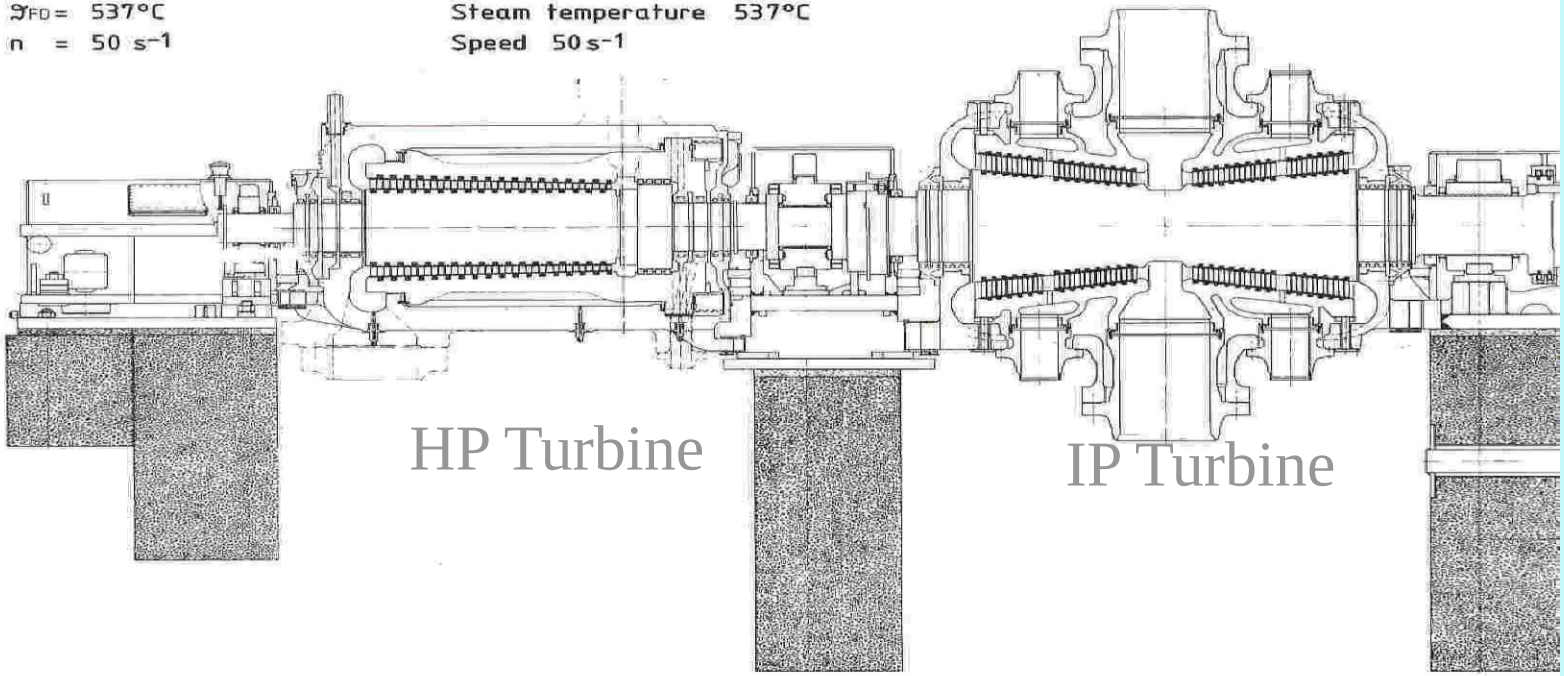
TURBINE ERECTION

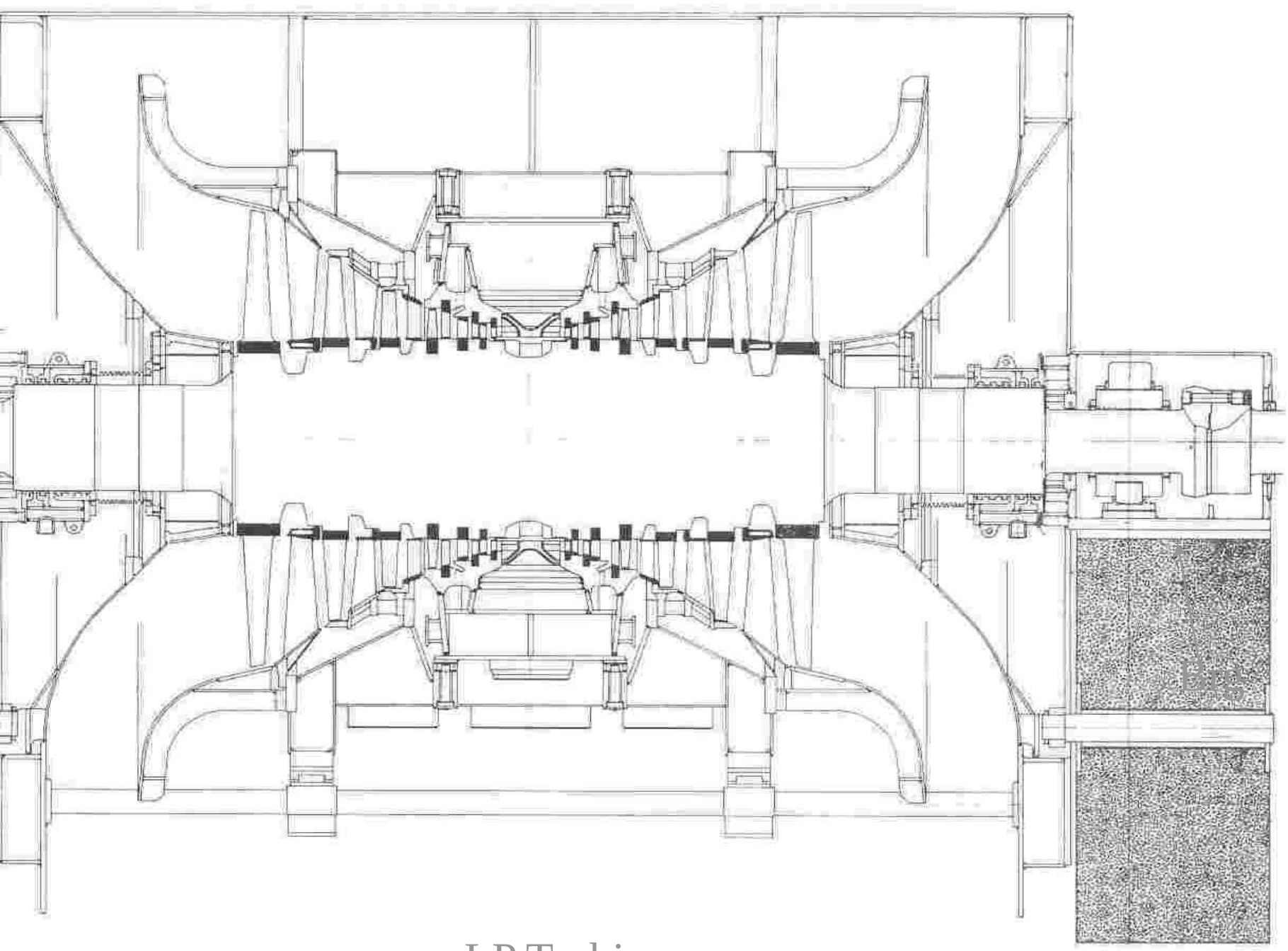
Kond.–Turbine

P = 500 MW
P_{FD} = 170 ata
ϑ_{FD} = 537°C
n = 50 s^{-1}

Cond.–Turbine

Rated capacity 500 MW
Steam pressure 170 ata
Steam temperature 537°C
Speed 50 s^{-1}





LP Turbine

Salient Features Of Turbine Erection

- The fore most activity before taking up the work is the safe working conditions. Thus we should first assemble temporary railing and covers before the start of the job
- Remove construction material & sweep the foundation well. A proper foundation is of utmost importance for proper operation of the machine. A hammer test is to be carried to detect any flaw / void in the concrete layer. An ultrasonic testing of the TG deck should also be carried out if possible. No looseness below the base plates is acceptable

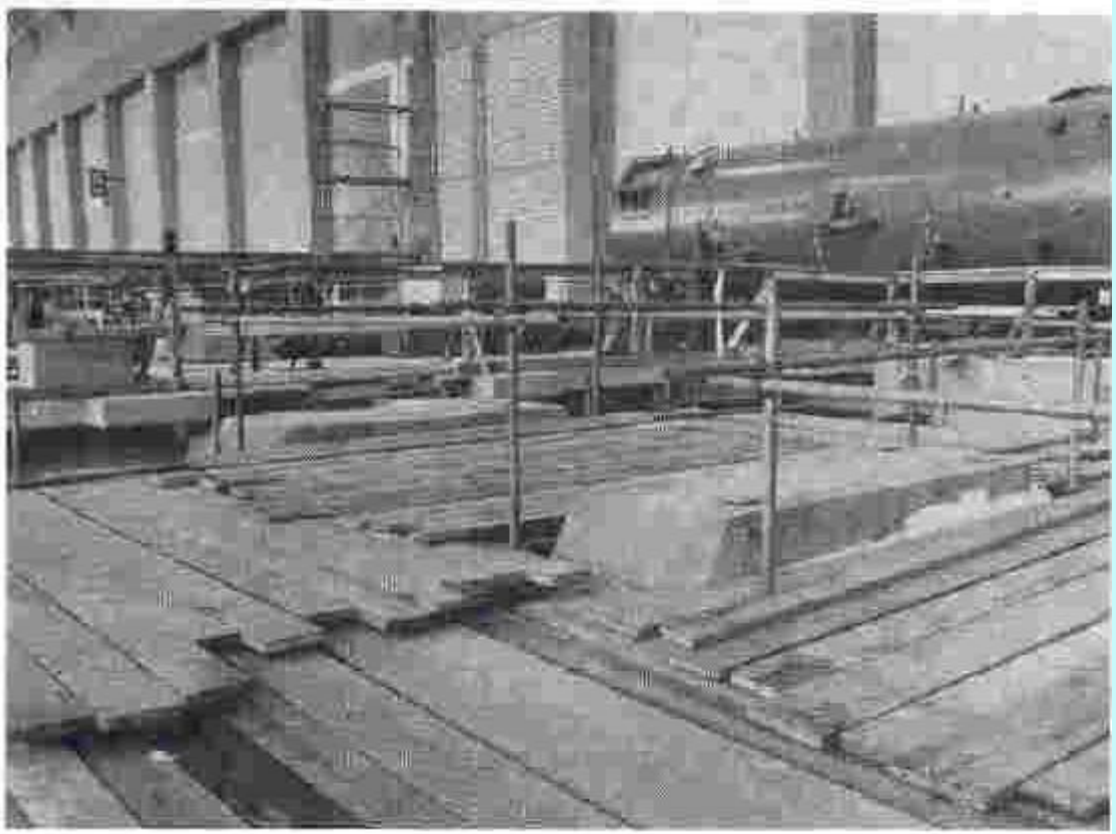


Fig. 1 Foundation Covering and Railings

Salient Features Of Turbine Erection (Contd.)

- **FOUNDATION CHECK**: check accuracy of size, elevation & axiality of foundation for conformance the erection drawing
- Check all contact surfaces & openings for turbine, generator etc., Holes for anchor bolts. Record final dimensions & make a protocol
- Check, mark & record main reference point (absolute floor level) for height against building wall or foundation pillar

Fig. 3 Foundation for a Turbine Generator Unit

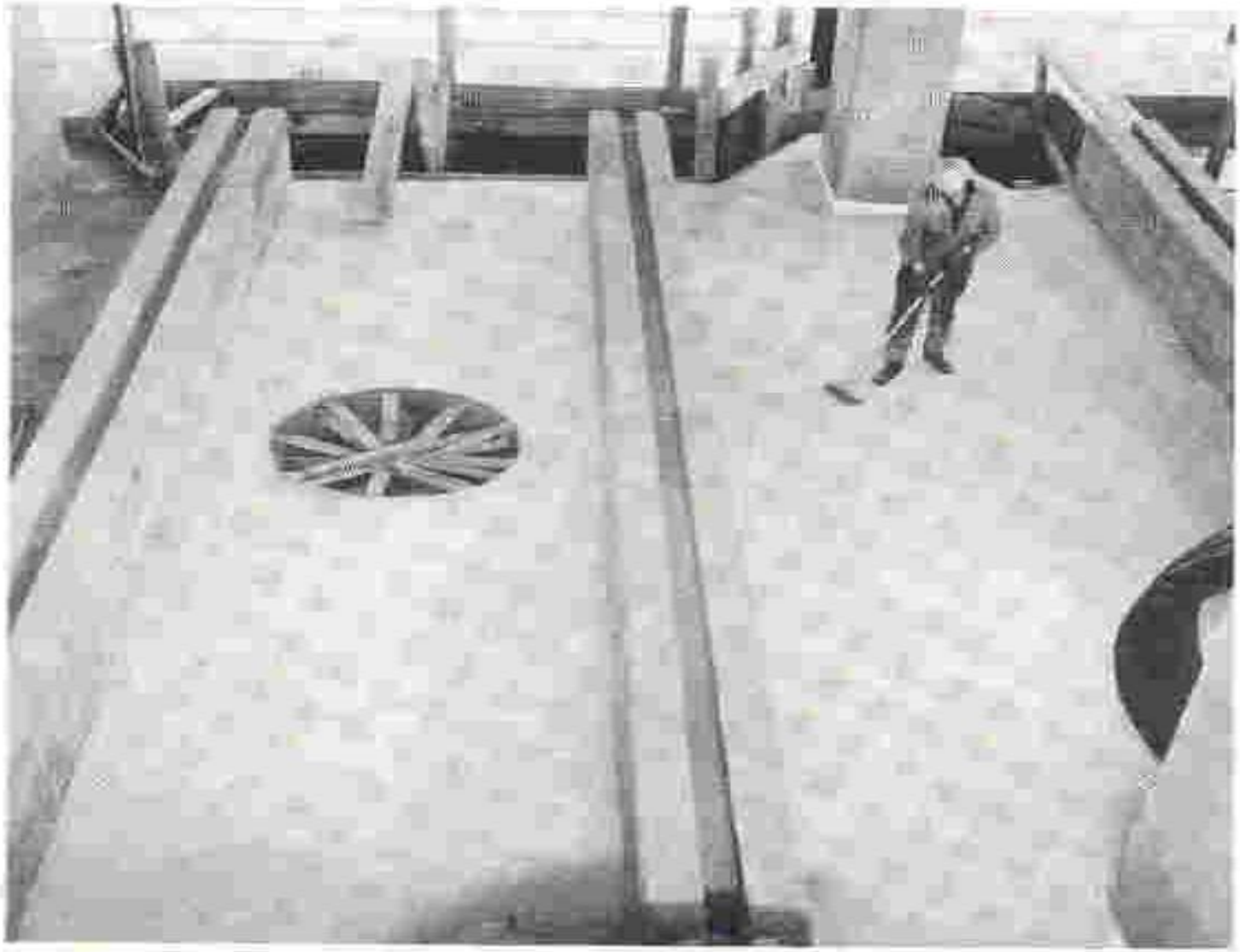


Fig. 2 Safeguarding and Cleaning the Condenser Foundation

Fig. 4 Foundation Beams

Salient Features Of Turbine Erection (Contd.)

- **BASE PLATES & BEARING PEDESTALS** :

LAYING The base plates are designed to transfer uniformly all forces & vibrations caused by the operation of the machine.The pedestal are aligned as the deflection curve of the rotor. The base plates are leveled with help leveling screws provided below the base plate

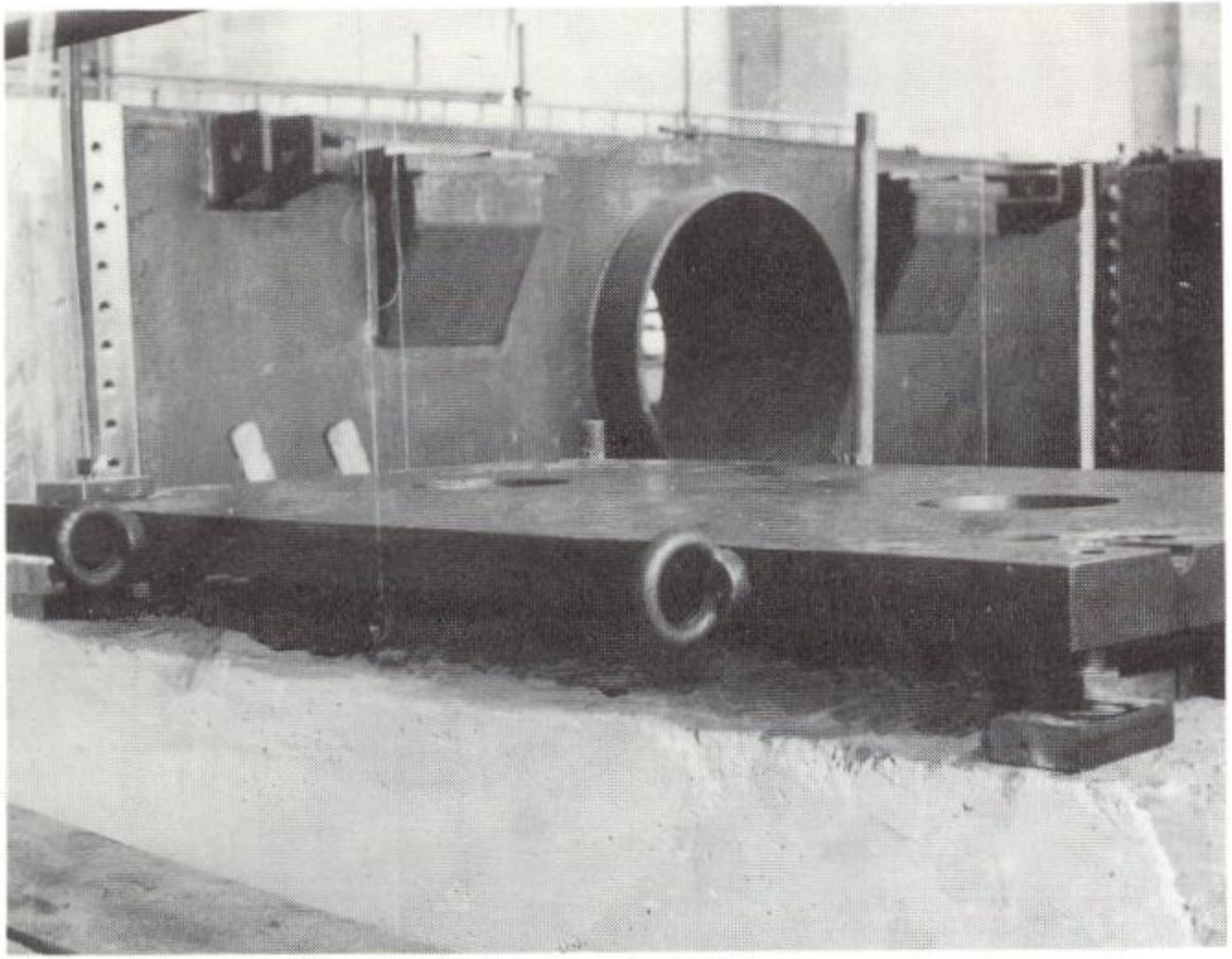
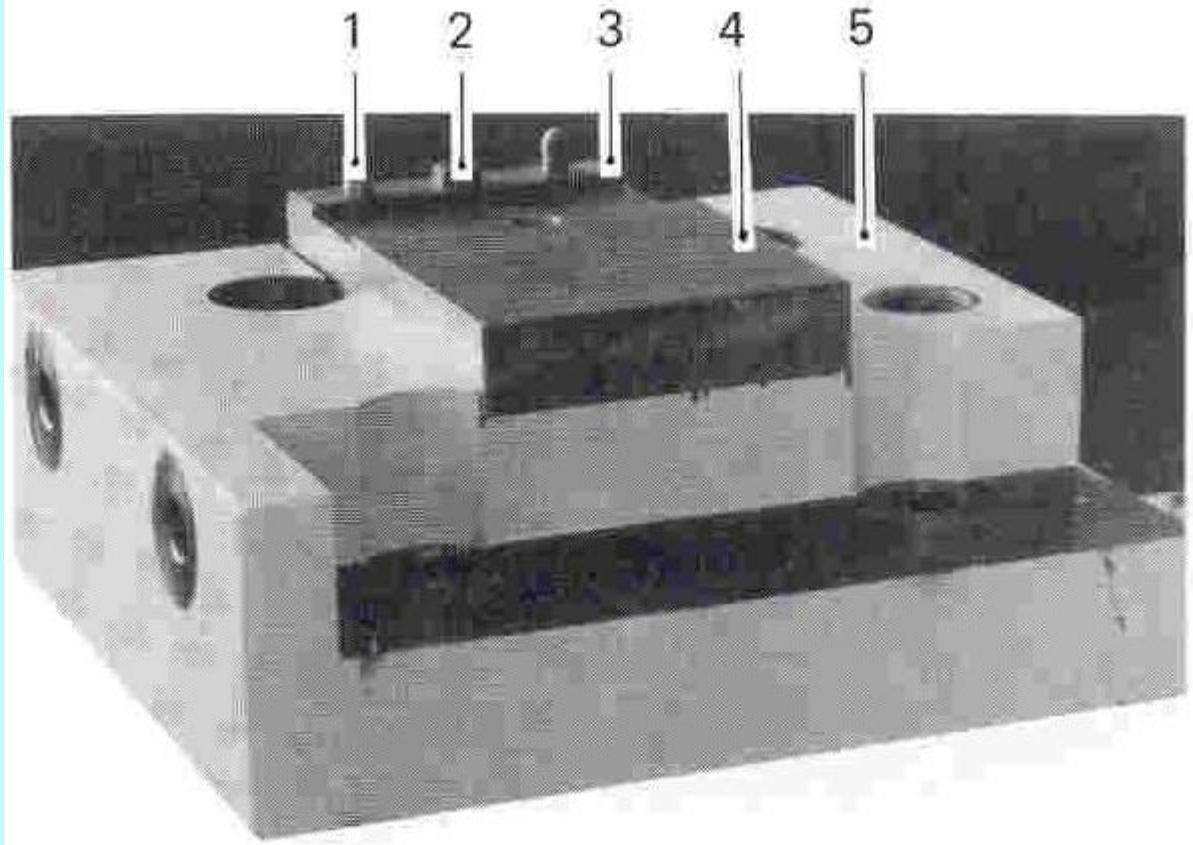


Fig. 1 Setting Down Base Plate



1 Tapered pin
2 Hexagon head bolt
3 Locking washer
4 Carrier plate
5 Base plate

Fig. 2 Base Plate for the Casing of the S Turbine

Salient Features Of Turbine Erection (Contd.)

- **ANCHOR BOLTS FOR BASE plates**:they are long through bolts for fastening the machine / base plates to the foundation. They are stretch elongated by specified length by the help of the bolt tensioning device.Normally diagonally opposite two bolts are tightened & locked subsequently

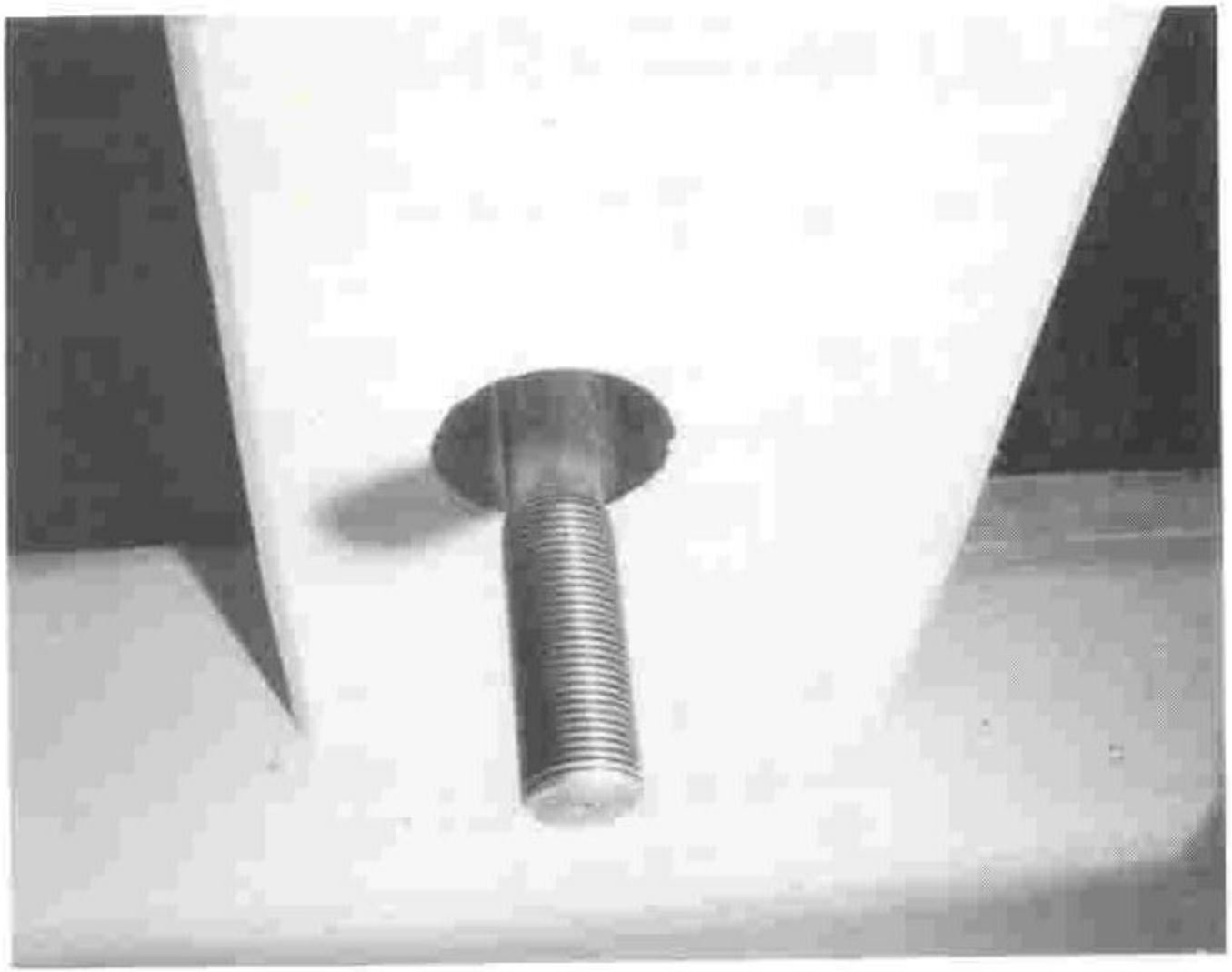
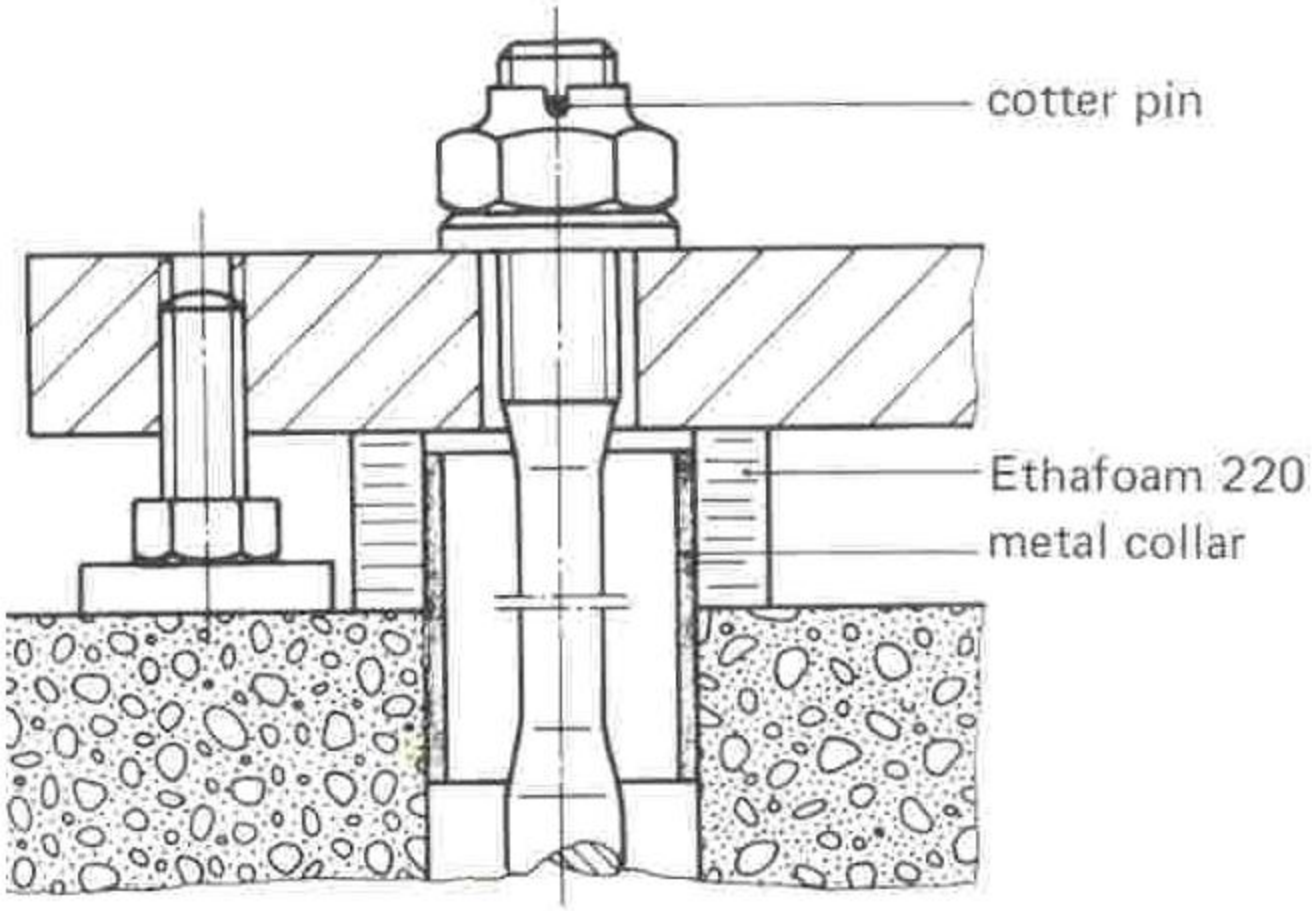


Fig. 1 Expansion Bolt in Anchor Hole



ig. 2 Anchor Hole Seal

Salient Features Of Turbine Erection (Contd.)

- **ANCHOR BOLTS FOR BASE plates**:they are long through bolts for fastening the machine / base plates to the foundation. They are stretch elongated by specified length by the help of the bolt tensioning device.Normally diagonally opposite two bolts are tightened & locked subsequently

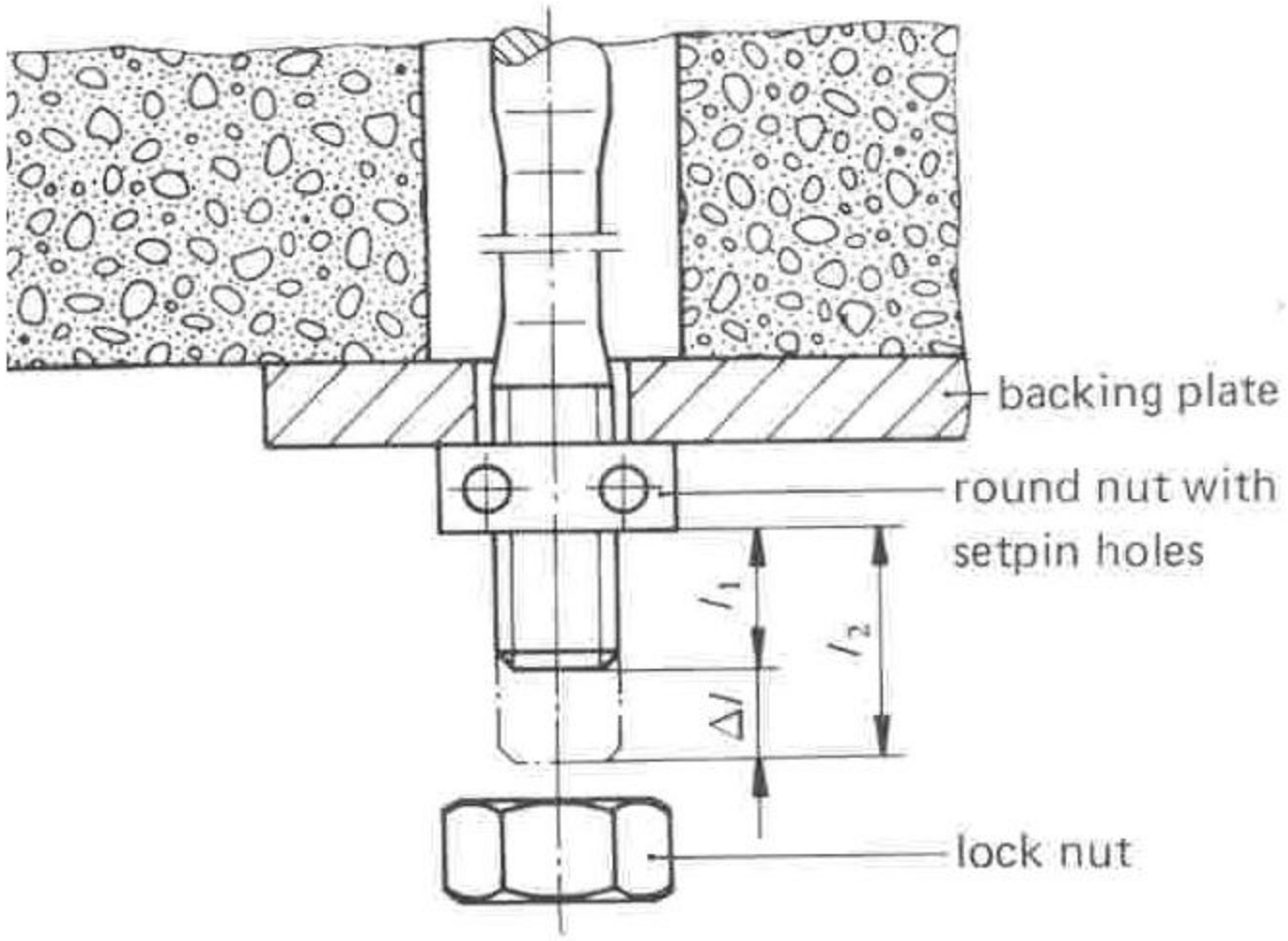


Fig. 3 Schematic of Bolt Expansion

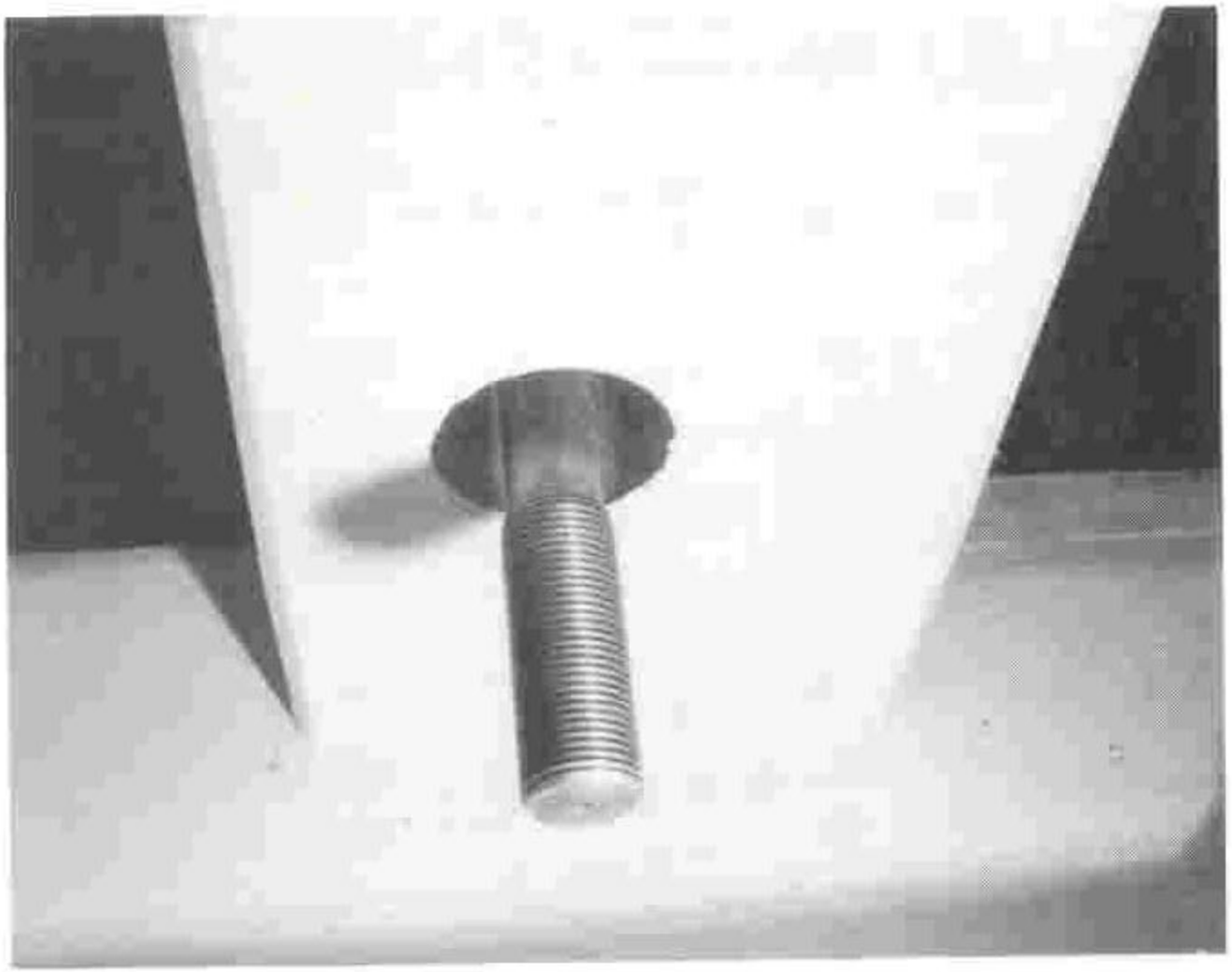
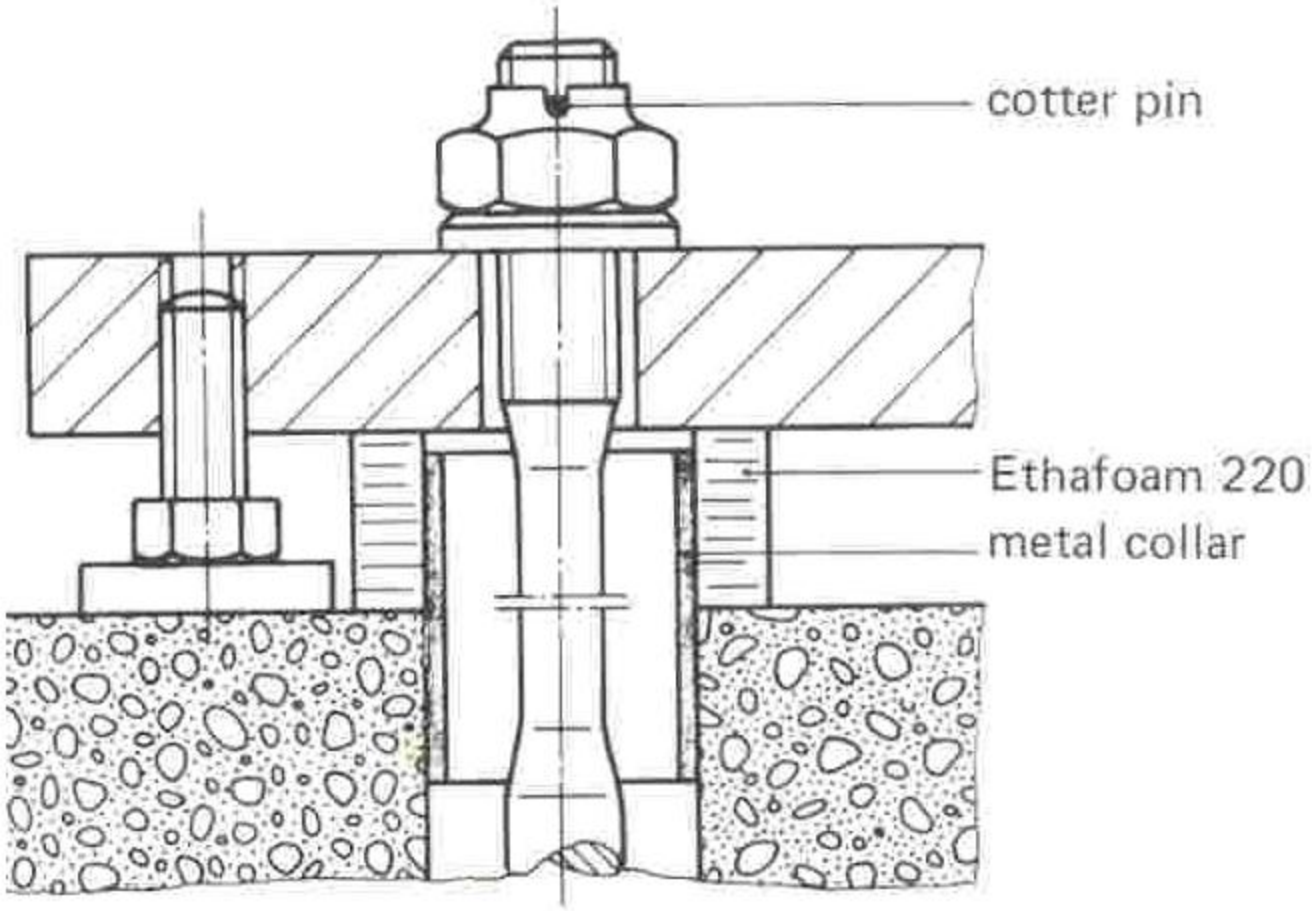


Fig. 1 Expansion Bolt in Anchor Hole



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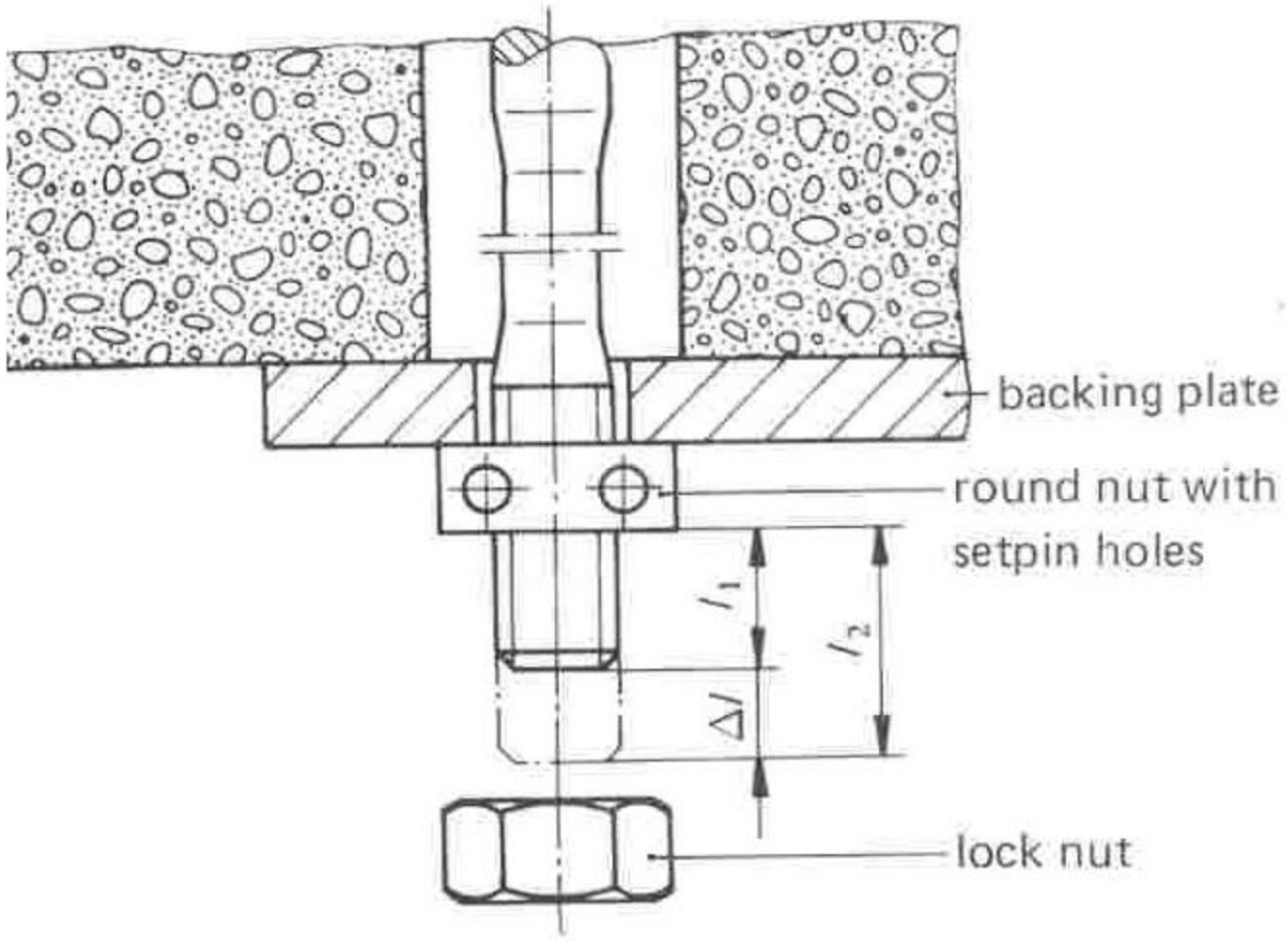


