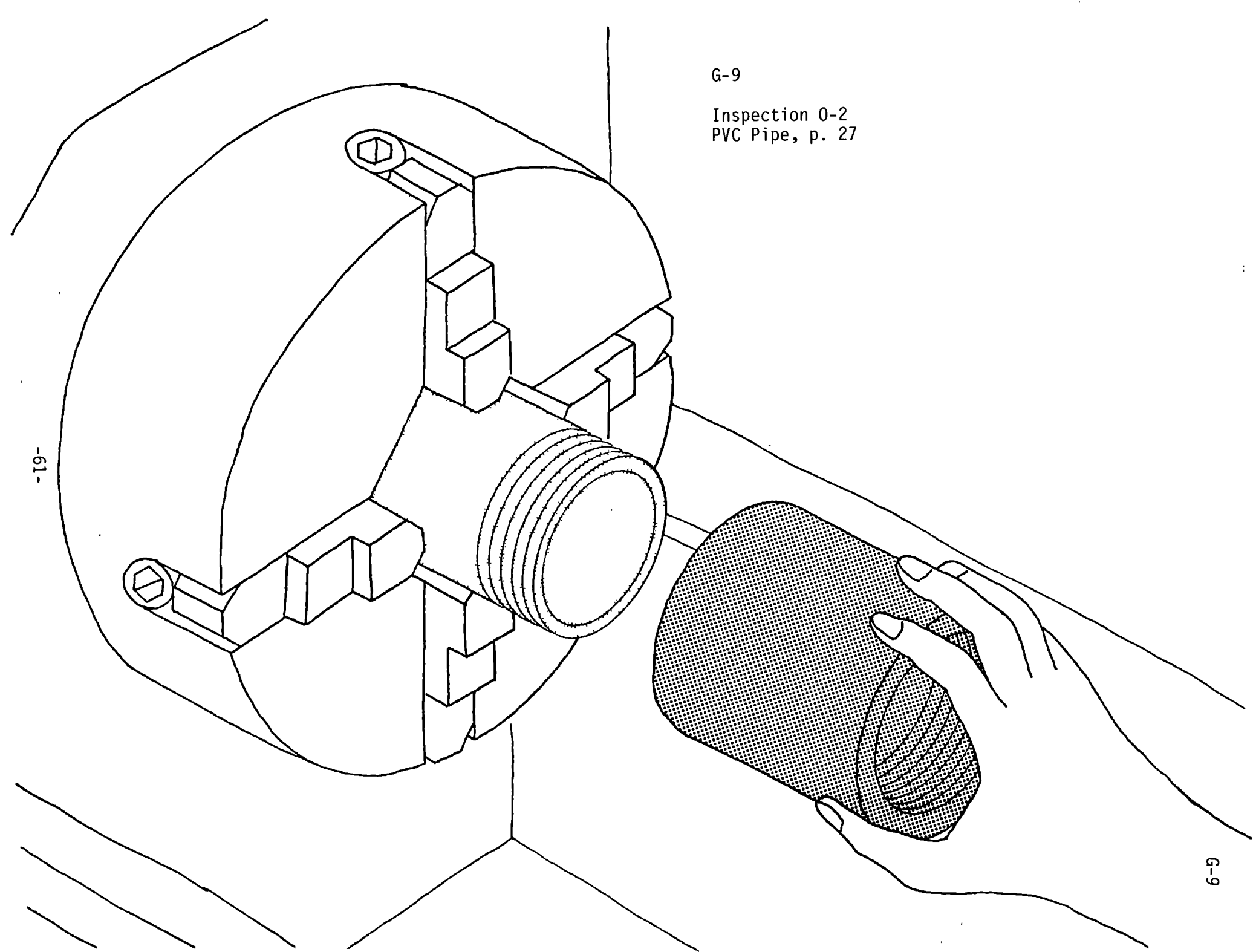
Inspection O-2
PVC Pipe, p. 27



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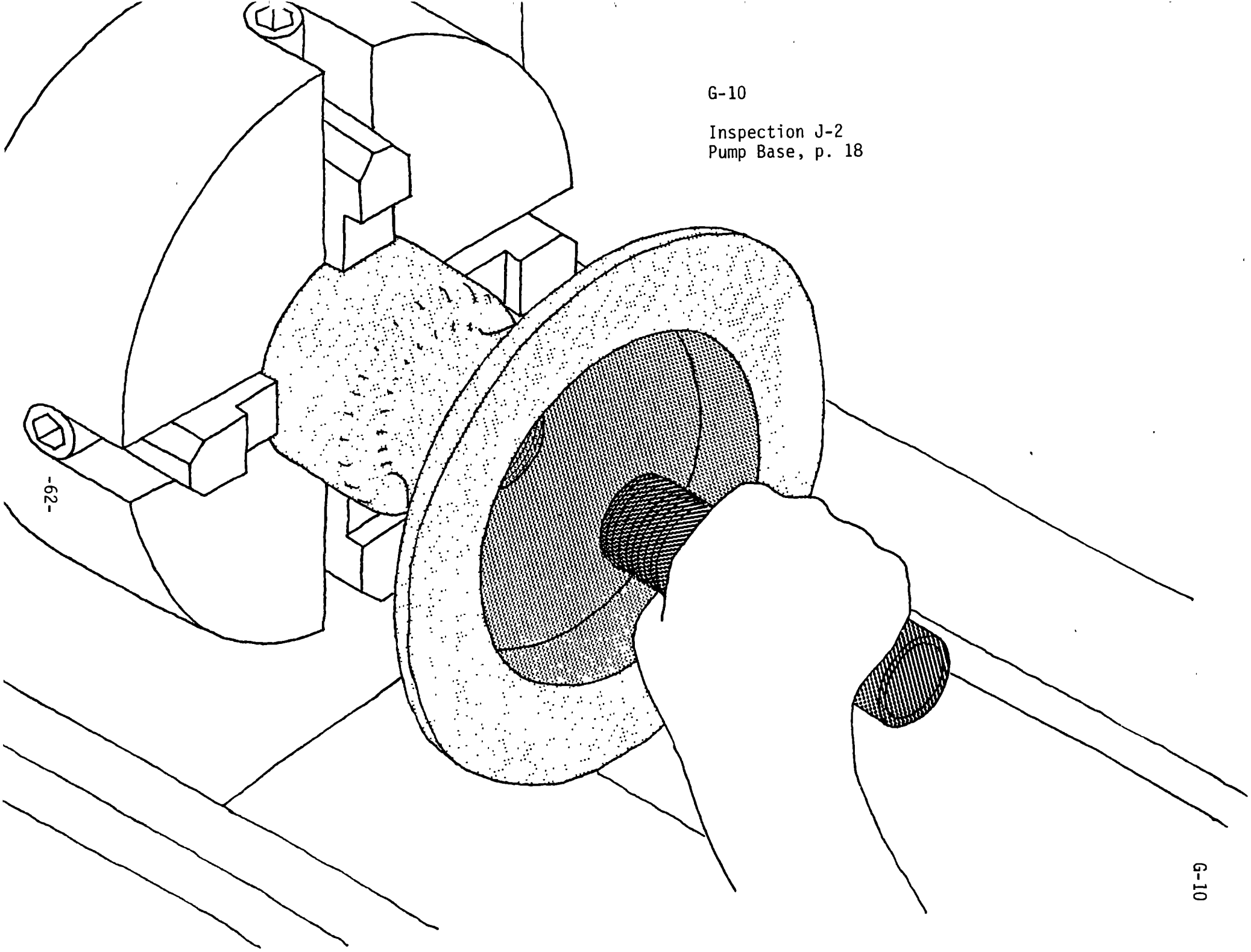
Inspection J-2
Pump Base, p. 18



