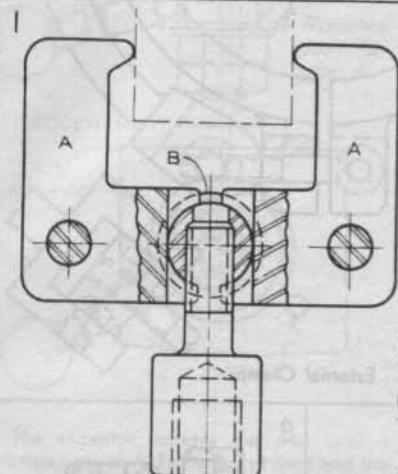


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Answers to Problems in WHAT IS WRONG WITH THIS DESIGN

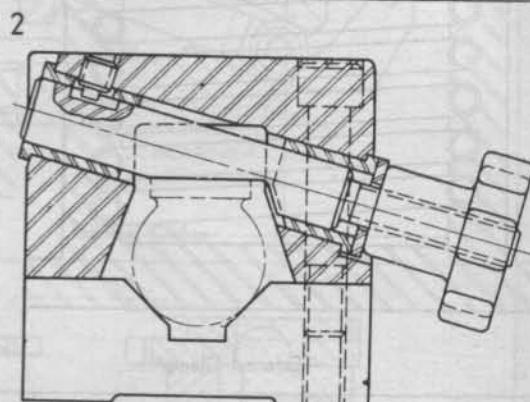
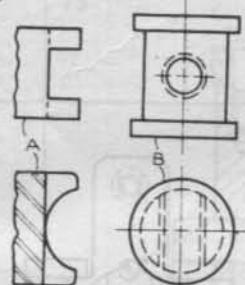
Index follows Answers to Problems.

EXTERNAL CLAMPS



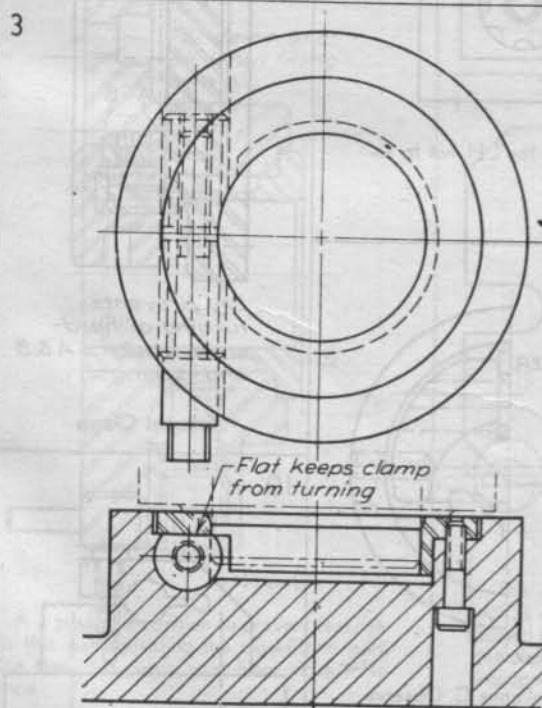
Cylindrical nut B when fitted into the sockets of A actuates the clamp.

External Clamp

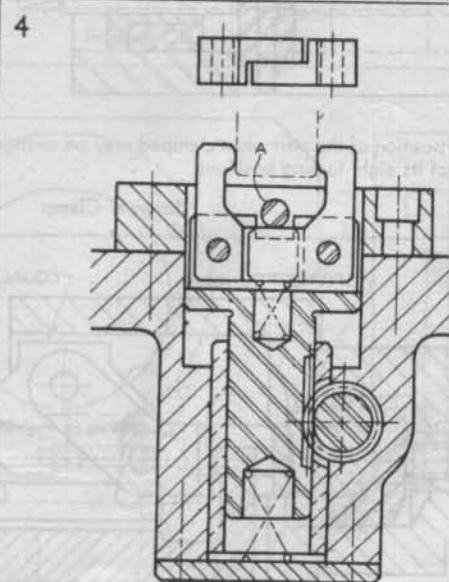


The small angle of the clamp shaft rigidly clamps the part, the dog point set screw preventing its rotation.