Fig. 3 Schematic of Bolt Expansion

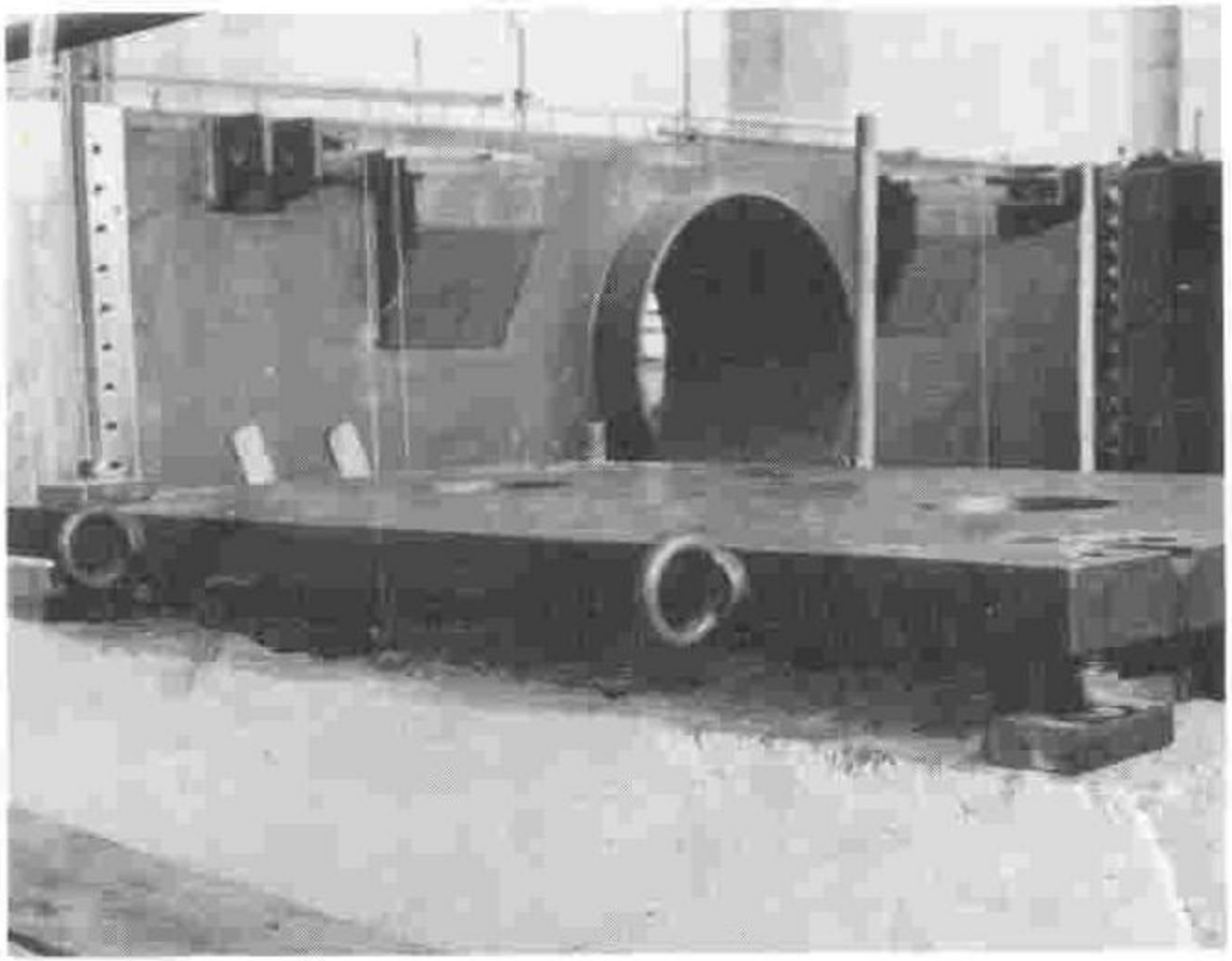


Fig. 1 Setting Down Base Plate

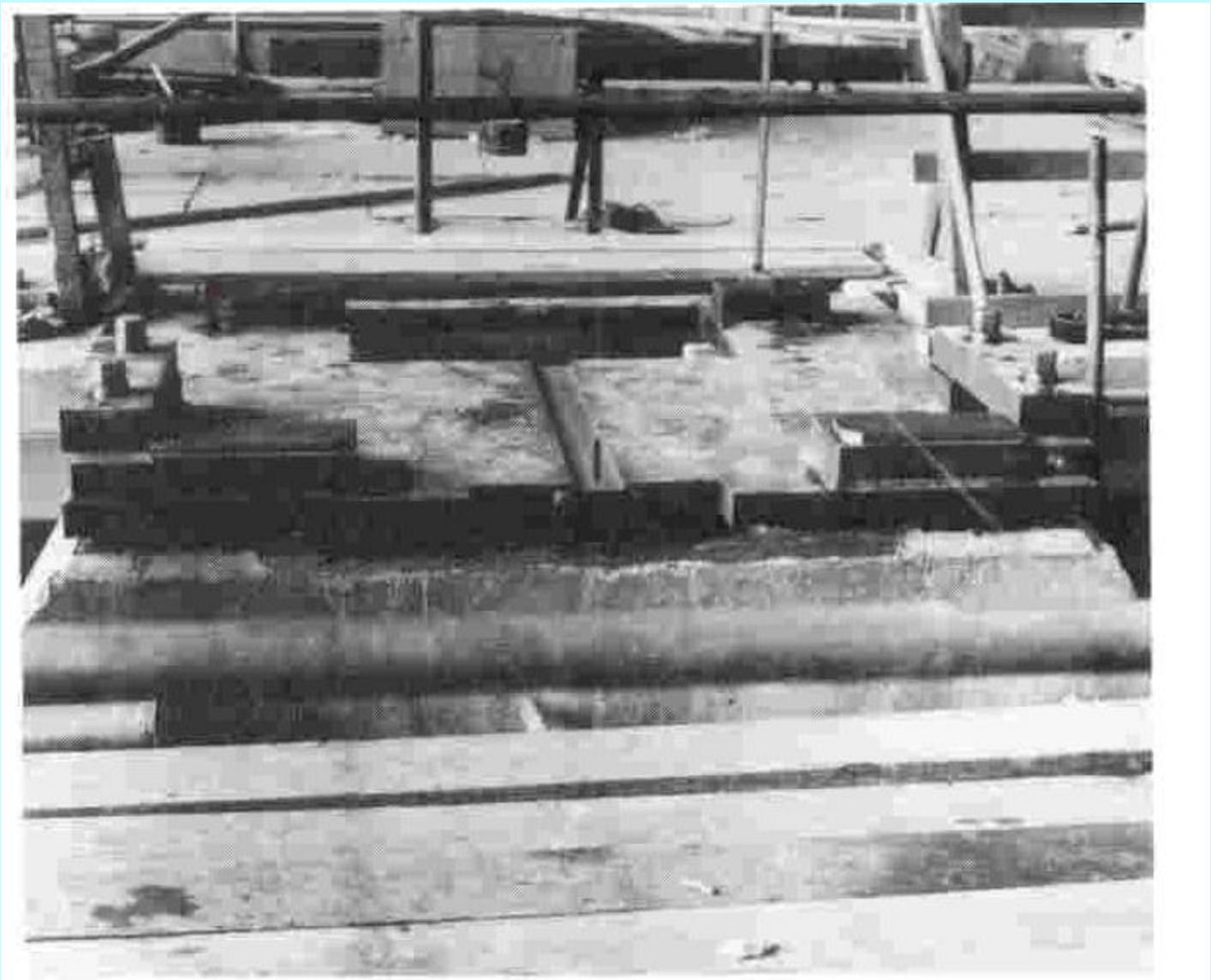


Fig. 2 Alignment to Central Axis

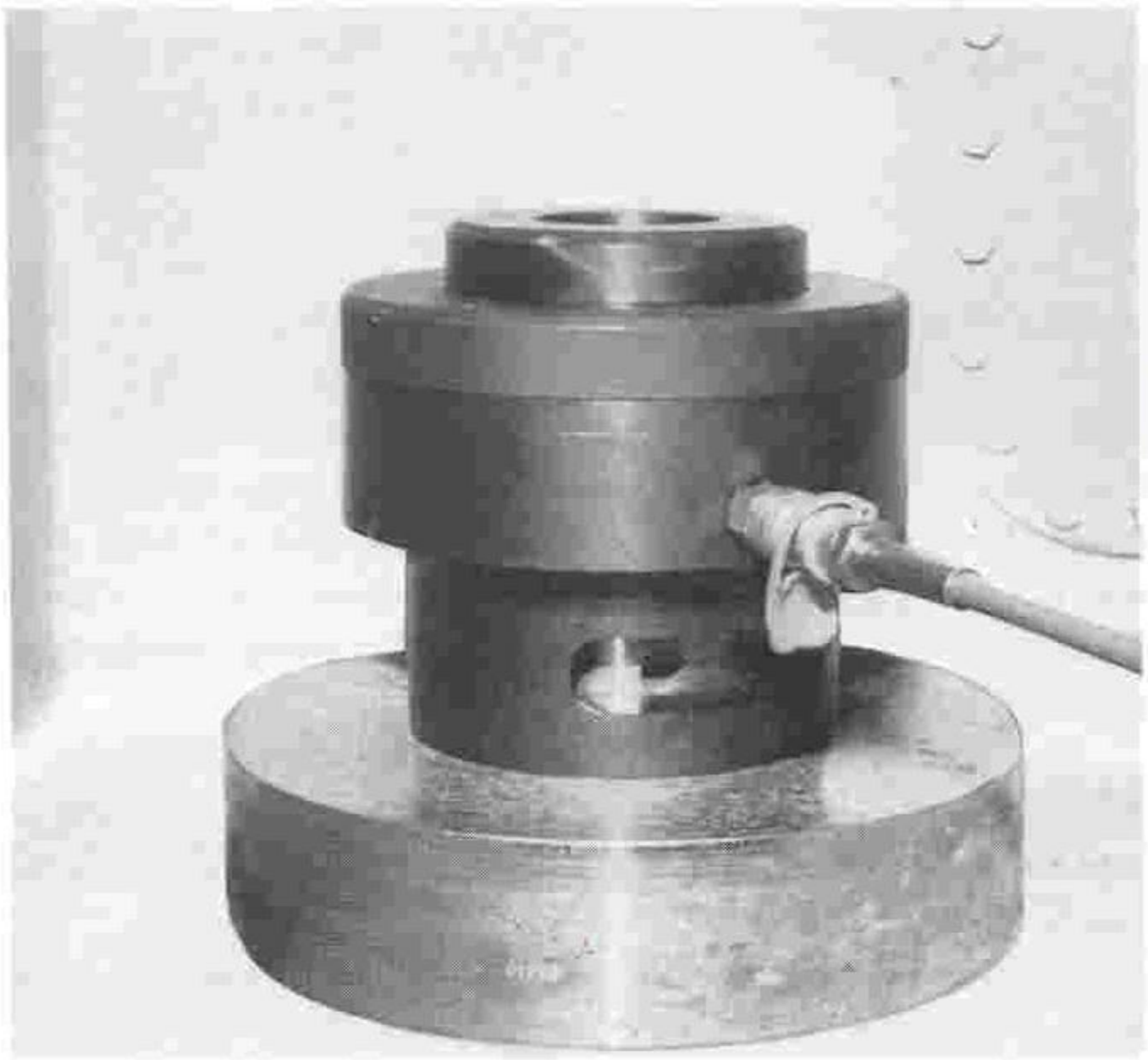


Fig. 3 Tensioning Device Attached with Exchangeable Sleeve M72 x 6

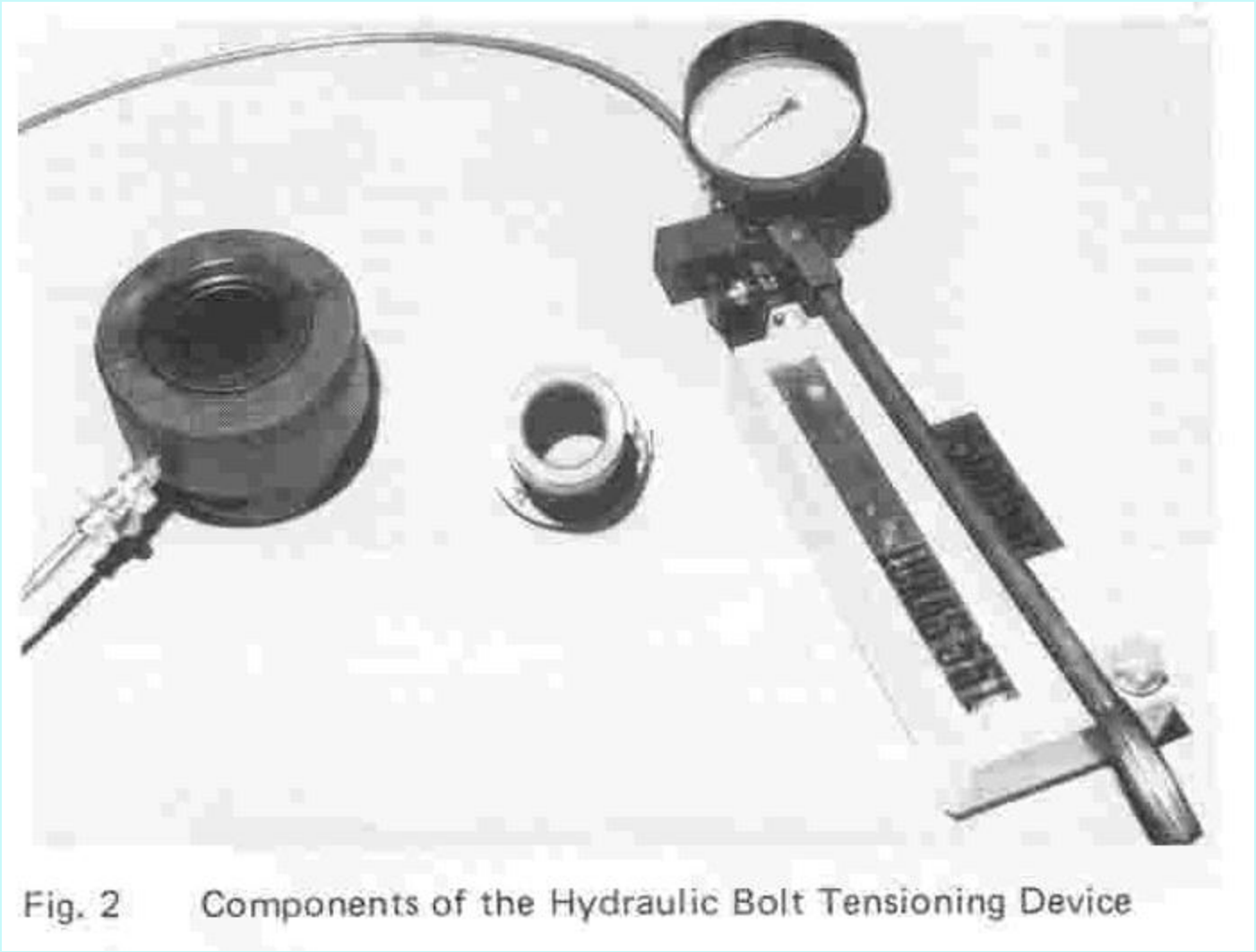


Fig. 2 Components of the Hydraulic Bolt Tensioning Device

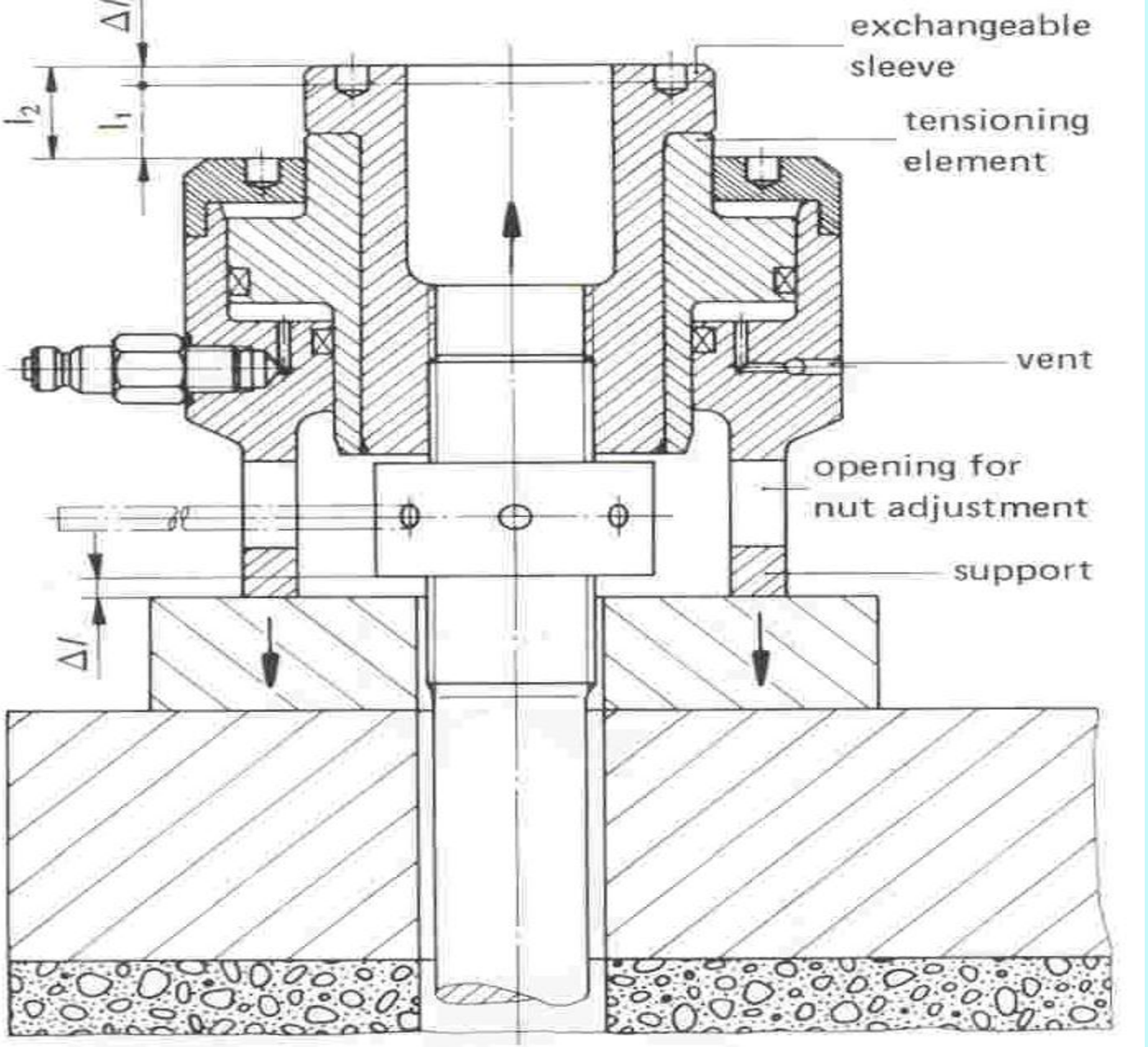


Fig. 1 Tensioning Configuration

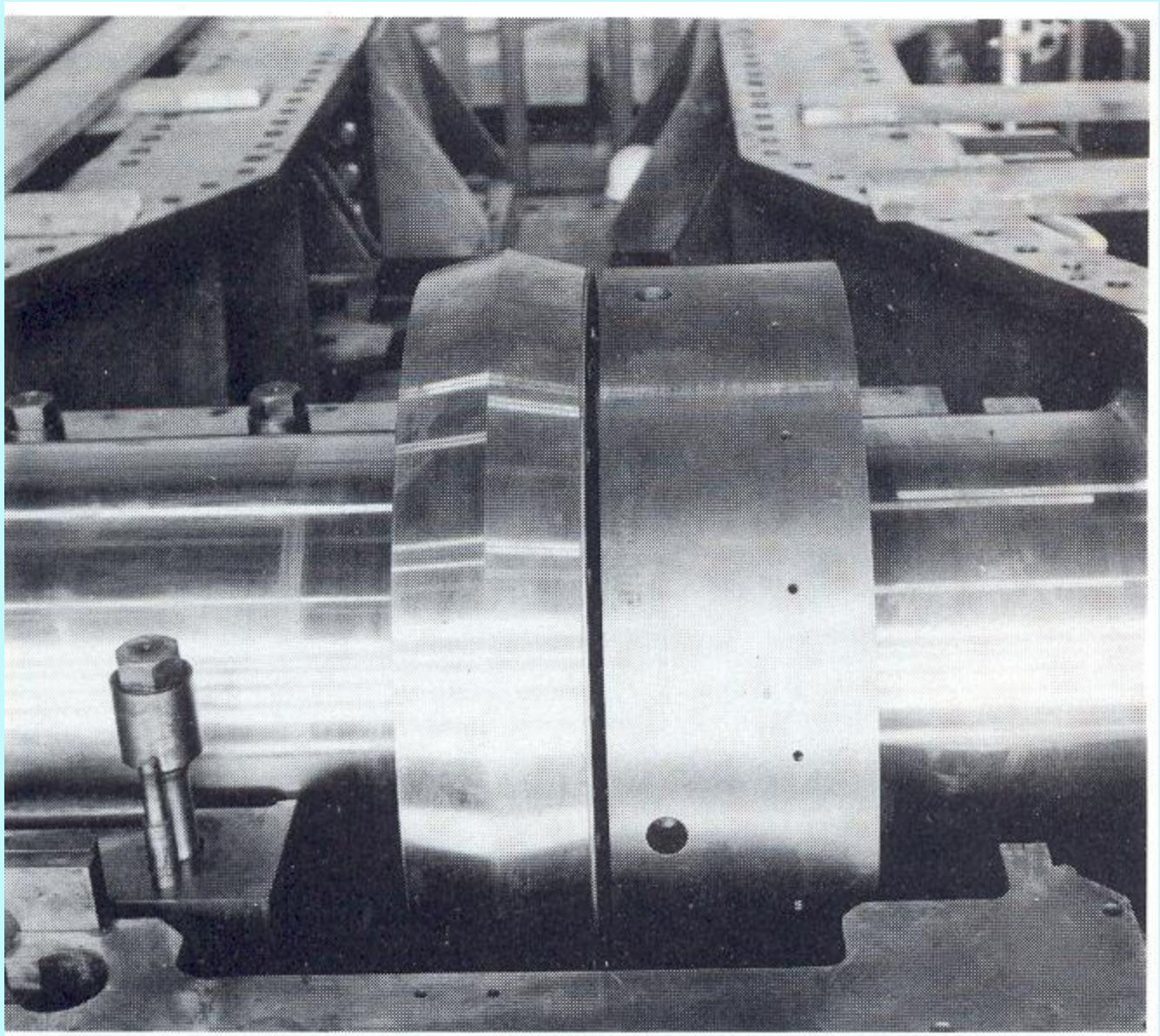


Fig. 1 Coupling Heads of Turbine Shafts

Salient Features Of Turbine Erection (Contd..)

- **ALIGNMENT** :align the base plates in zero position as per the deflection curve. The location is fixed in longitudinal & transverse axes using plumb & piano wires.The levels are fixed using the leveling instrument such as the dumpy level or by scale & water tubes and final levelling is done by the help of precision spirit level.Normally bearing pedestal #4 acts as the zero level for the turbine.The base plates & pedestals are then tightened with spanners for taking up the grouting

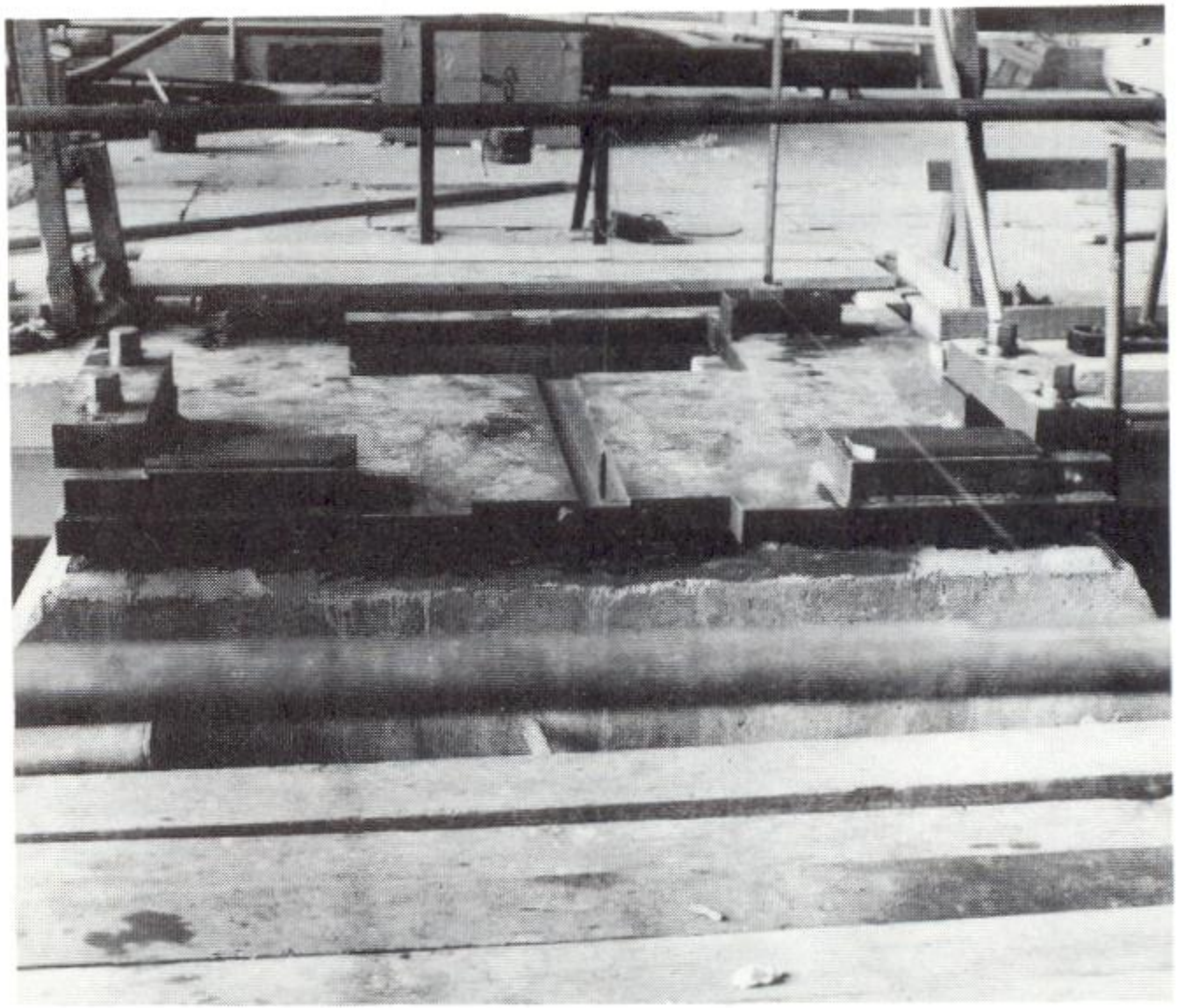


Fig. 2 Alignment to Central Axis

Salient Features Of Turbine Erection (Contd..)

- **Grouting:** The grouting of the base plates & pedestals is carried using shrink free grouting cement which is intended to ensure uniform transmission of mass and vibration of the machine on the foundation.The activity is carried with great care as the operation behavior of the machine depends largely on workmanship while carrying out the assembly of the load bearing components
- **Bolt tensioning:**

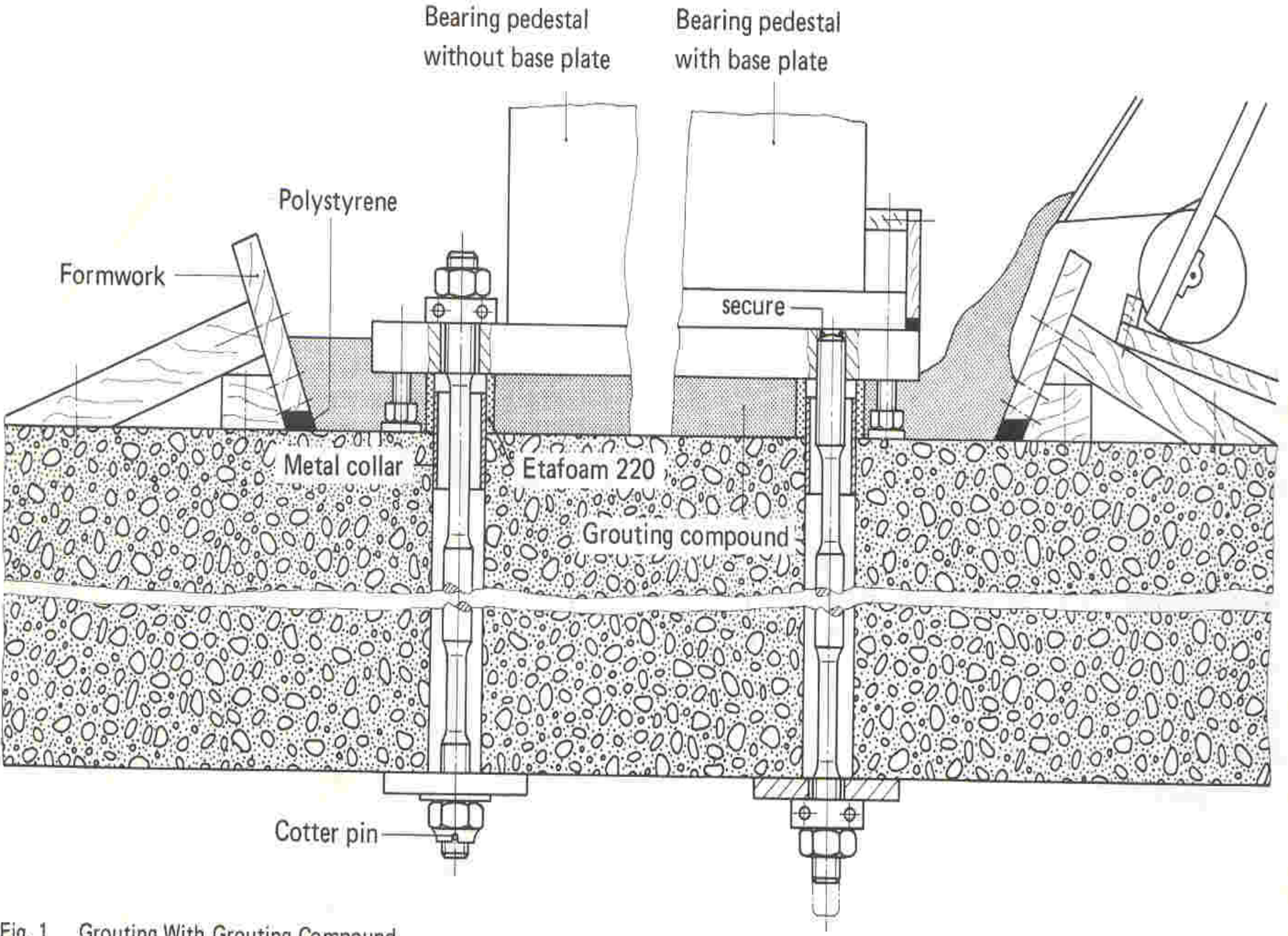


Fig. 1 Grouting With Grouting Compound

Salient Features Of Turbine Erection (Contd..)

- **COUPLINGS:** coupling on turbine shaft are generally rigid couplings. The couplings are used to connect two shafts to form a shaft assembly. The couplings are so designed so as to perform the following two functions:
- a)the dimensions & design is such that it is capable of transmission of all torque encountered during its service.
- b) The coupling must not influence the smooth running of the shaft assembly

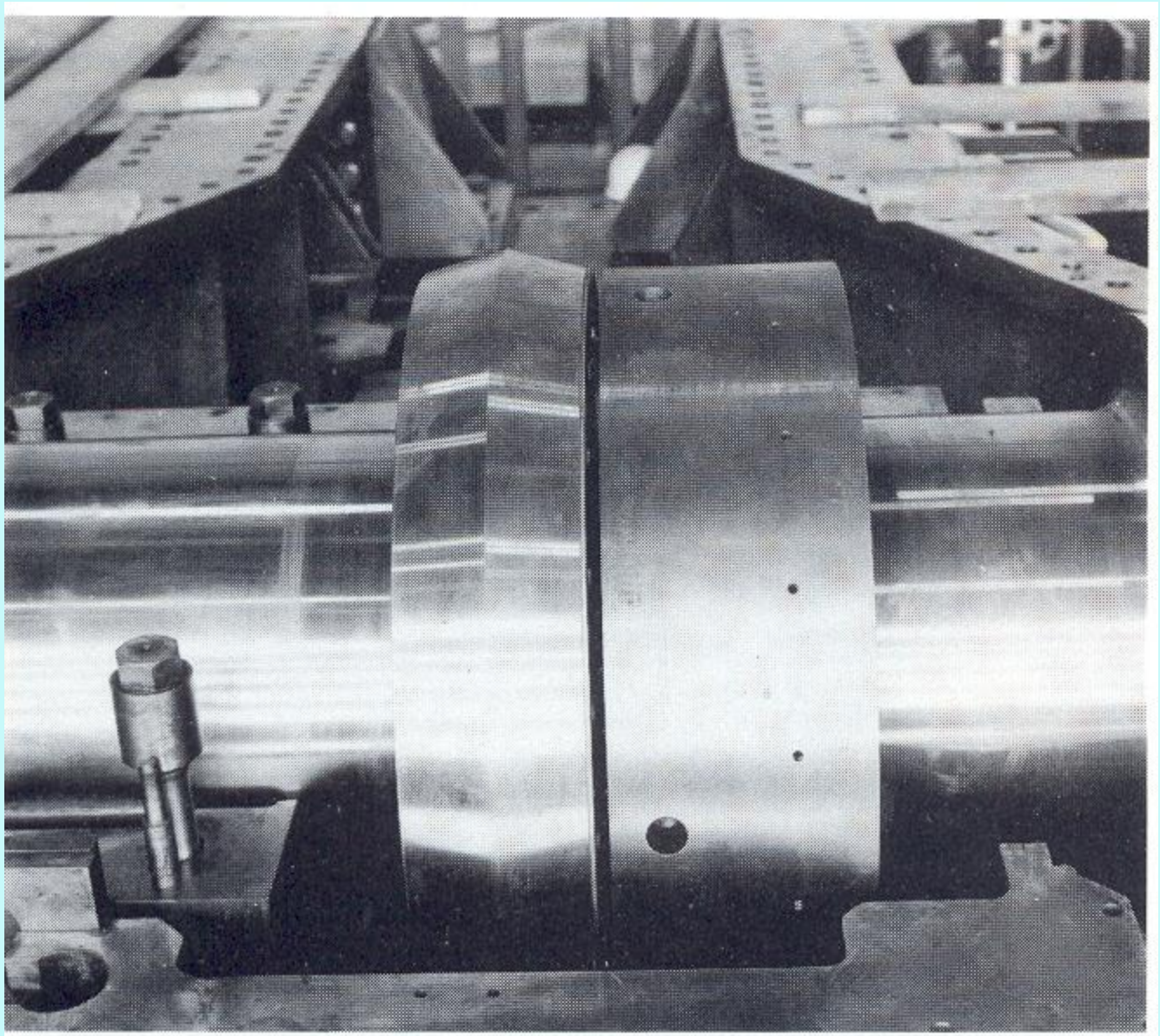


Fig. 1 Coupling Heads of Turbine Shafts

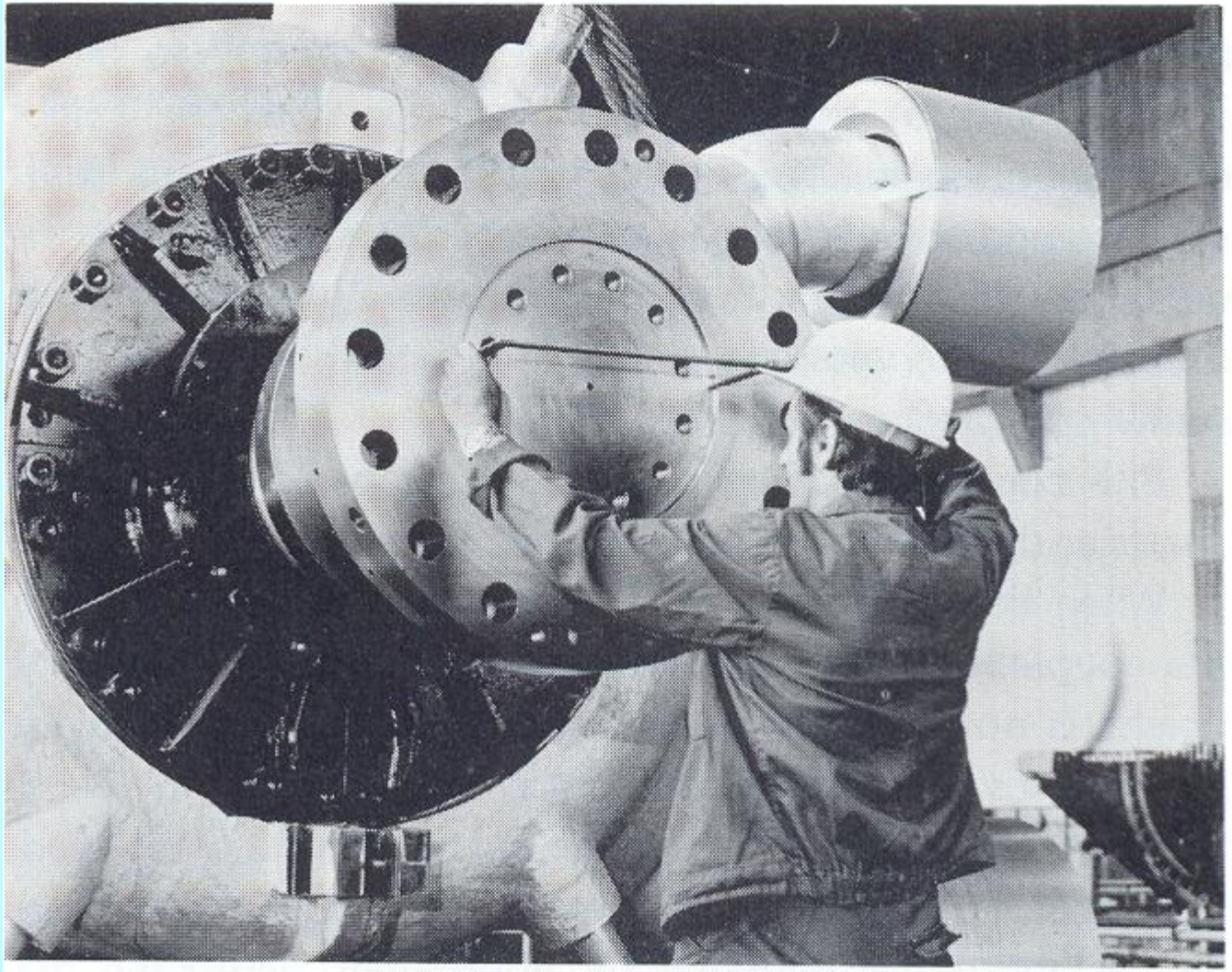


Fig. 2 Checking the Centering Fit before Installation

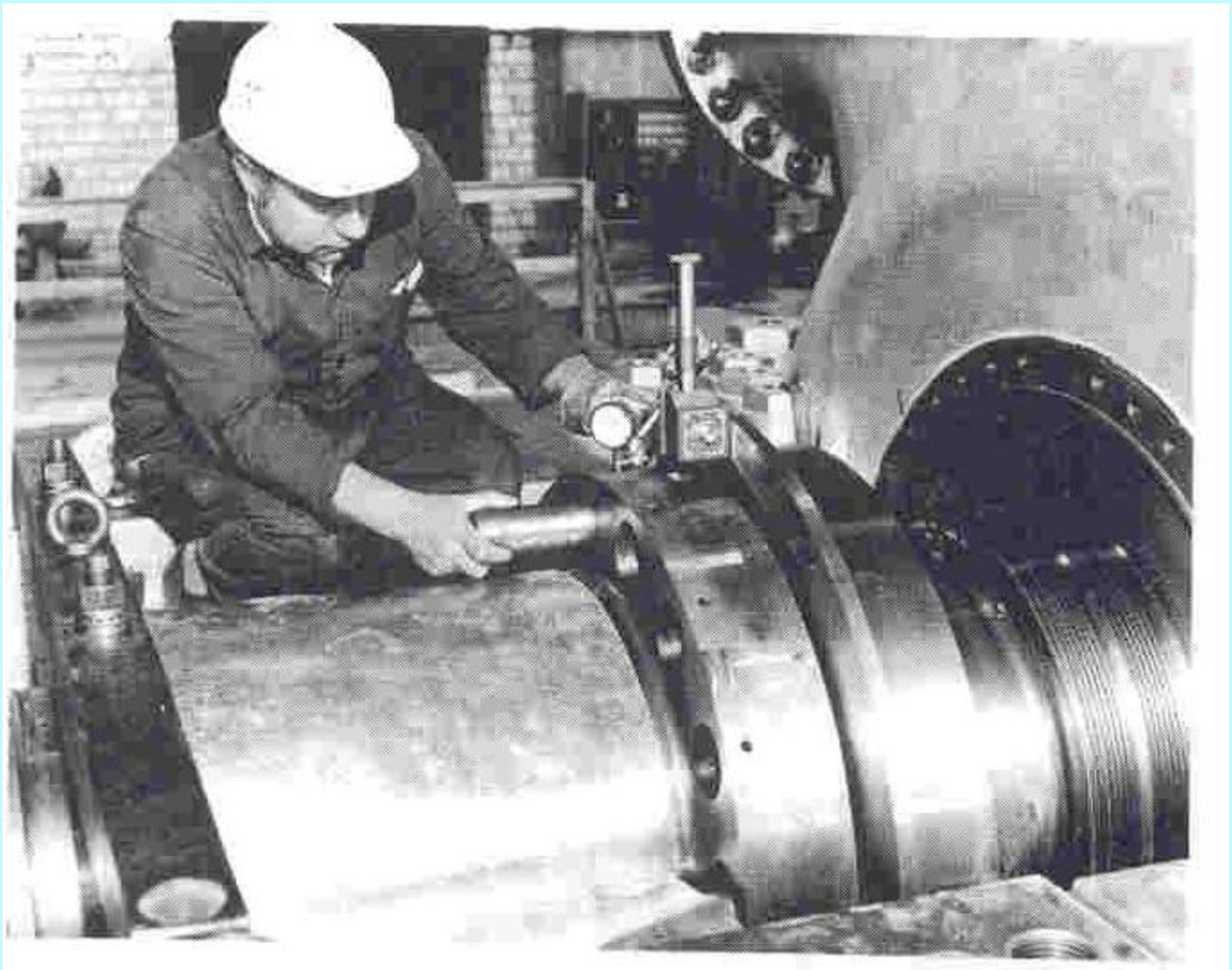
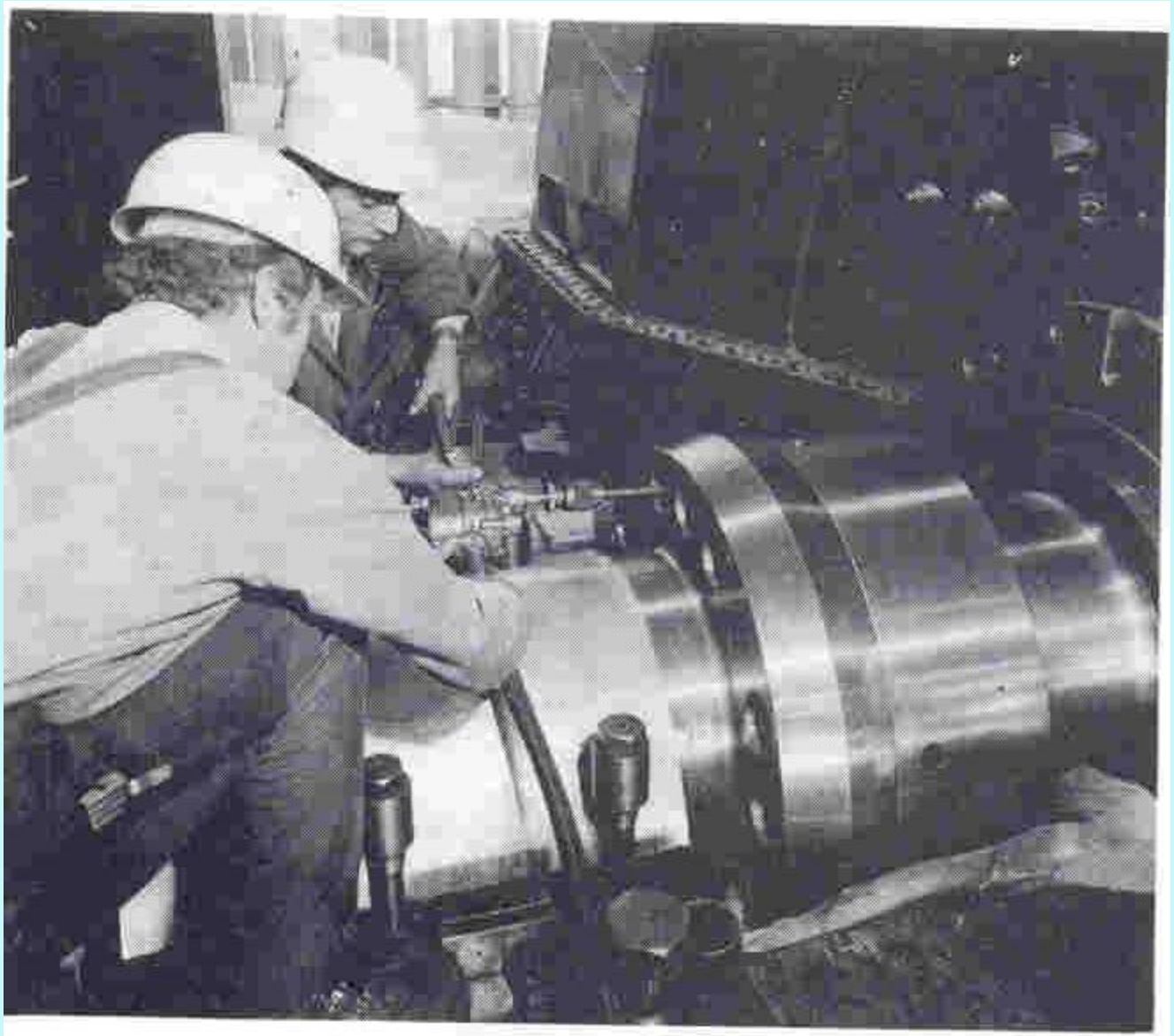


Fig. 3 Checking and Drawing Together Coupling Heads



ig. 4 Honing the Holes for the Coupling Bolts

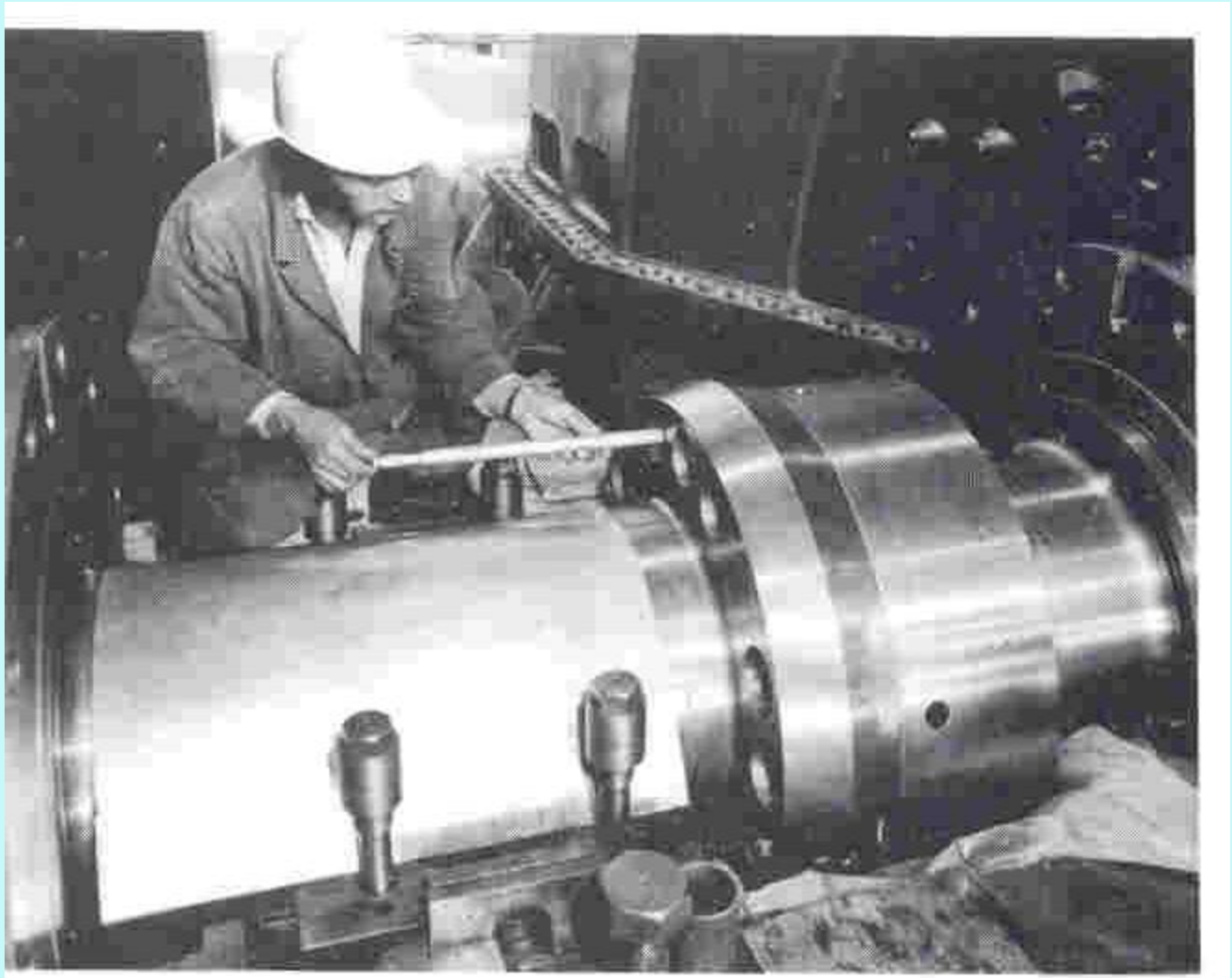


Fig. 5 Measuring the Coupling Bolt Holes Using a Three-Point Gauge

SALIENT FEATURES OF TURBINE ERECTION (CONT)

- After carrying out the coupling check and performing the adjustments necessary in the shaft position, the coupling of the shafts is carried out. Check for concentricity / radial alignment before carrying out the the coupling. Also measure the clearance between the spigot & recess. This should be well within the specified limit s of 0.08mm or else it shall give a lot of problem while doing the alignment of the rotors. There after carry out the axial alignment of the rotors

SALIENT FEATURES OF TURBINE ERECTION (CONT)

- While coupling ensure the concentricity of the coupling holes of the two coupling. This shall minimize the requirement of reaming & honing. A run out check at the shaft journal is necessary to ensure a good coupling. It may be noted that even a run out of 0.03mm at journal area will eventually lead to vibrations of 30 microns.A higher run out is an indication of improperly connected coupling. It is imperative to locate the cause of the improper connection& to eliminate them by appropriate measures

SALIENT FEATURES OF TURBINE ERECTION (CONTD..)

- **CASING GUIDES:** The casing guides are used to link the turbines & bearing casing together in such away that turbine casing can expand freely in desired direction when heated. Prior to installation of the turbine casing, check their mating surfaces& t6hose of bearing casing for perfect condition. Permanent casing guide keys are fixed with required clearance after the final alignment of rotor and casings. Ensure a thin layer of molykote on keys while installing. The thickness of keys& the clearances are to be recorded in the log-sheets

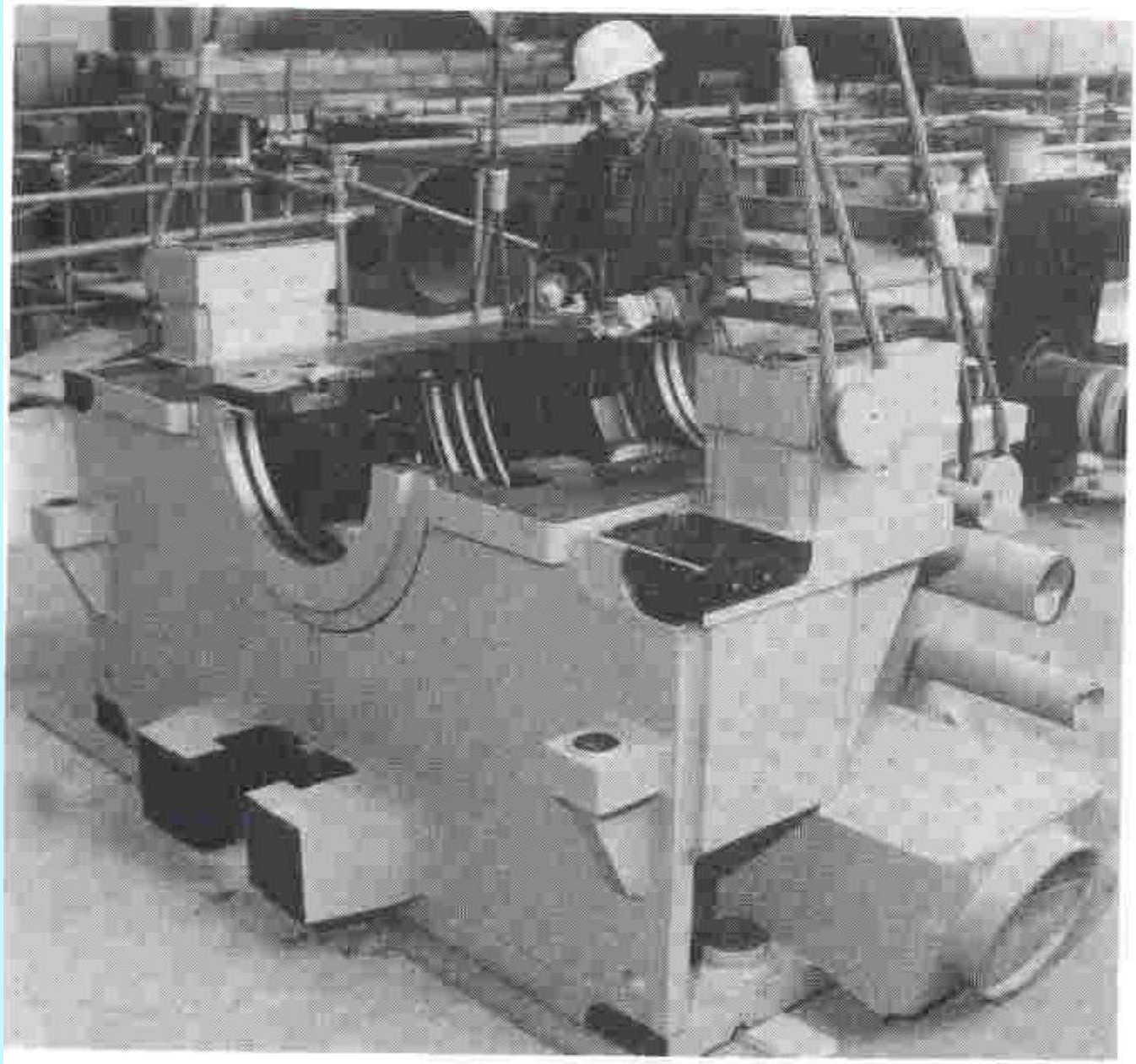


Fig. 2 Casing Guide on Bearing Casing Side

SALIENT FEATURES OF TURBINE ERECTION (CONTD..)