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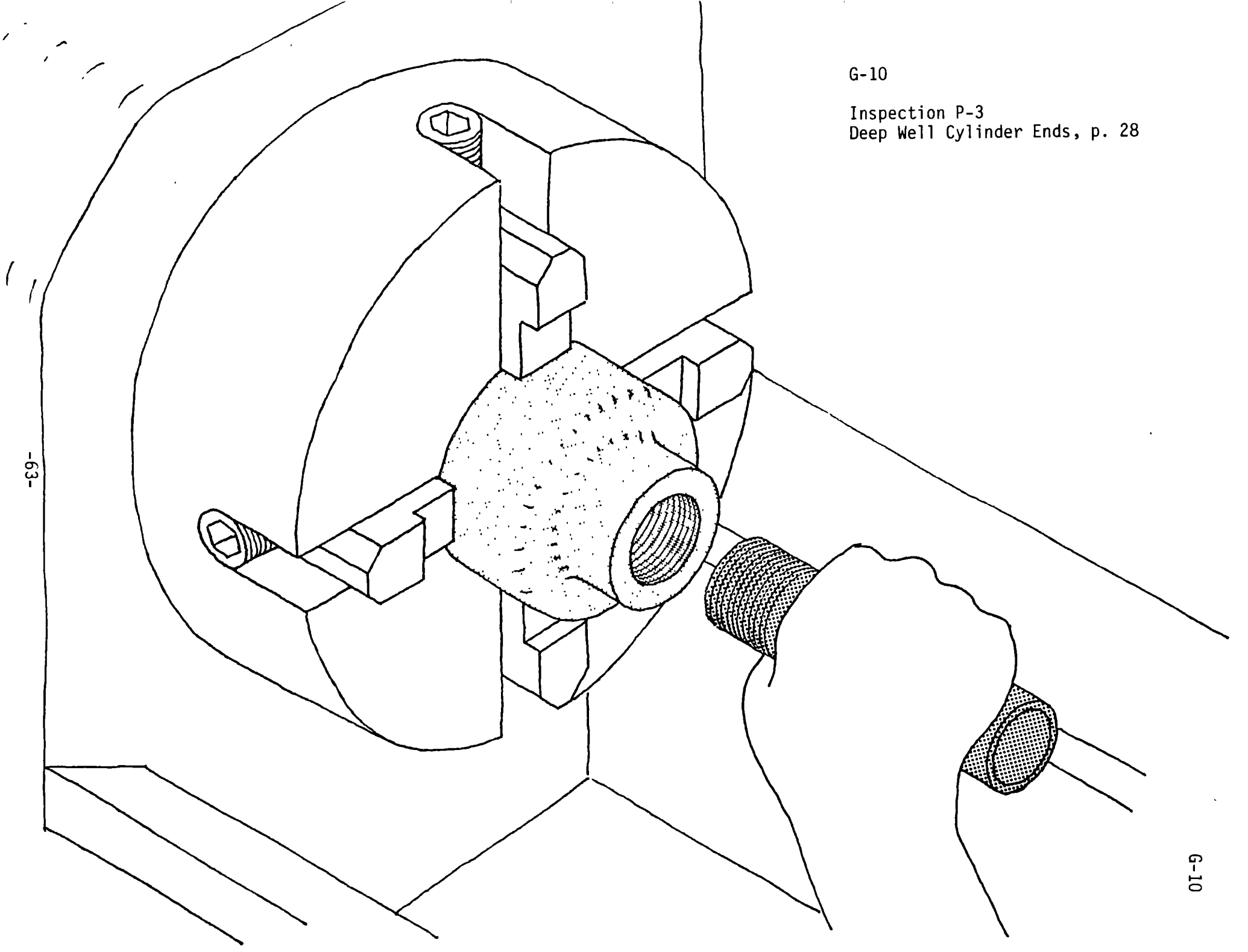
Inspection P-3
Deep Well Cylinder Ends, p. 28