- **CASING SUPPORTS** :The position of all outer casing & that of inner casing of LP turbine are fixed horizontally by casing supports. When the turbine casing rests on the bracket supports the casing is at proper elevation wrt turbine shaft
- The HP &IP turbine casing are supported in the turbine axis by two front & two rear bracket supports standing on the support blocks of the pedestals.The support are free to slide during the thermal expansion

Fig. 3 Treating the Casing Brackets

•BEARING PEDESTALS

The Function of the Bearing Pedestal Is To:
-Support the Rotors
-Connect HP & IP to Form One Unit
-Support HP & IP Turbine Sections
-Center the Turbine Sections

- **THRUST BEARING** takes care of the uncompensated residual thrust
- **FRONT BEARING PEDESTAL** houses the main oil pump for lube oil & control oil. The over speed trip device is also installed in this pedestal
- **AXIAL MOVEMENT :** those pedestals which are not fixed point are designed to take care of thermal expansion. The movement is based in the length of the turbine section and the casing temperatures
- Setting of spacer bolt clearance
- Checking of radial & axial clearance on the right & left hand sides

The Erection any equipment is a complete & systematic process which is well conceived before start of the job. It involves detailed planning about the content and the scope of work that needs to done. The complete technical specification of the equipment, its Layout, the foundations, and the Terminal points have to be defined before the start of the work. It is well said, that a work well planned is half done.
Thus while award of the work the complete technical specifications are frozen in detail during pre award discussions with the Engineering and the Contract services.

-The complete erection of a TG is a long drawn process requiring more that 30 months of work.
-Thus the sequence of supplies and their dates of dispatches are decided before hand.
-Similarly the dates of readiness of the Foundations is also decided before hand.
-The Terminal points are also decided before the Final award of the contract i.e. NTPC scope(Customer Scope) which generally are free construction power supply, water supply, Civil foundations, EOT Crane (optional) with operators, Compressed air, Area lighting, accommodation land, storage area, DM water etc.
-The rest of the work is in the scope of the equipment supplier.
- This includes Supply, Storage, Erection, Testing & Commissioning and Trial operation of the equipment.

Pert Networks

- The contractor is required to submit a PERT network indication the major mile stone dates
- The three types viz. L1, L2 & L3 networks are submitted by the contractor which is reviewed & finalized after incorporating the comments of the owner. L3 is the complete detailed network which is normally used at site for each commitment
- Similarly the supplies are also decided as per the milestone dates and any slippage from the committed date is subject to LD to be levied by the owner. This is levied @ 1/2 % per week's delay subject a maximum ceiling of 5 %

Handing Over Of Fronts

- The fronts are handed over to the contractor after due checking of the soundness & dimensional check of the elevation & pocket, insert sizes and their location after a joint protocol
- It is essential to provide weather proof TG hall along with crane girder which includes side wall cladding, railway siding, approach ladders / staircase, adjoining floors etc

CONSTRUCTION OF TG DECK

- The TG deck is supported on steel / RCC columns. A vibration isolation system is provided on the column to isolate the deck vibrations from the columns
- After the layout of steel inserts on the form work/ shuttering, the TG deck is constructed by a process of non stop casting in order to provide monolithic structure. The cement setting is delayed by adding certain additives to the concrete mixture. The curing is carried out for a period of 28 days after which it is released for erection of the equipments

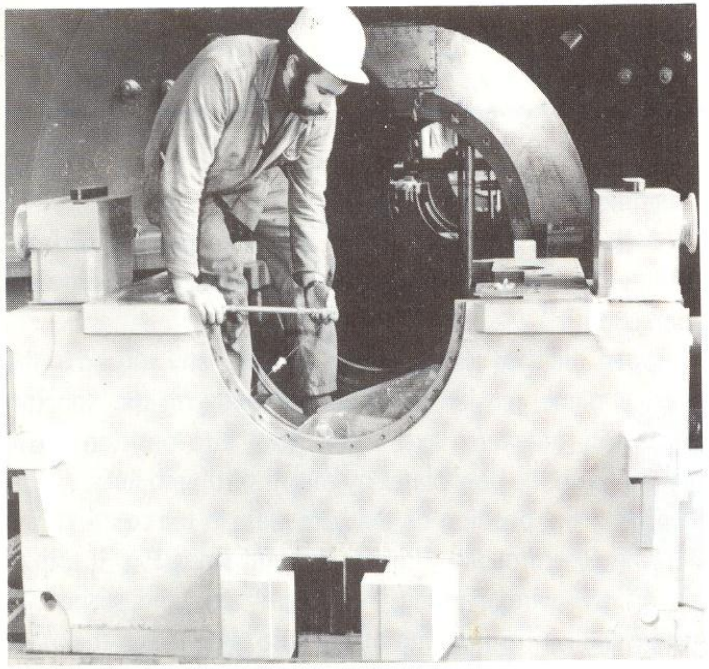


Fig. 3 Aligning the Bearing Pedestal to the Central Axis

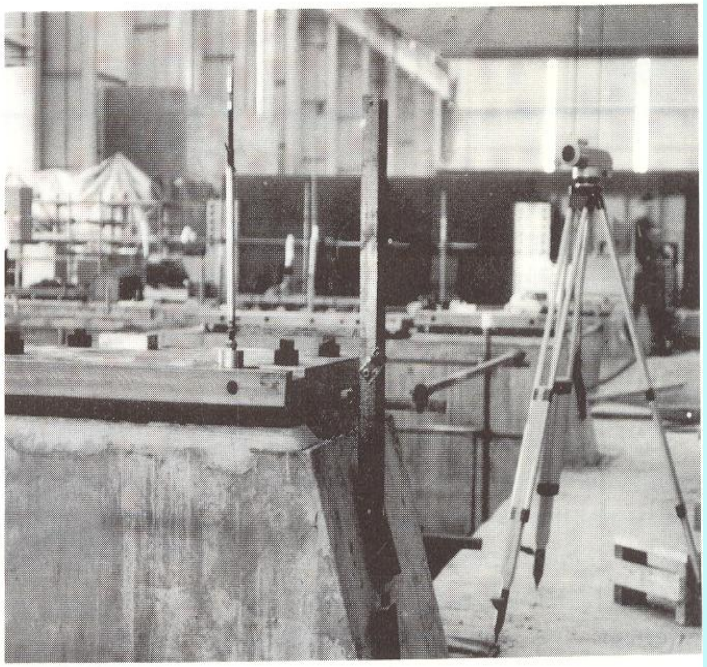


Fig. 4 Setting the Height

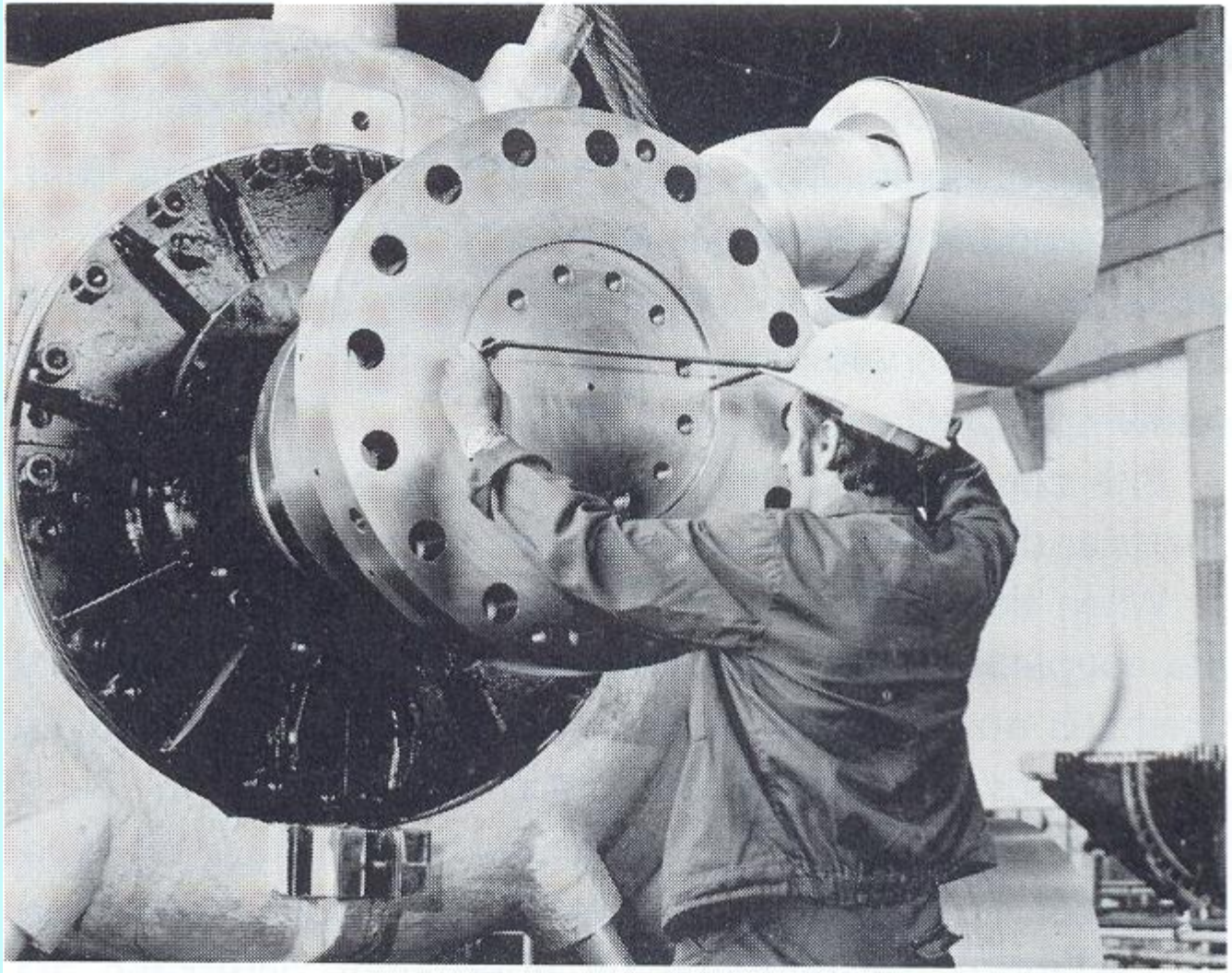


Fig. 2 Checking the Centering Fit before Installation

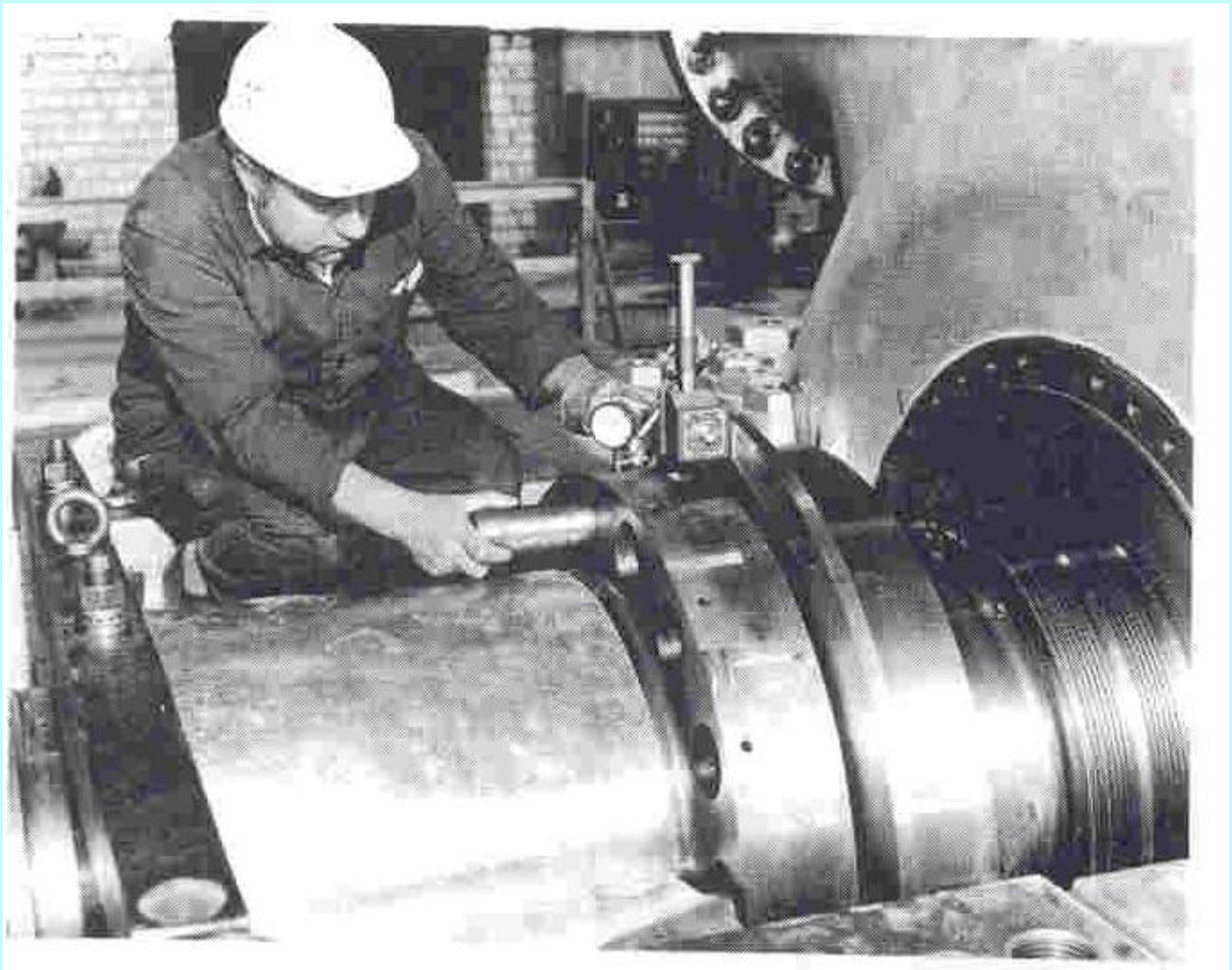
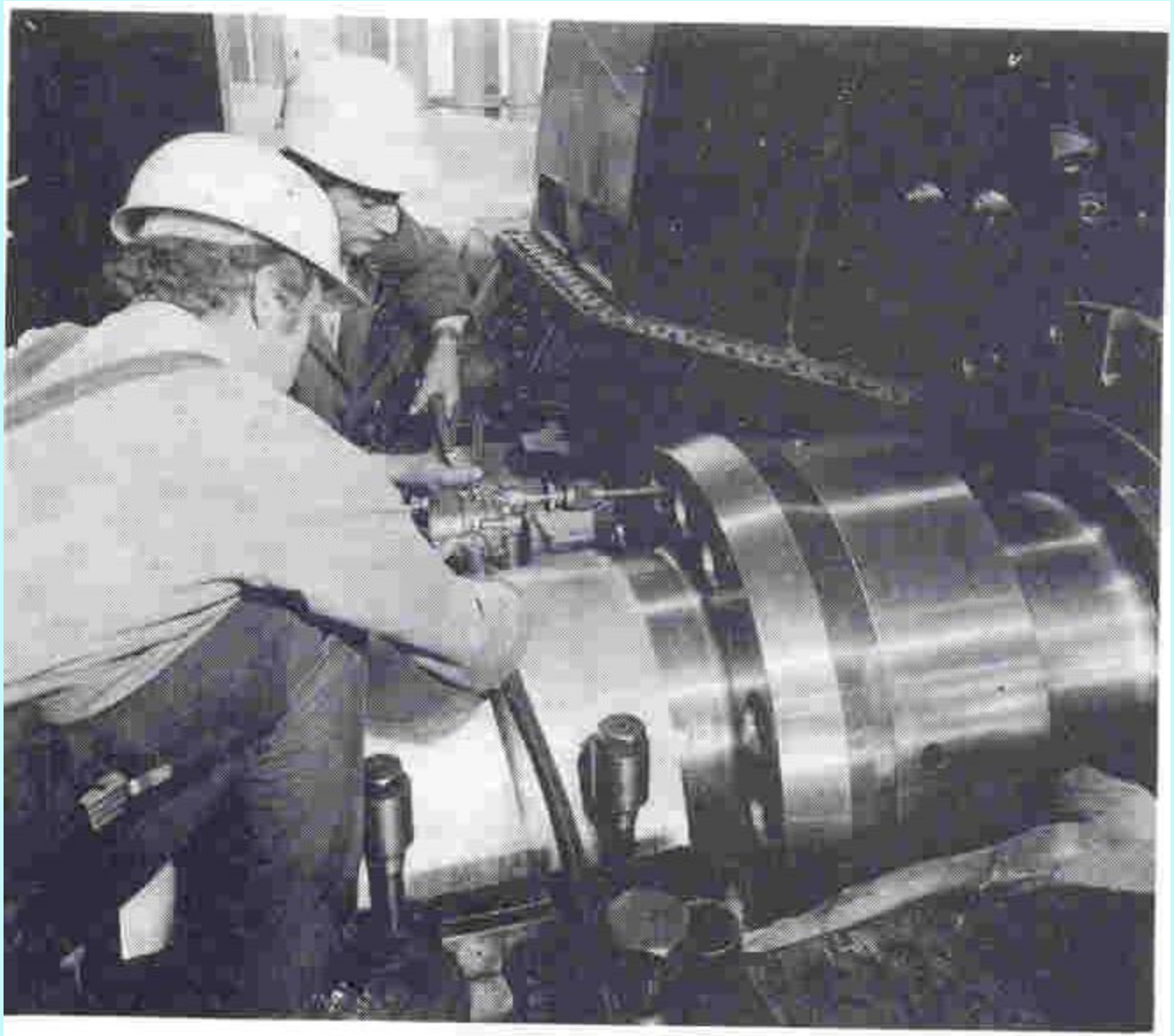


Fig. 3 Checking and Drawing Together Coupling Heads



ig. 4 Honing the Holes for the Coupling Bolts

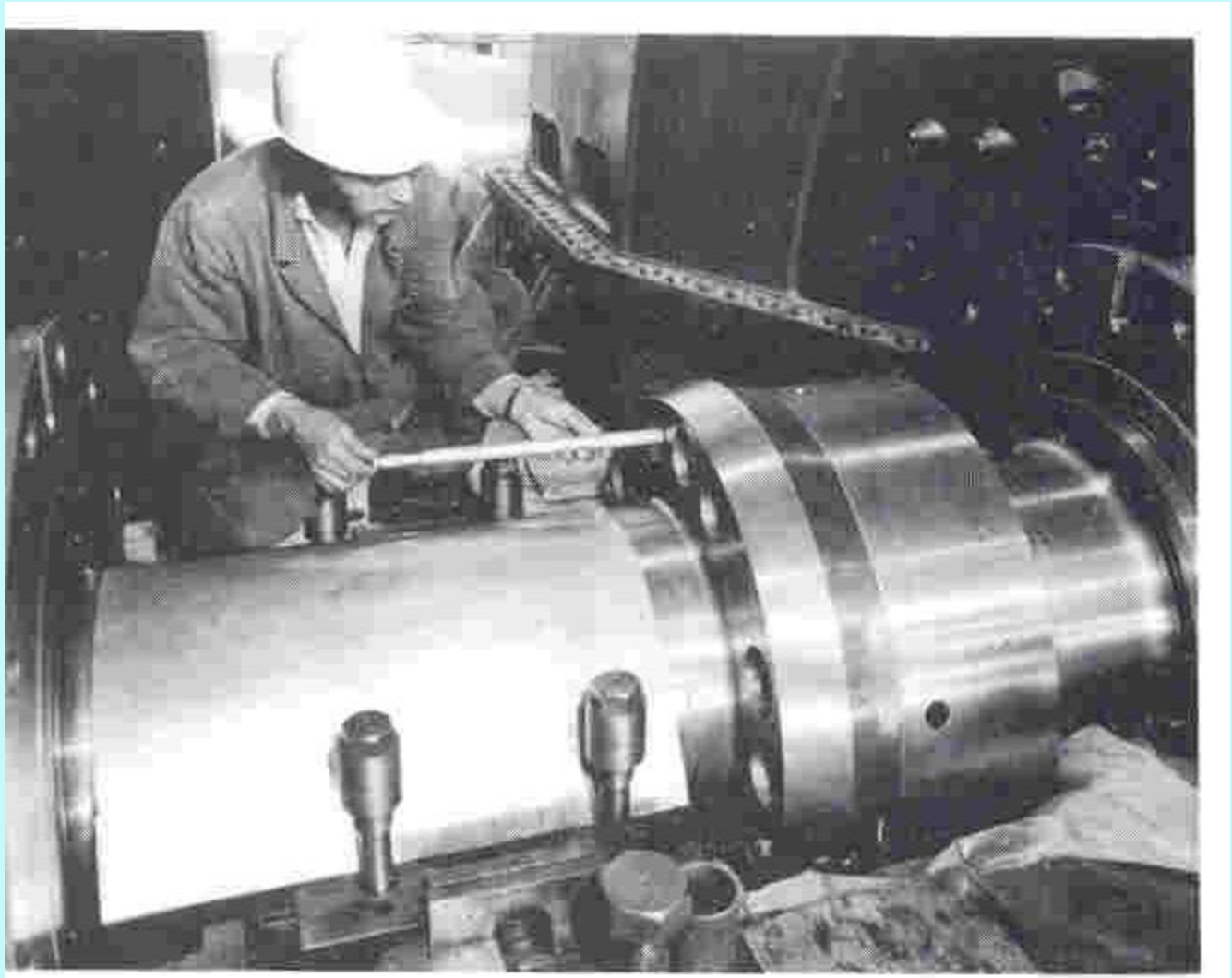


Fig. 5 Measuring the Coupling Bolt Holes Using a Three-Point Gauge

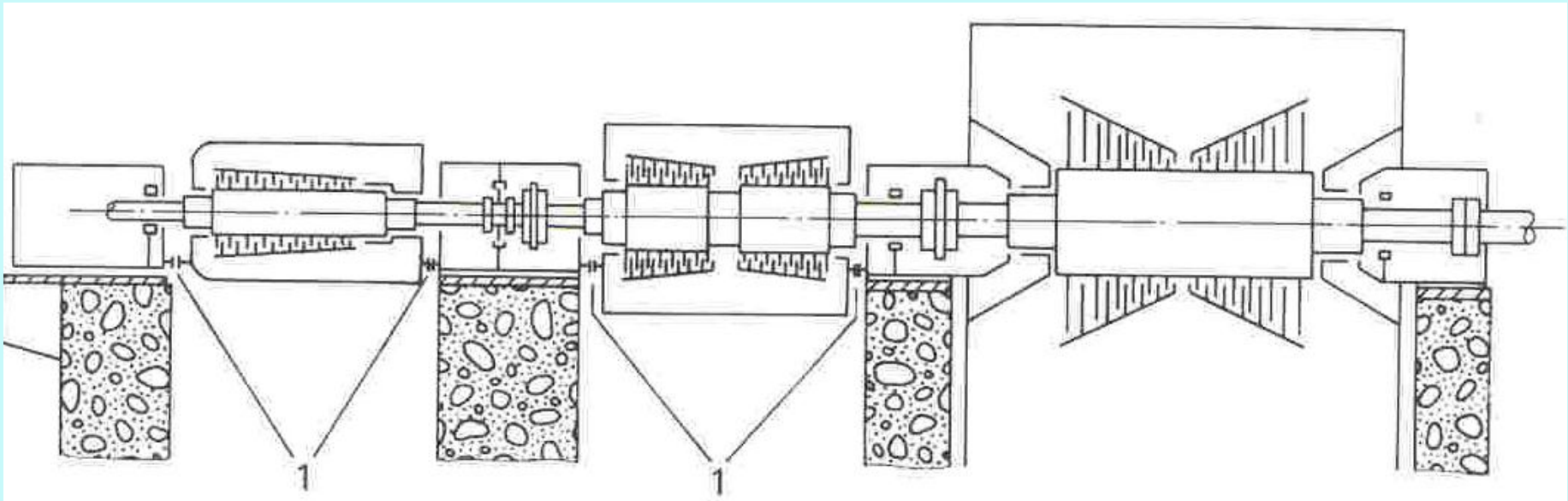
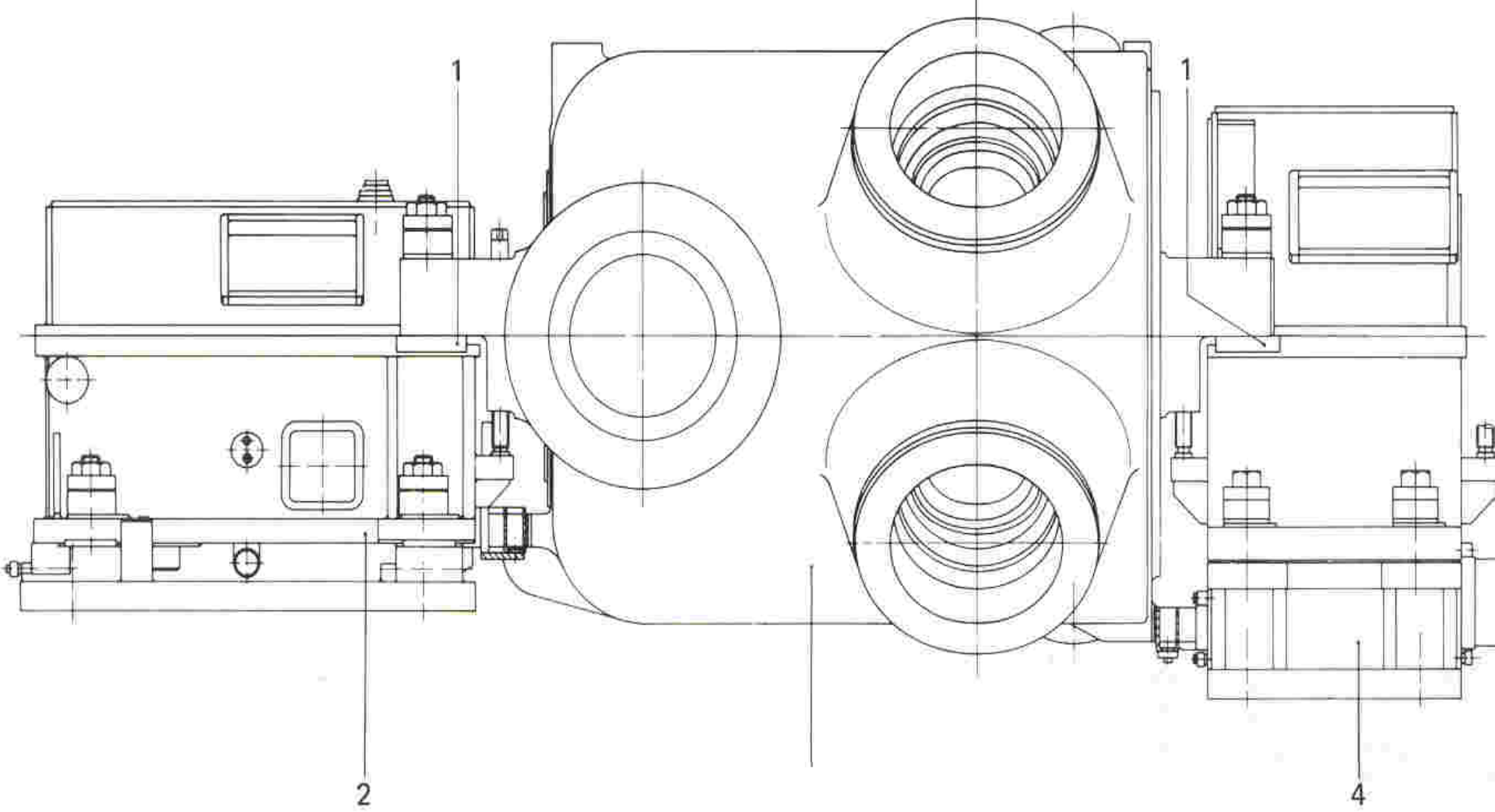


Fig. 1 Arrangement of Casing Guides for HP and IP Turbine Section



1 Casing Supports
2 Front bearing pedestal
3 Turbine casing
4 Rear bearing pedestal

Fig. 1 Casing Supports of the HP Turbine

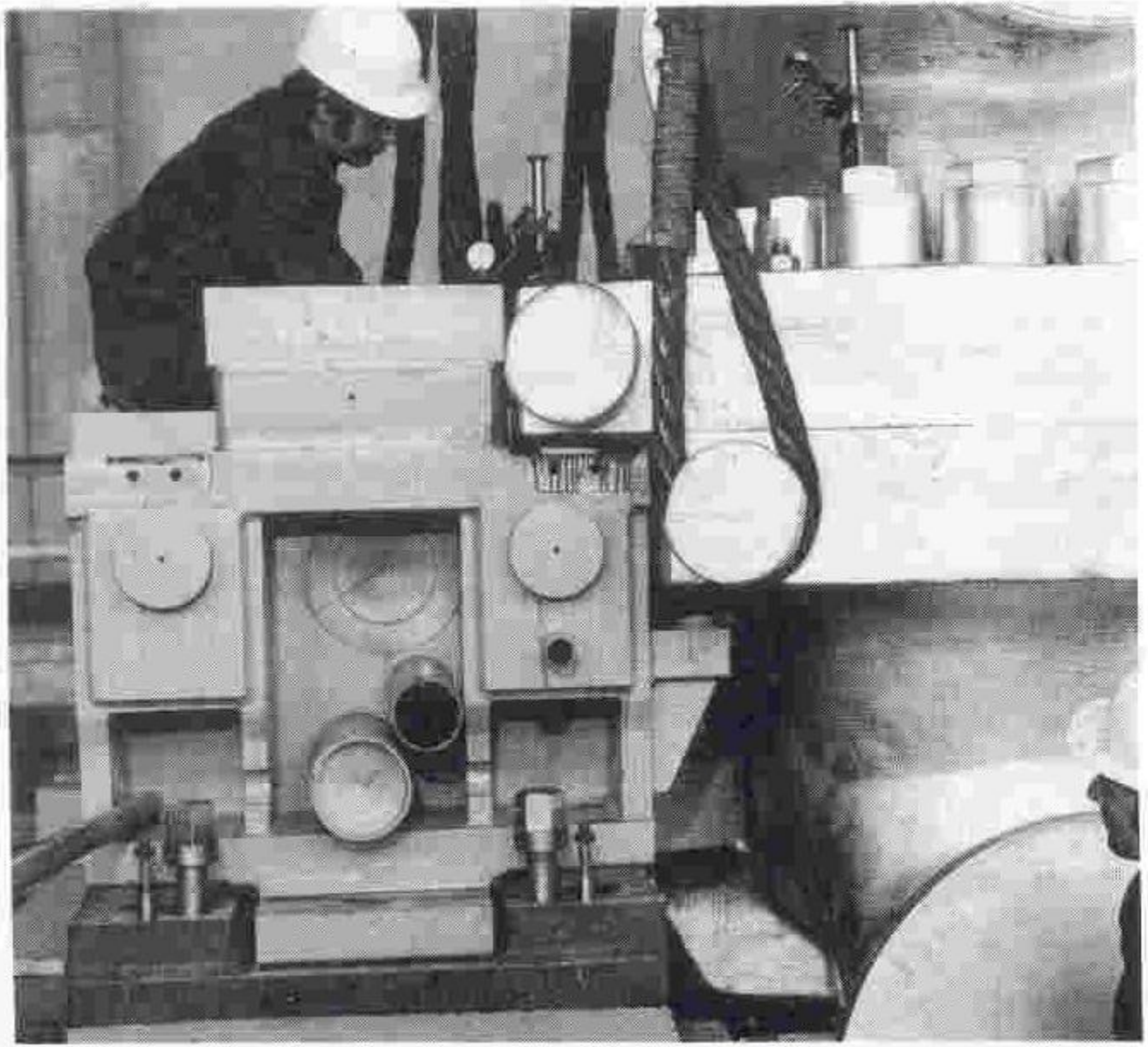


Fig. 4 Adjusting the Elevation of the IP Turbine

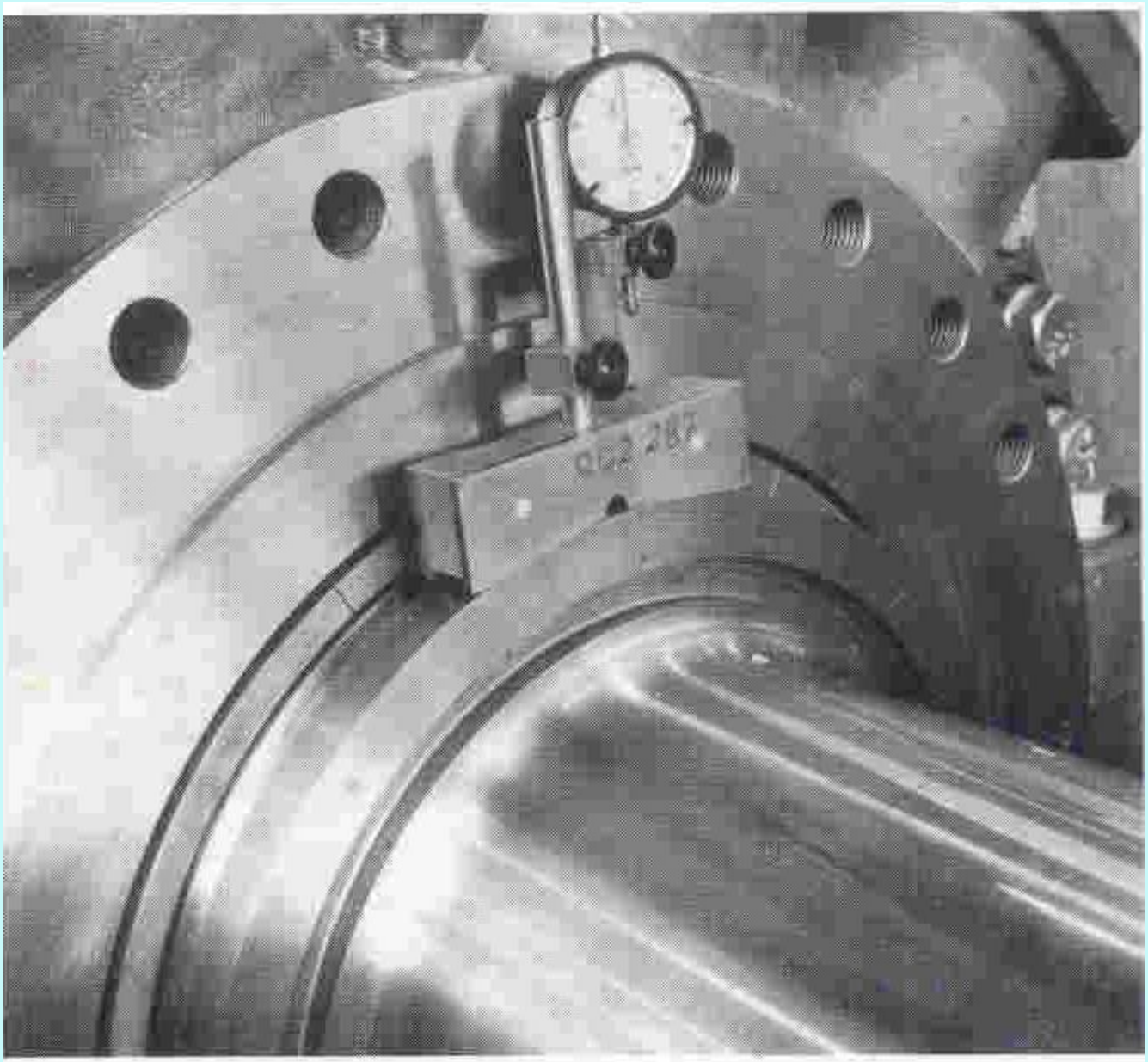


Fig. 6 Radial Alignment Check on Casing

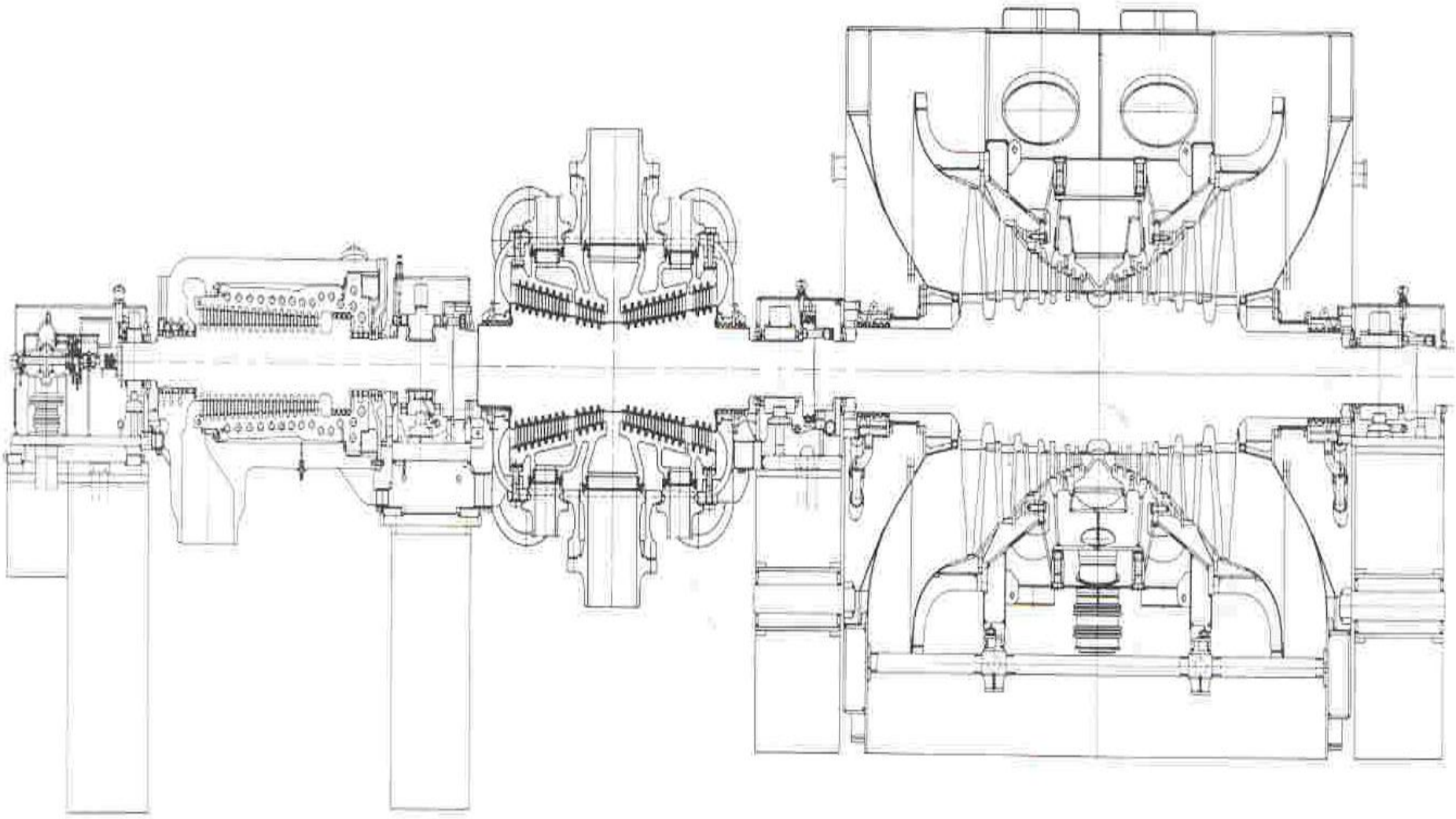
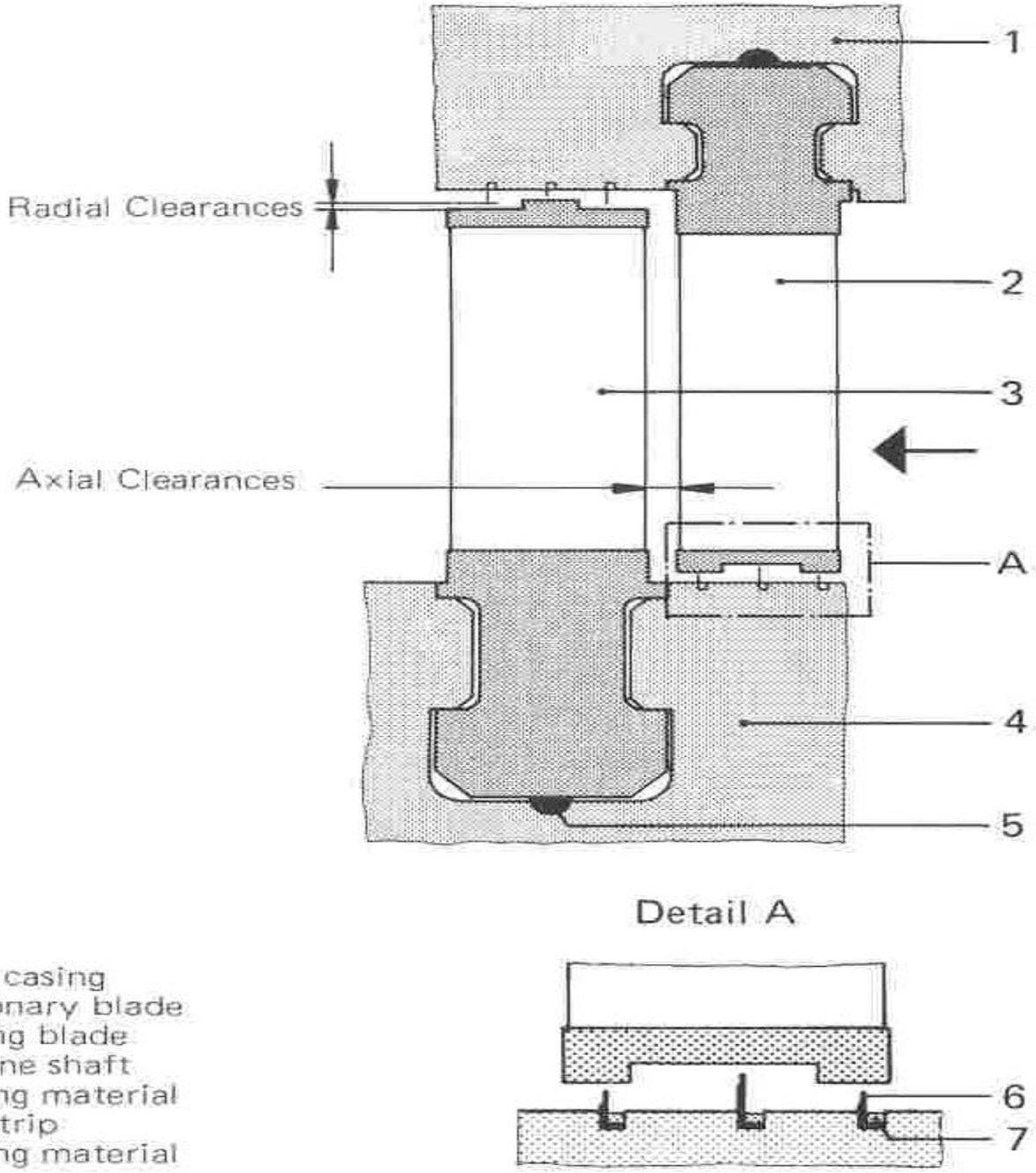


Fig. 1 Cross-Section Through an HMN Turbine



1 Inner casing
2 Stationary blade
3 Moving blade
4 Turbine shaft
5 Calking material
6 Seal strip
7 Calking material

Fig. 1 Drum Stages, Gap Sealing of the Drum Stages

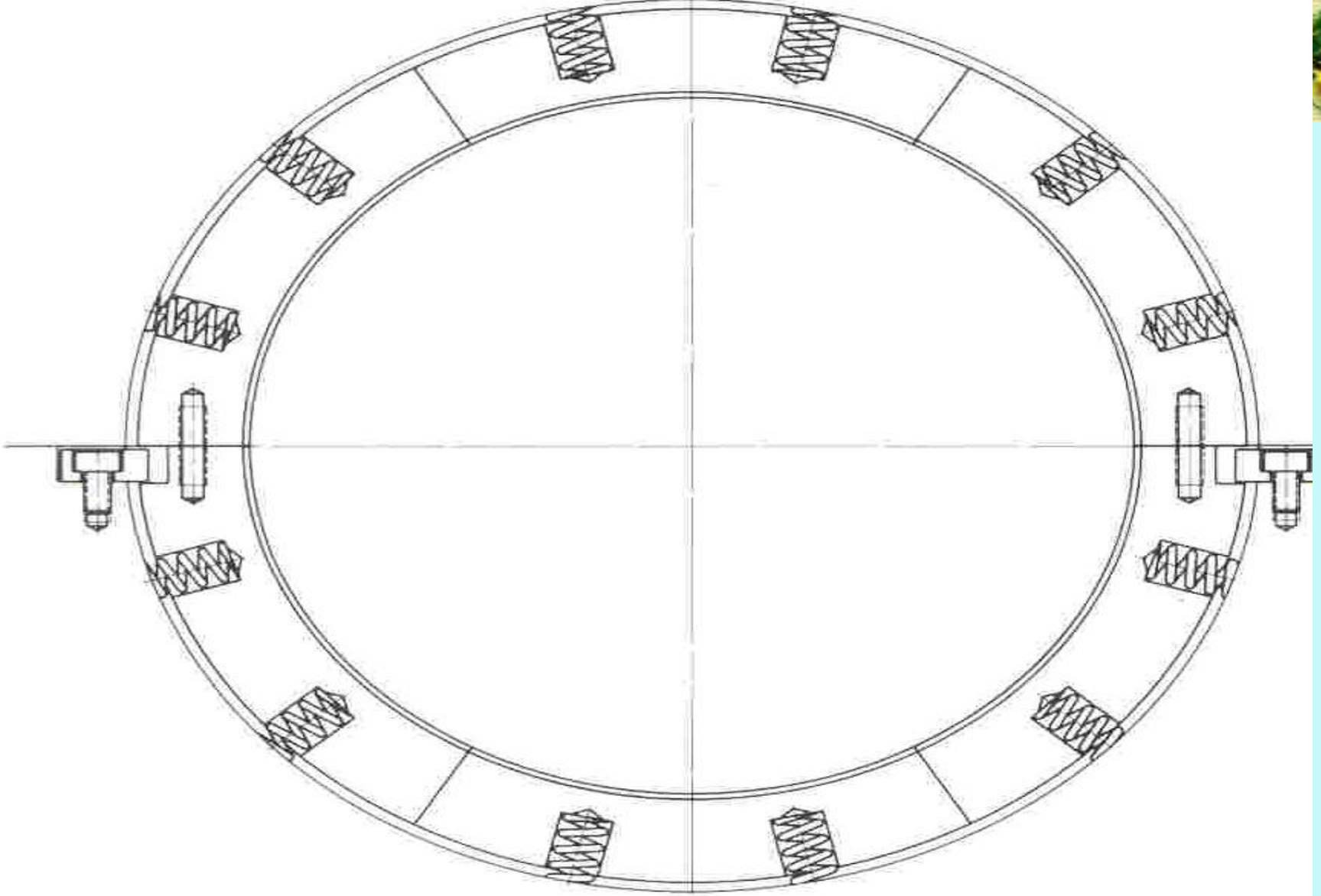
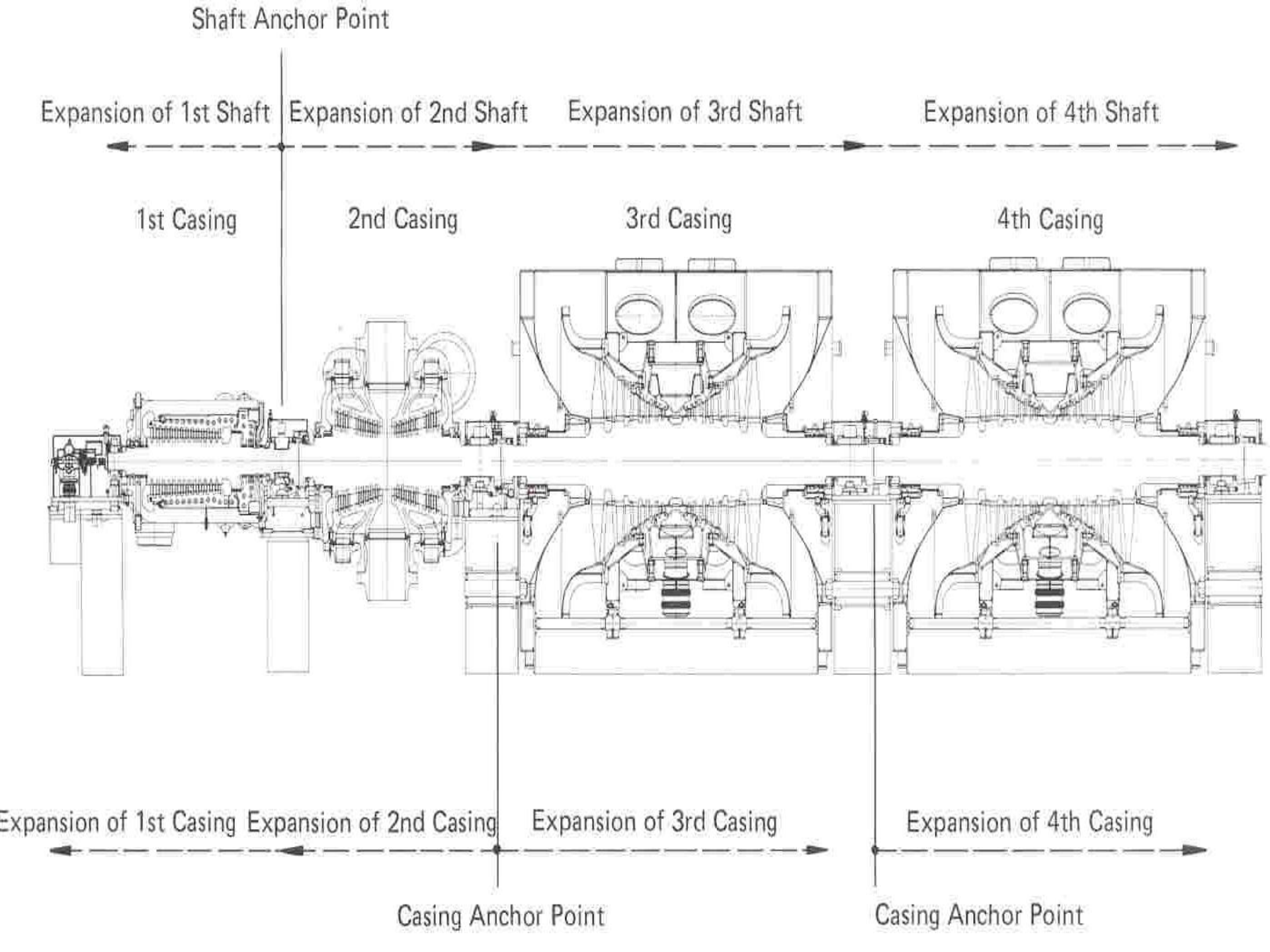
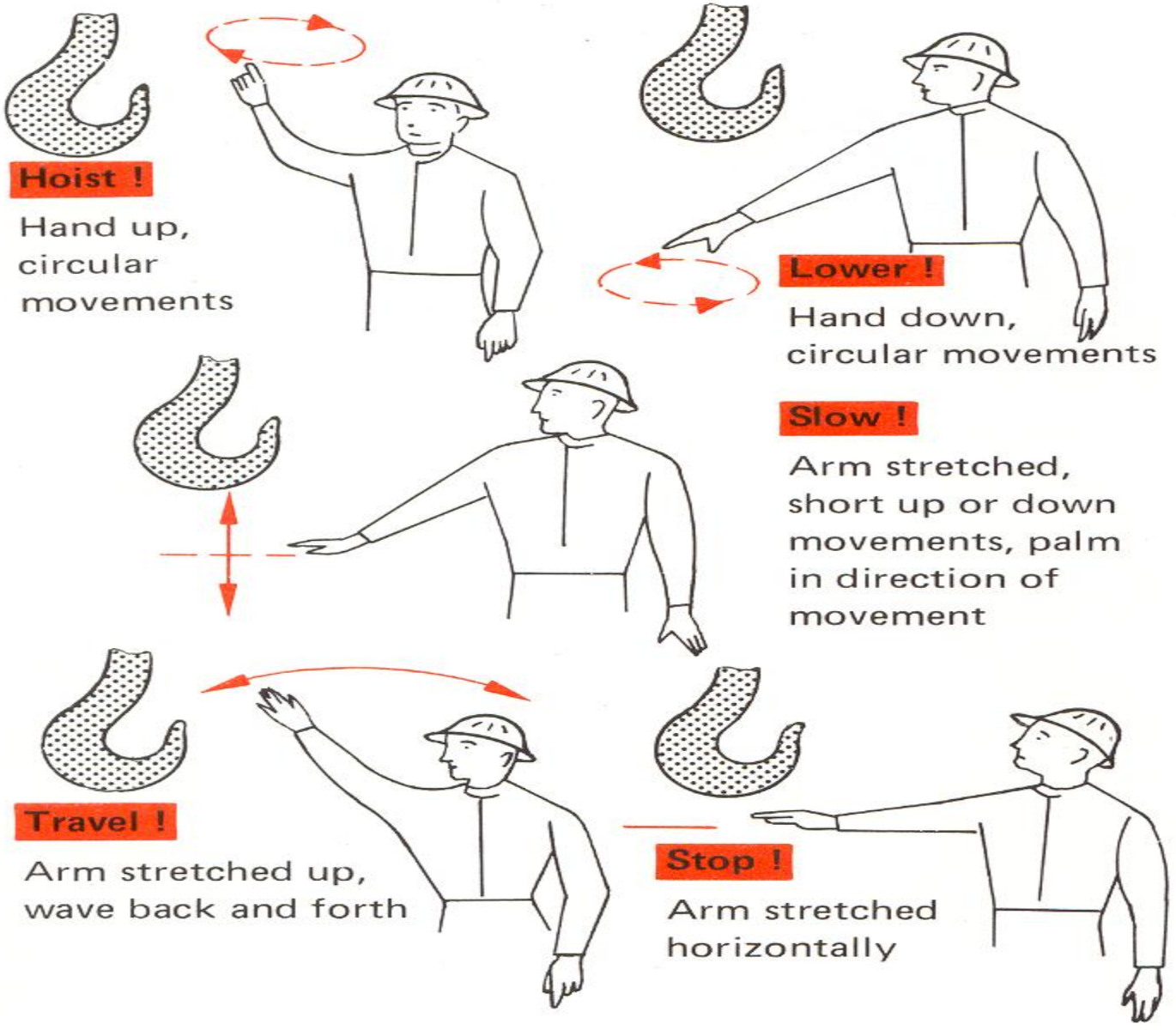


Fig. 2 Shaft Seals


Shaft Anchor Point
Expansion of 1st Shaft
Expansion of 2nd Shaft
Expansion of 3rd Shaft
Expansion of 4th Shaft
1st Casing
2nd Casing
3rd Casing
4th Casing
Expansion of 1st Casing
Expansion of 2nd Casing
Expansion of 3rd Casing
Expansion of 4th Casing
Casing Anchor Point
Casing Anchor Point

Loads may only be moved on signal from person in charge



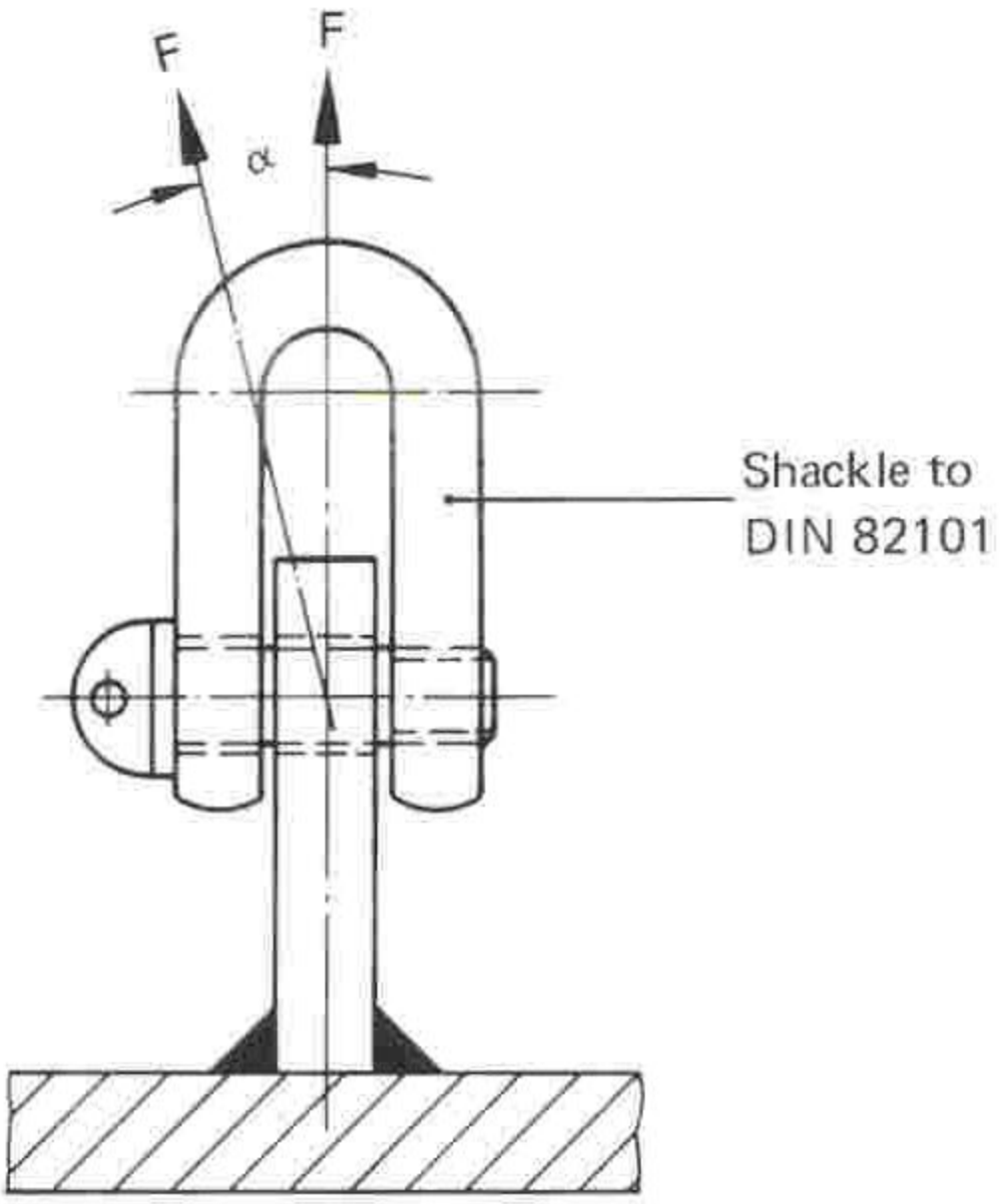


Fig. 1 Angle Deviation Not Permissible

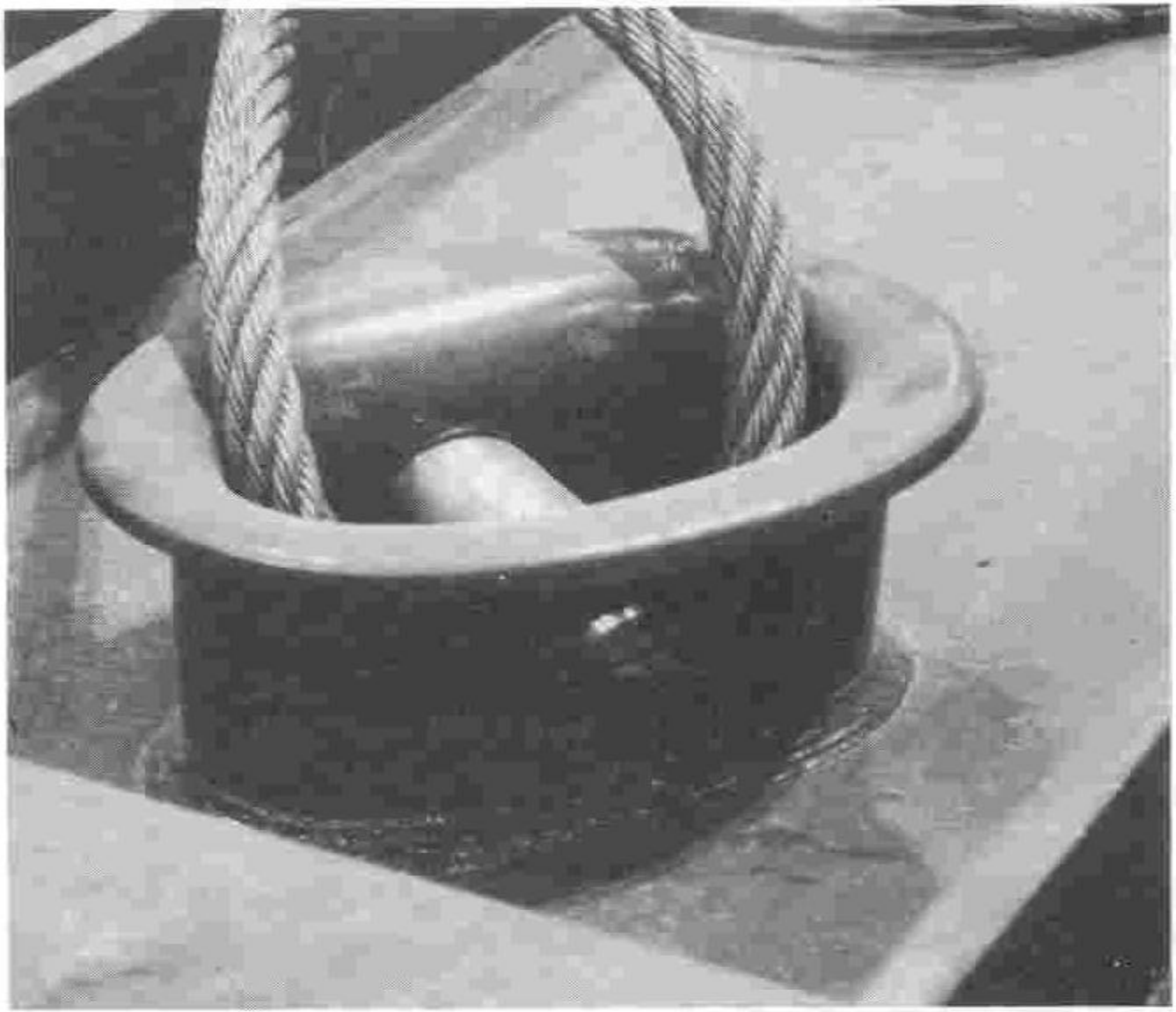


Fig. 3 Lifting Attachment on Heavy Turbine Components

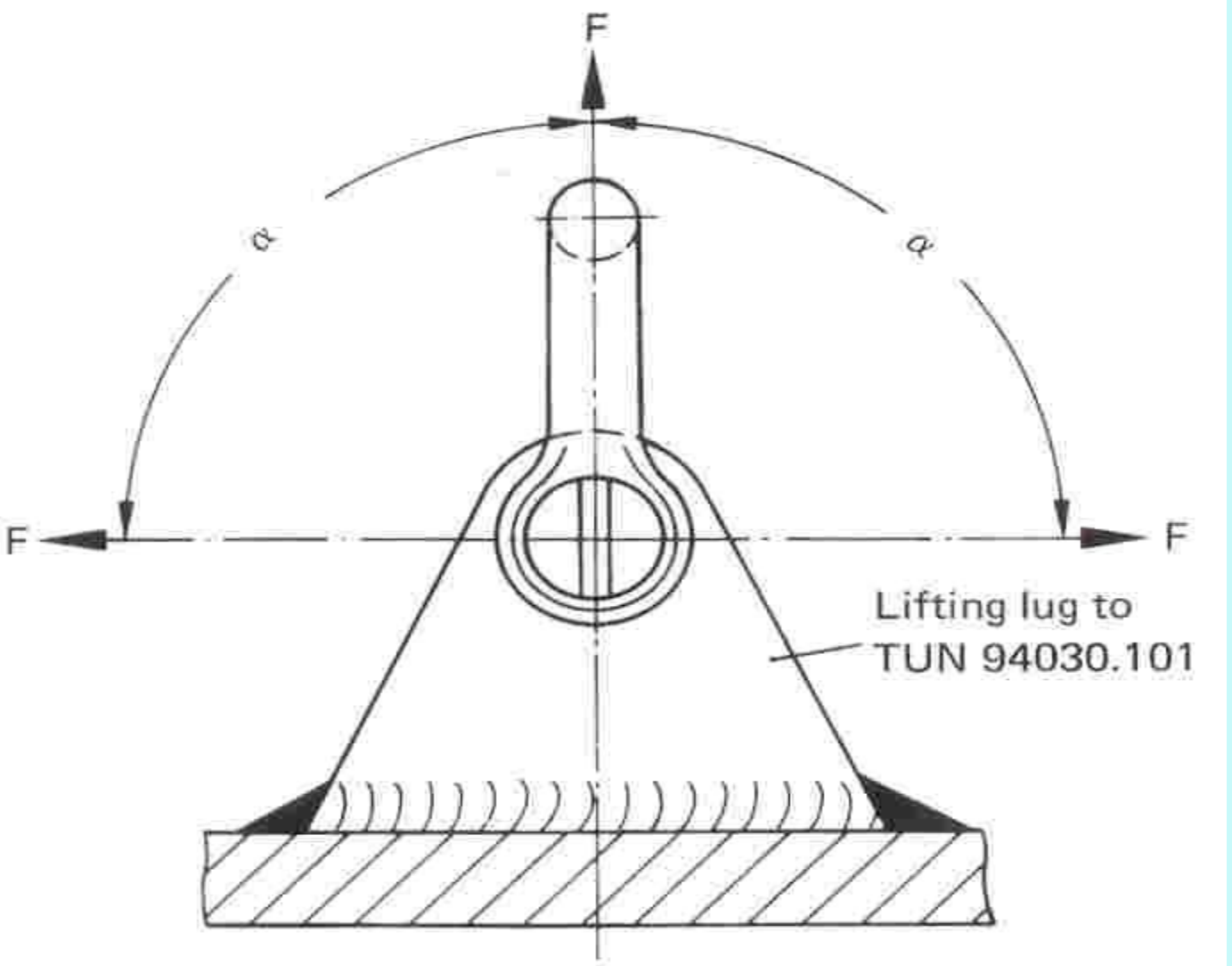


Fig. 2 Angle Deviation Permissible up to 90°

case to protect the wire attachment ropes and machined surfaces against damage, Fig. 4.

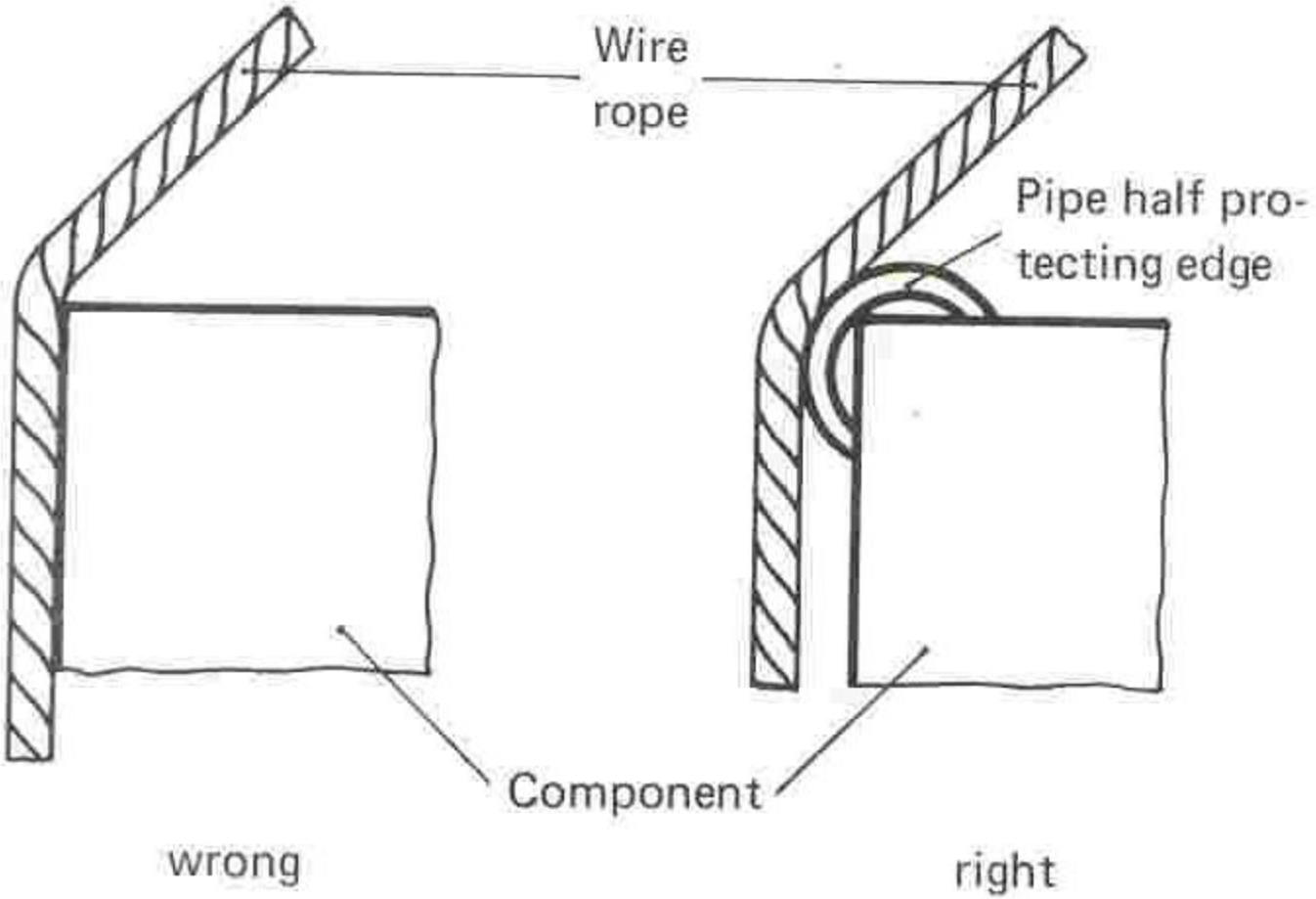


Fig. 4 Protection of Sharp Edges to Prevent Damage to Wire Ropes

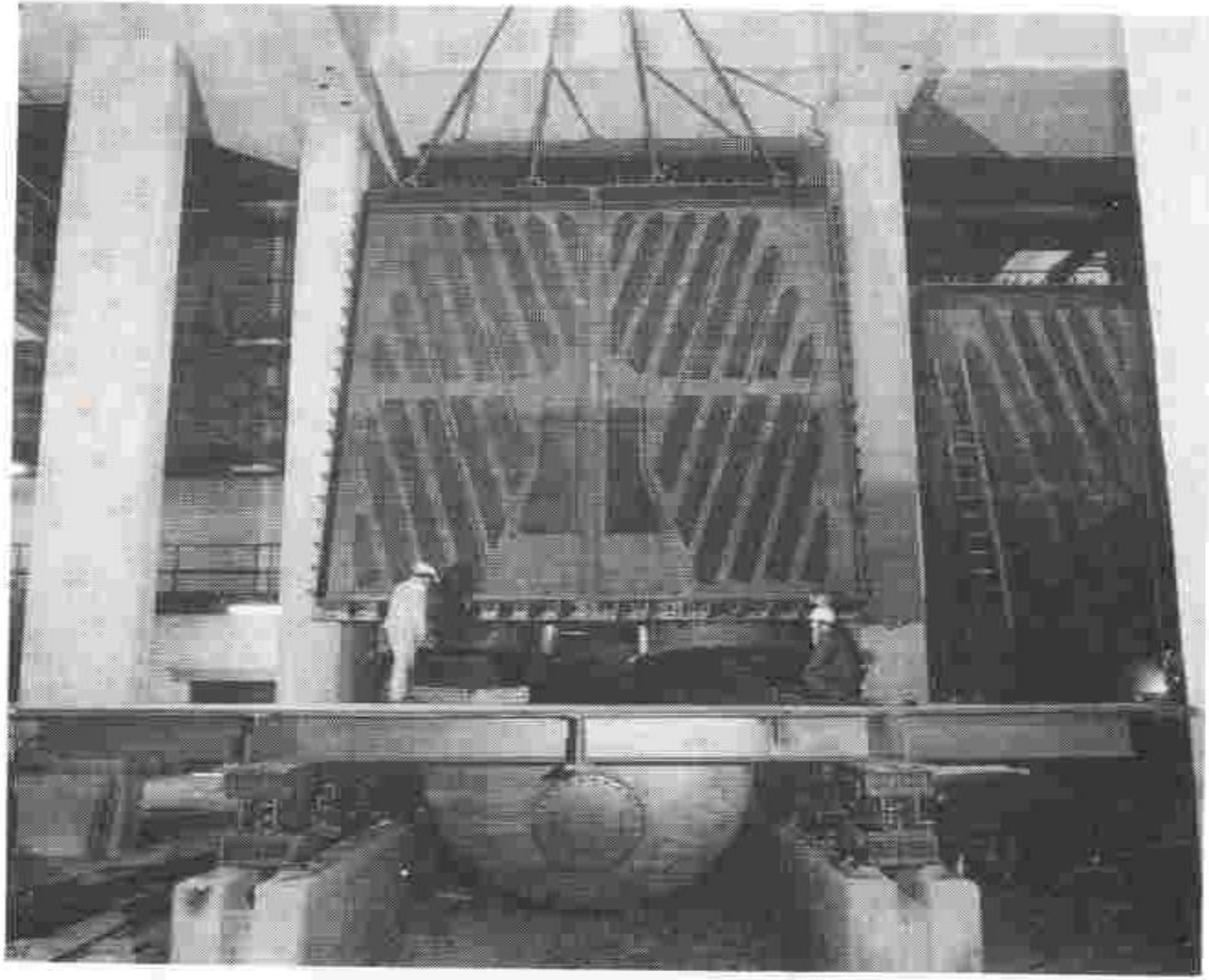


Fig. 6 Attachment of a Condenser Waterbox

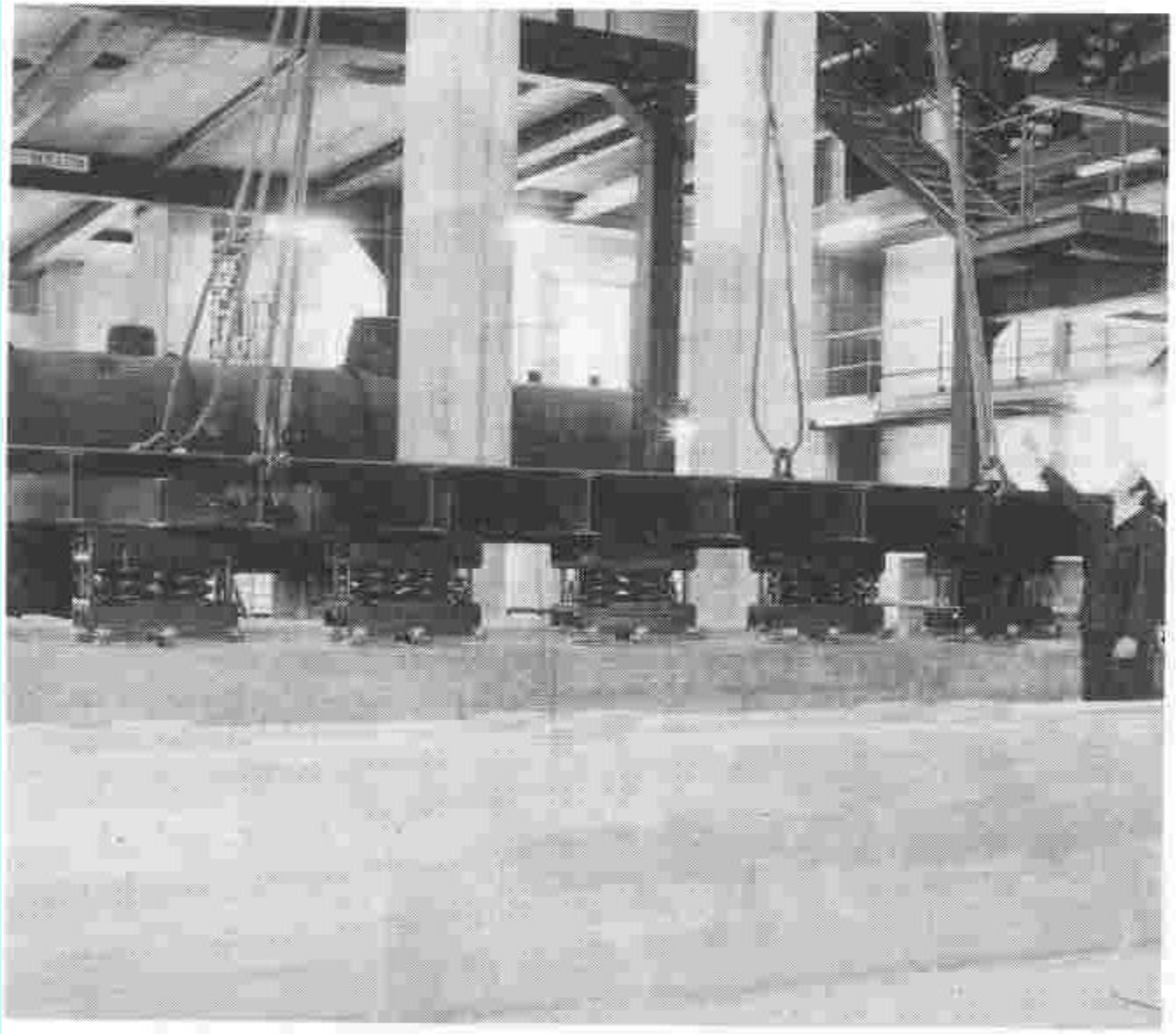


Fig. 5 Attachment of a Condenser Bottom Plate Section

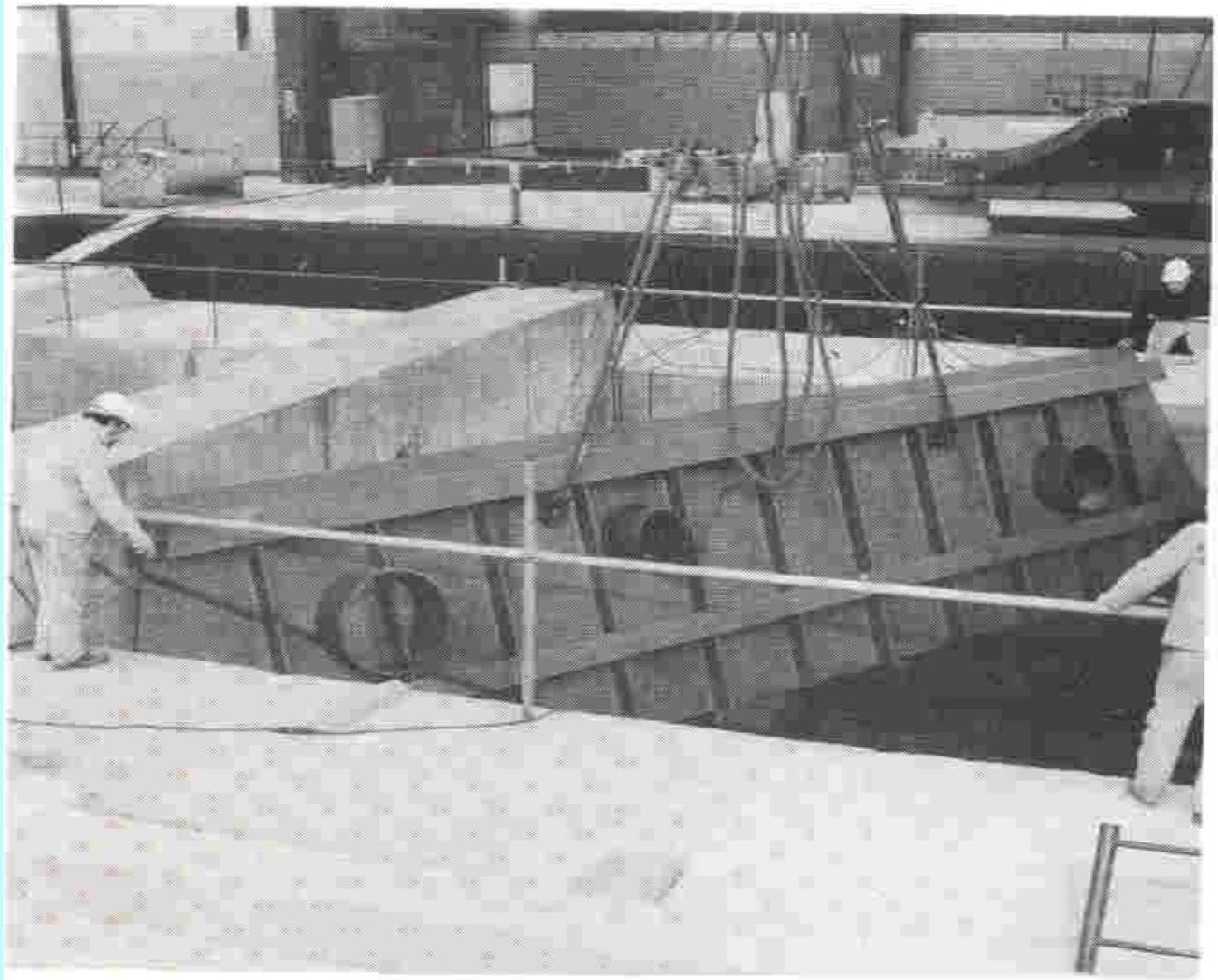


Fig. 7 Attachment of a Condenser Steam Dome Wall

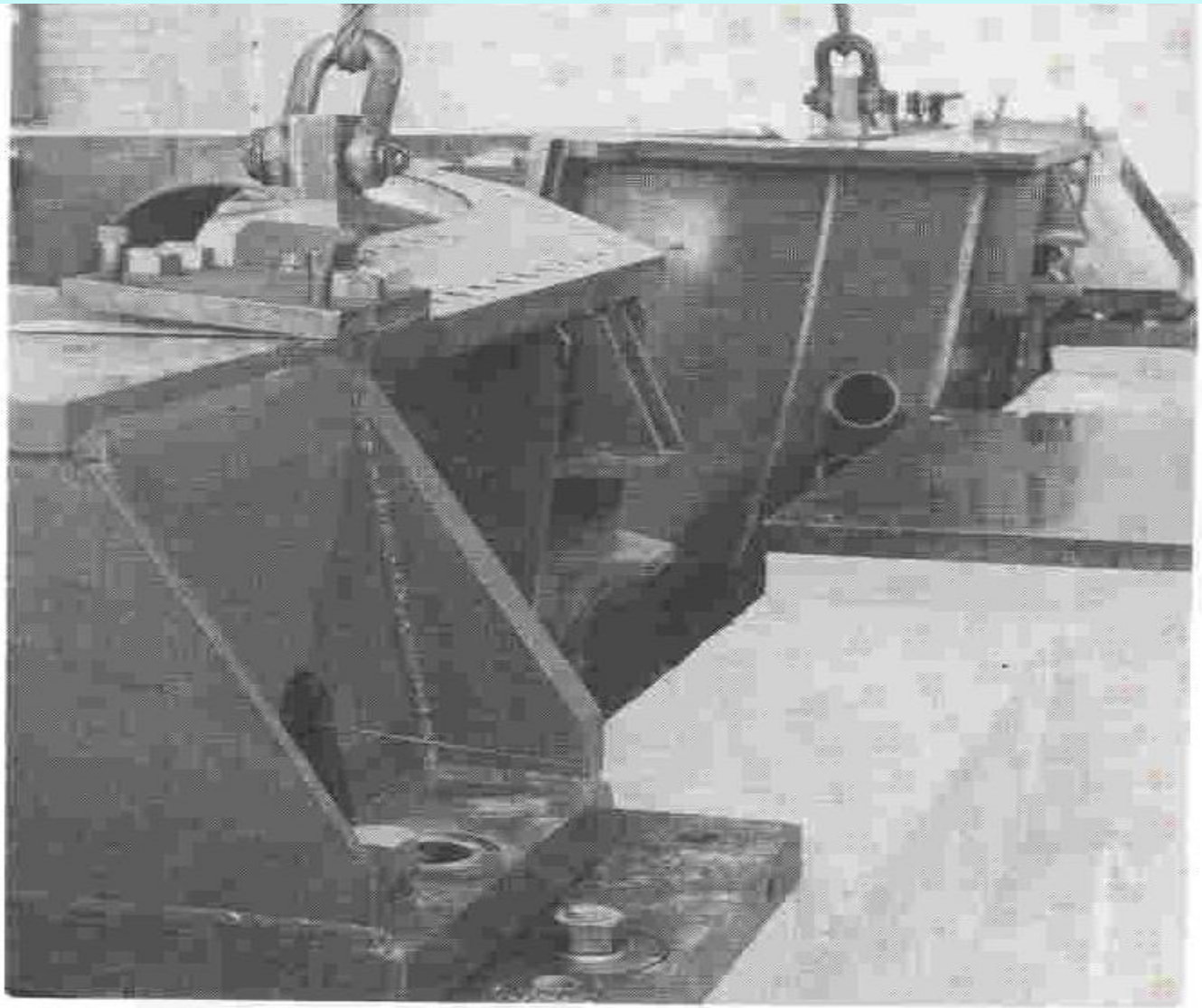


Fig. 8 Lifting Attachment for the Assembly of an LP Casing End Wall

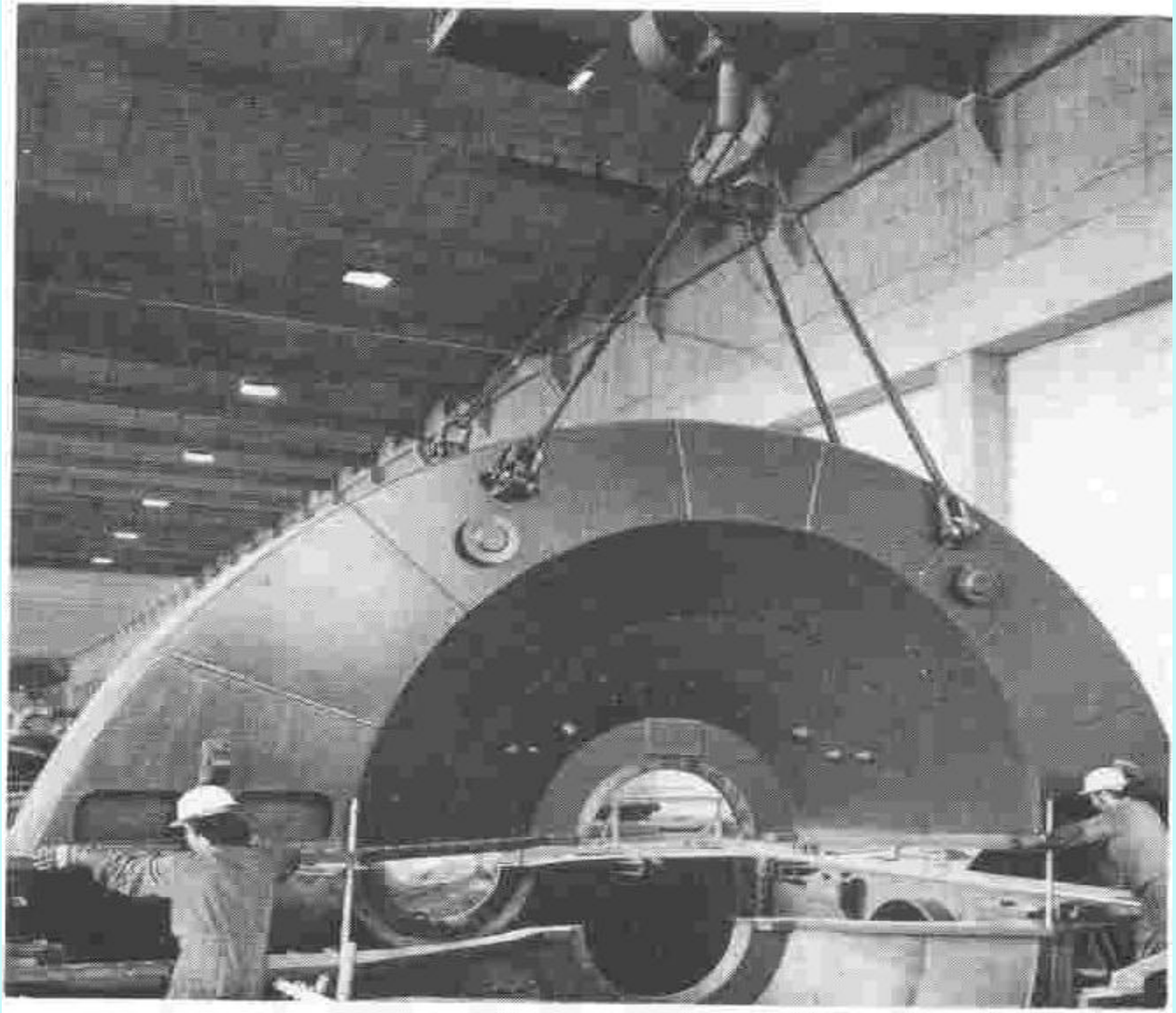


Fig. 10 Lifting Lugs on the LP Casing Hood Sections

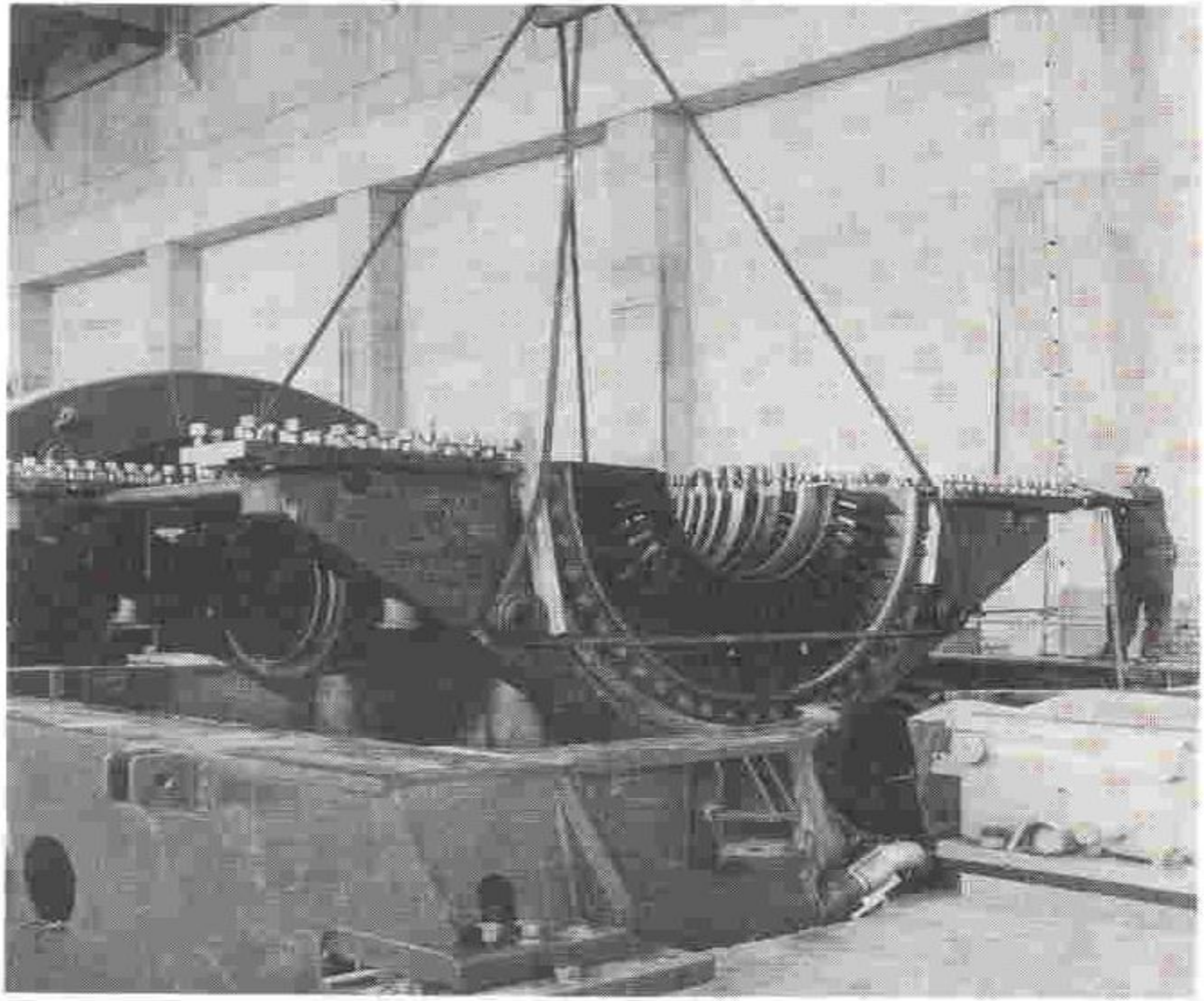


Fig. 9 Lifting Attachment with Edge Protection for the Assembly of the Outer Inner Casing