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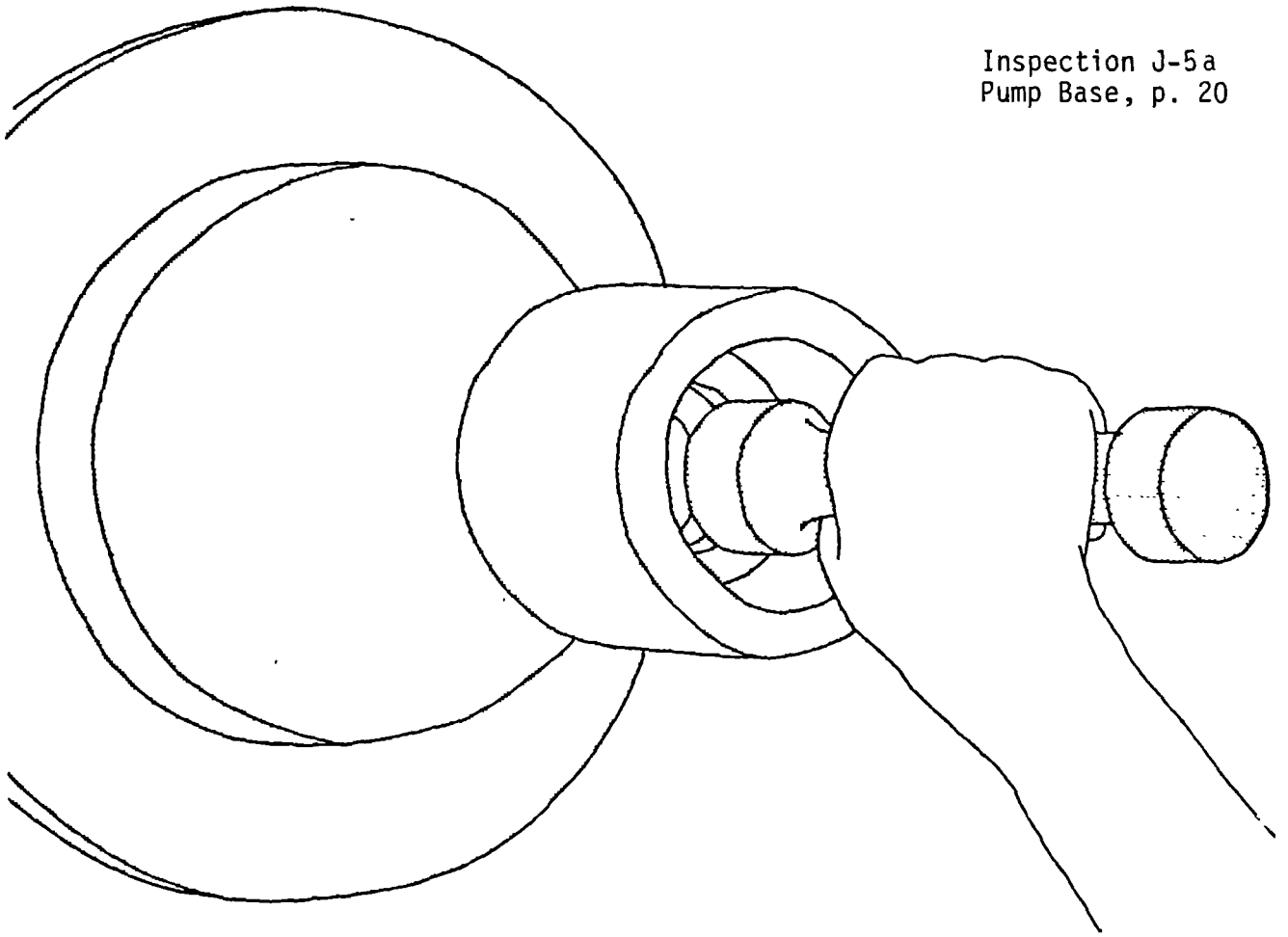
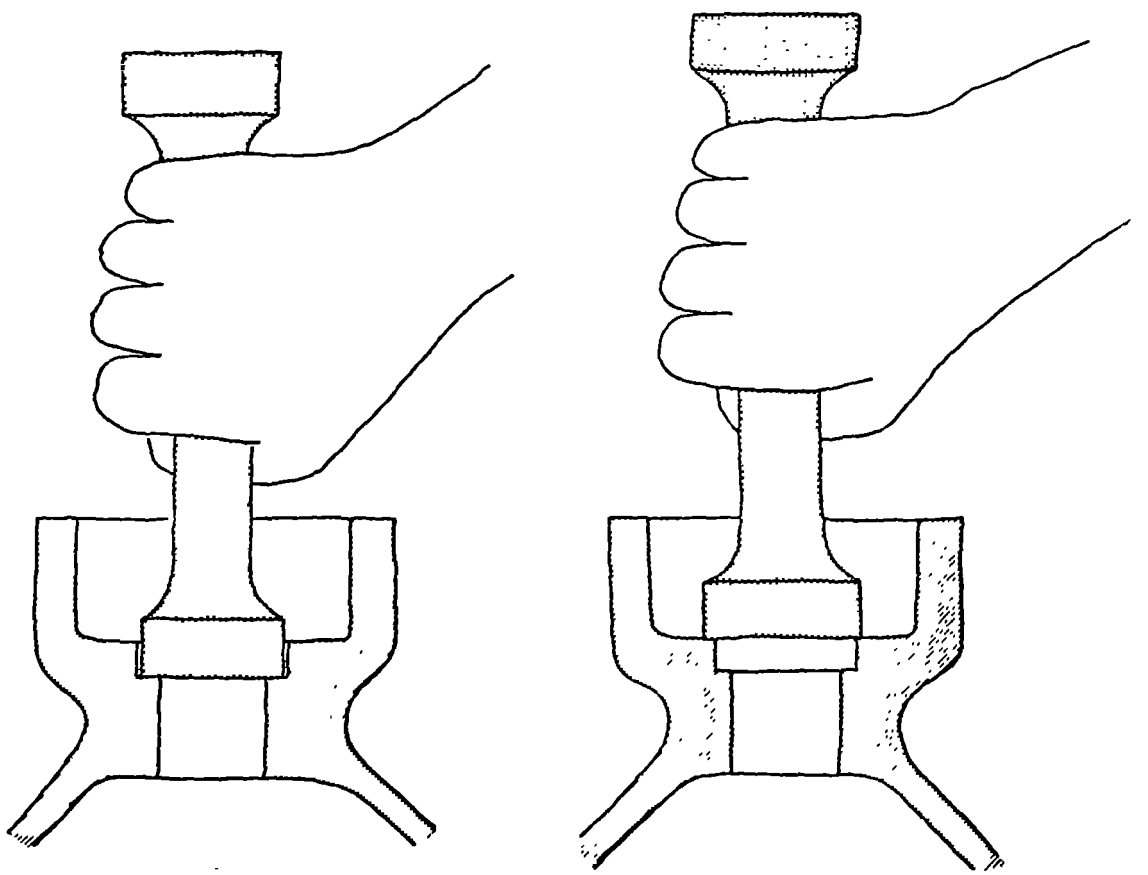
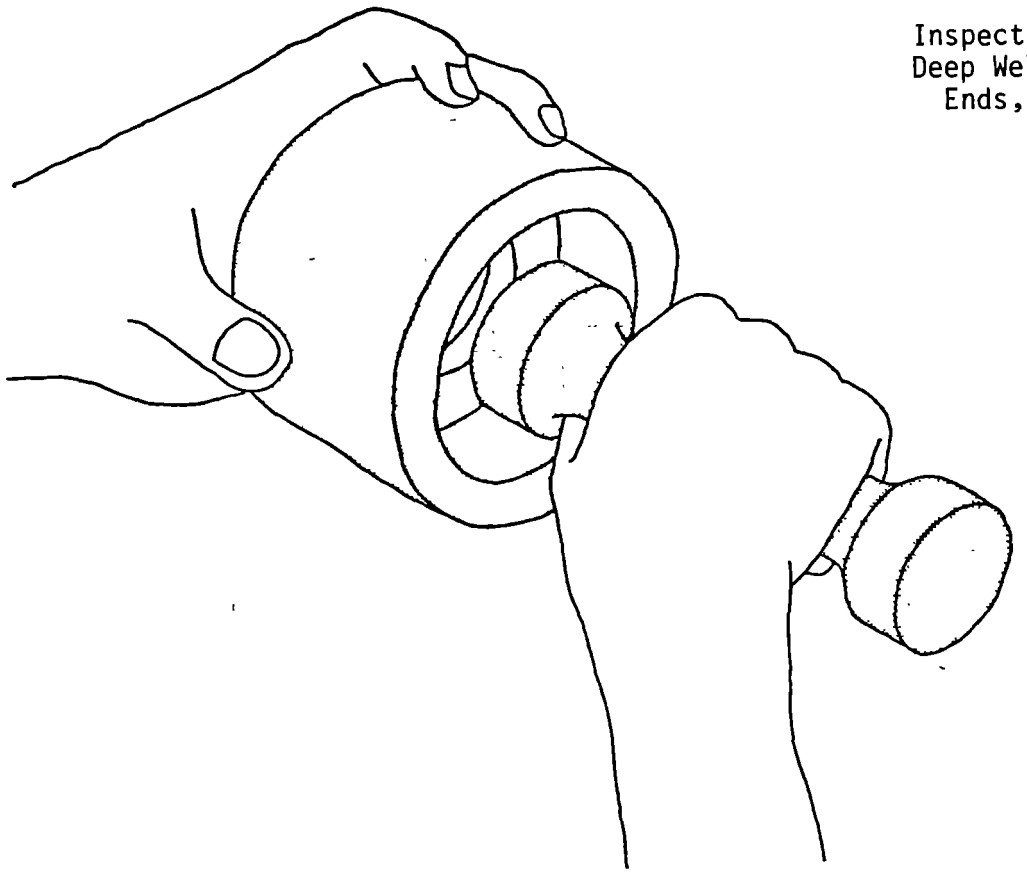
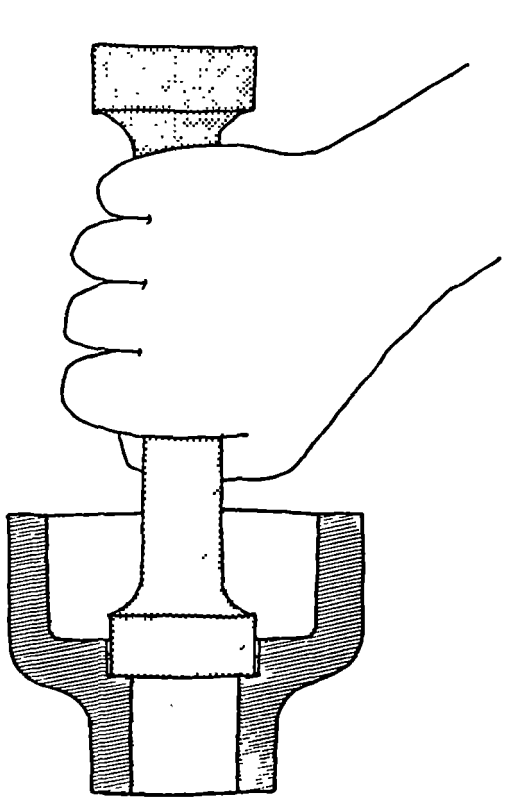
Inspection J-5a
Pump Base, p. 20