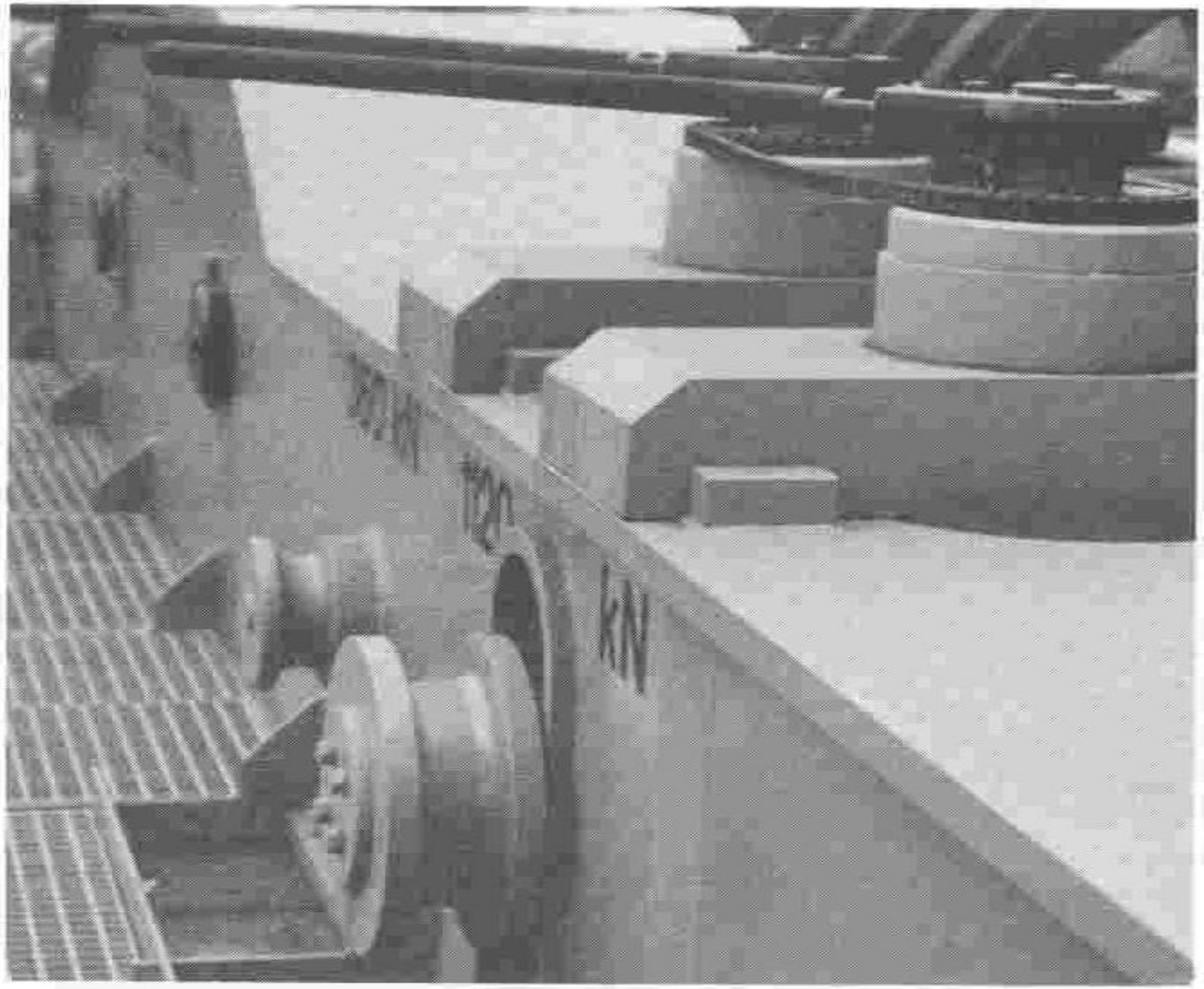


Fig. 11 Adjusting Device on the Lifting Beam

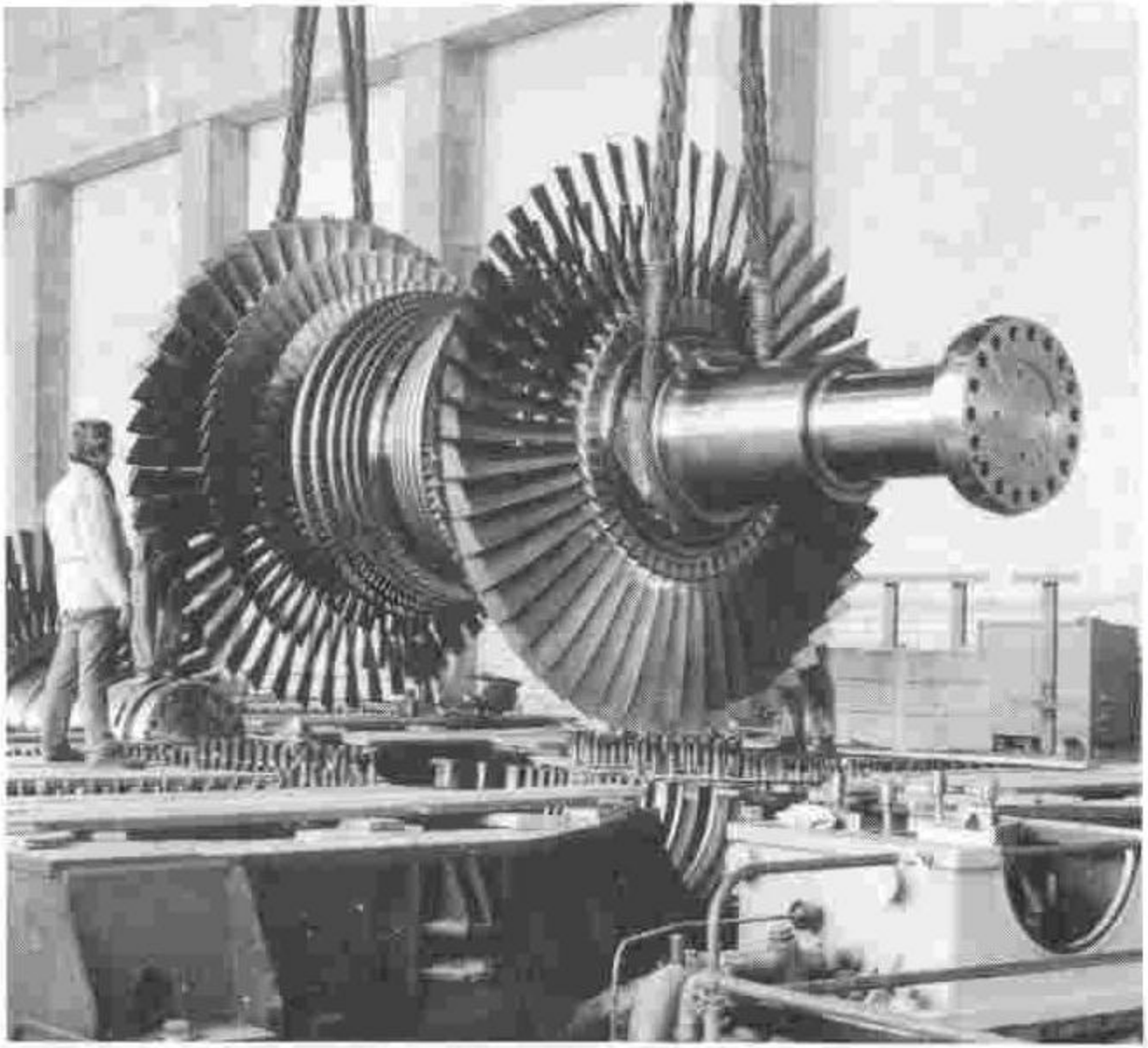


Fig. 12 Installation of a Turbine Shaft

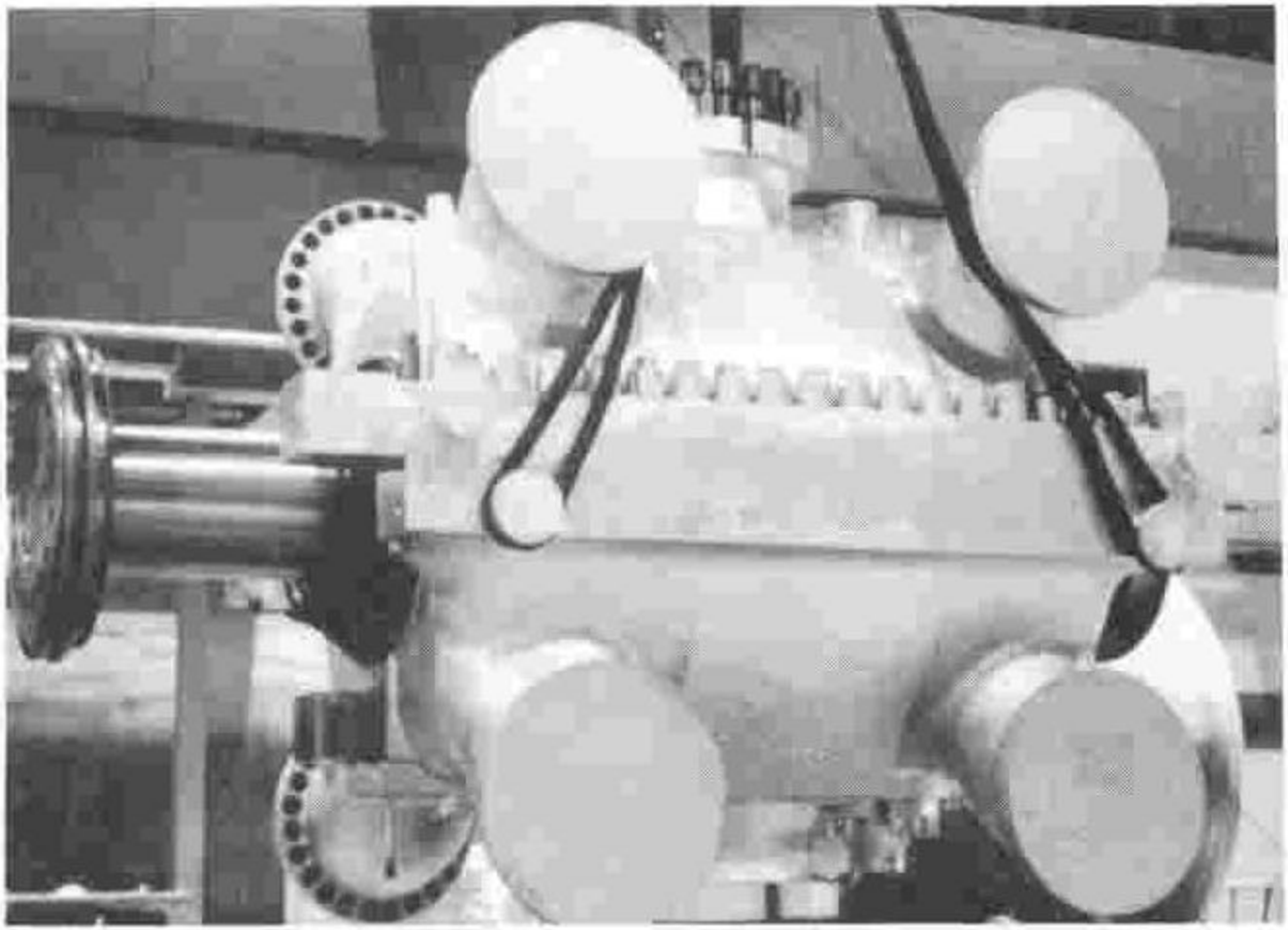


Fig. 13 IP Turbine Attached

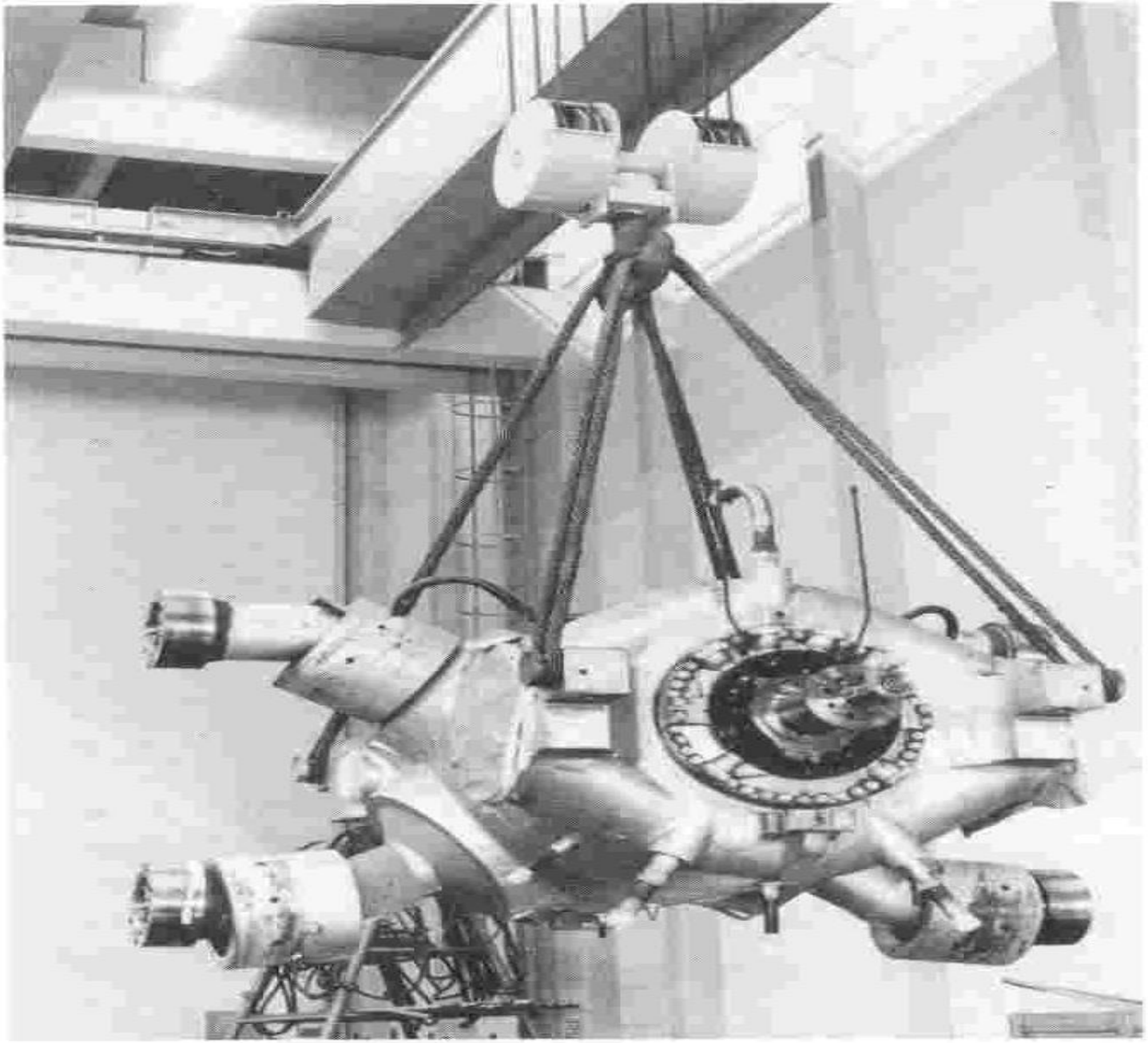


Fig. 14 Attachment Trunnions on the HP Turbine

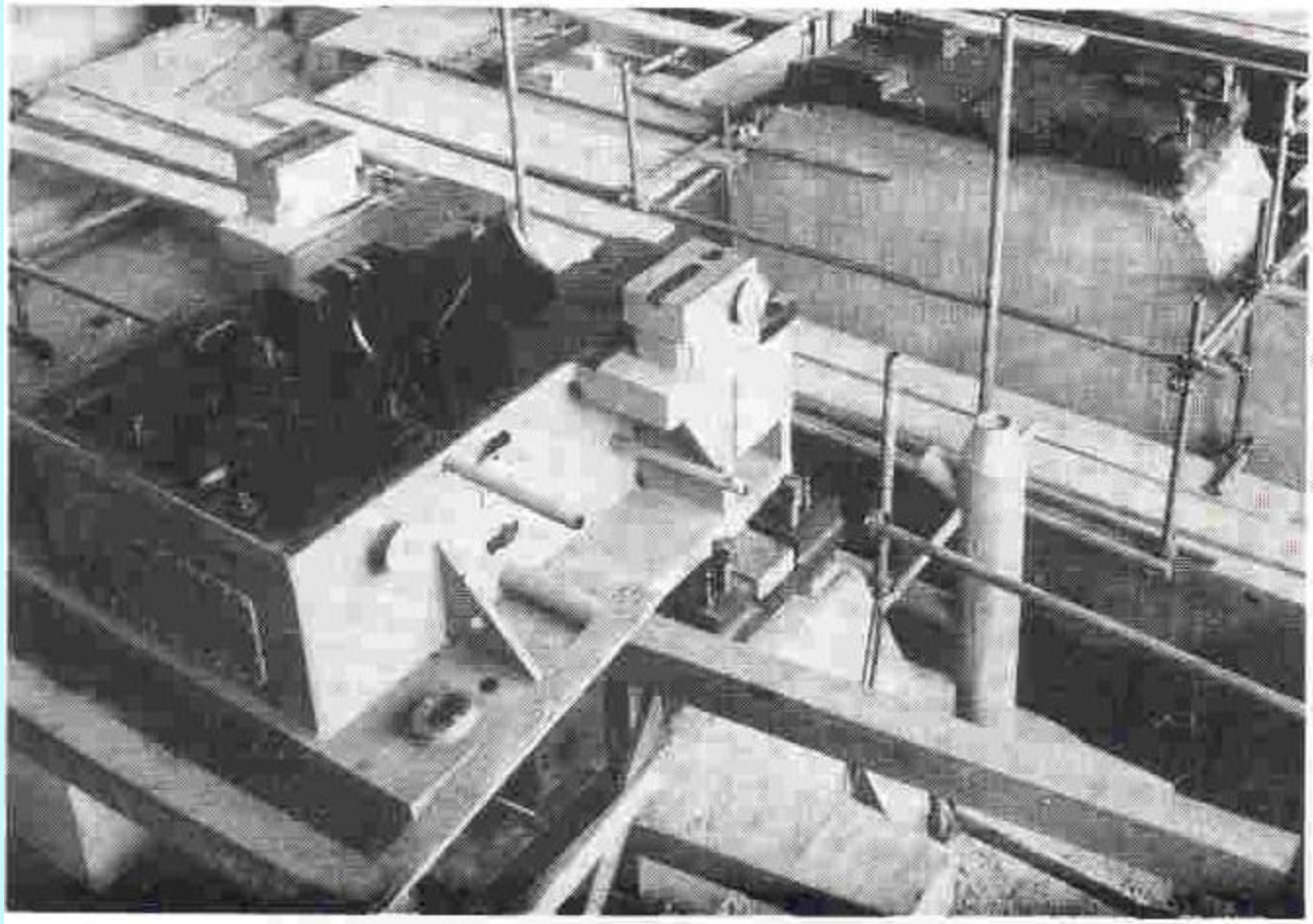


Fig. 1 Uncovered Front Bearing Pedestal

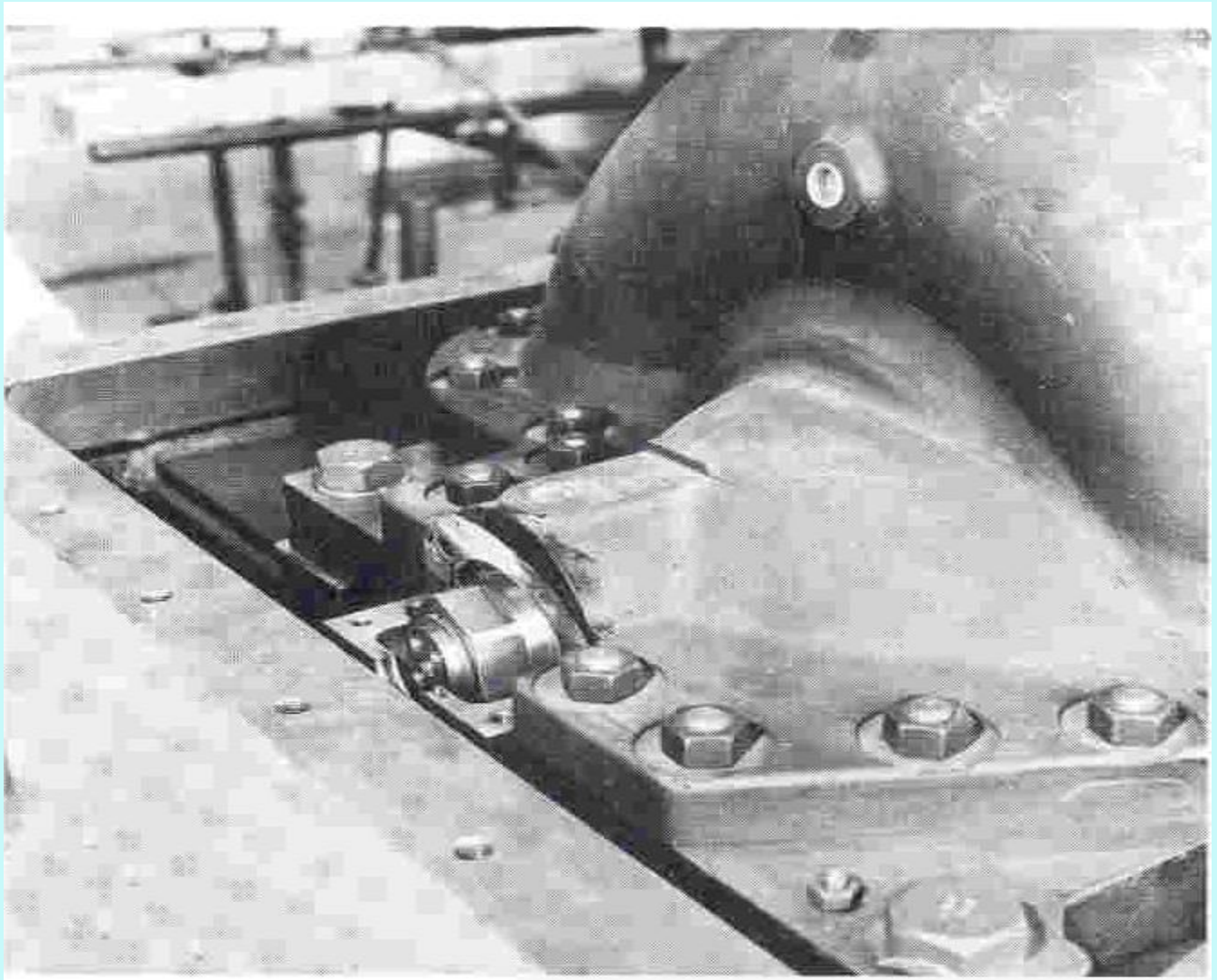


Fig. 2 Main Oil Pump in Front Bearing Pedestal

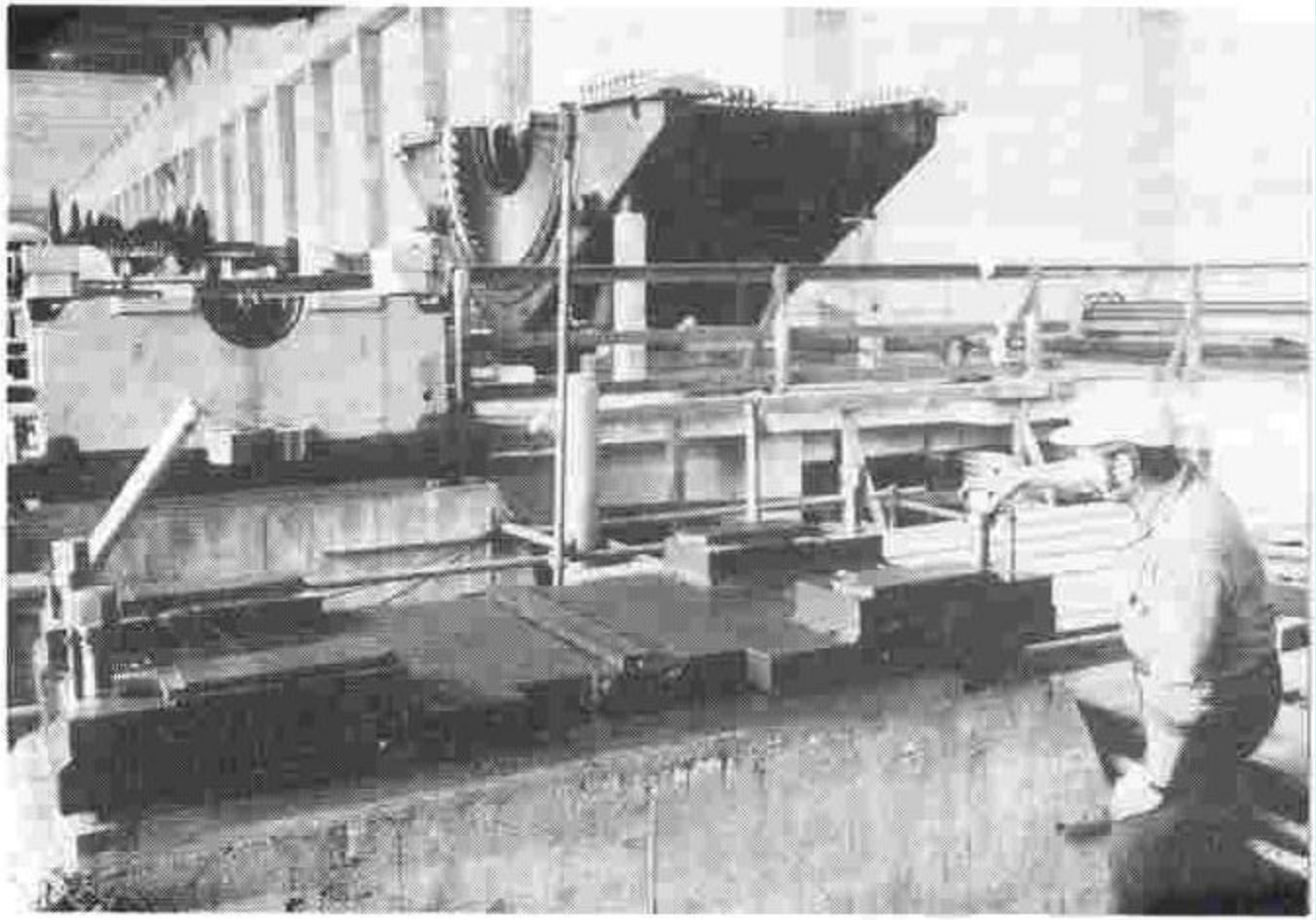


Fig. 3 Treatment of Base Plates

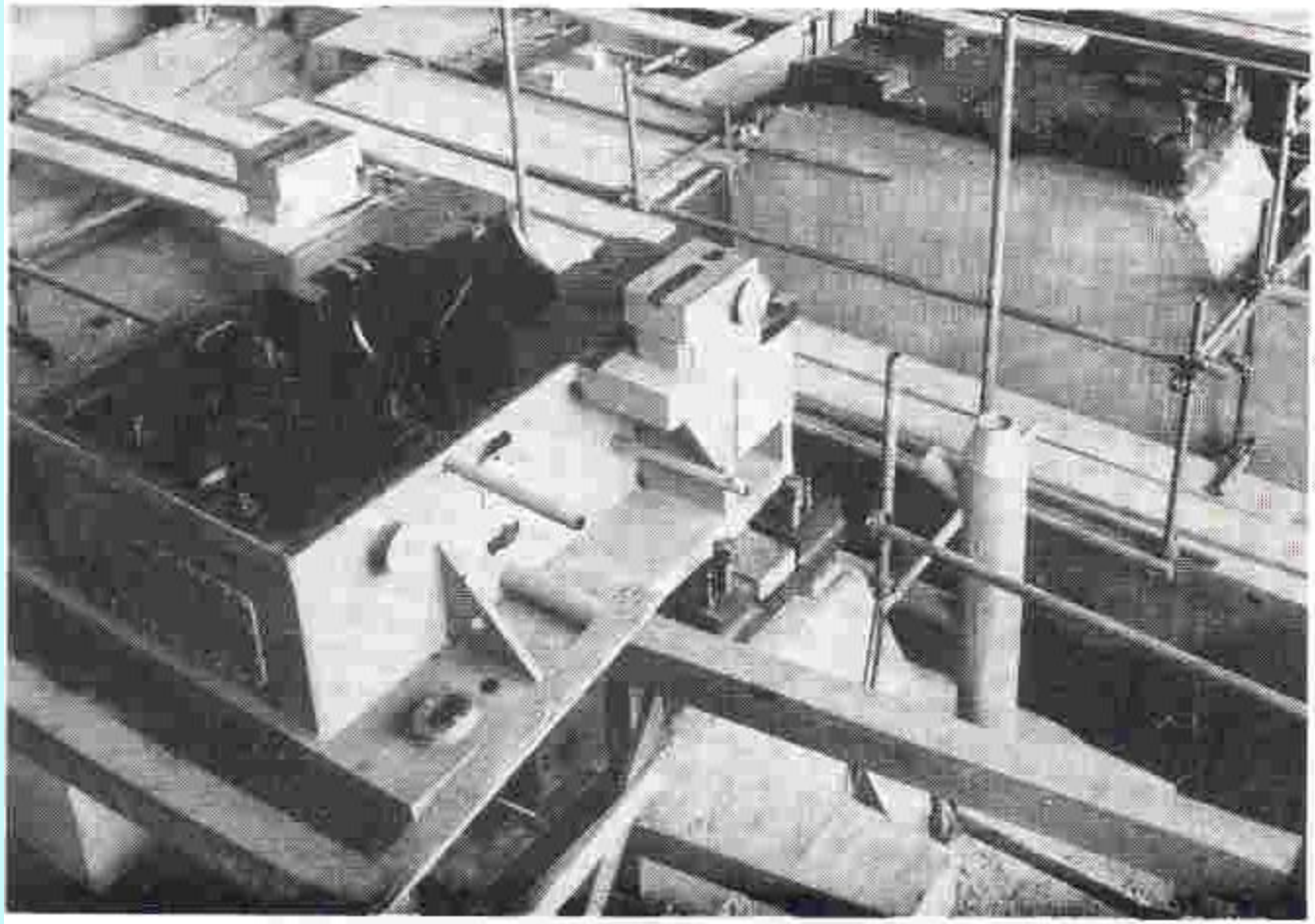


Fig. 1 Uncovered Front Bearing Pedestal

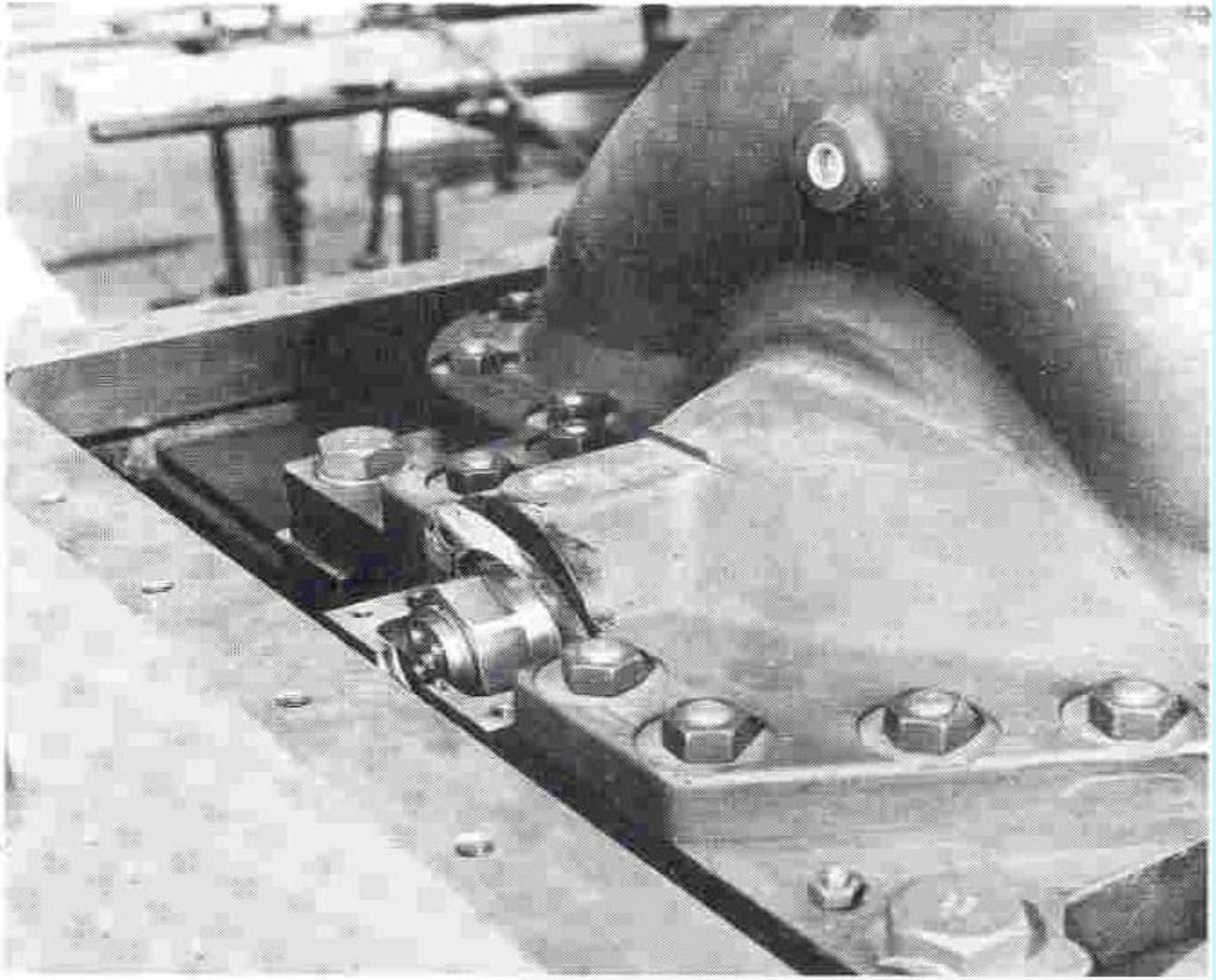


Fig. 2 Main Oil Pump in Front Bearing Pedestal

Fig. 4 Treatment of Base Plates

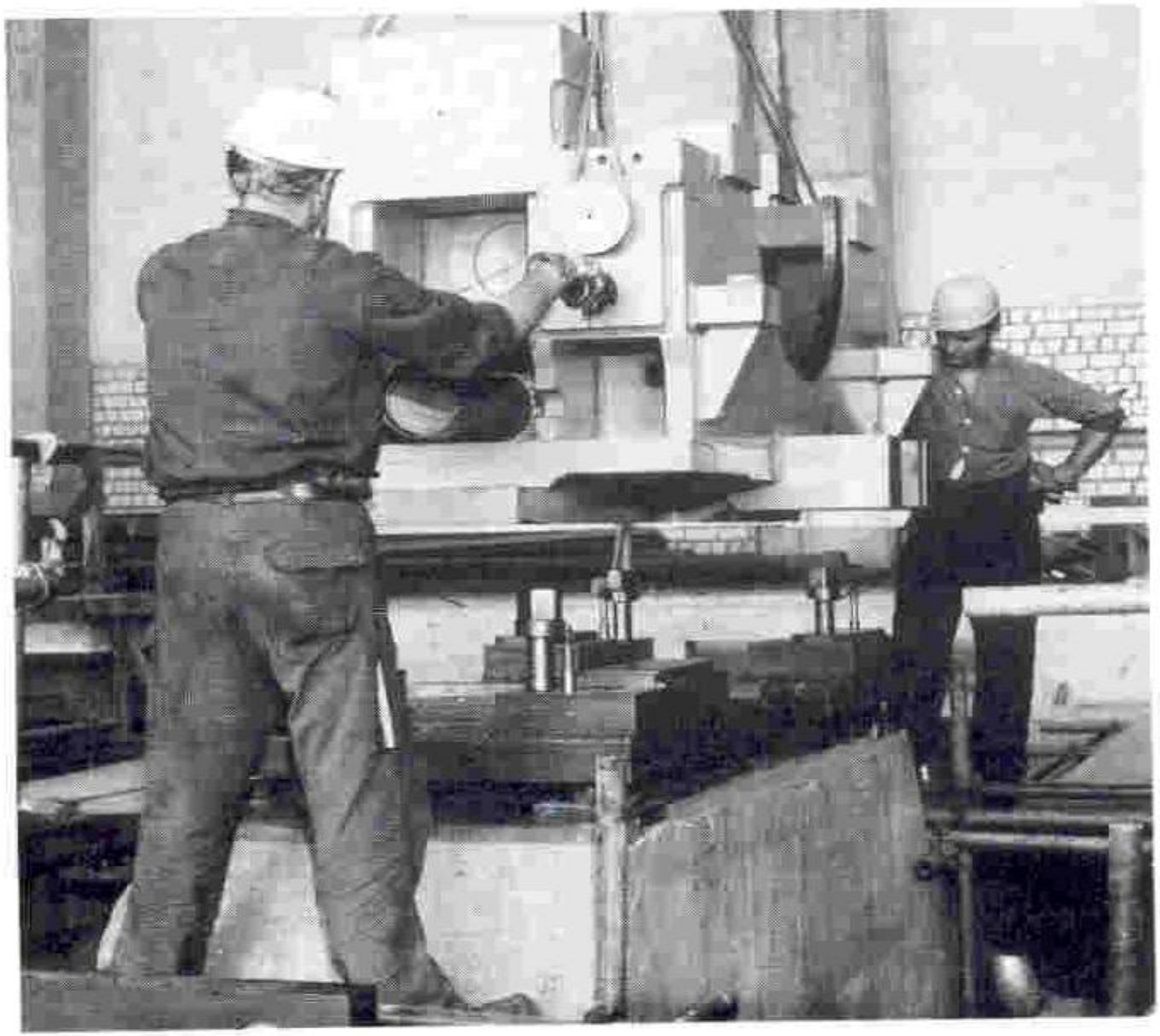


Fig. 6 Setting Down Bearing Pedestal

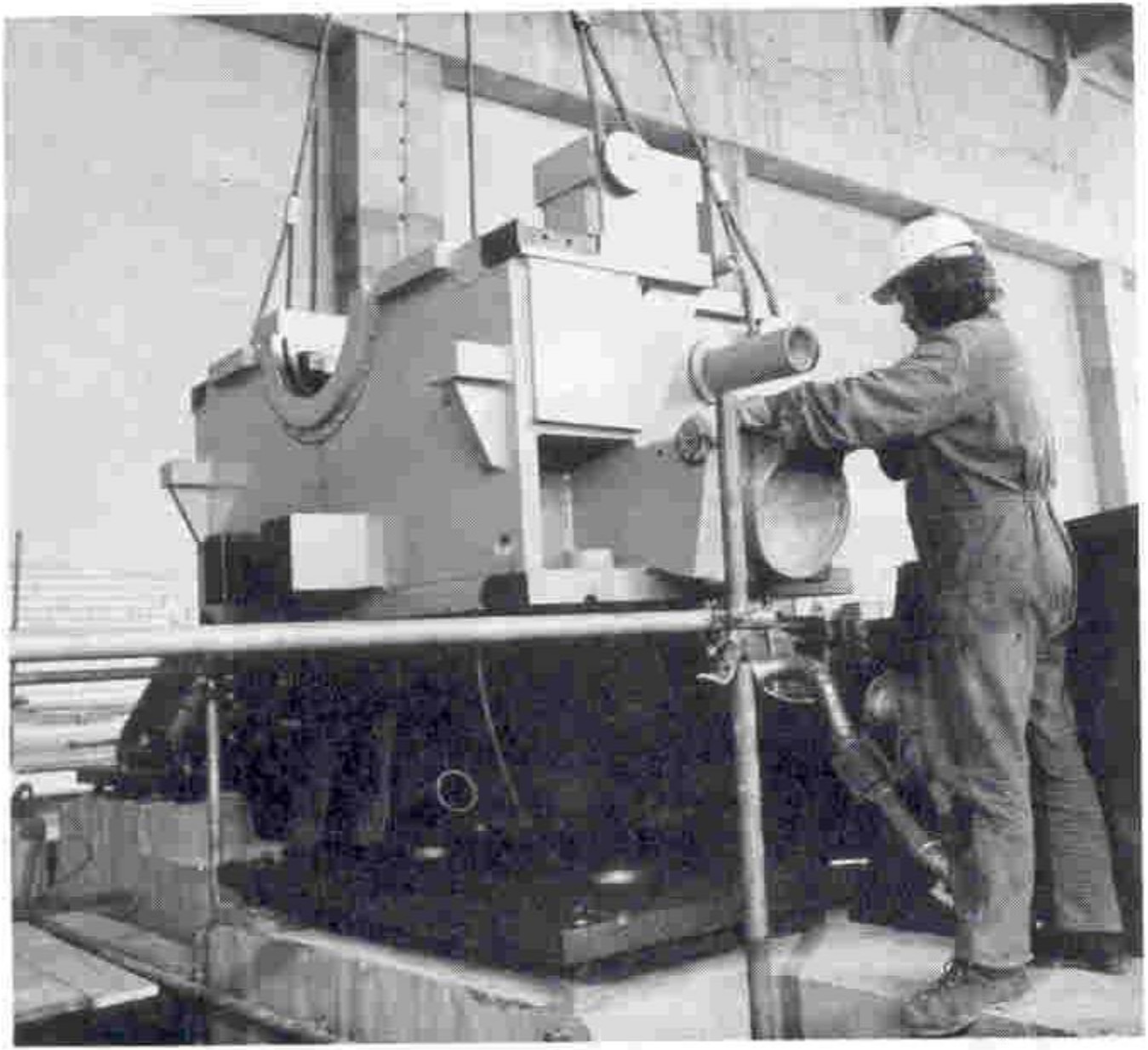


Fig. 5 Setting Down Bearing Pedestal

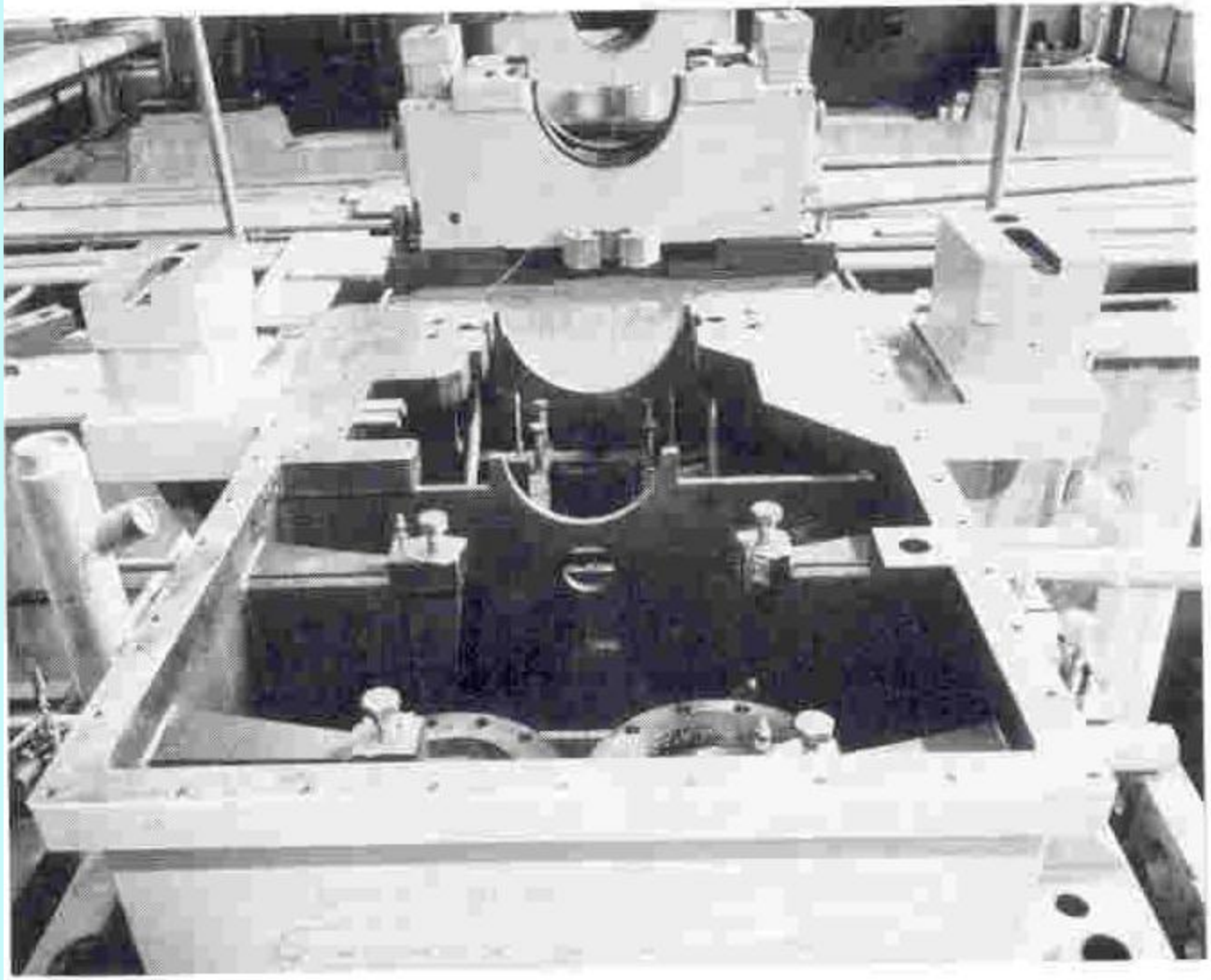


Fig. 7 Bearing Pedestal in Mounted Position

Fig. 8 Aligning Bearing Pedestal

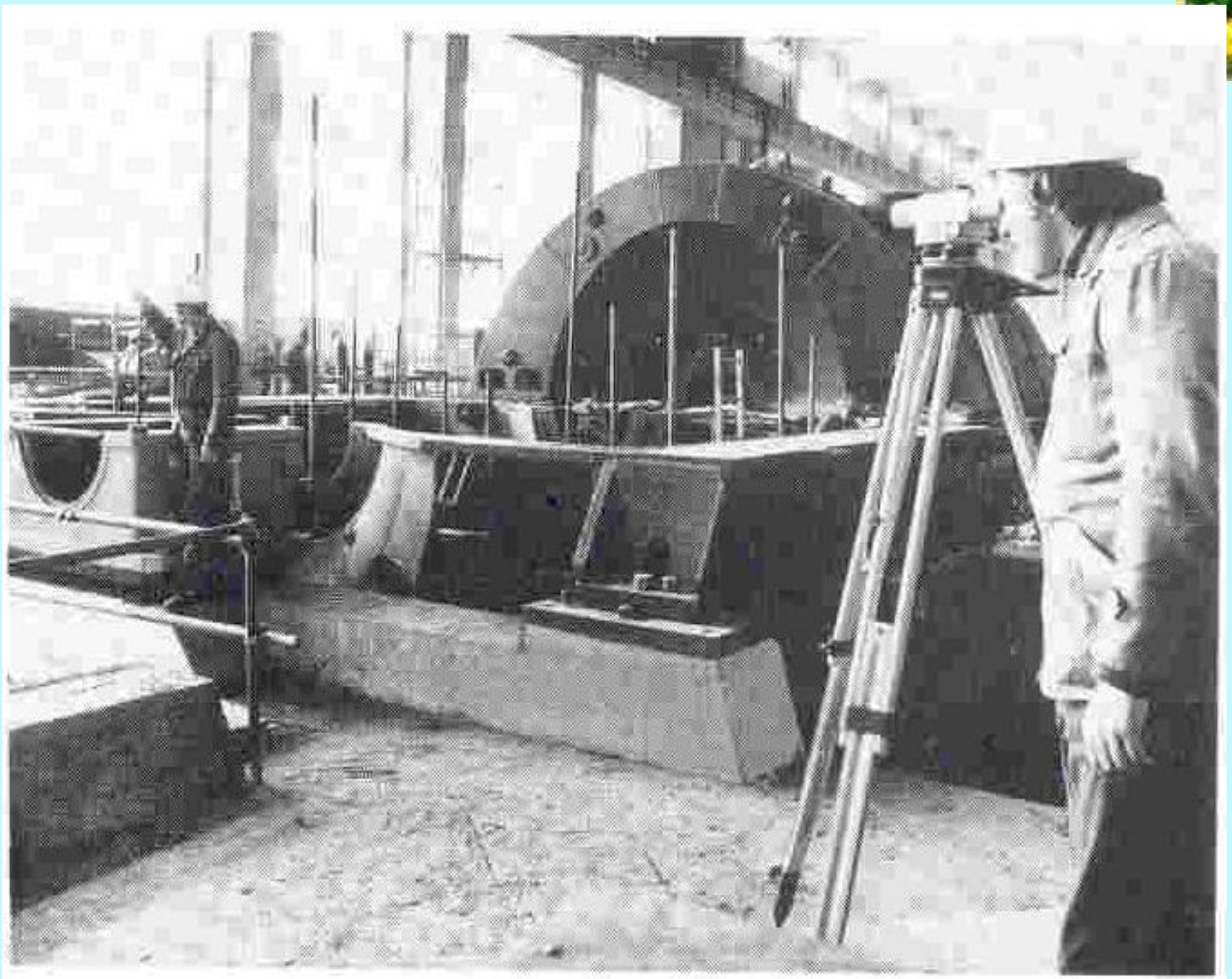


Fig. 9 Checking the Elevation

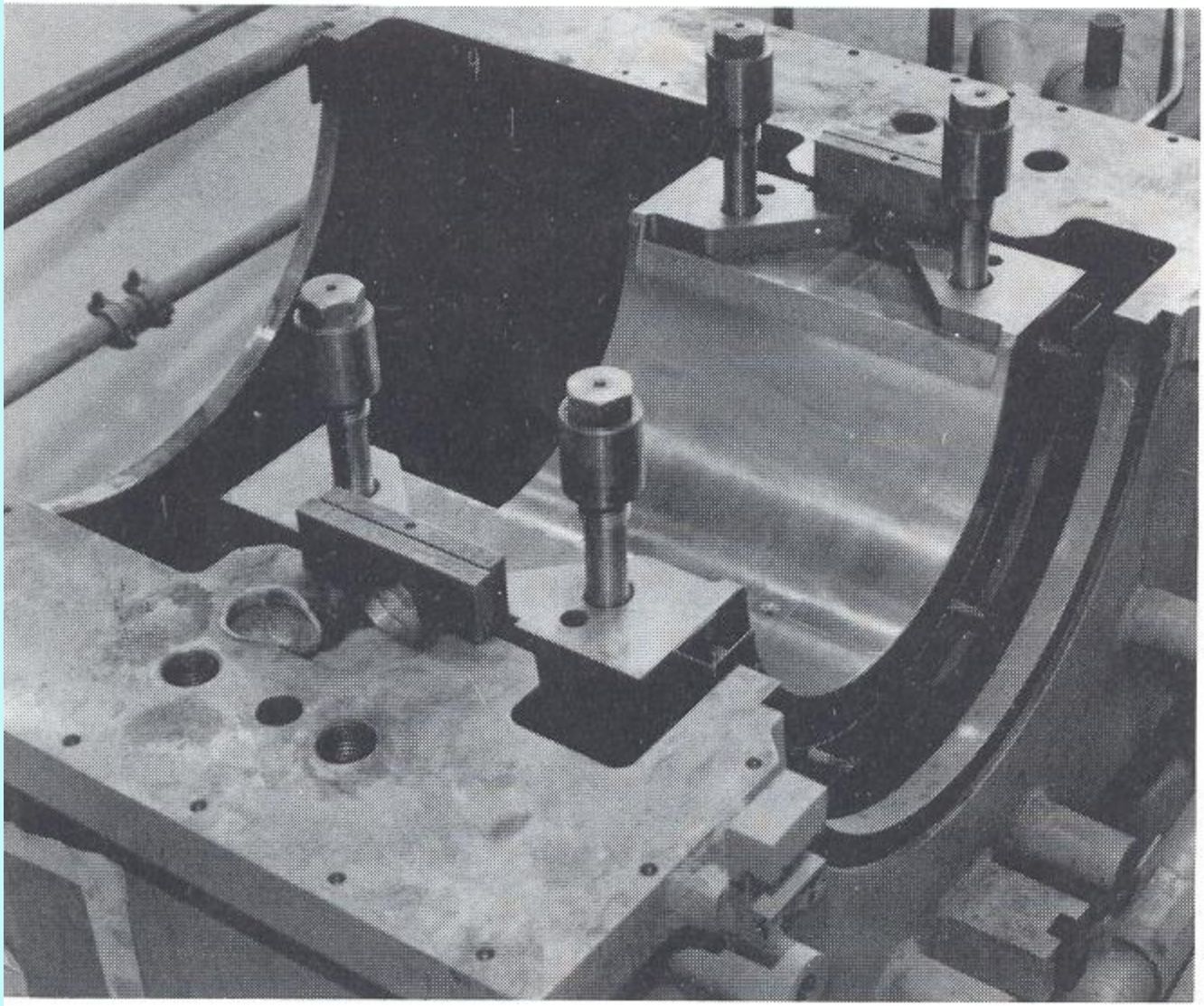
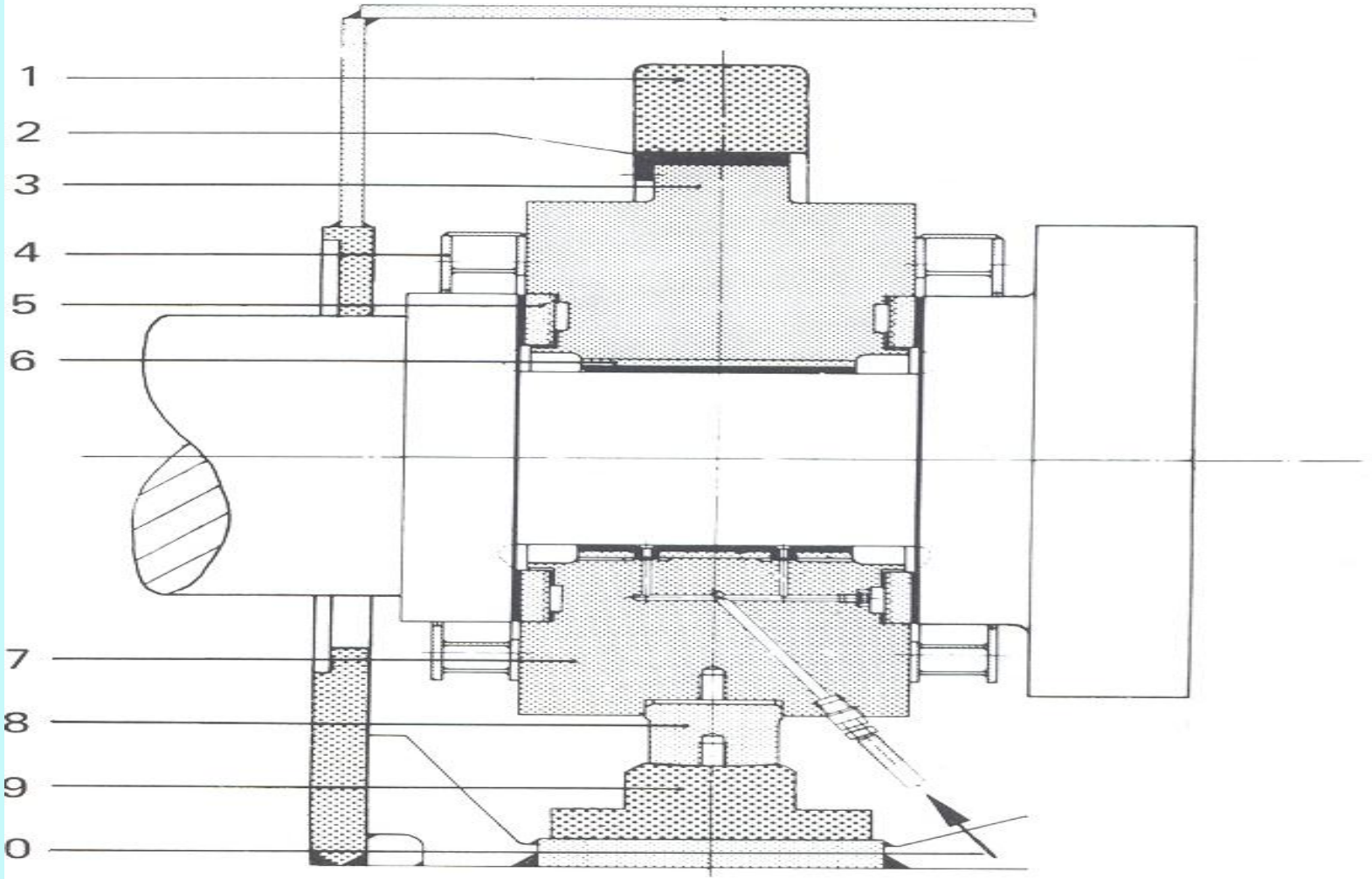


Fig. 1 Lower Bearing Shell in Bearing Pedestal



1 Cap
2 Key
3 Upper bearing shell
4 Oil return cowling
5 Thrust pad
6 Bearing bushing
7 Lower bearing shell
8 Spherical block
9 Cup
0 Jacking oil connection

ig. 2 Components of Combined Journal and Thrust Bearing

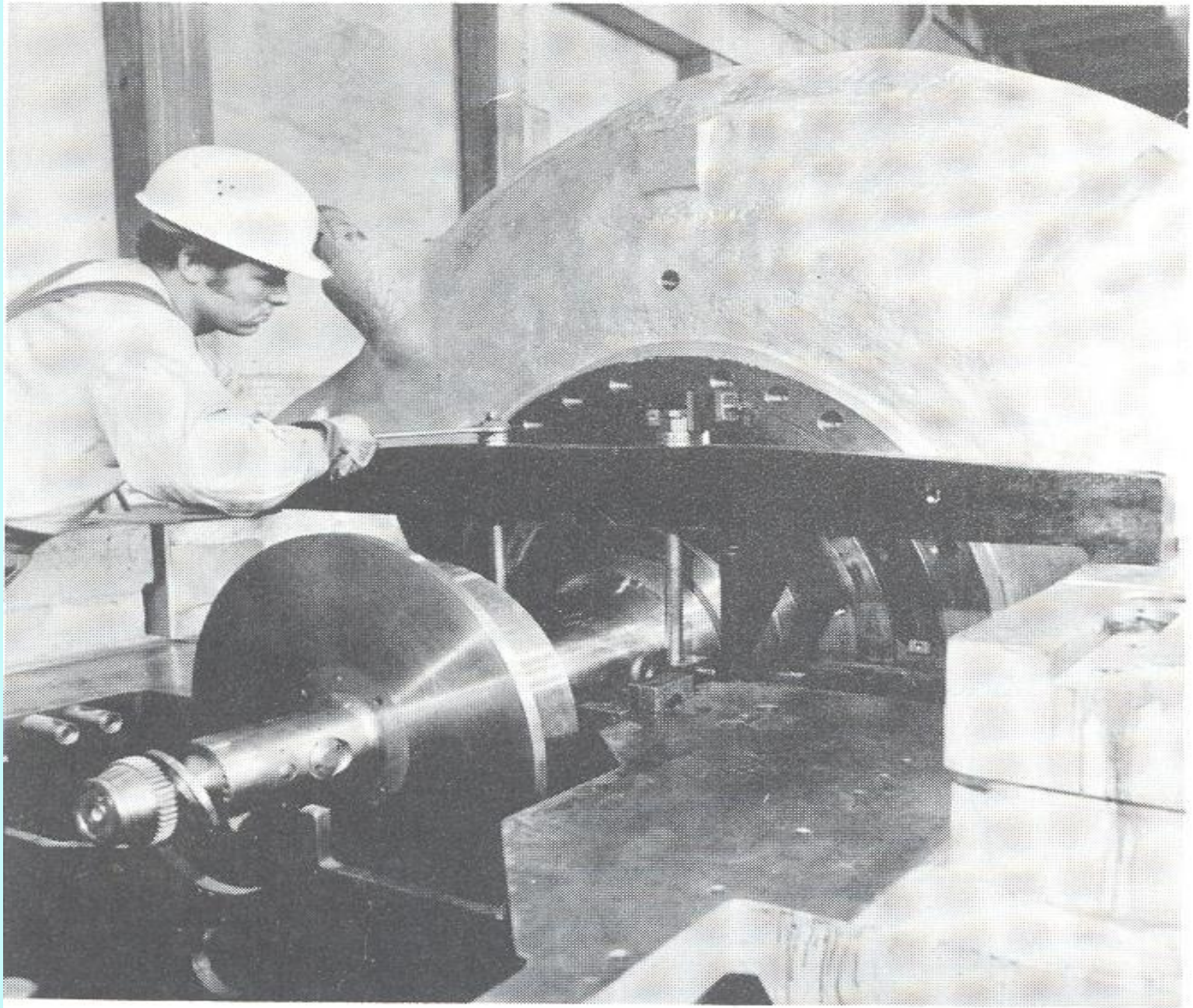


Fig. 3 Lifting Turbine Shaft for Installation of Bearing

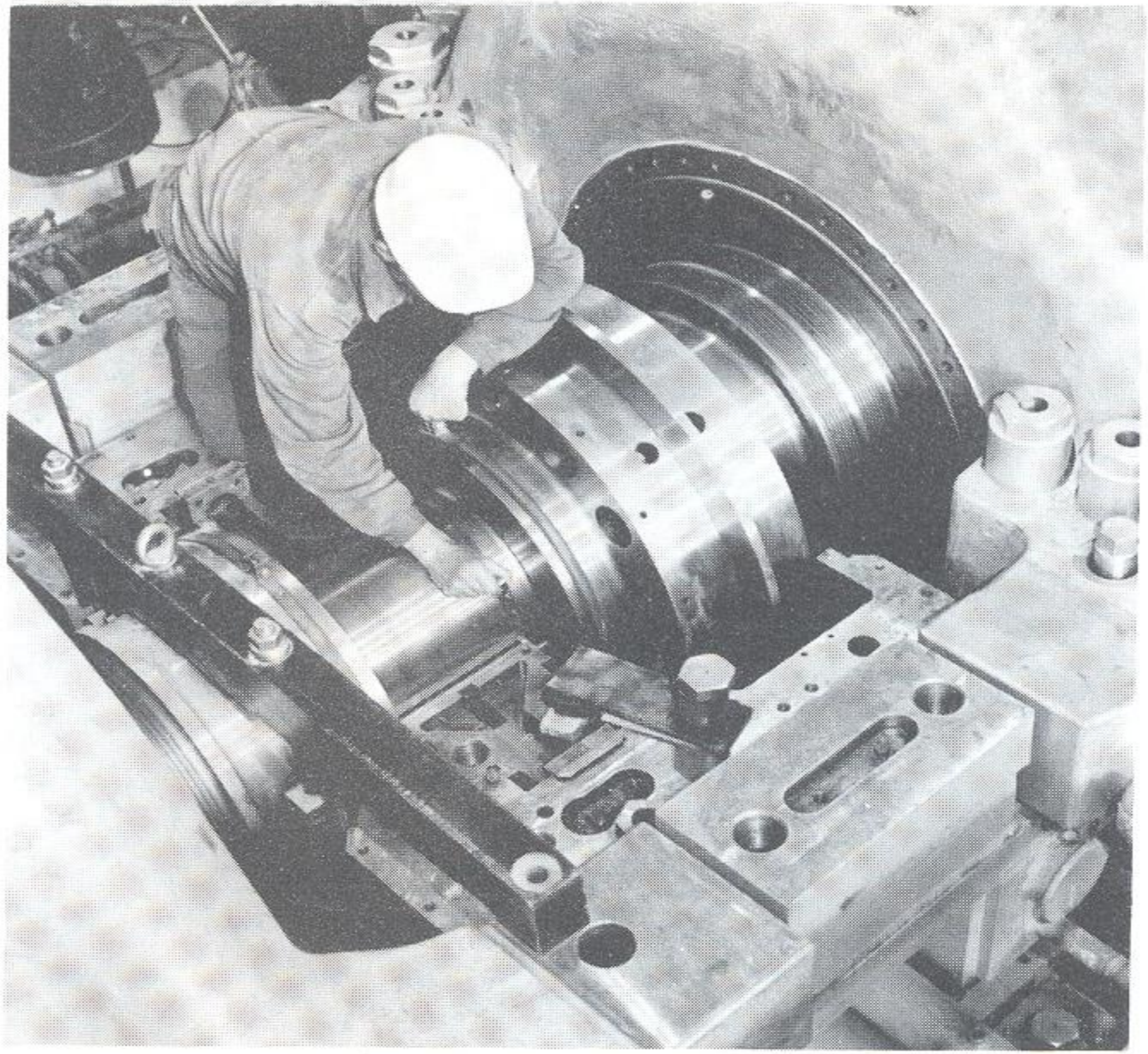


Fig. 5 Measuring Lateral Clearance of Lower Bearing Shell

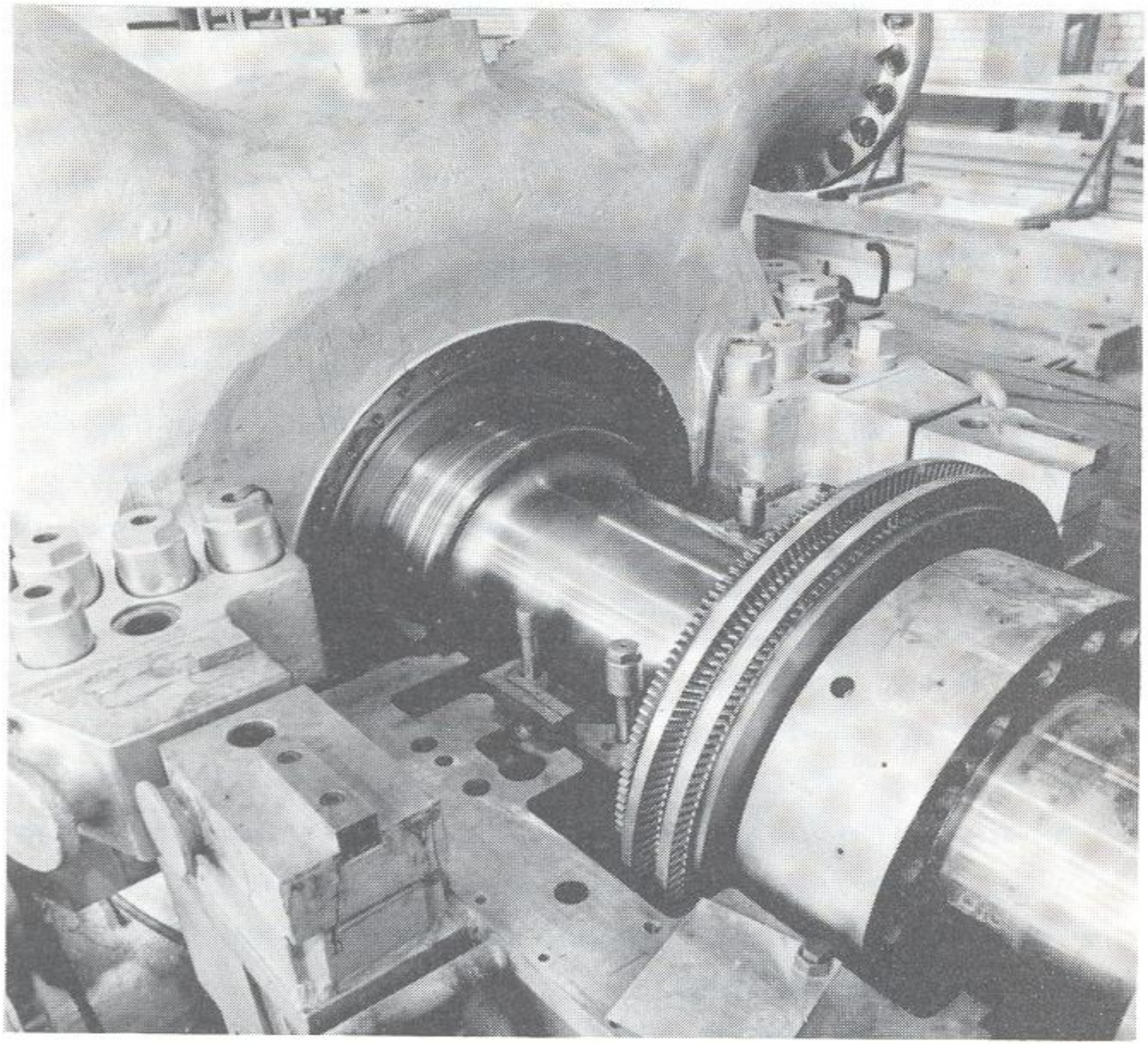


Fig. 4 Turbine Shaft in Position in Lower Bearing Shell

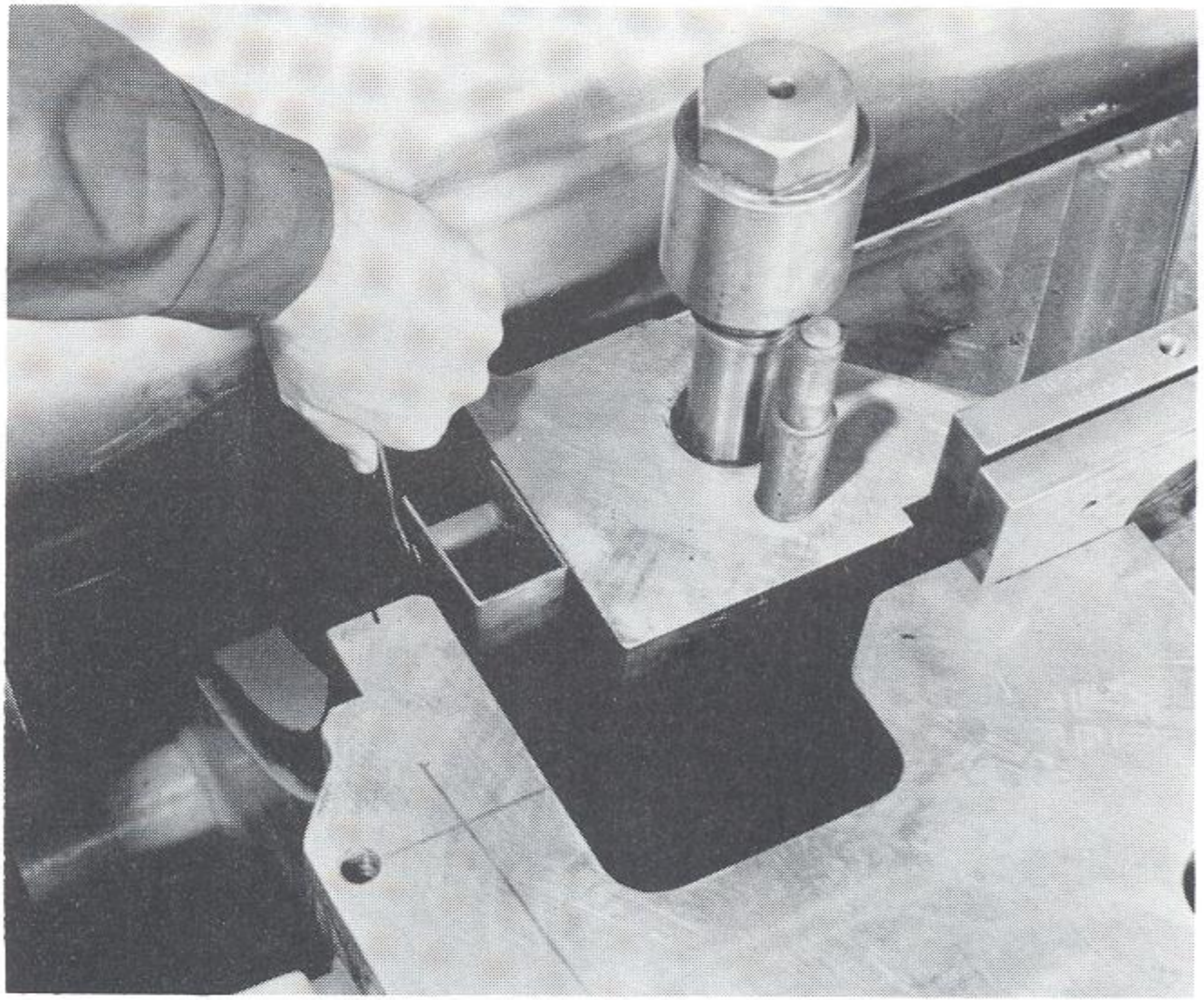
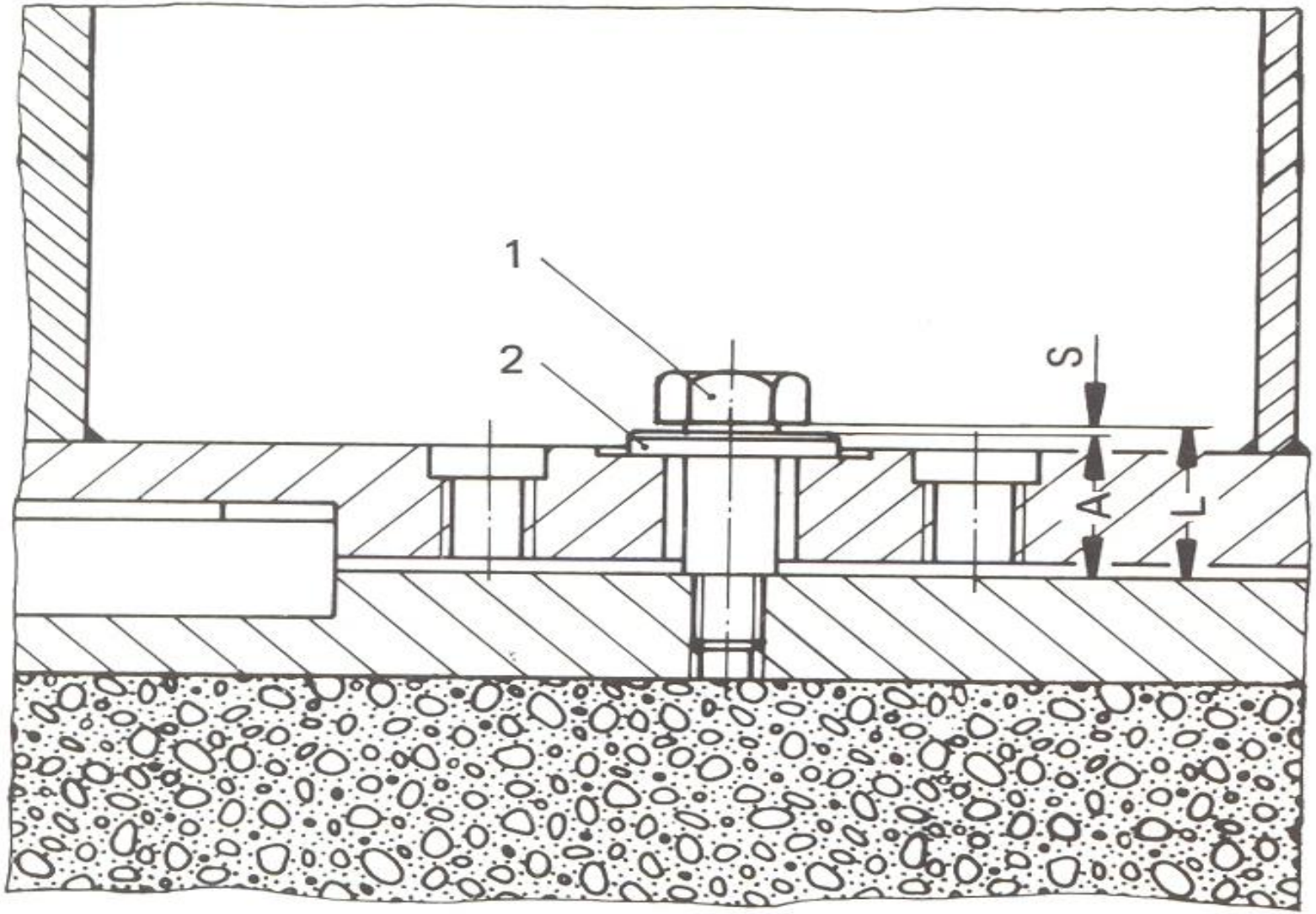


Fig. 6 Attachment of Lower Ring Half



1 Spacer bolt
2 Washer

A Assembly dimension
L Insertion length
S Clearance

Fig. 1 Installation Detail

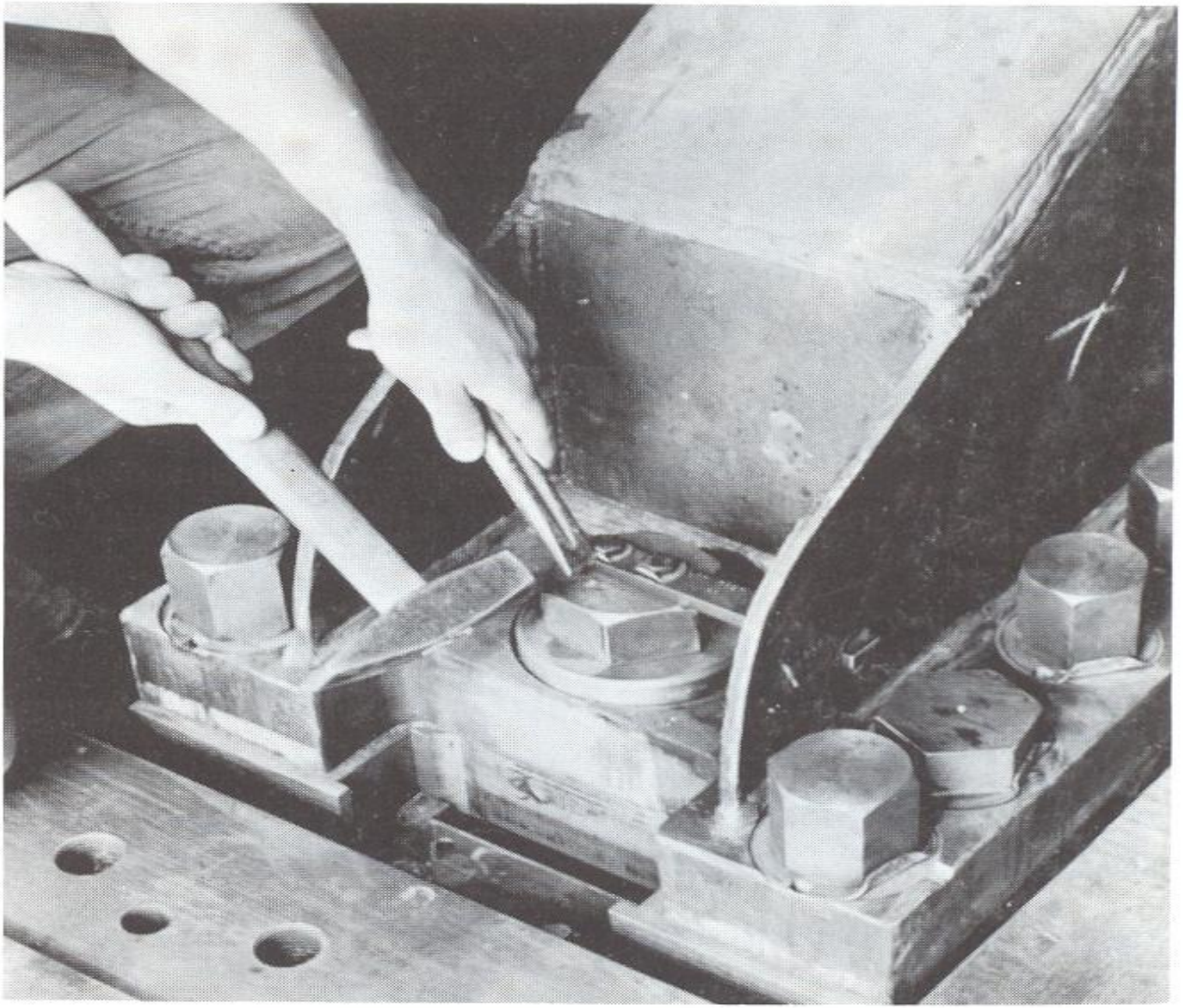
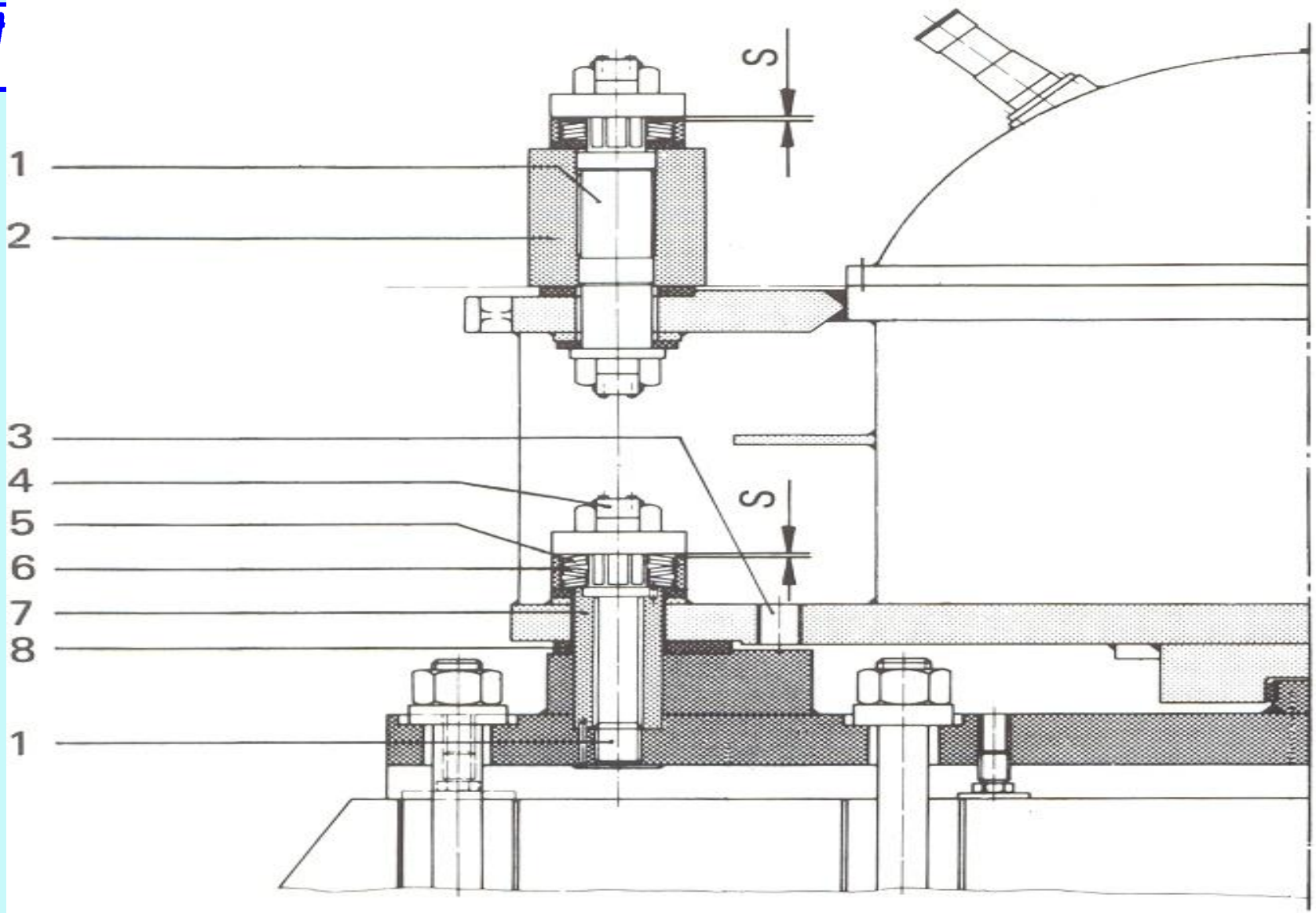


Fig. 2 Securing the Spacer Bolt and Washer when Installed



1 Stud or spacer bolt
2 Casing bracket
3 Tapped hole for jacking screw
4 Nut
5 Belleville washers
6 Ring-type shim
7 Sleeve
8 Washer

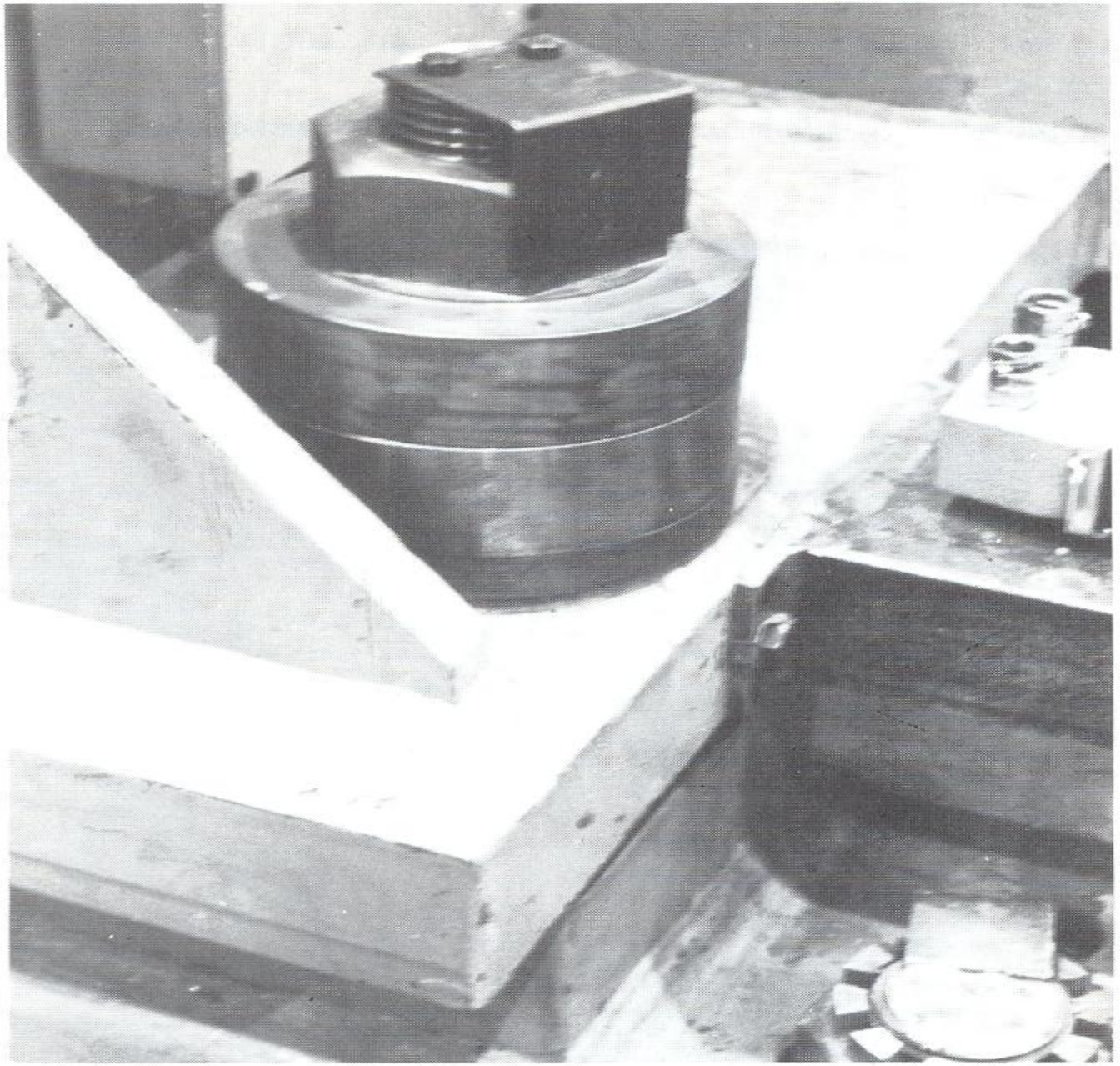
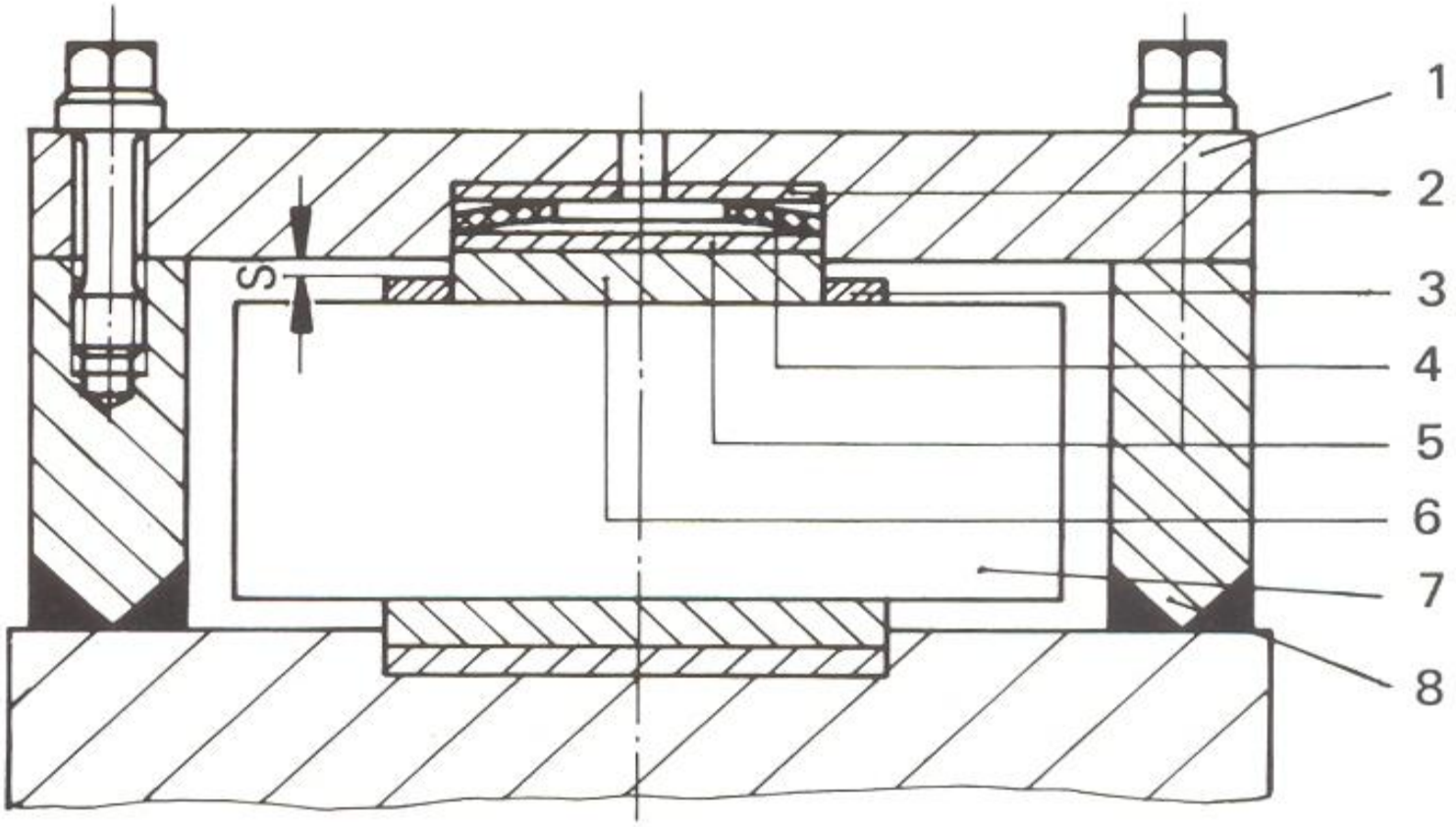