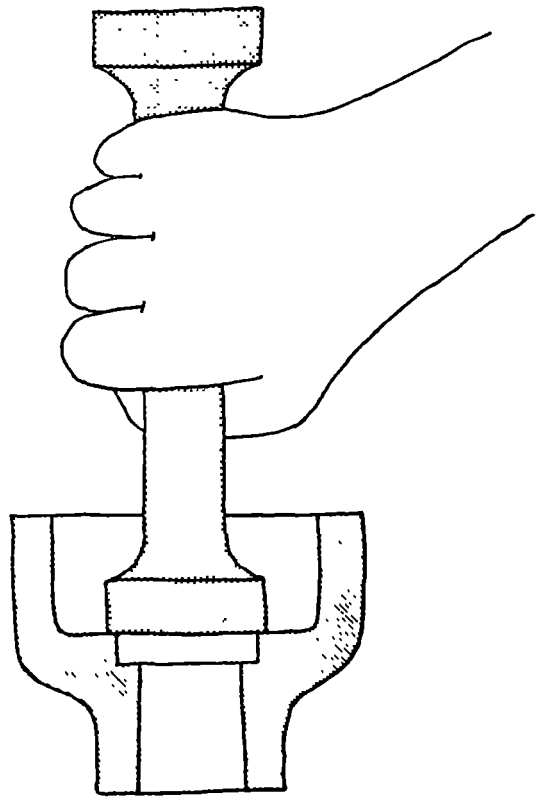




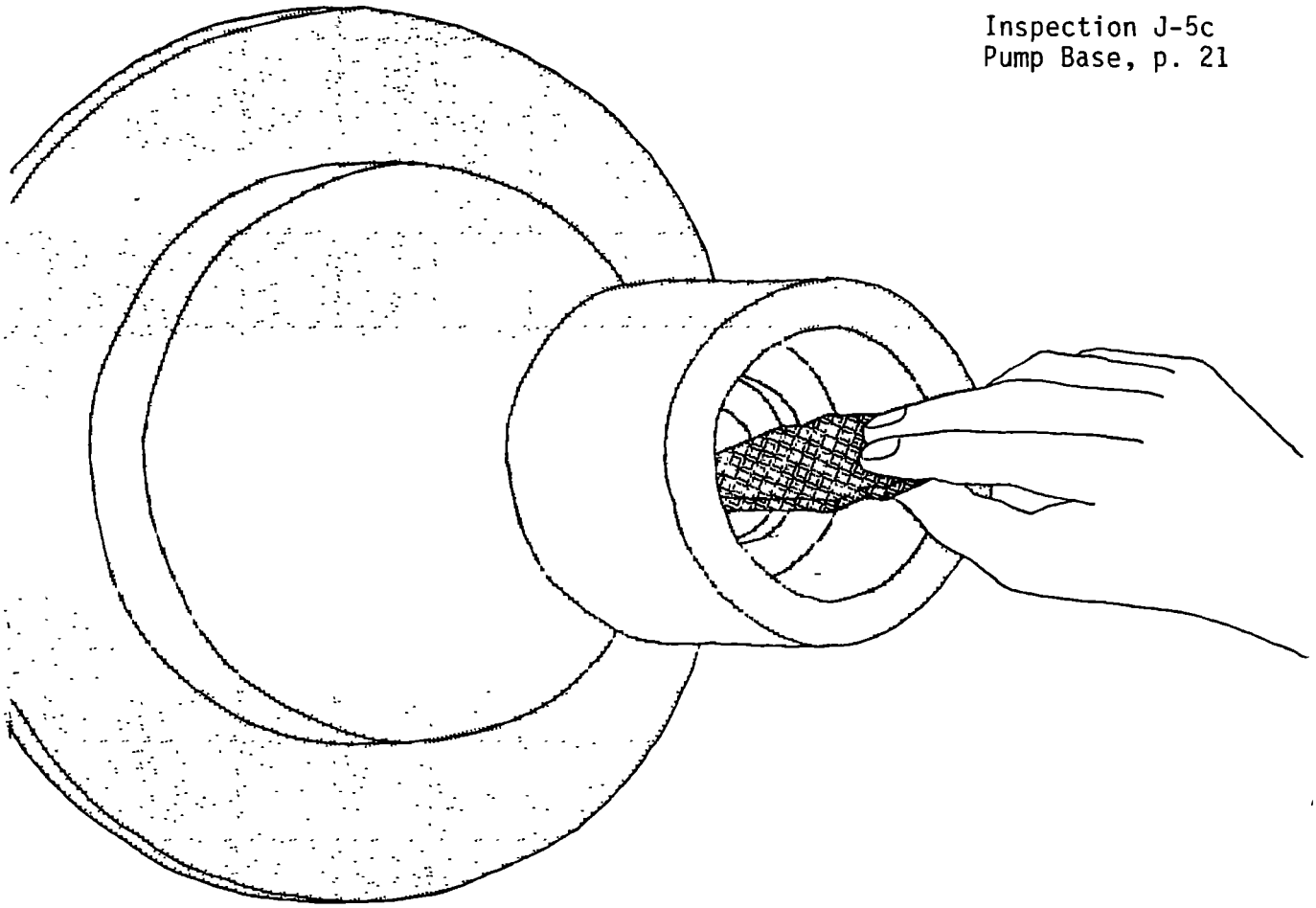
Inspection P-4a
Deep Well Cylinder
Ends, p. 29

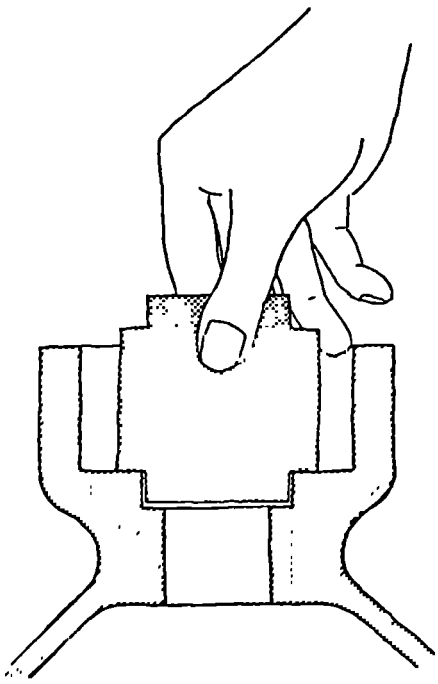


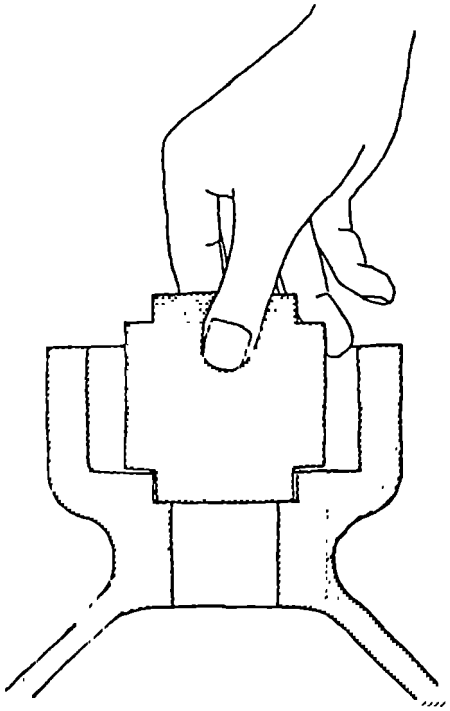




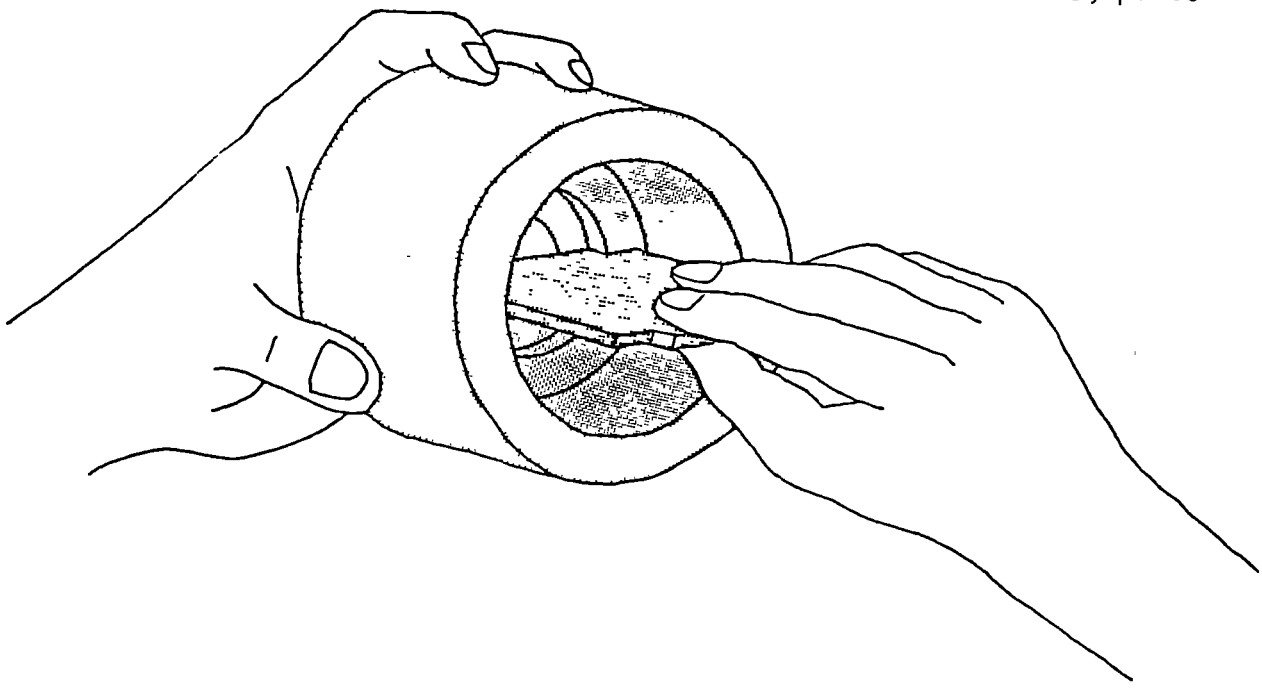
Inspection J-5c
Pump Base, p. 21

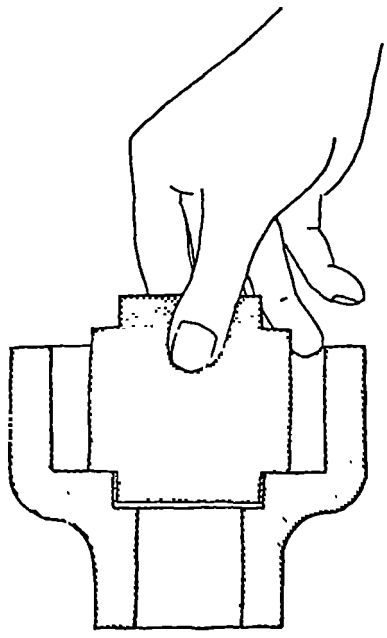


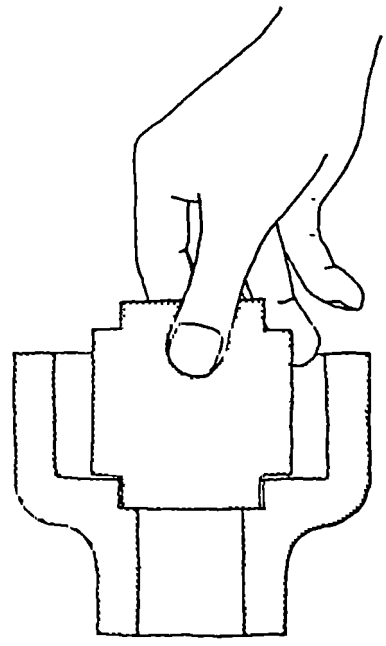




Inspection P-4c
Deep Well Cylinder