Fig. 3 Elastic Restriction of Spacer Bolts



1 Cage
2 Thrust washer
3 Washer
4 Belleville washer
5 Thrust washer
6 Disc
7 Turbine casing
8 Support frame

Fig. 4 Elastic Restriction by means of a Cage

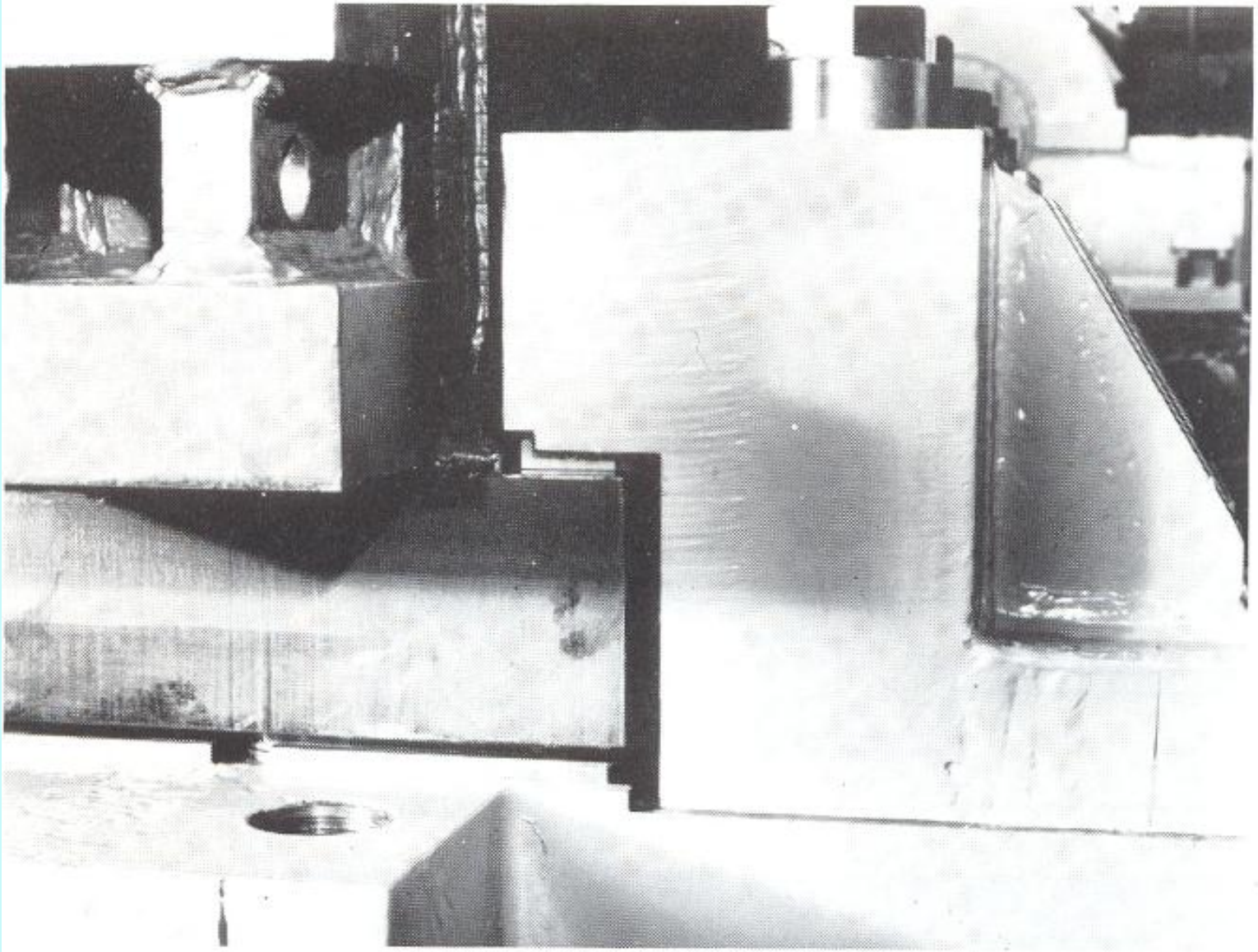


Fig. 5 Hold Down Bracket

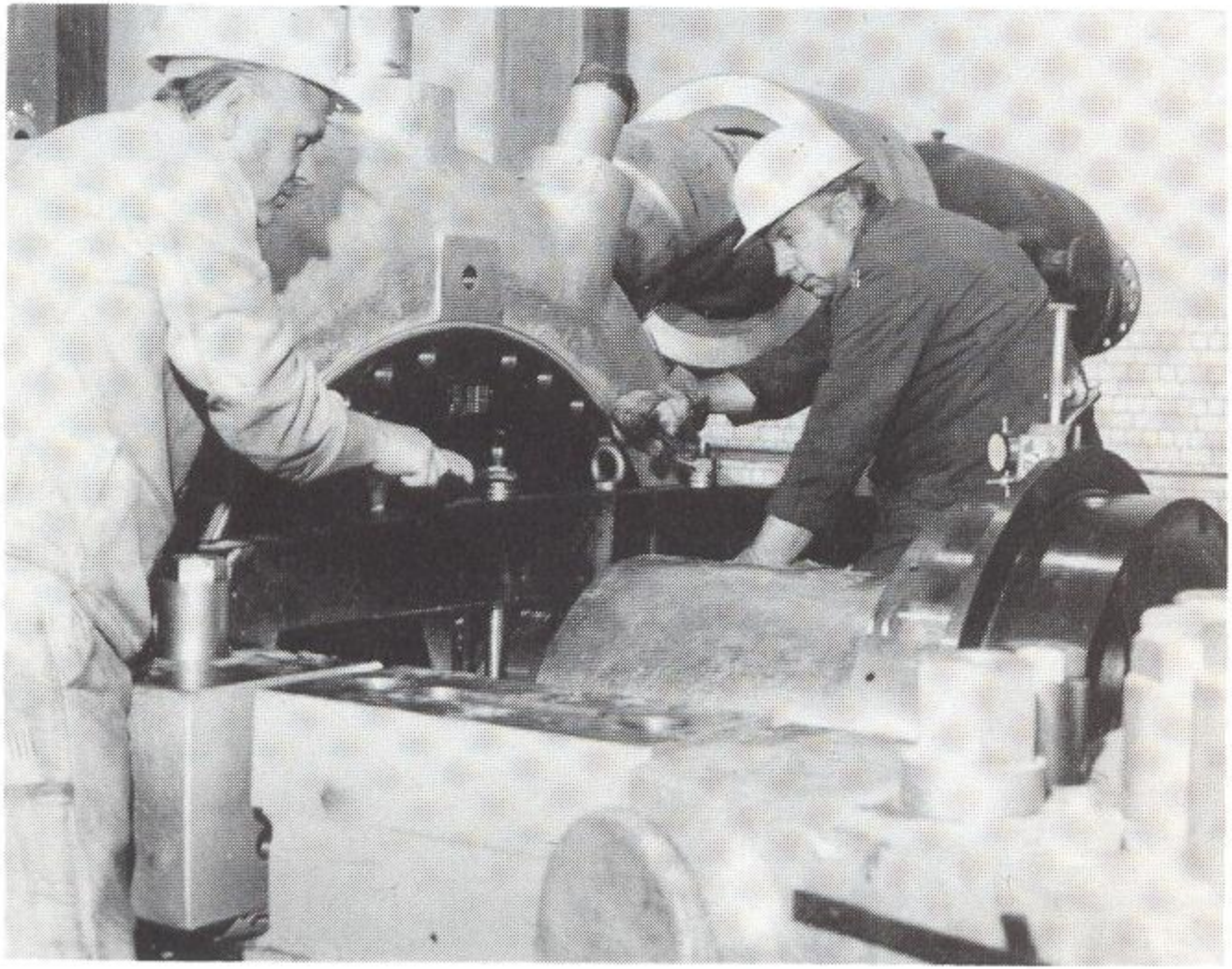


Fig. 1 Checking Radial Clearance of Assembled HP Turbine Section

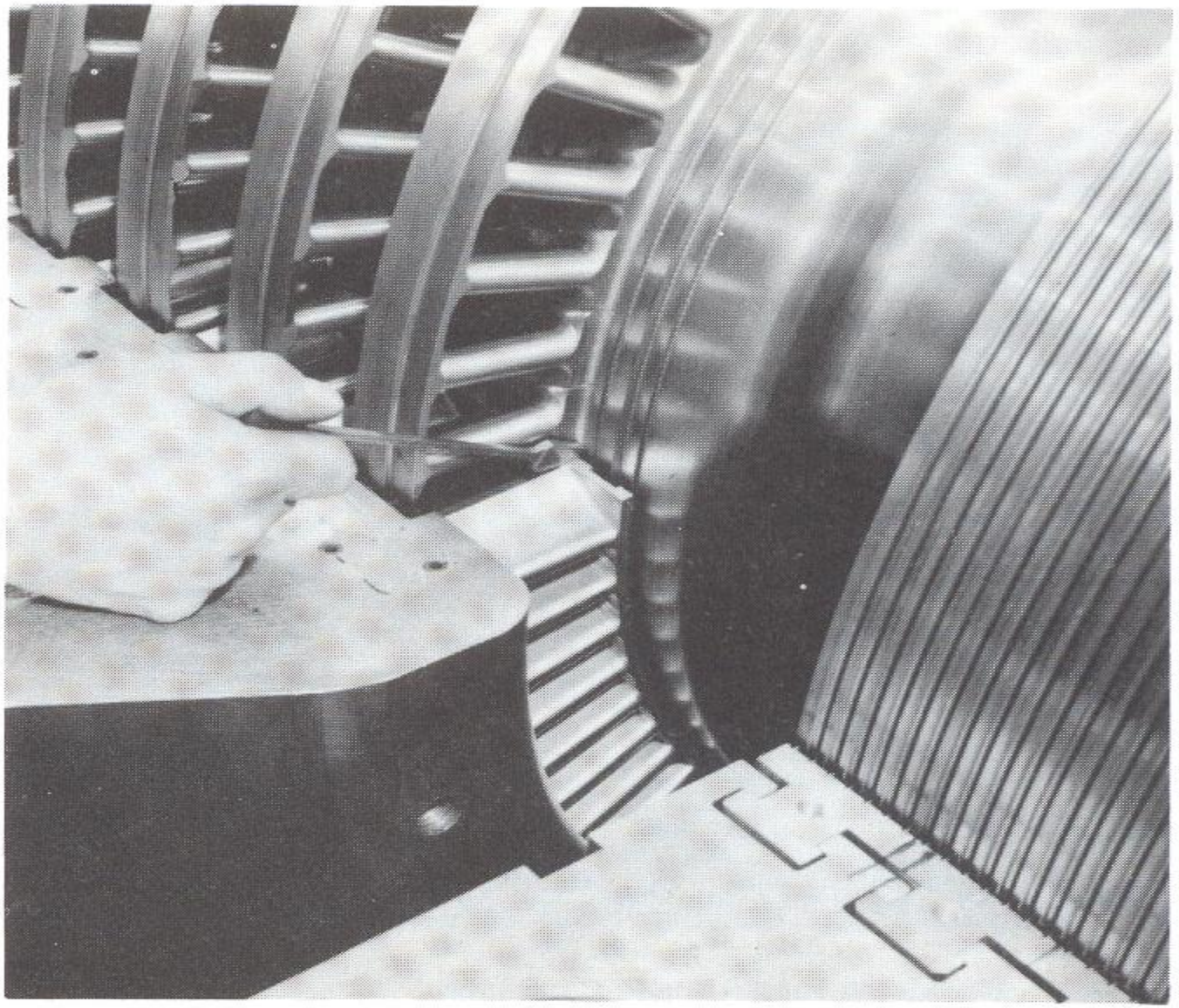


Fig. 2 Measuring the Axial Blade Clearance using Block Gauges

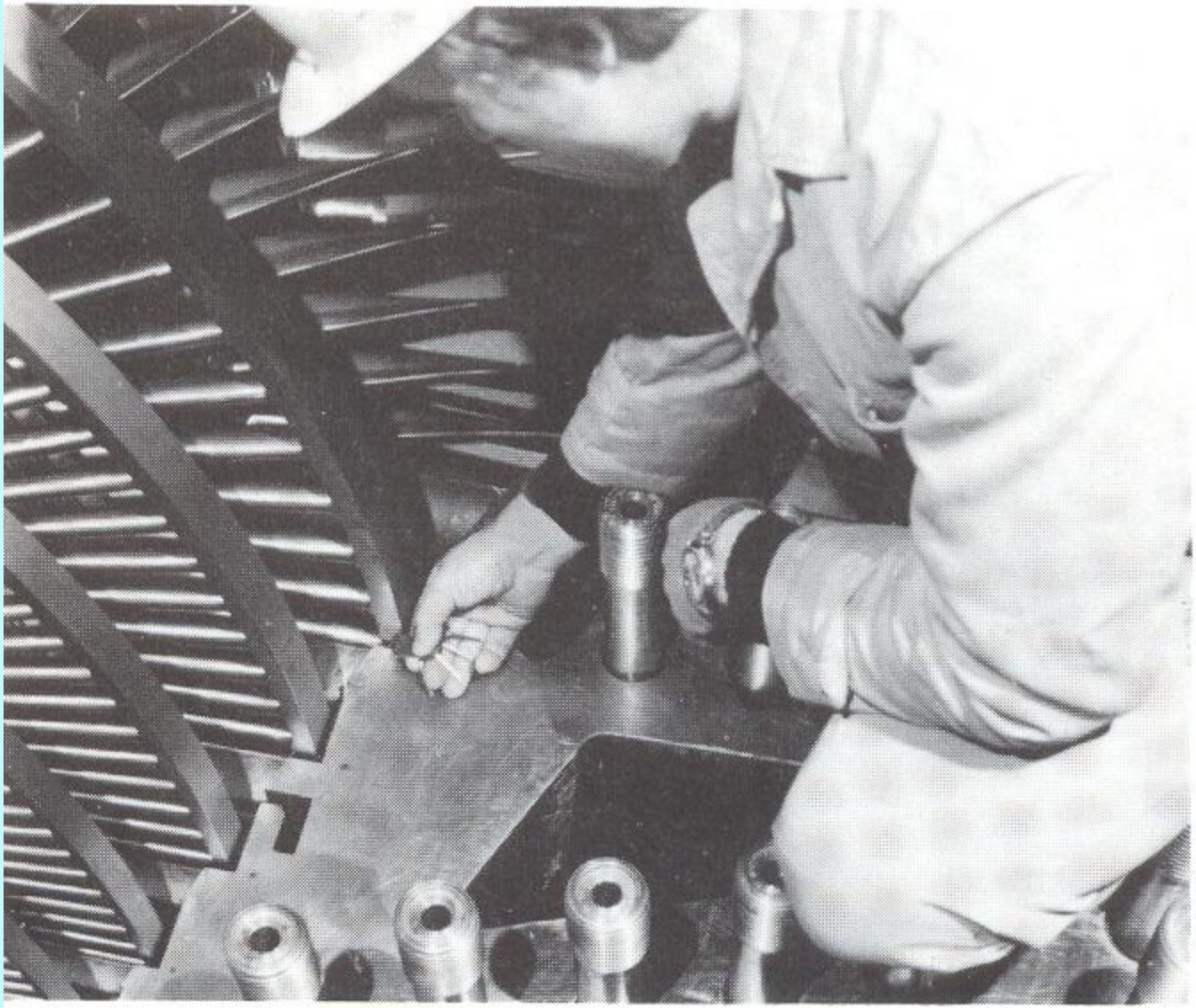


Fig. 3 Checking Axial Clearance using Feeler Gauges

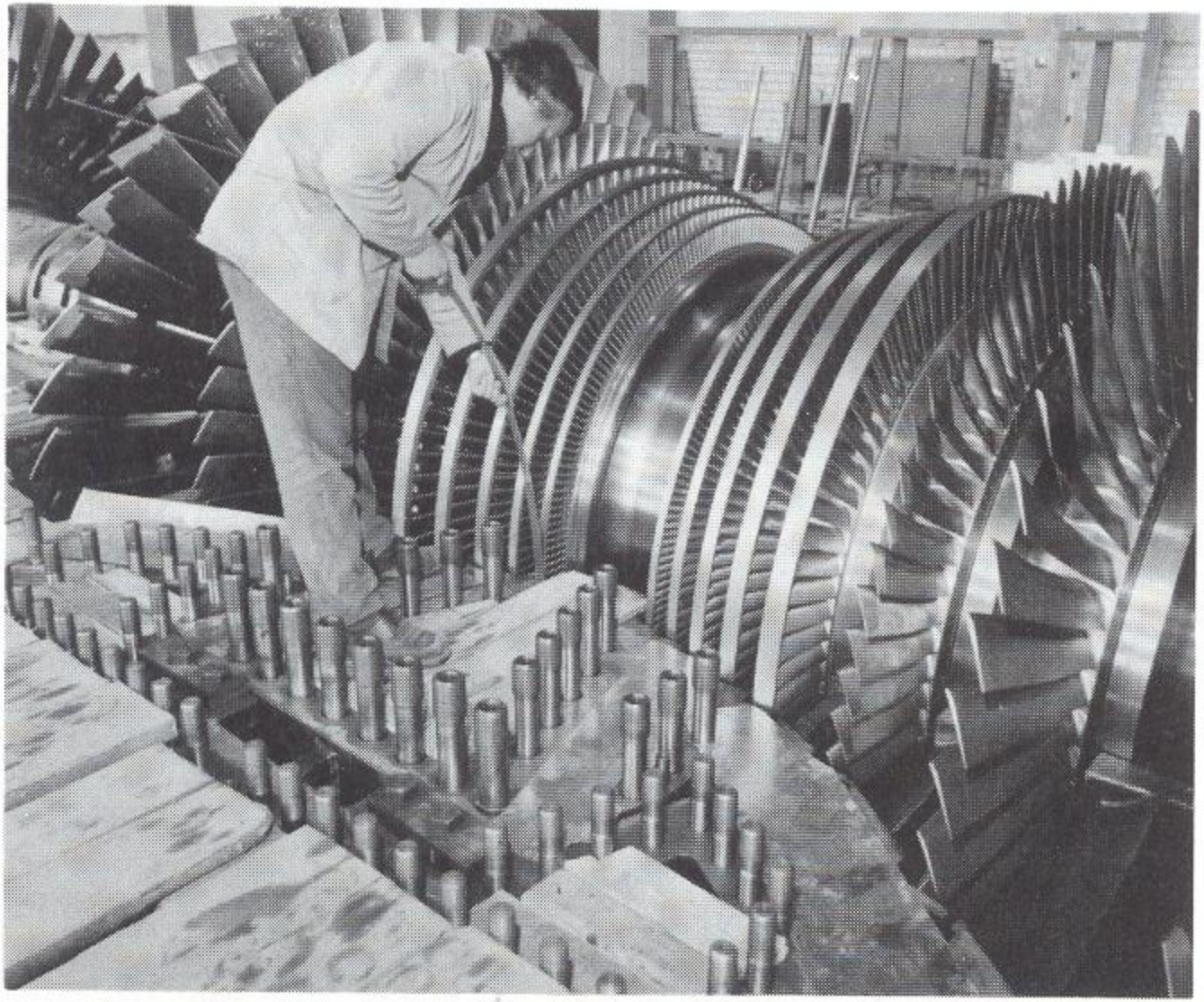


Fig. 4 Measuring Radial Blade Clearance using Feeler Gauges

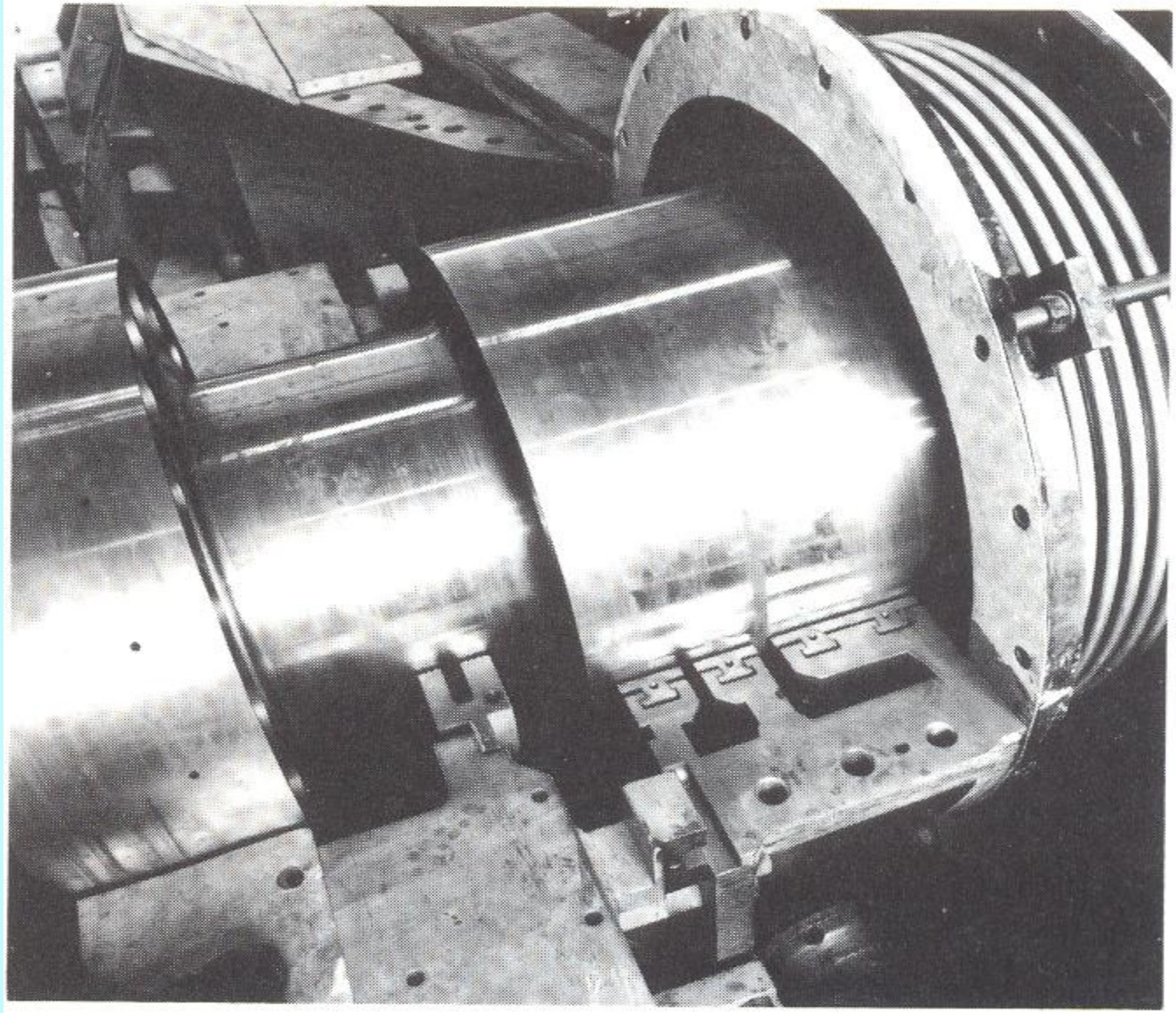


Fig. 5 Disassembled Shaft Seal Casing

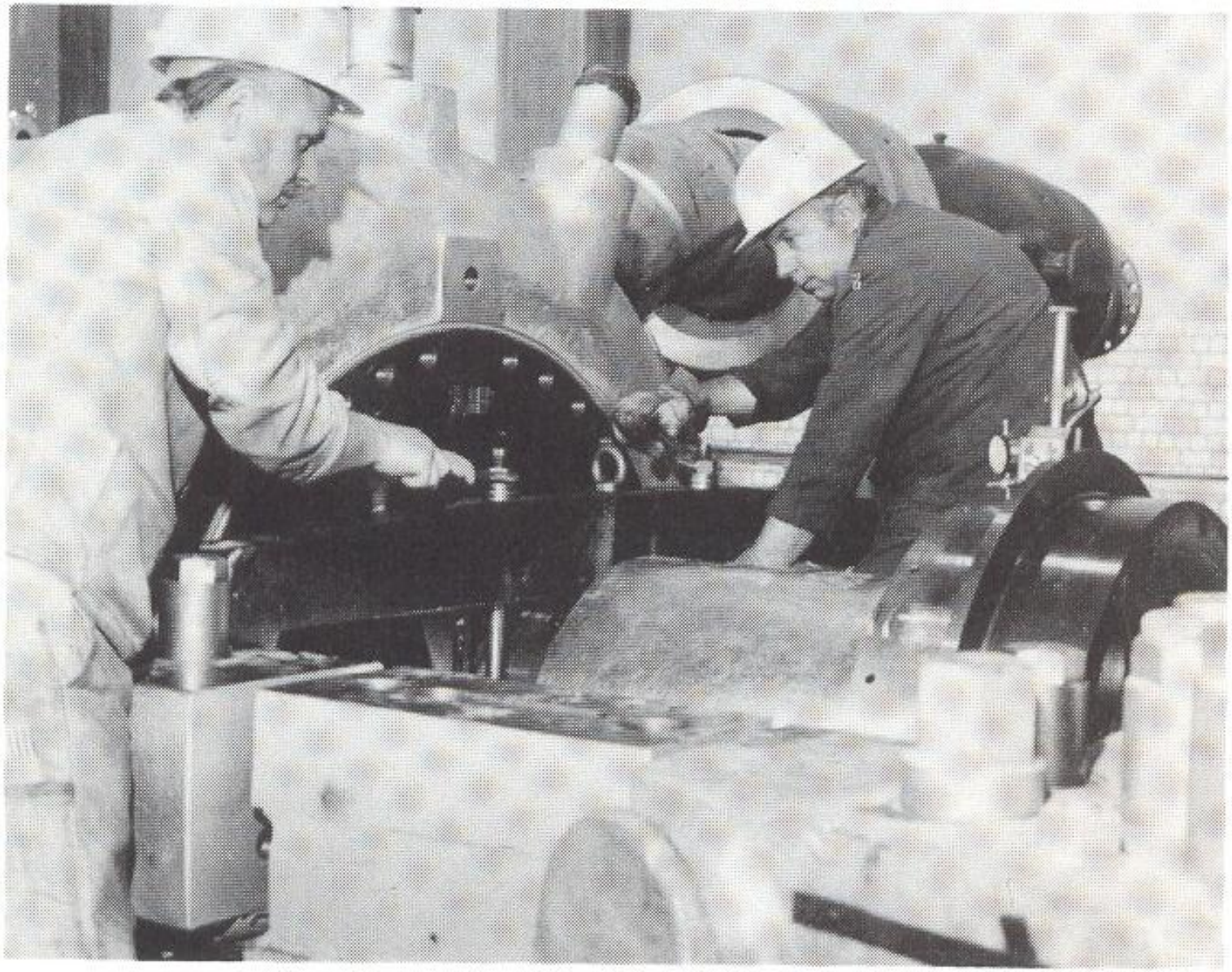


Fig. 1 Checking Radial Clearance of Assembled HP Turbine Section

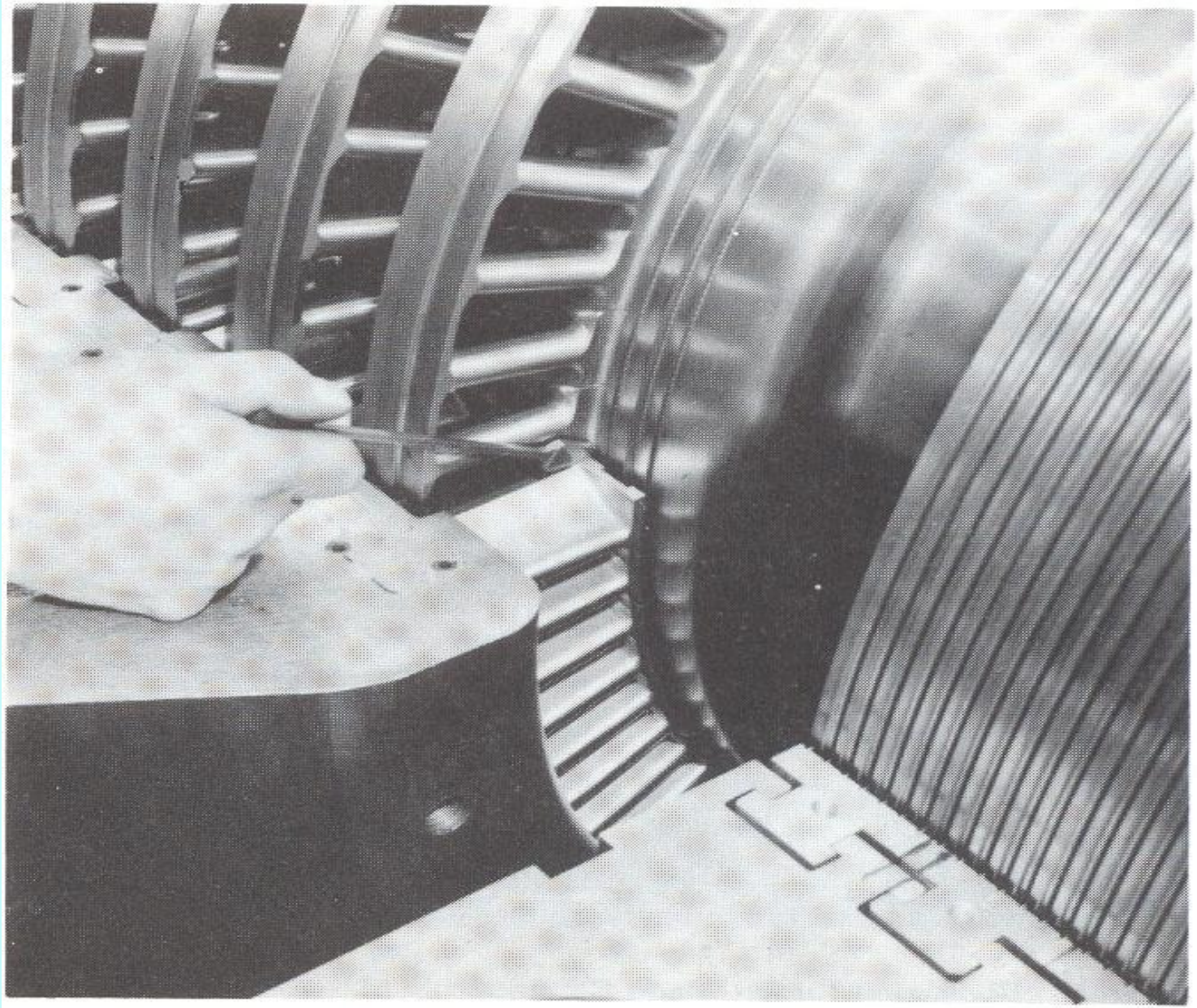


Fig. 2 Measuring the Axial Blade Clearance using Block Gauges

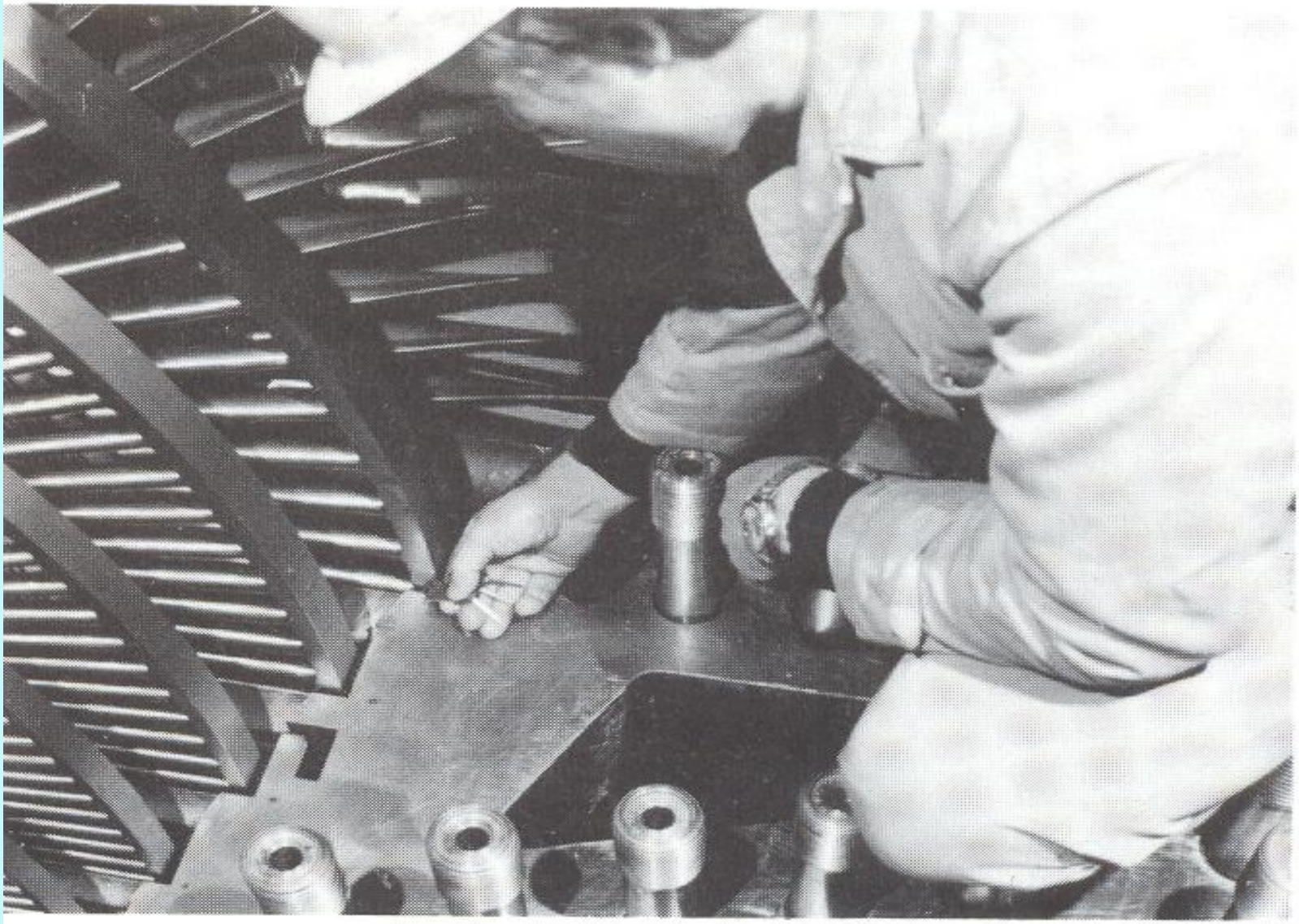


Fig. 3 Checking Axial Clearance using Feeler Gauges

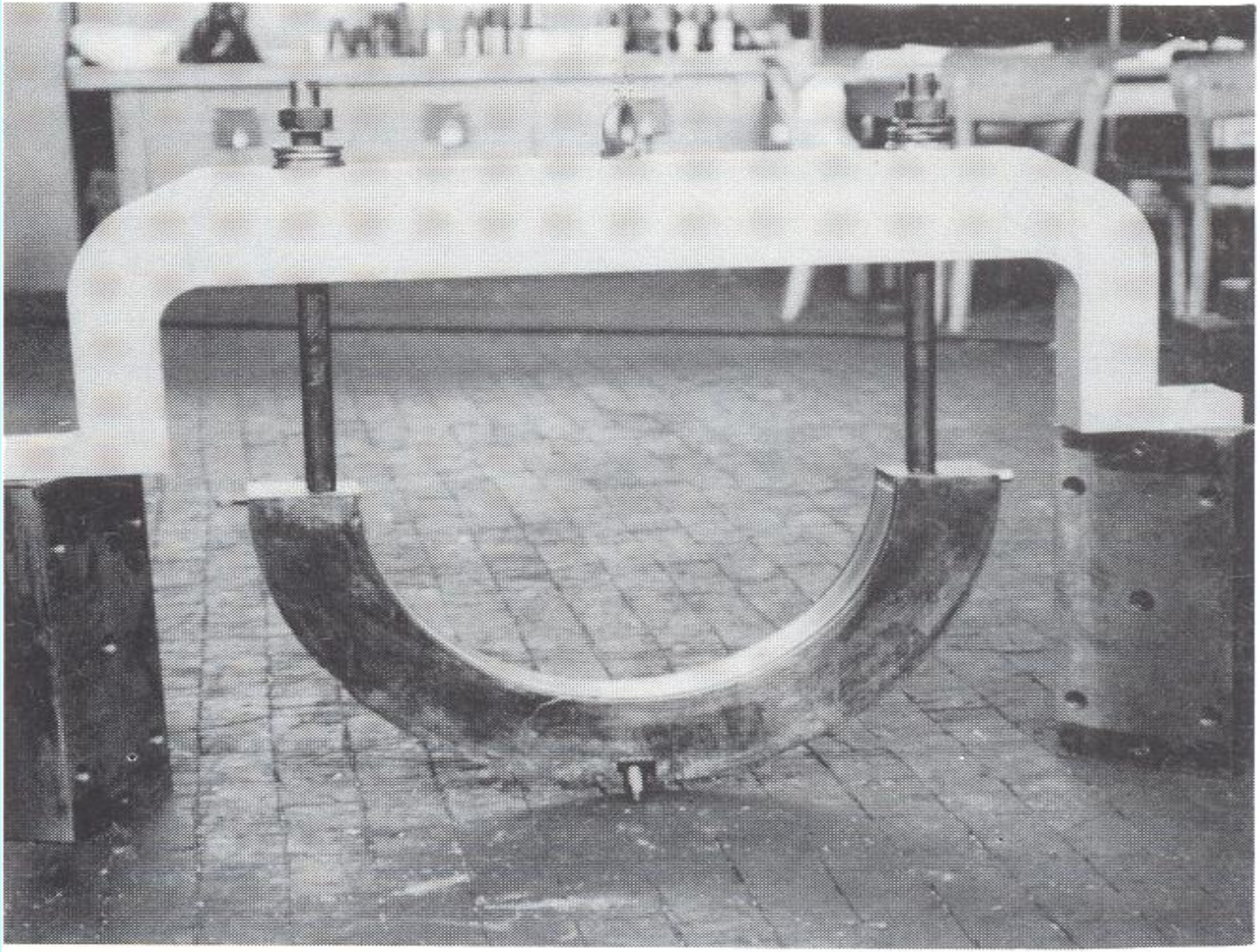


Fig. 1 Hydraulic Shaft Alignment and Lifting Device Checked for Proper Functioning

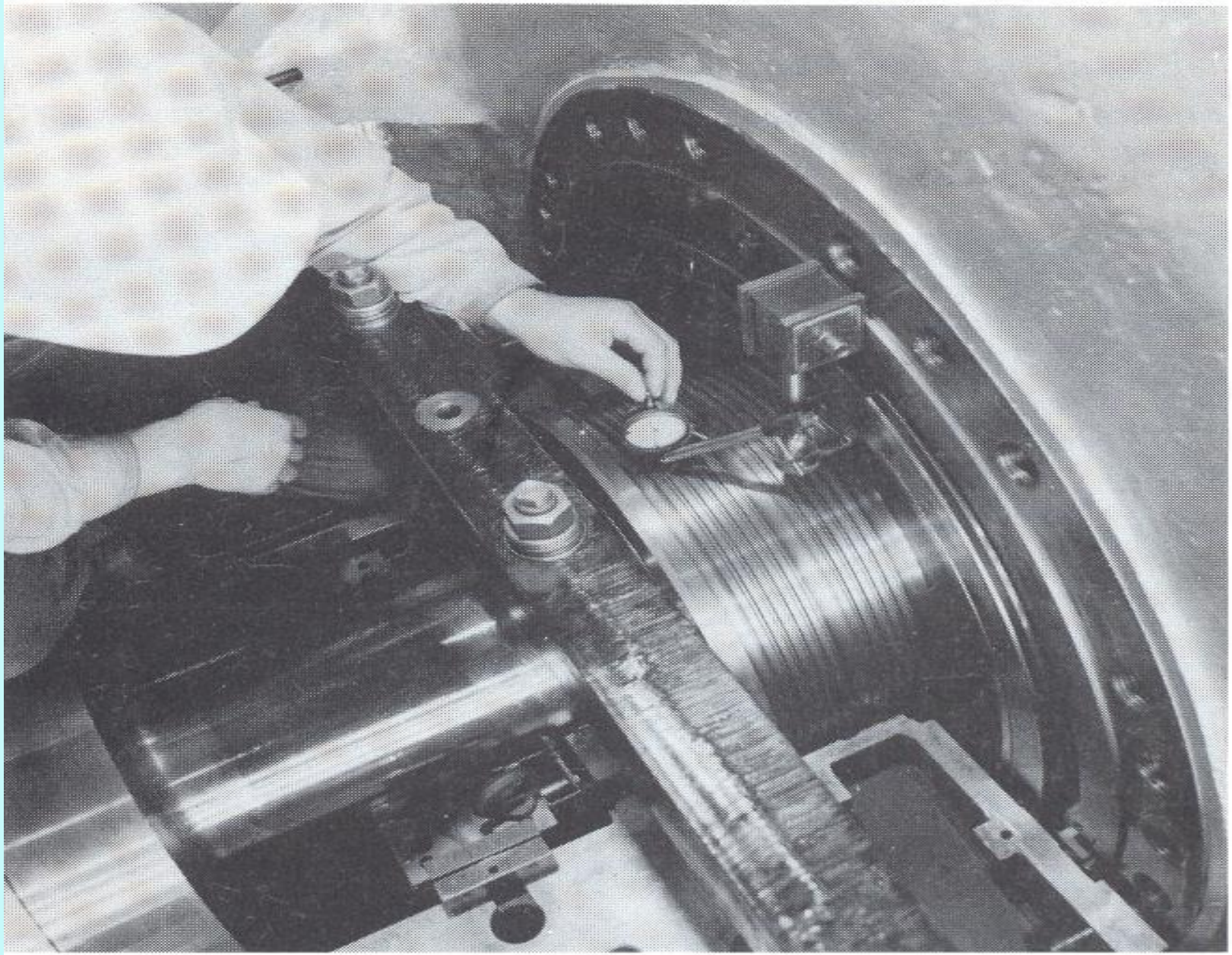
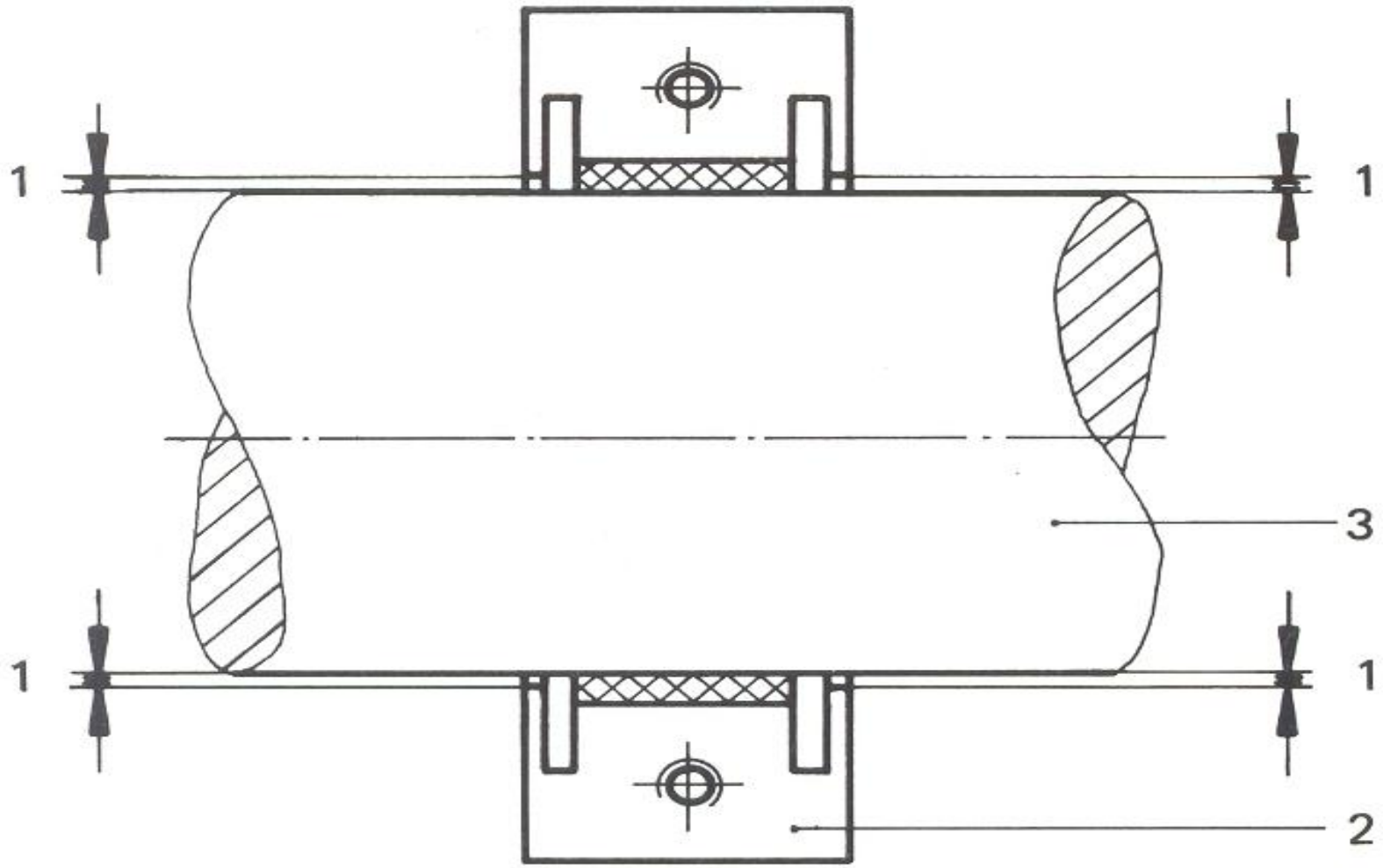


Fig. 2 Lifting the Turbine Shaft and Checking its Position



1 Measuring points
2 Cradle with babbitting
3 Turbine shaft

Fig. 3 Measuring Points between Turbine Shaft and Cradles

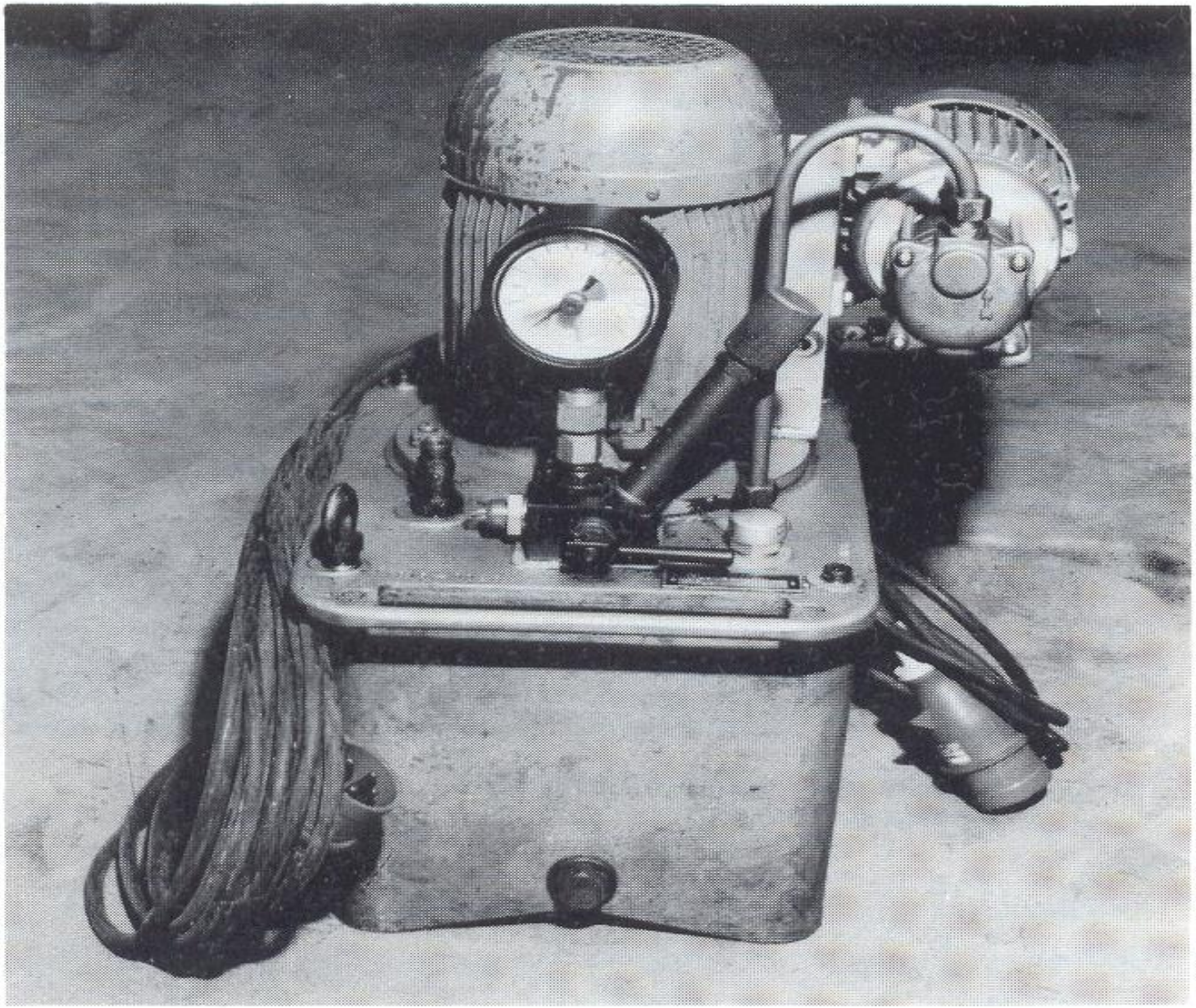


Fig. 4 High-Pressure Pump Unit with Assembled Oil Return Pump

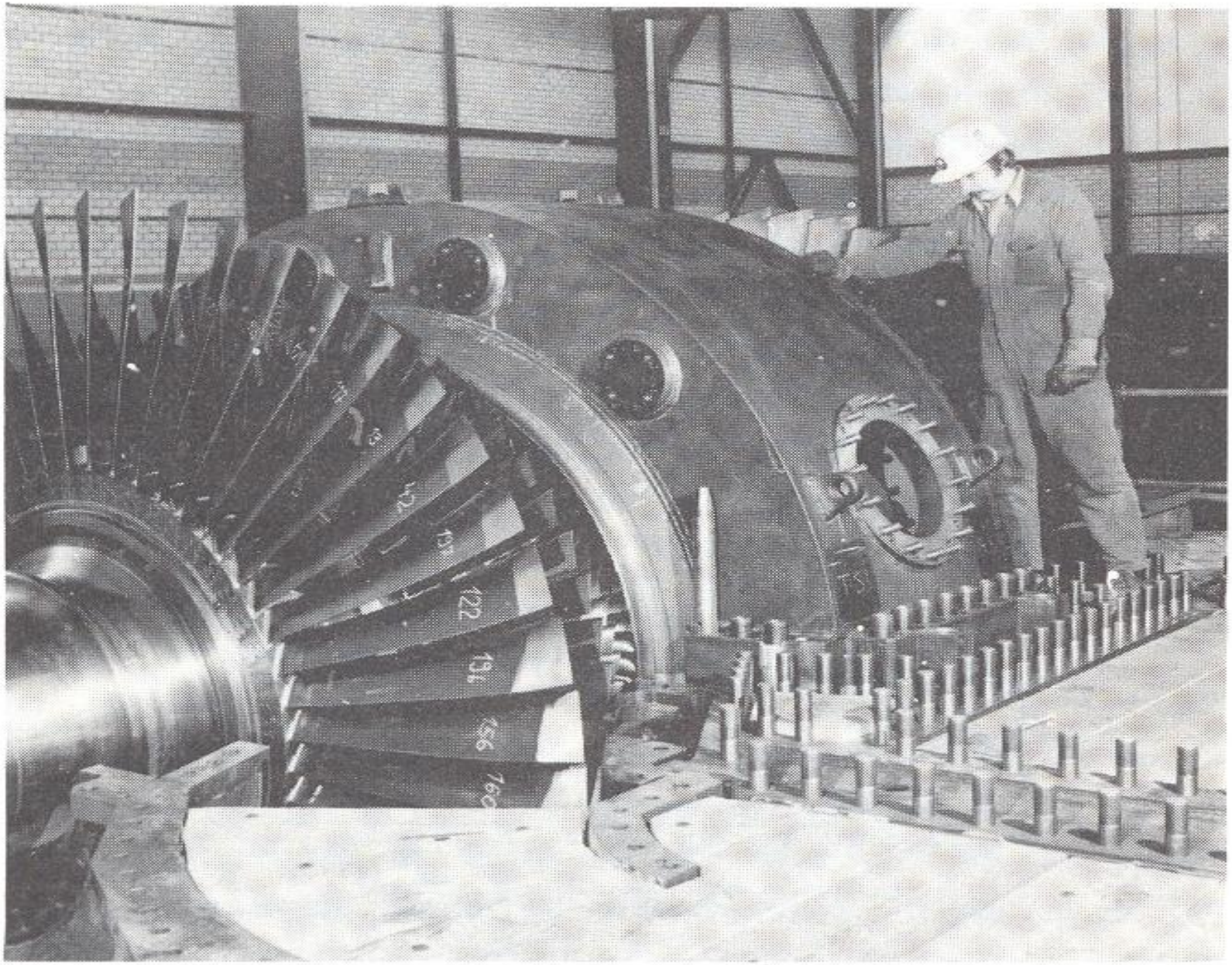
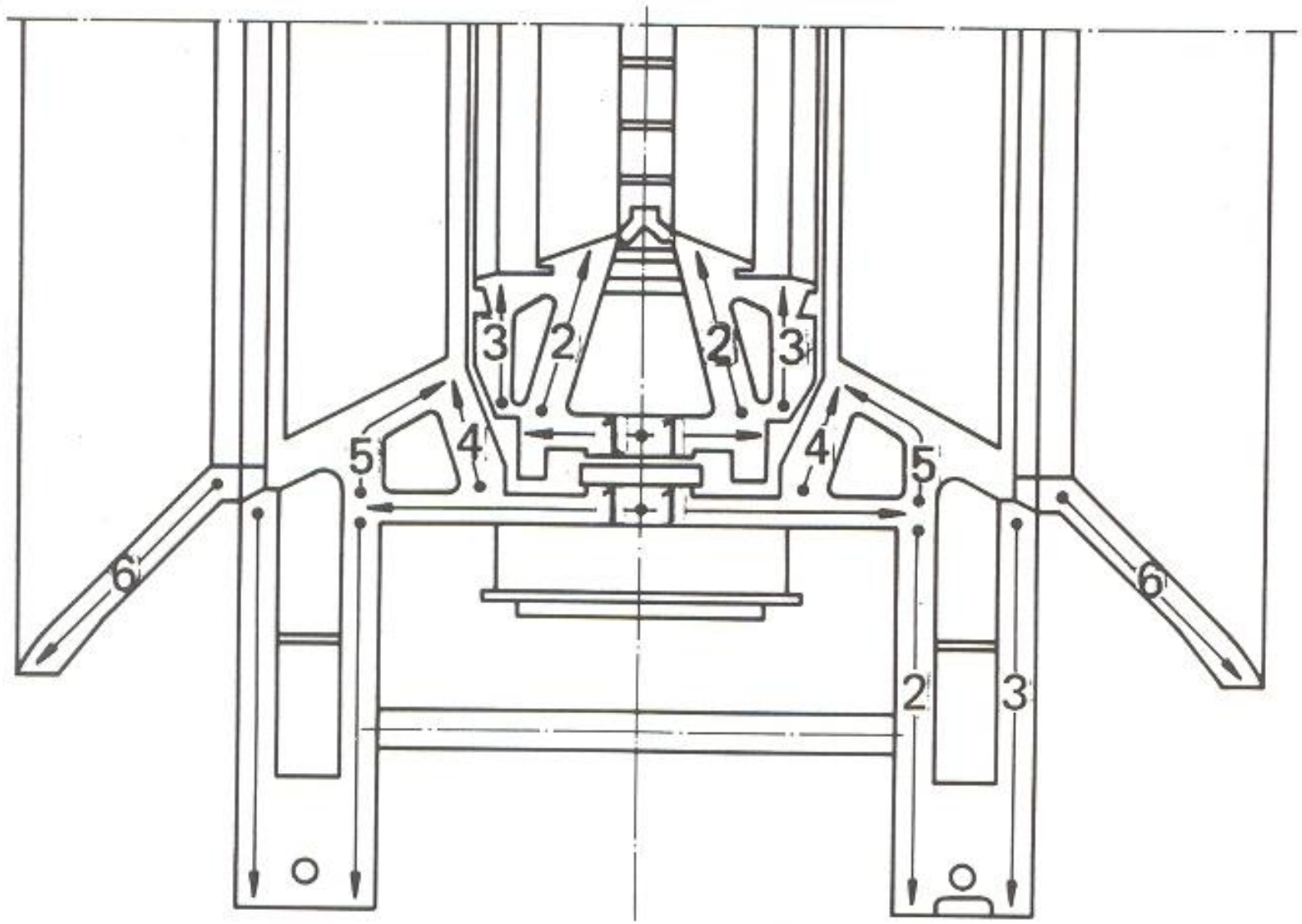
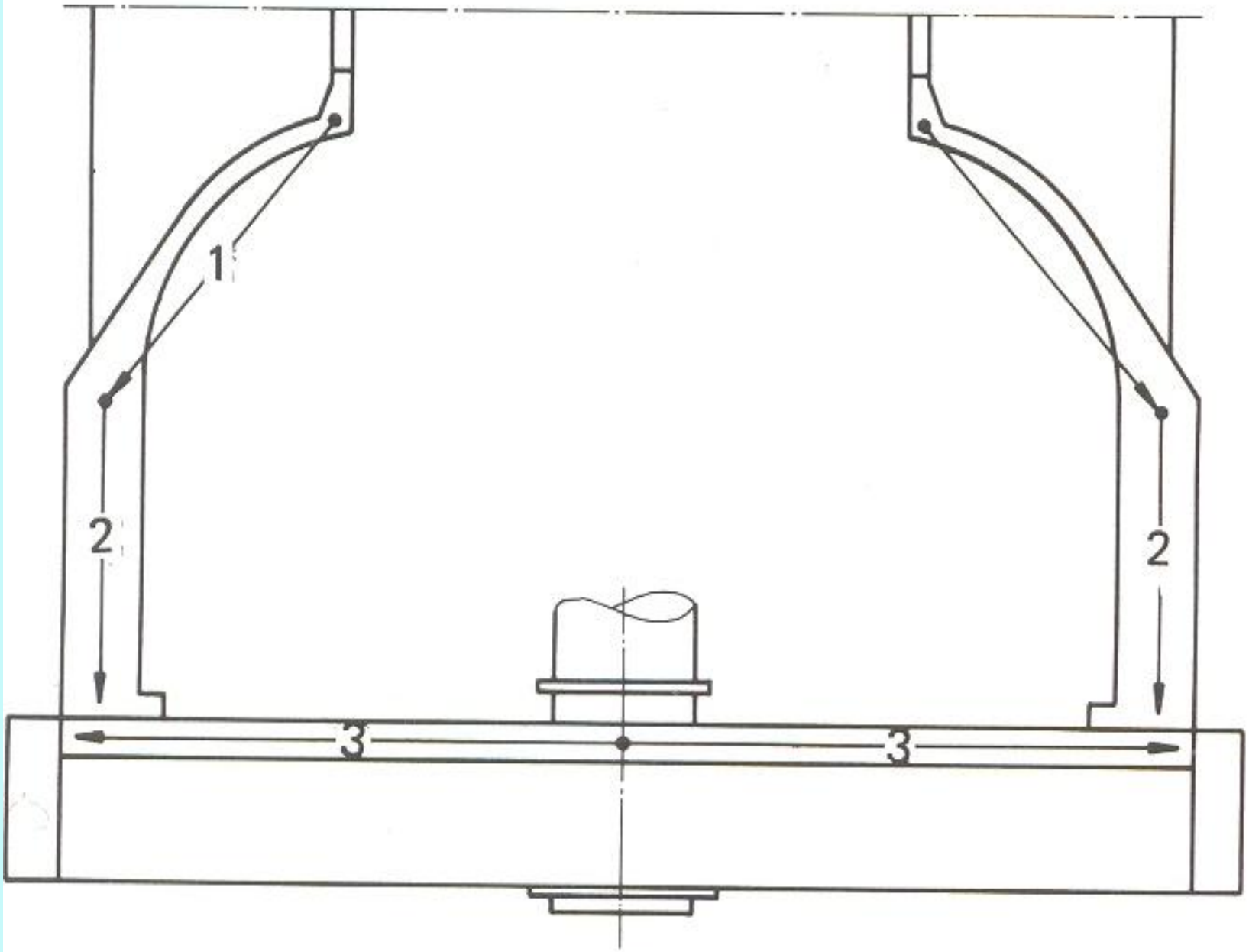


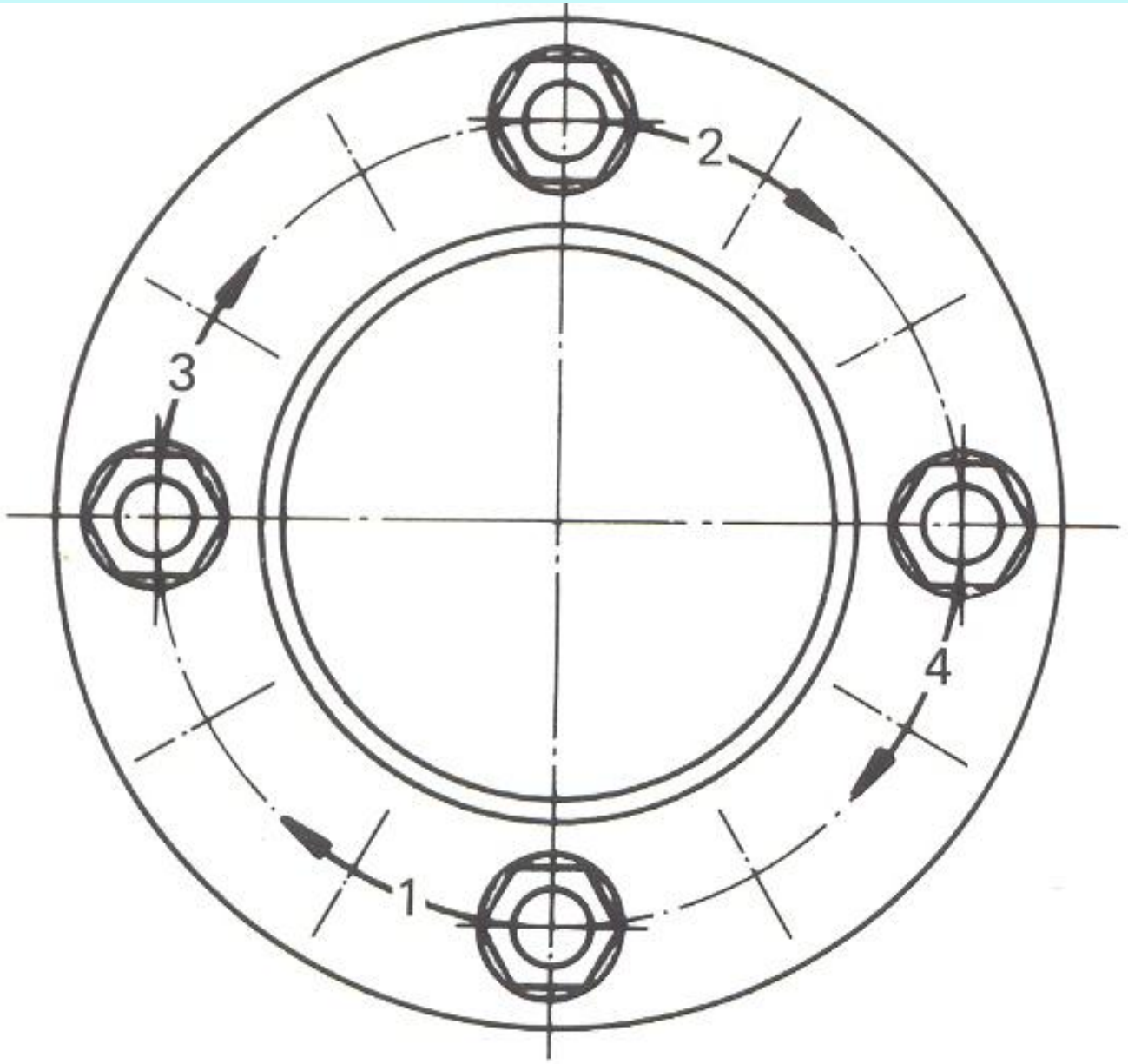
Fig. 1 LP Turbine with Top-Half Inner Shell of Inner Casing Assembled



Inner and Outer Shells of the
Inner Casing of the LP Turbine [3]