Ends, p. 30







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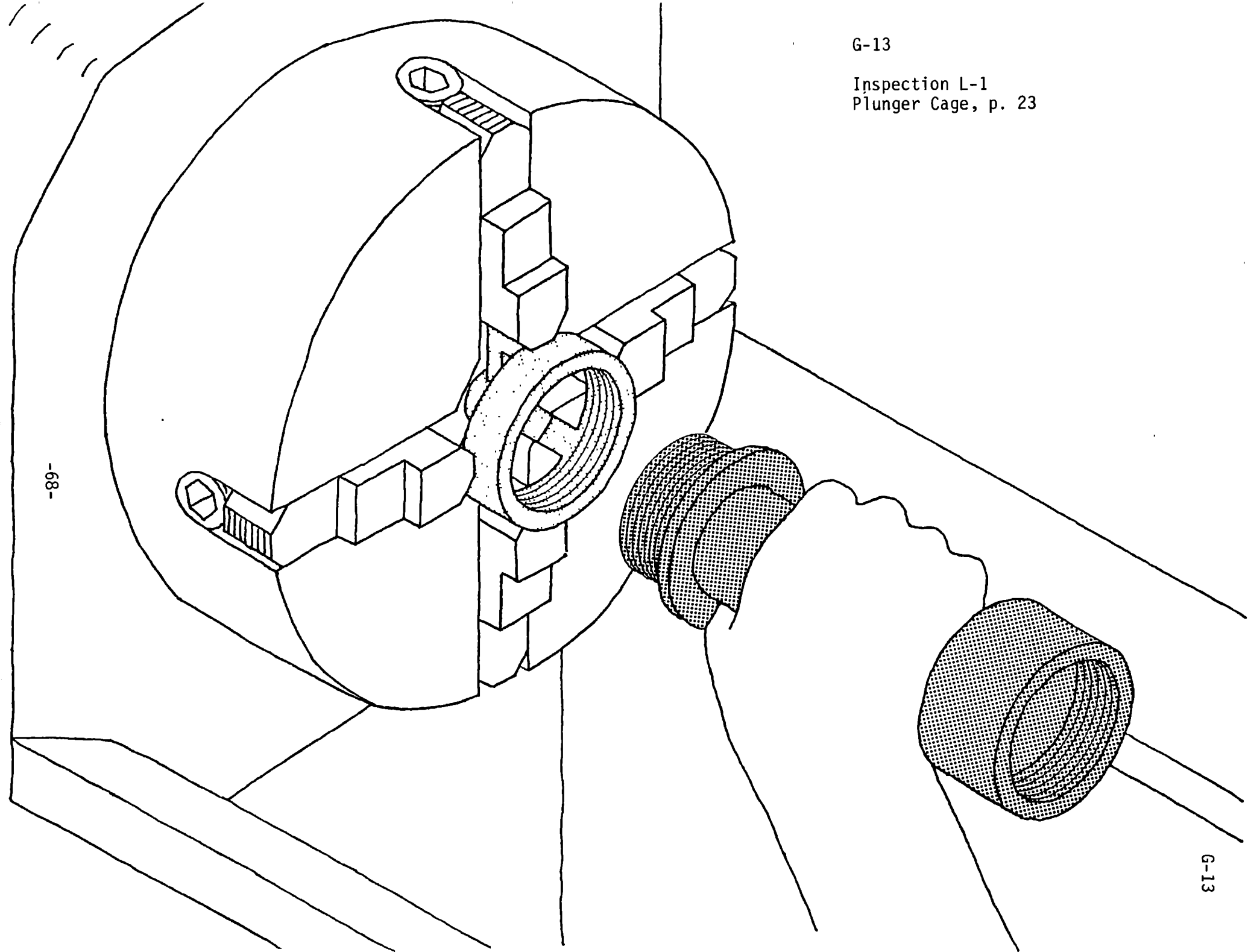
Inspection L-1
Plunger Cage, p. 23



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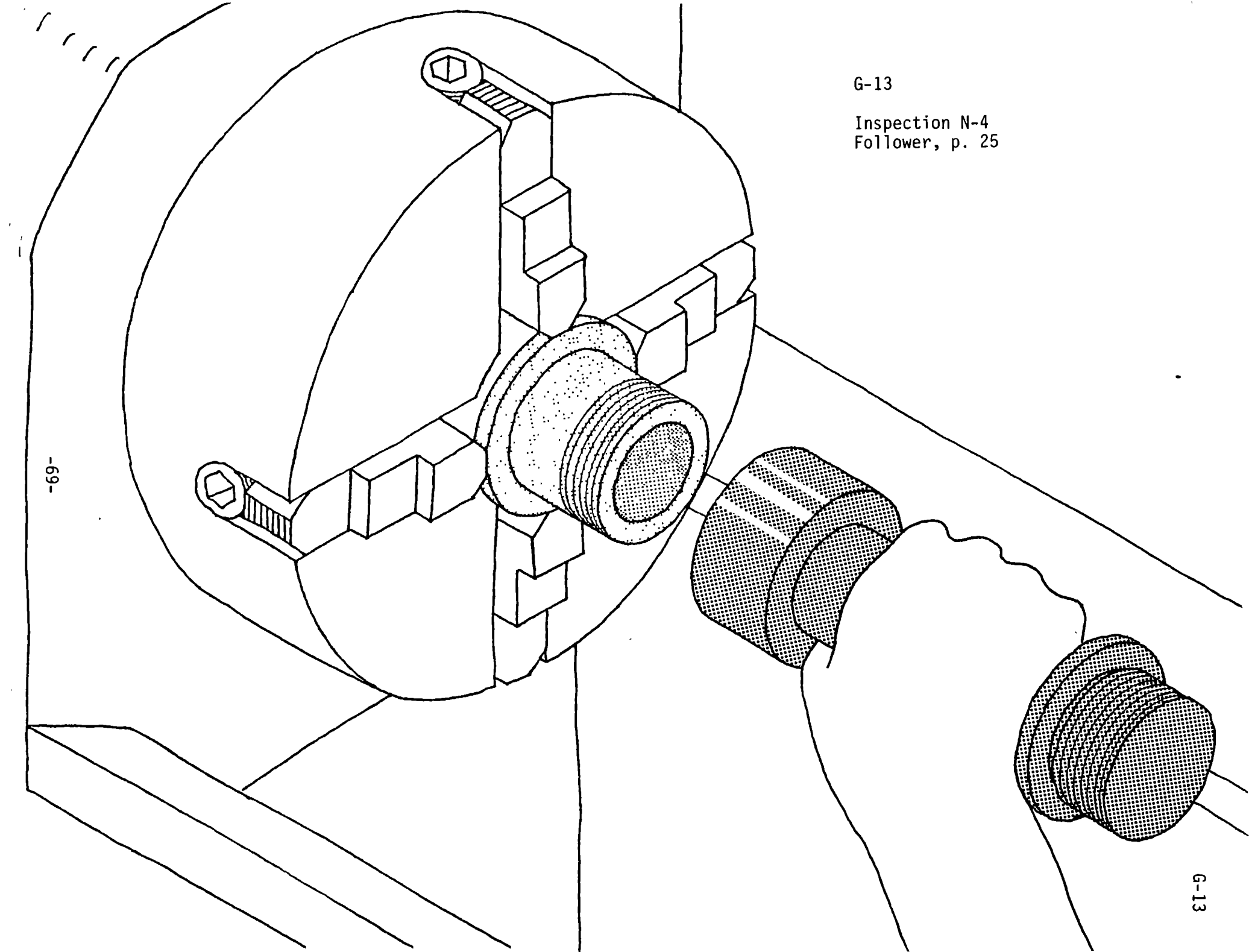
Inspection N-4
Follower, p. 25



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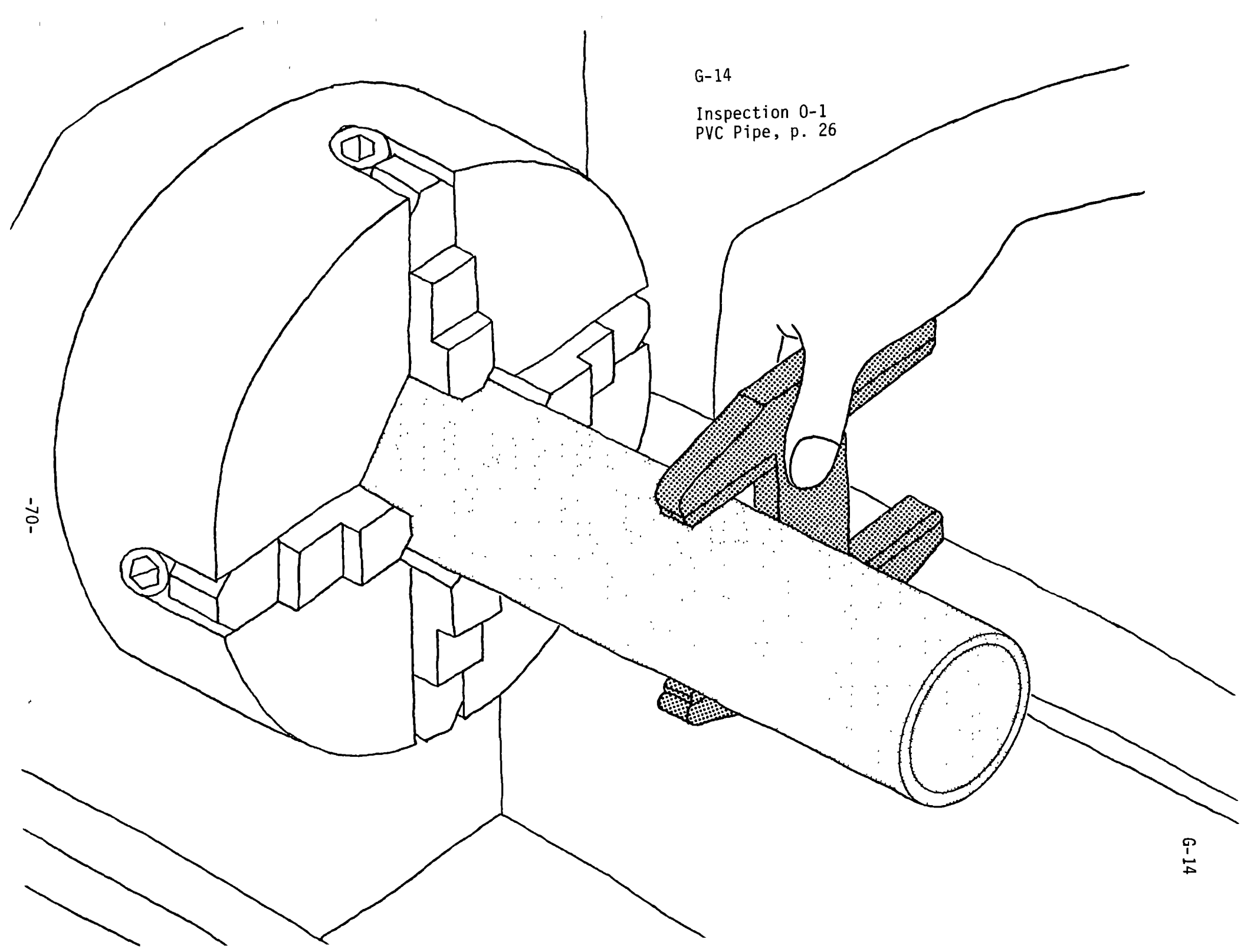
Inspection O-1
PVC Pipe, p. 26



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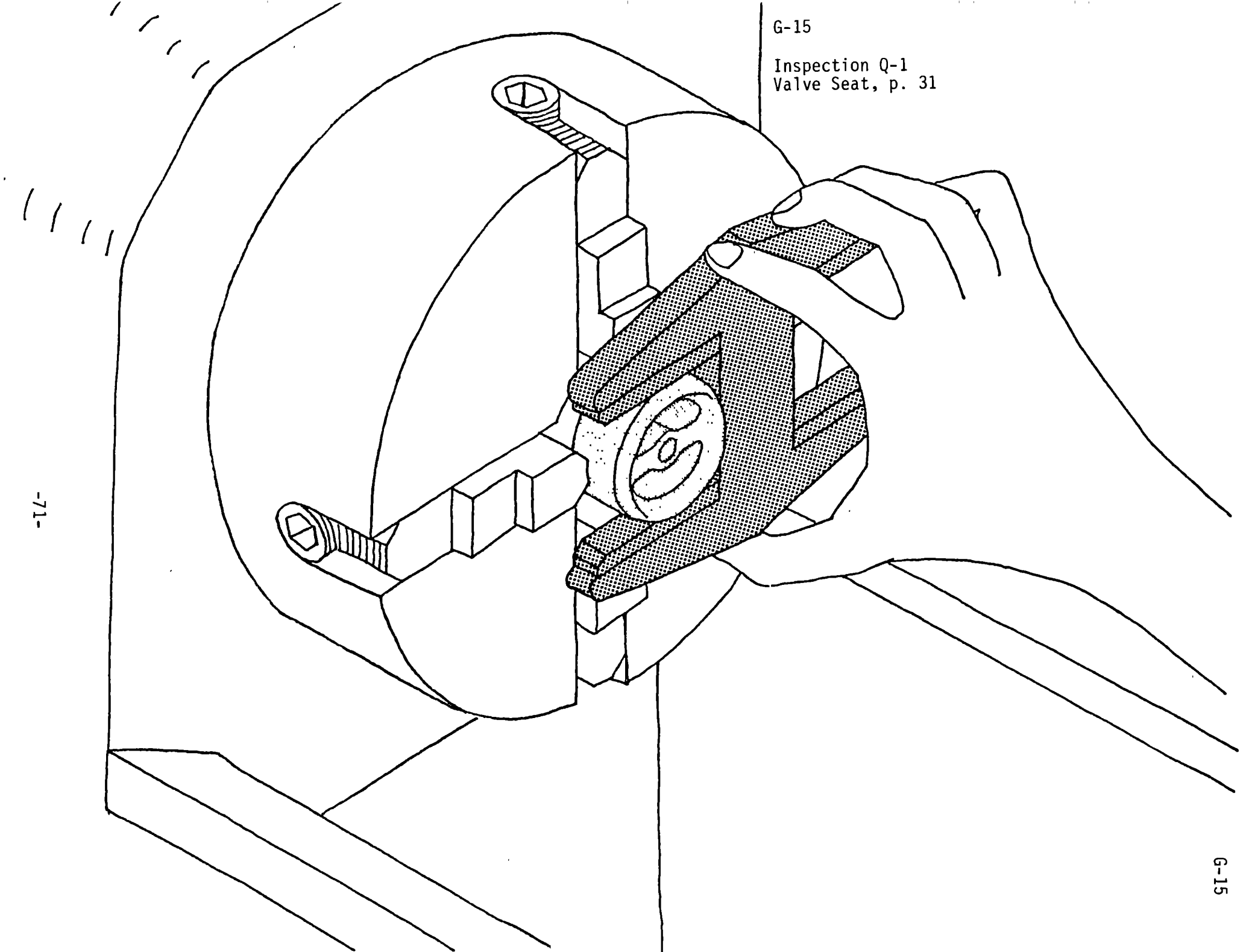
Inspection Q-1
Valve Seat, p. 31