Outer Casing of the LP Turbine [4]



g. 2 Tightening Sequence for the Bolts of a Flange Connection

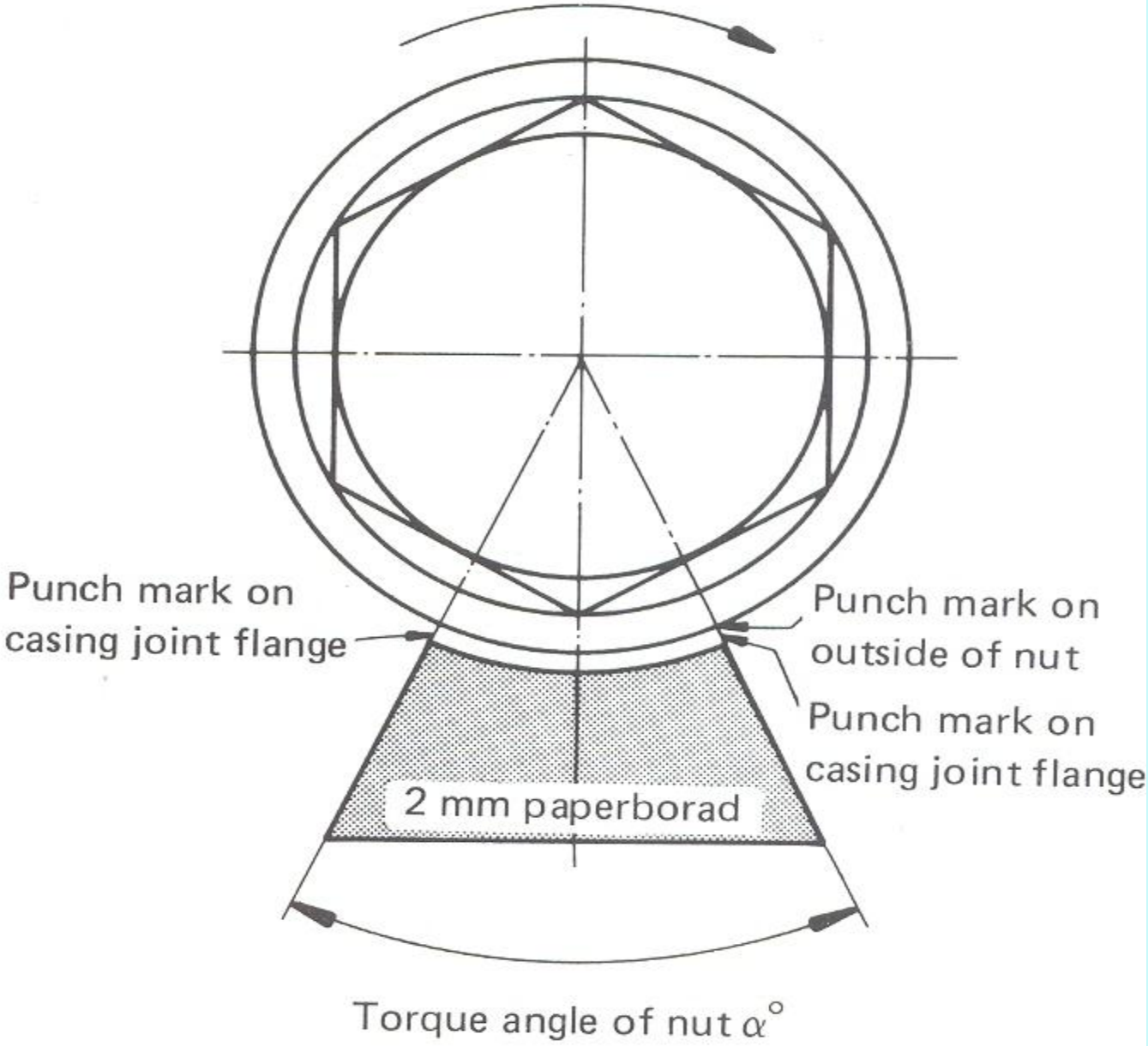


Fig. 5 Template for Marking the Nut Torque Angle

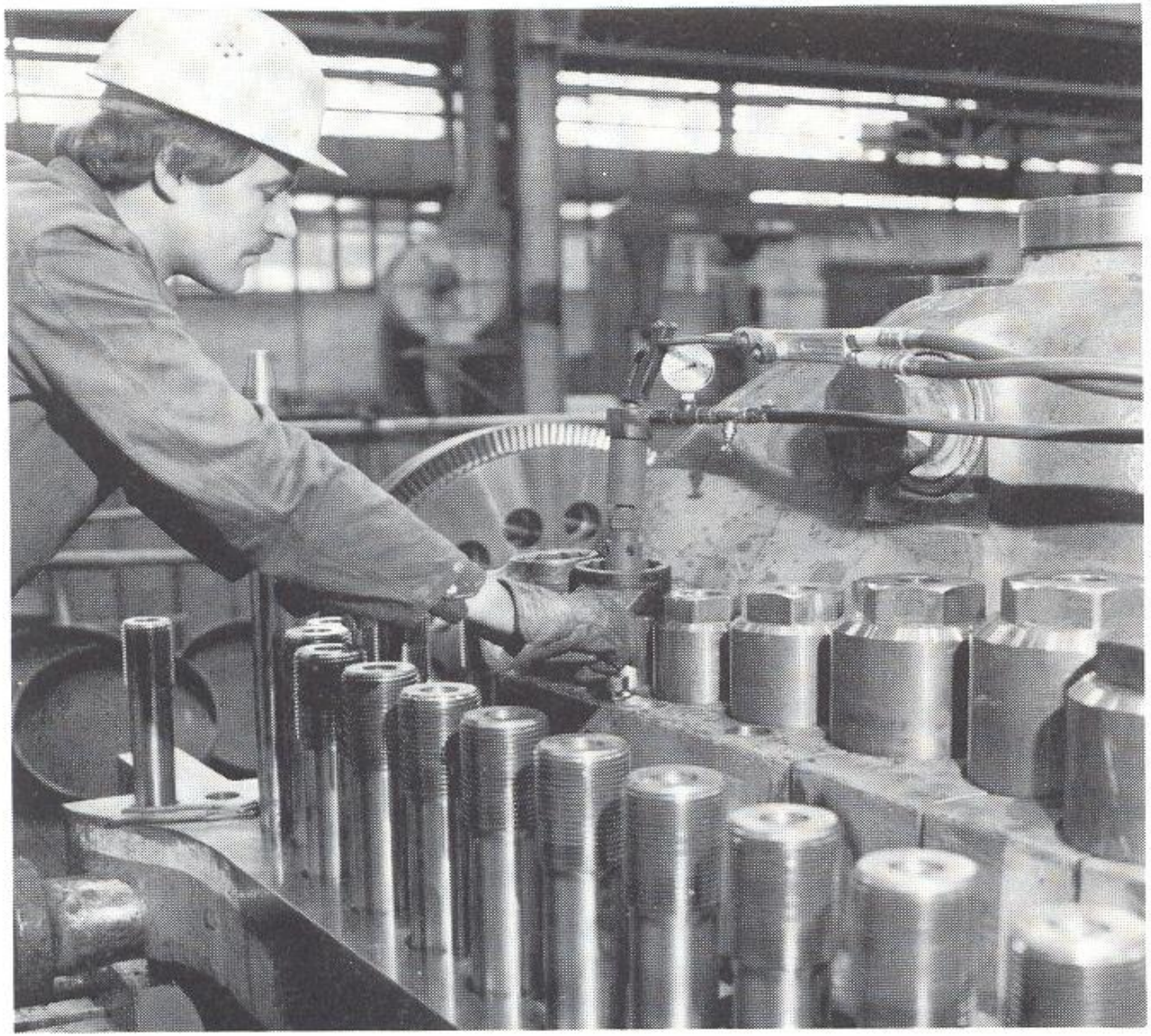


Fig. 6 Heating the Casing Joint Bolts

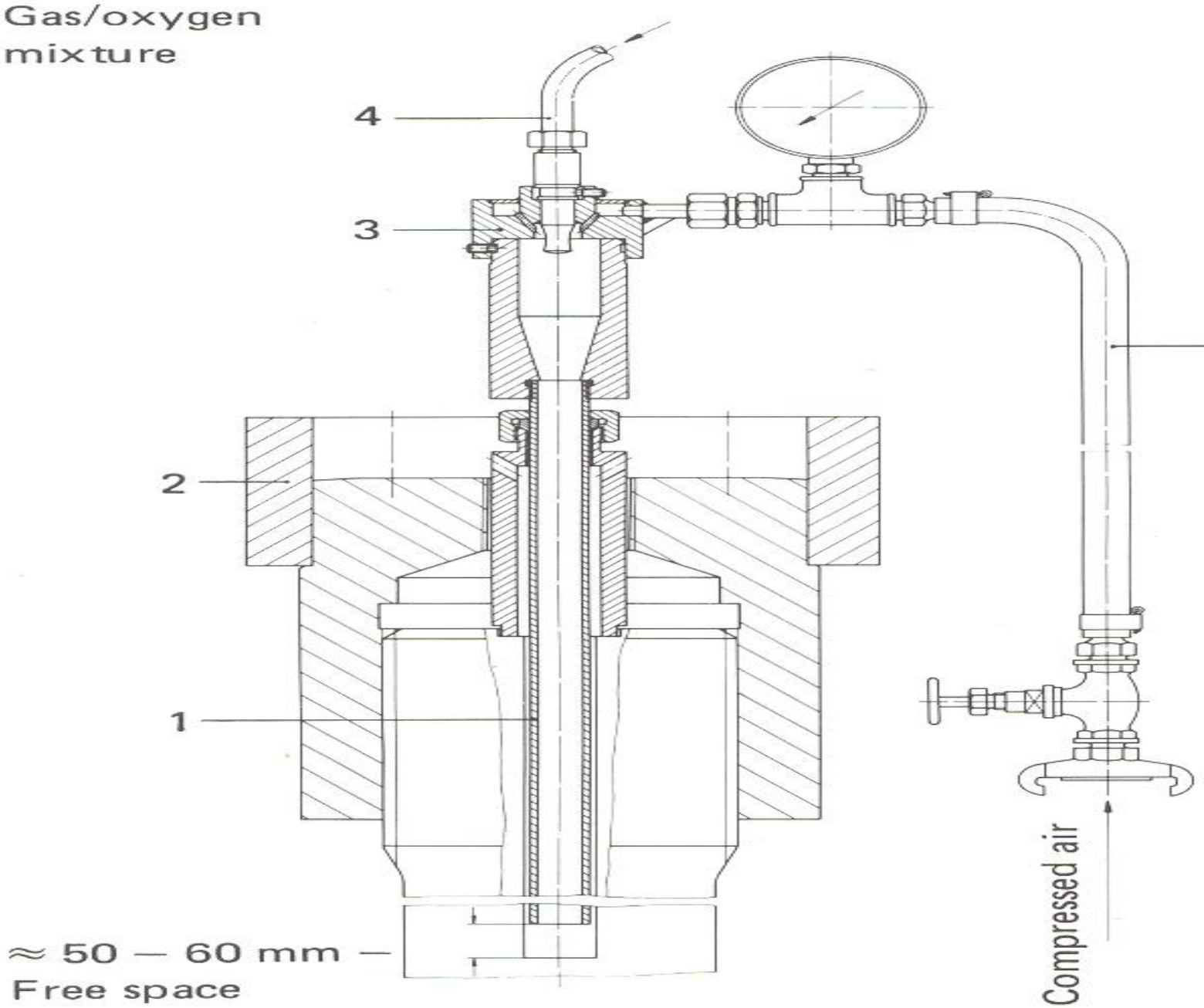


Fig. 7 Configuration of the Gas-Fired Bolt Heater

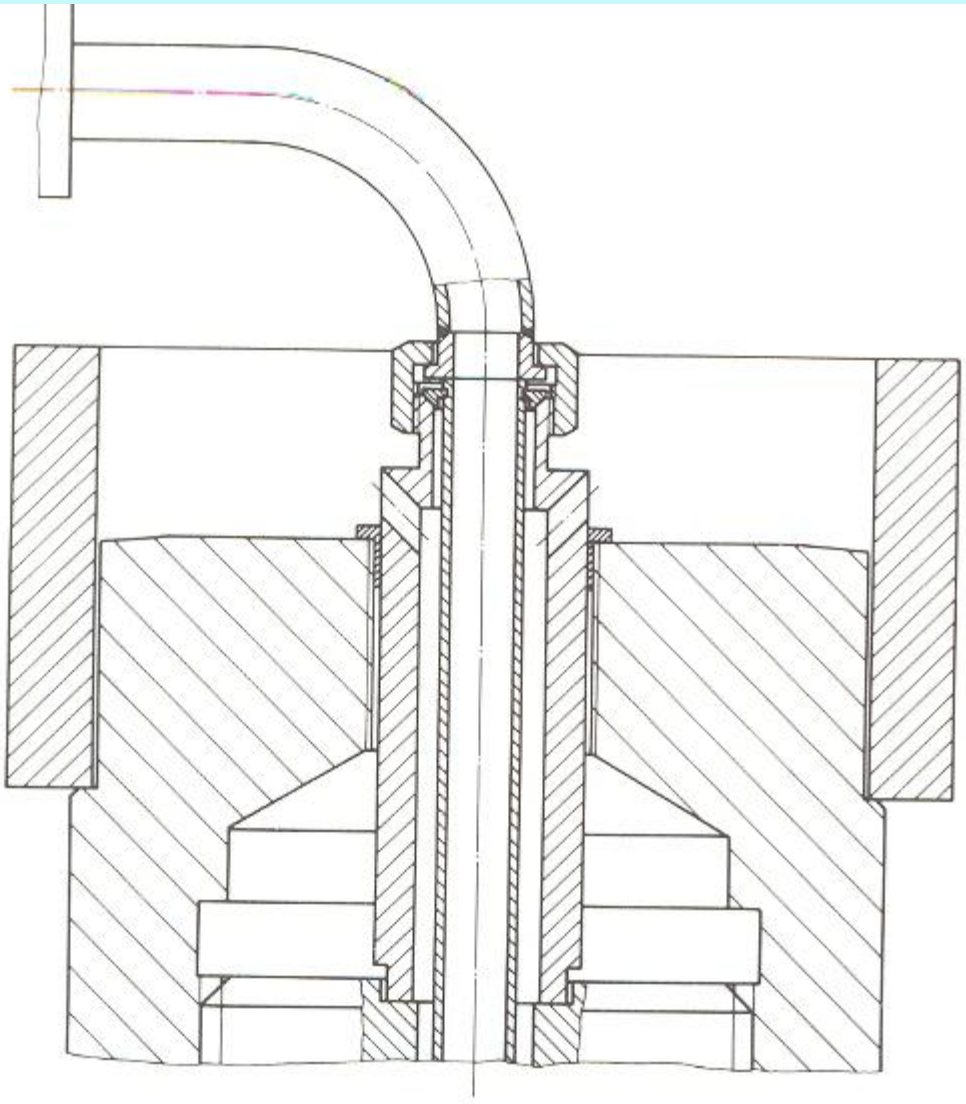


Fig. 8 Insertion of Bolt Heater from above where Space is Restricted

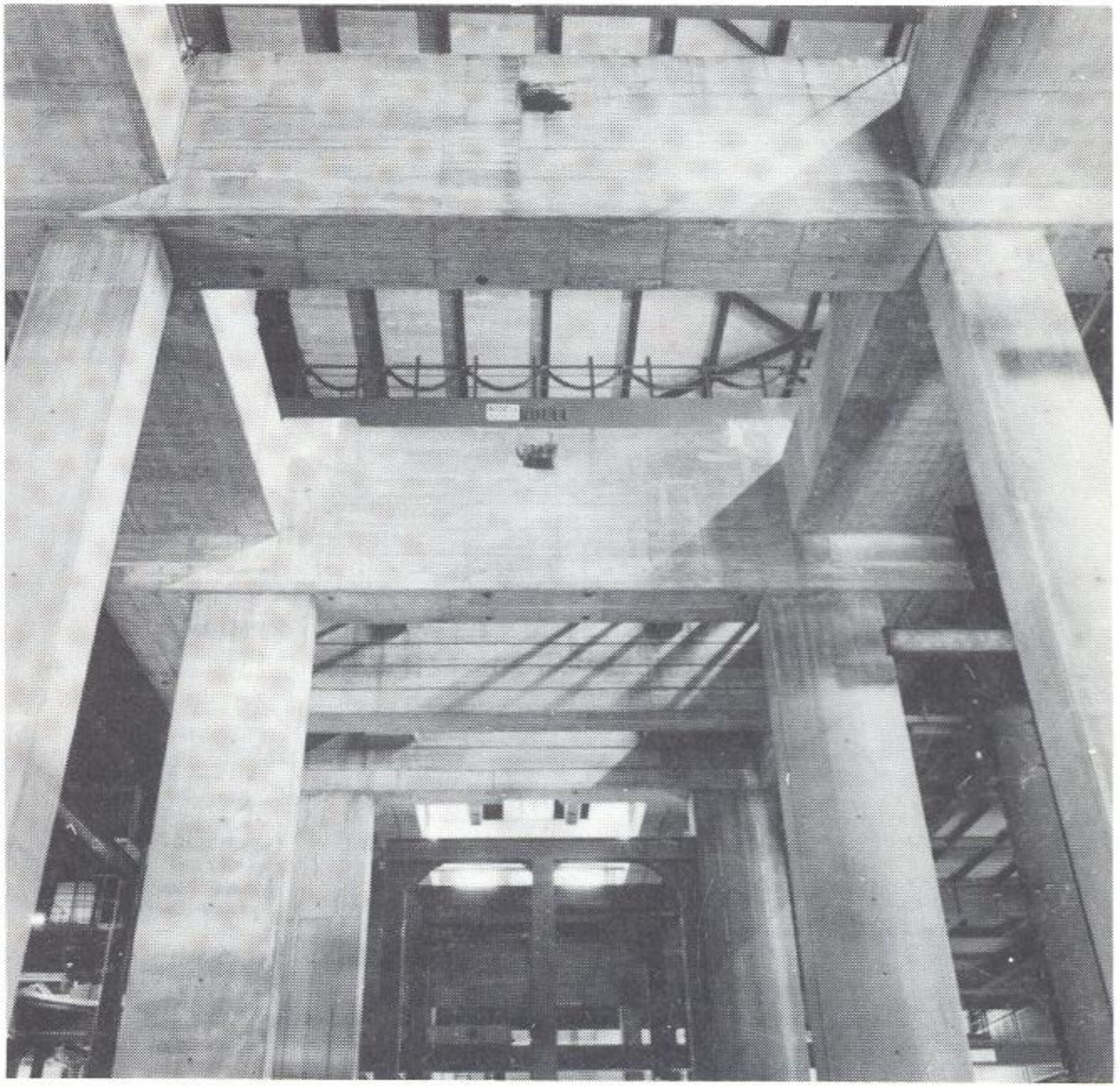
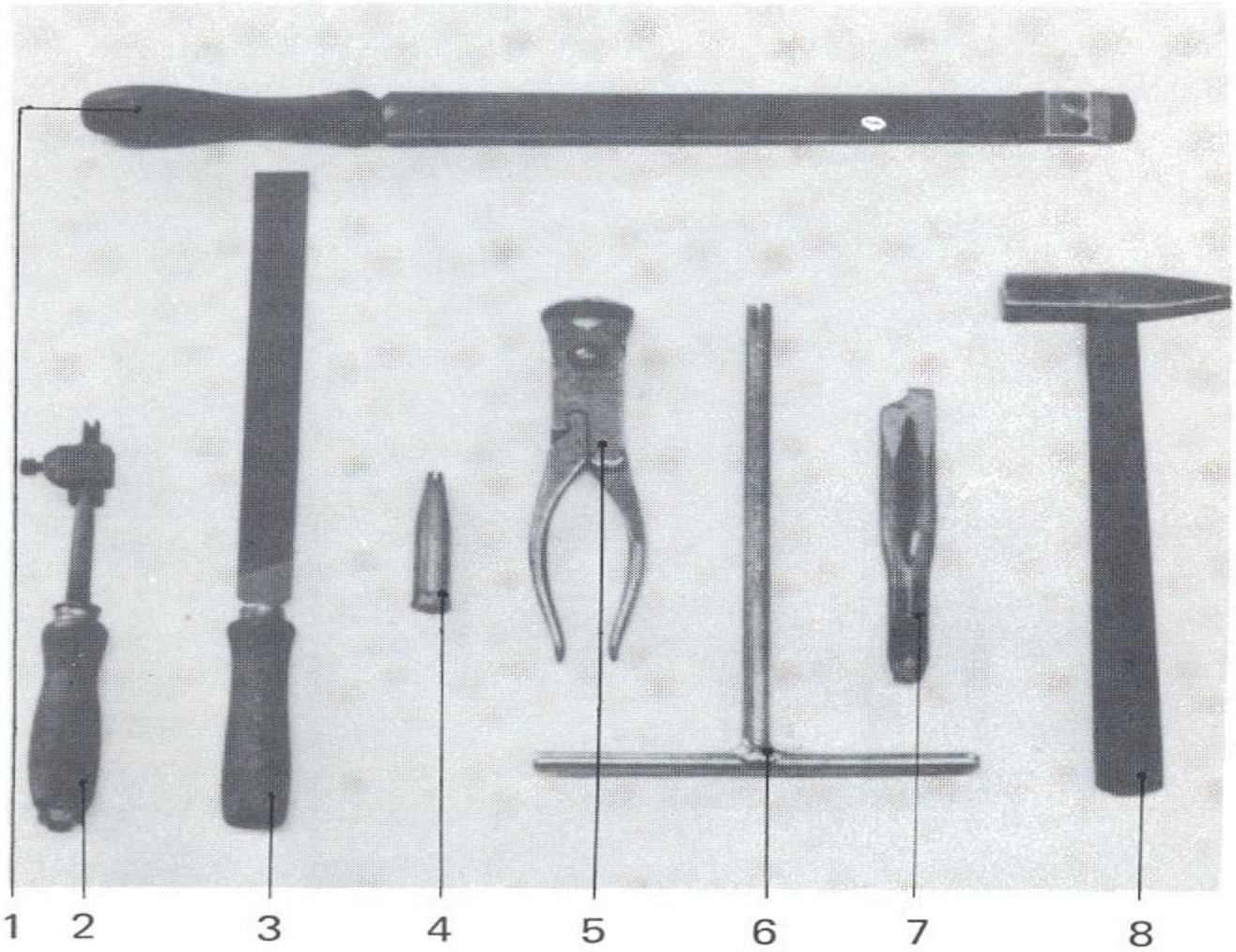


Fig. 4 Foundation Beams



1 Scraper
2 Sharpener
3 Finishing file
4 Caulking tool
5 Pincer pliers
6 Turning key
7 Driver
8 Hammer

Fig. 1 Tools for Removal and Insertion of Seal Strips

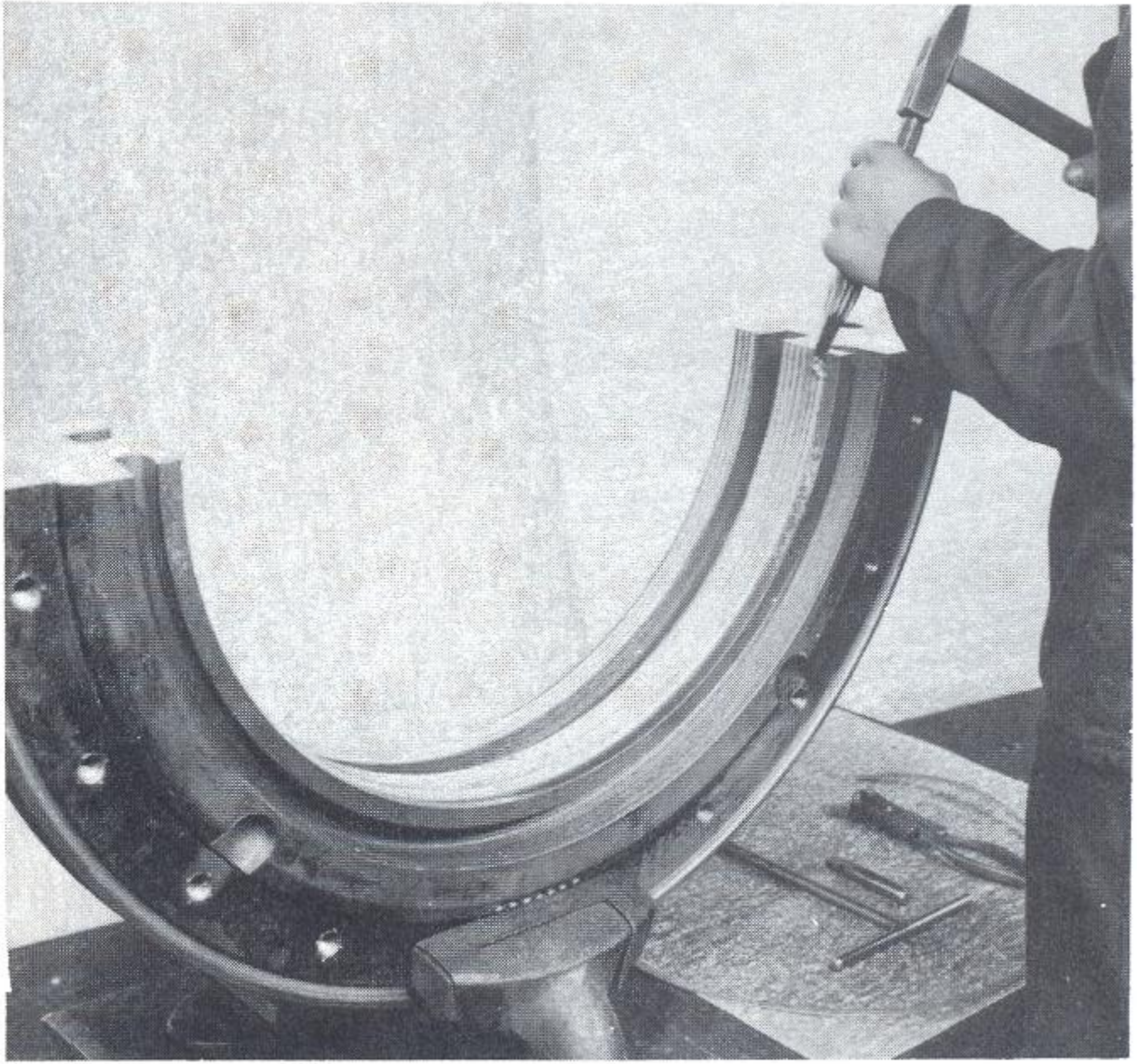


Fig. 2 Forcing out the Seal Strip

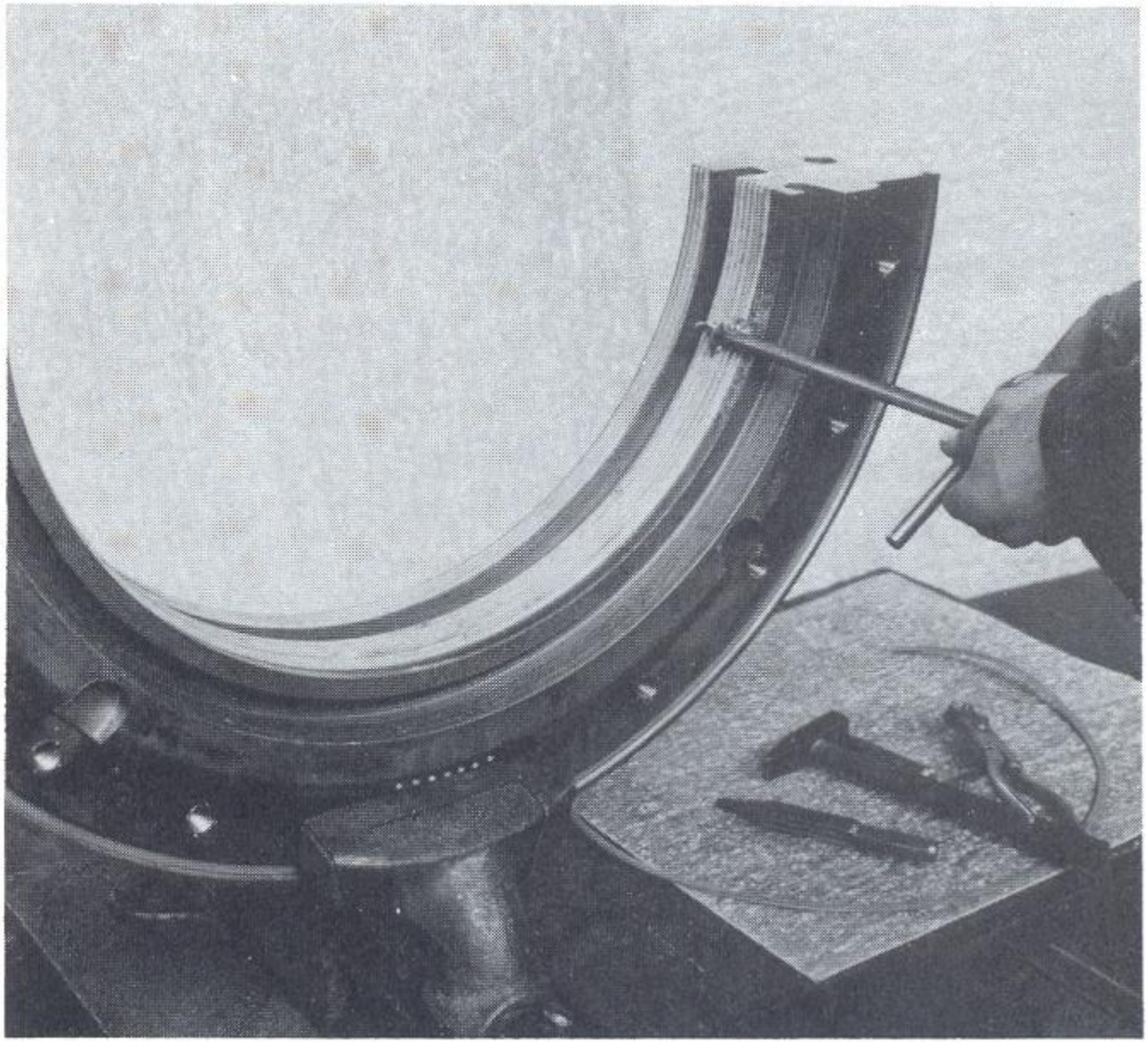


Fig. 3 Turning the Seal Strip out of the Slot

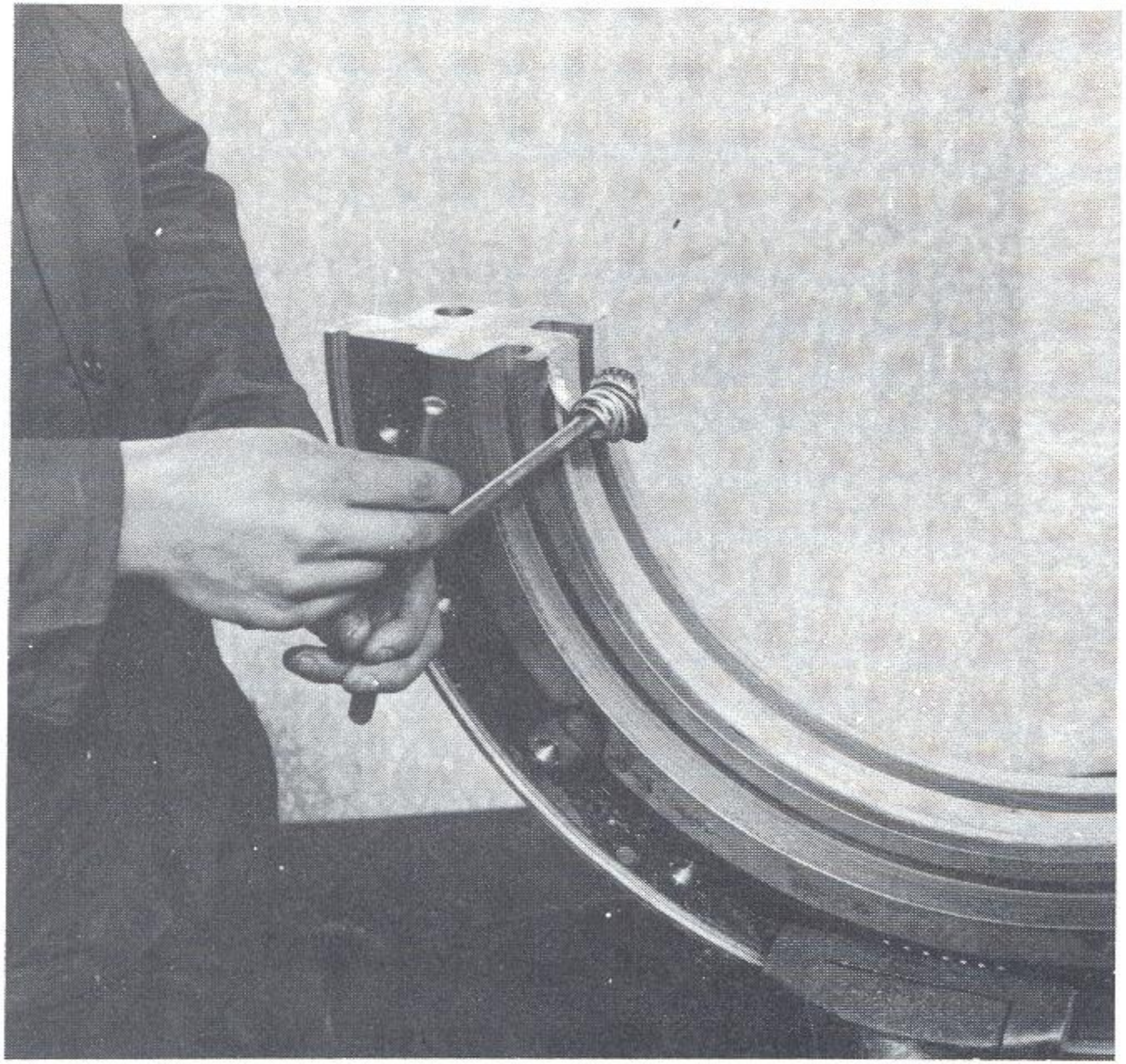


Fig. 4 Seal Strip Rolled around Turning Key

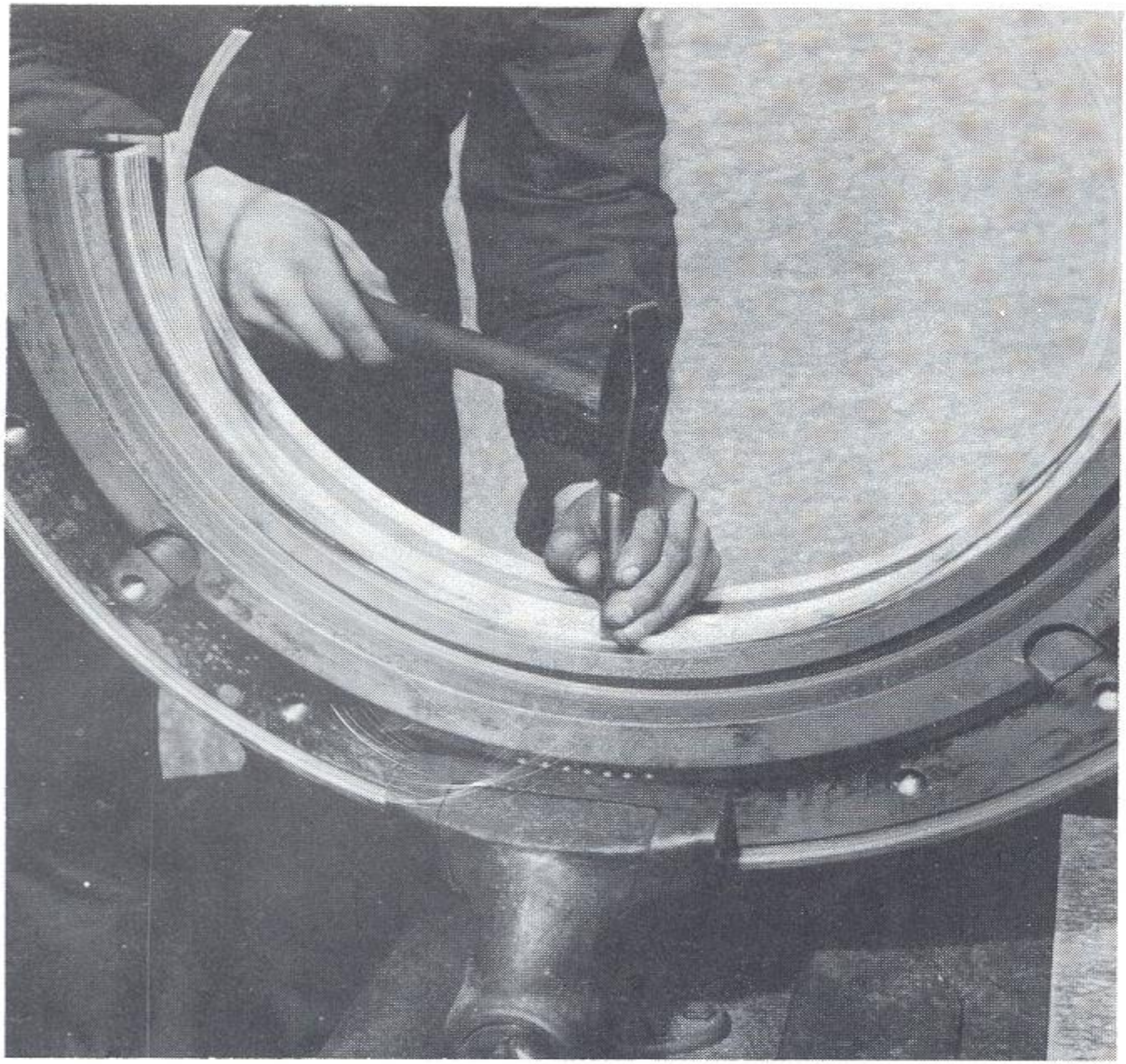


Fig. 5 Hammering in the Seal Strips

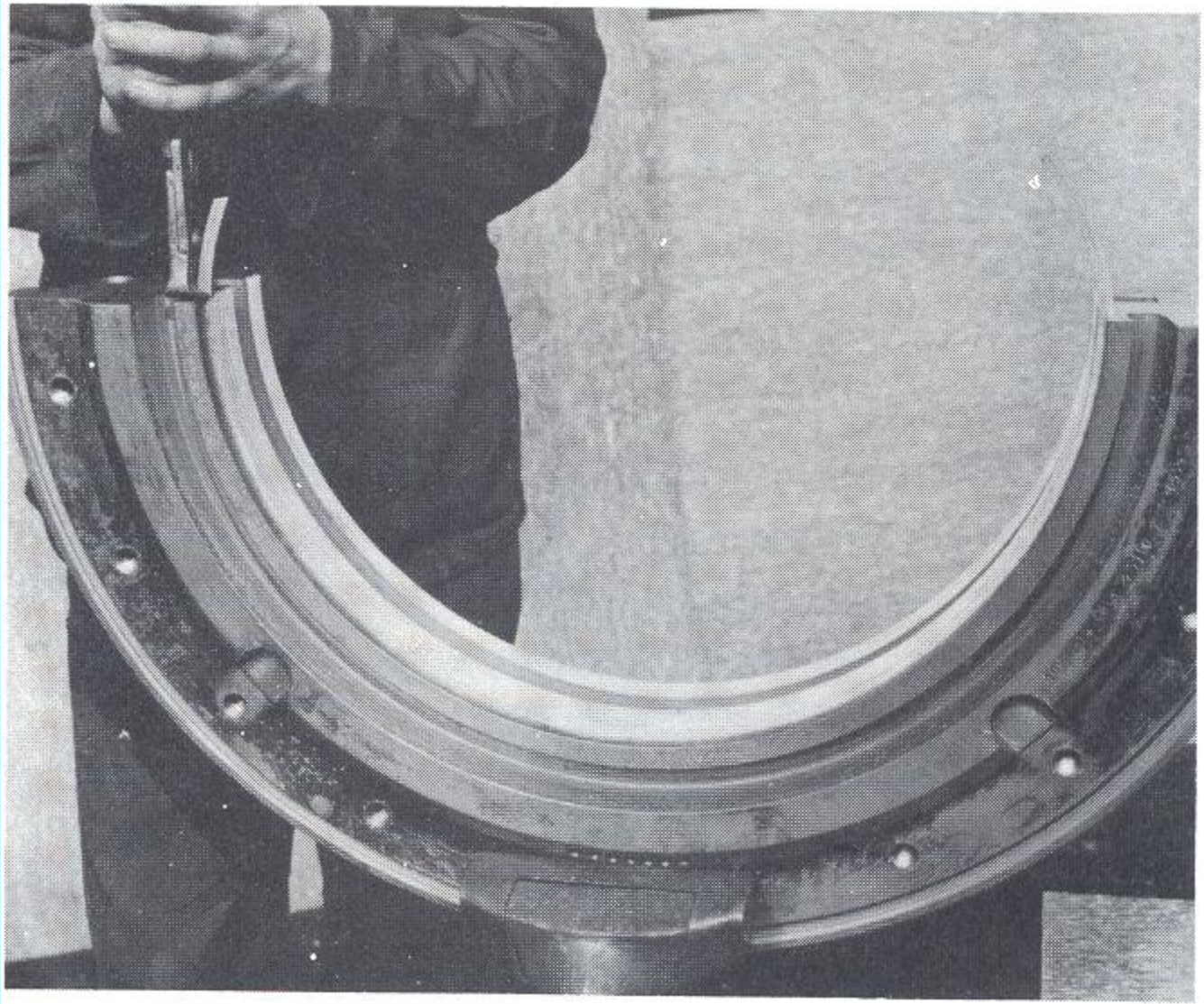
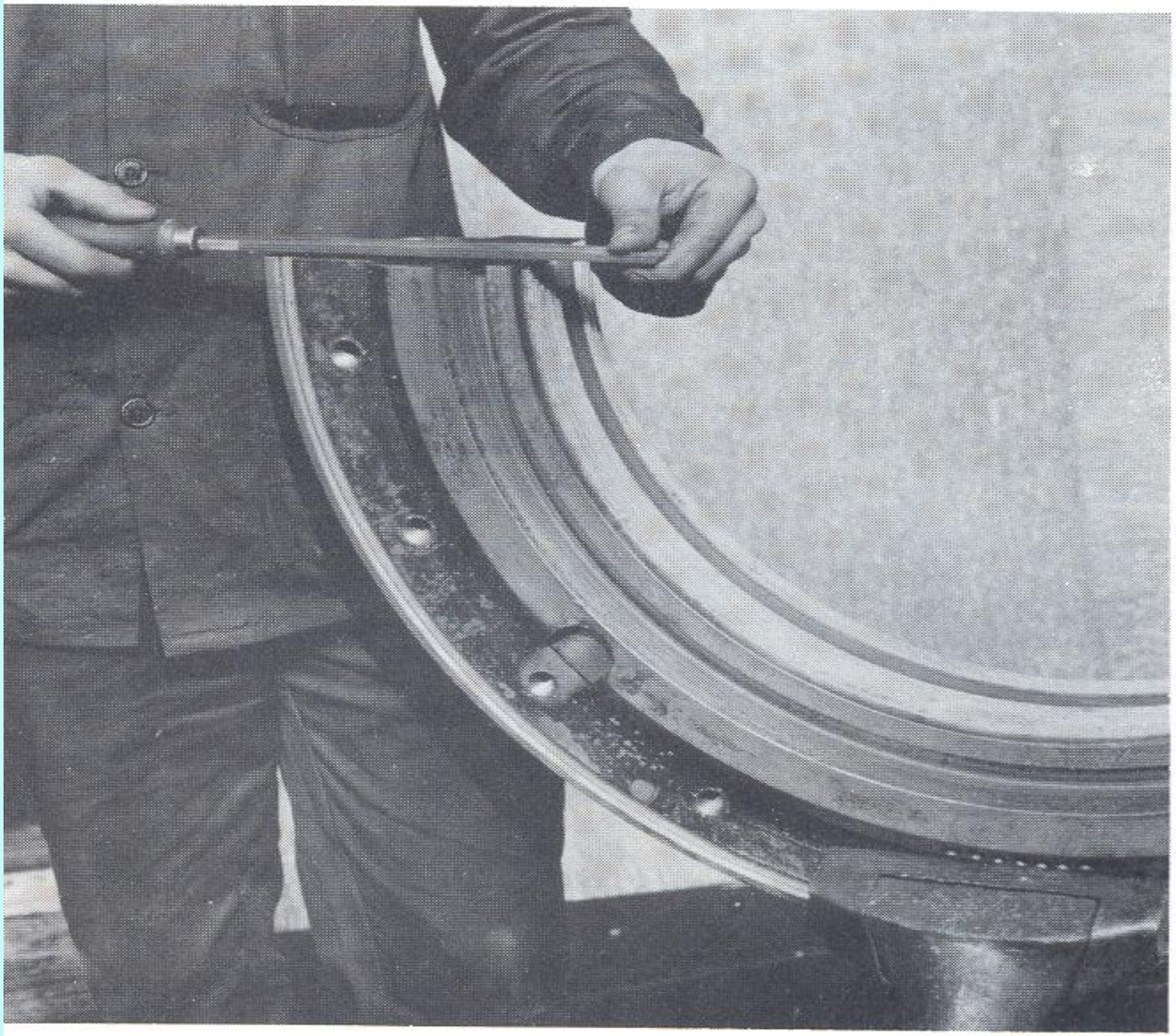


Fig. 6 Cutting off Protruding Seal Strip Ends



g. 7 Trimming the Ends of the Seal Strips with a Finishing File

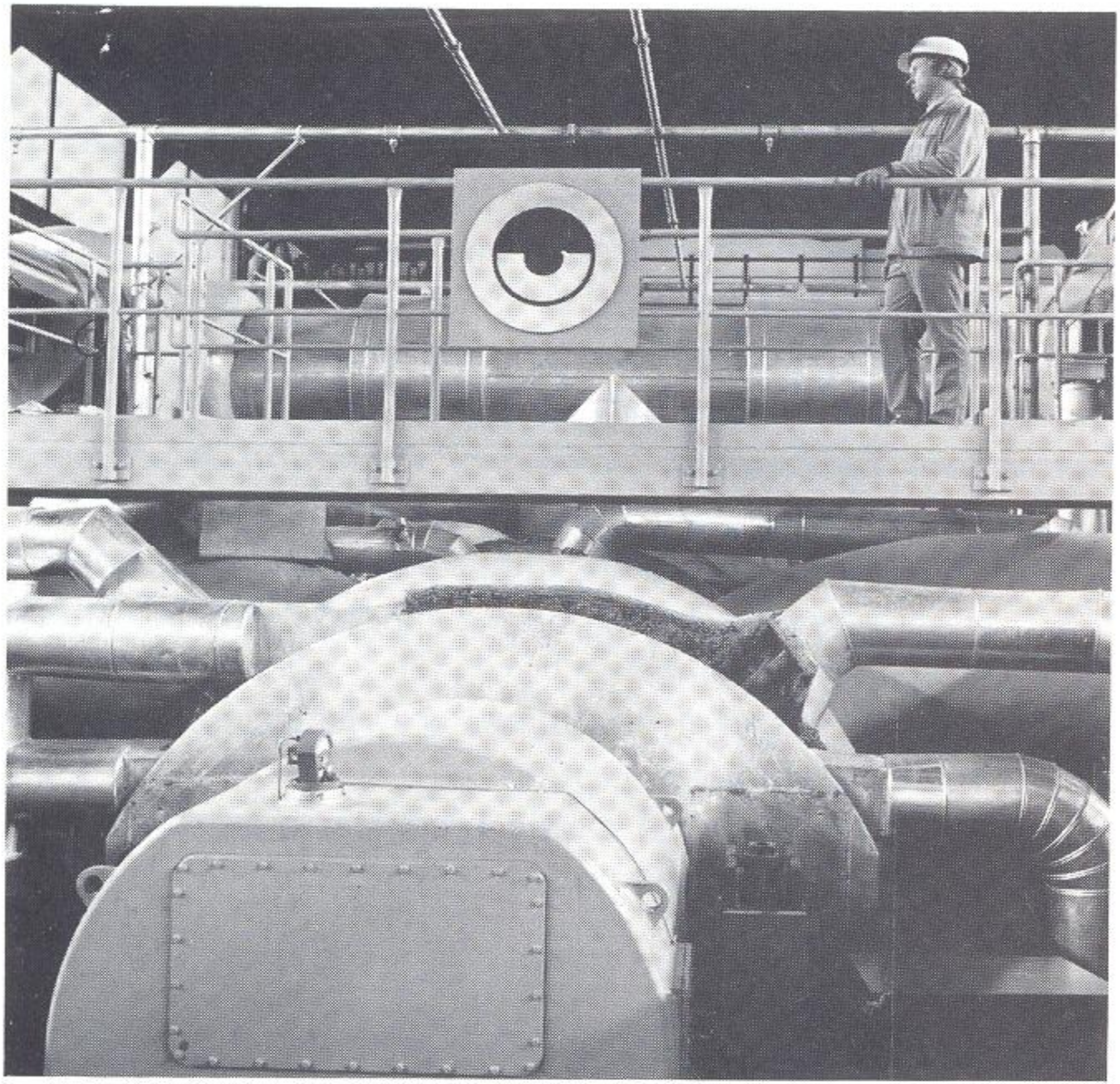
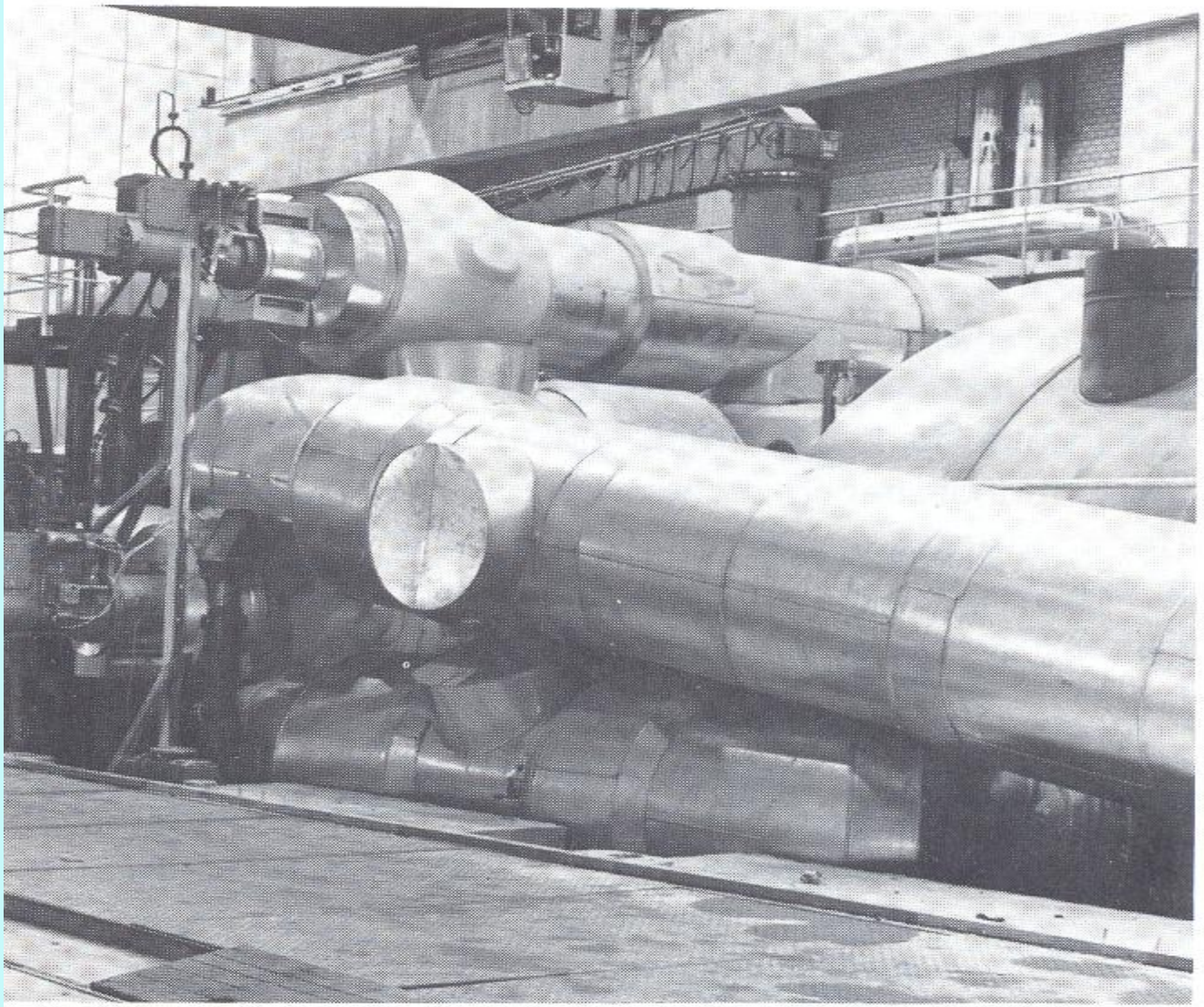


Fig. 1 Insulated HP and IP Turbines with Piping



ig. 2 Inlet Lines to IP Turbine
and Cross-Around Lines to LP Turbine

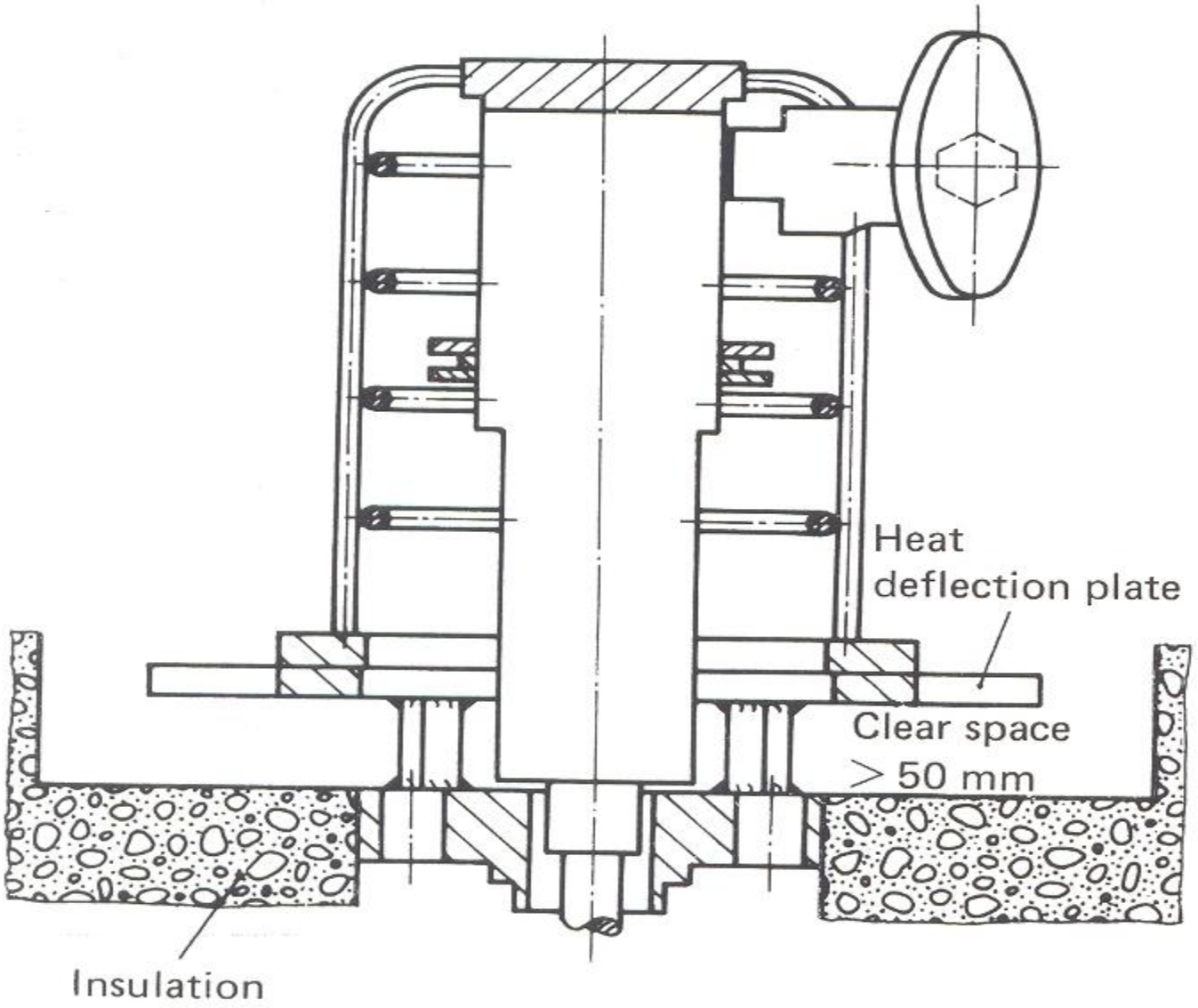


Fig. 3 Insulation Arrangement for Head of Valve Position Indicator

THANK YOU