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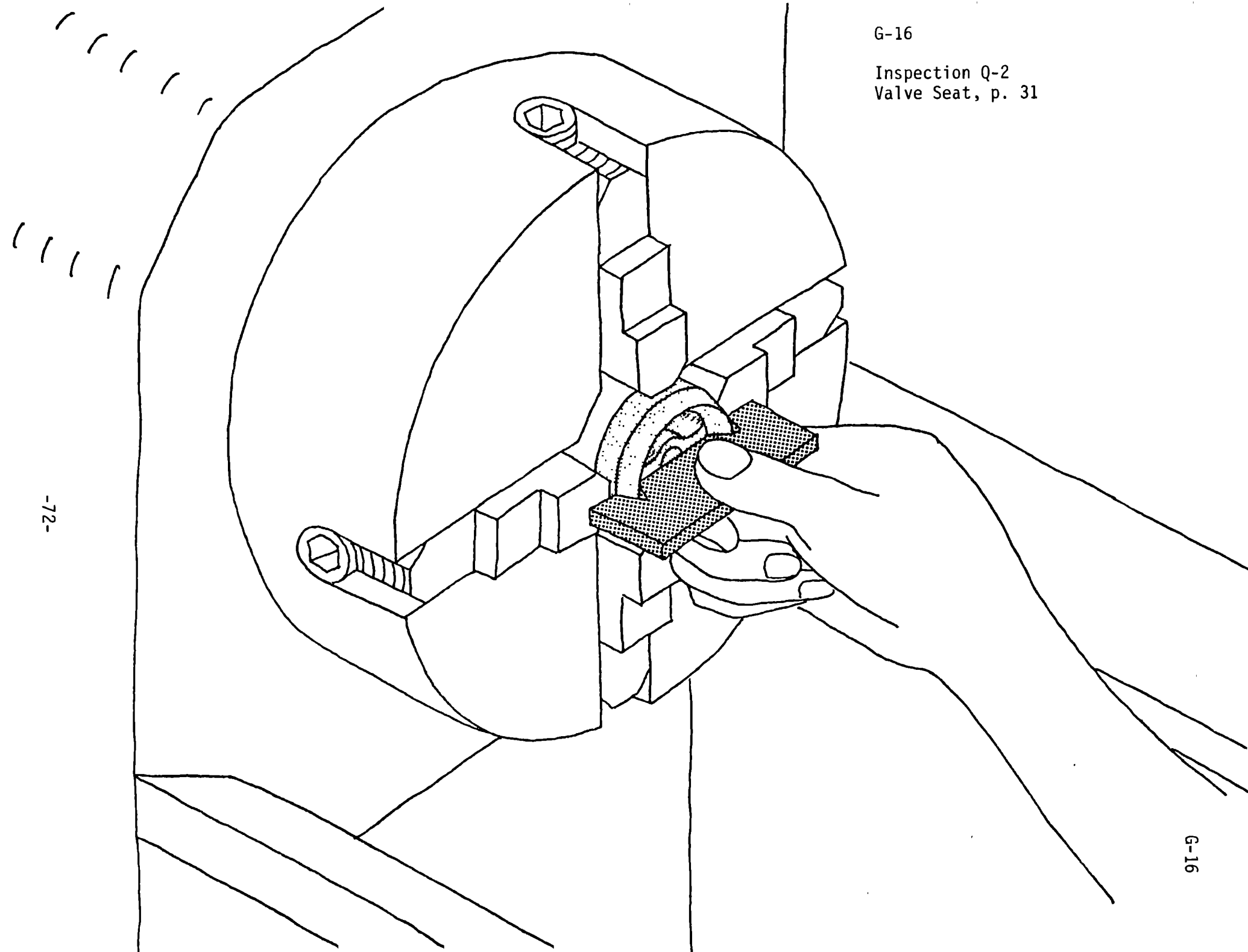
Inspection Q-2
Valve Seat, p. 31



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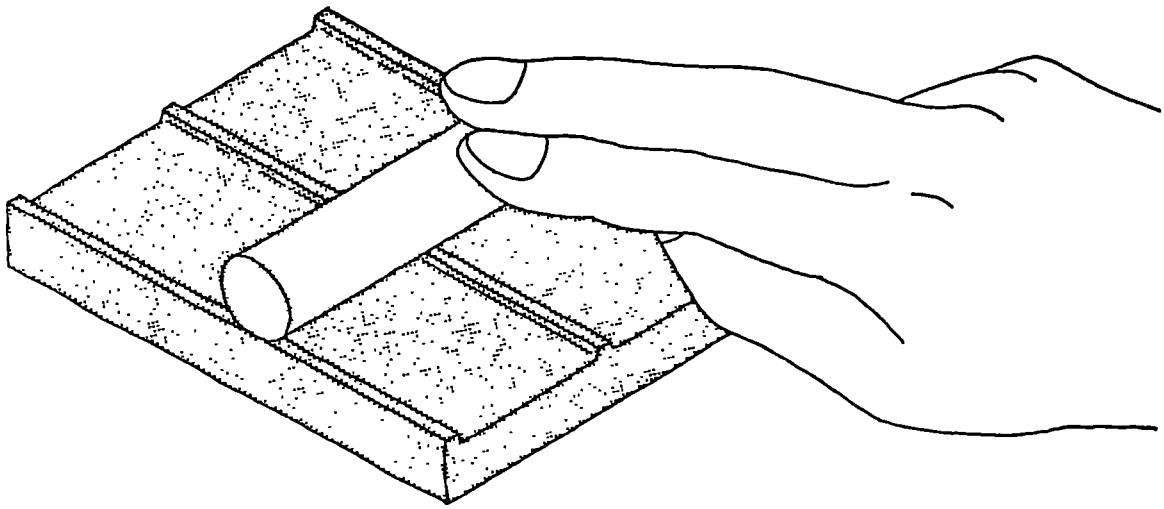
Heat Treating
Inspection A-2b
Pins, p. 32



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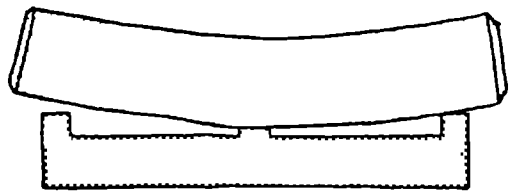

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