External Clamp



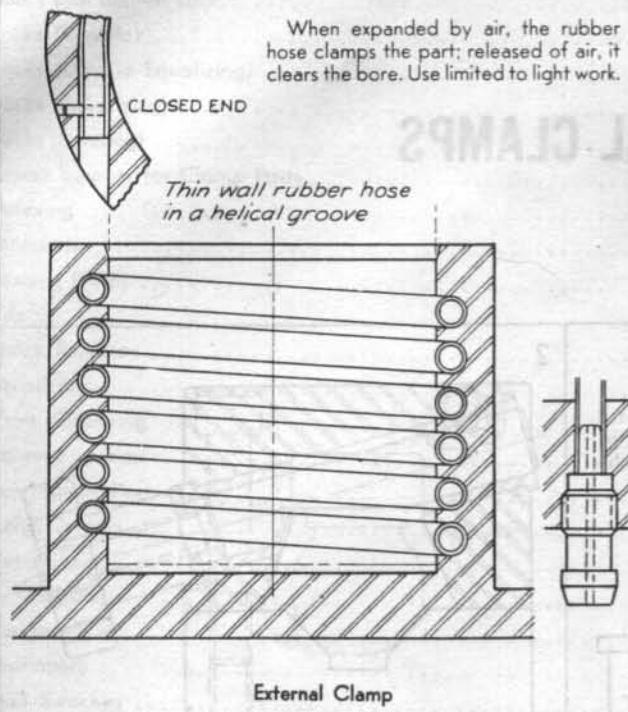
External Clamp



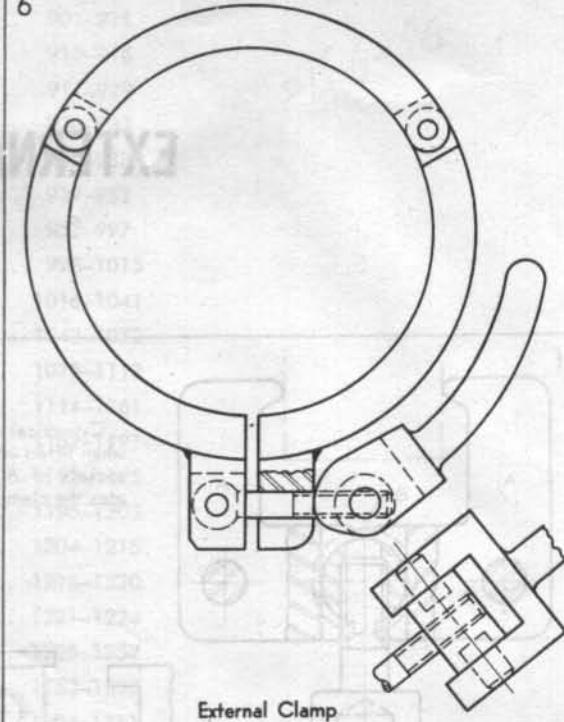
The clamp is actuated by a rack and pinion. The two jaws which were held apart by the small spring are forced to clamp by pin A.

External Clamp

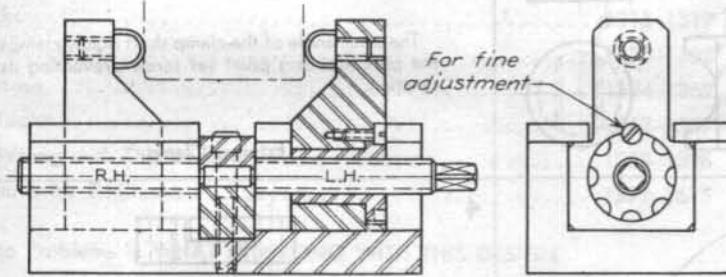
5



6

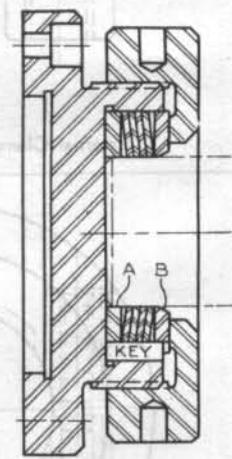


7

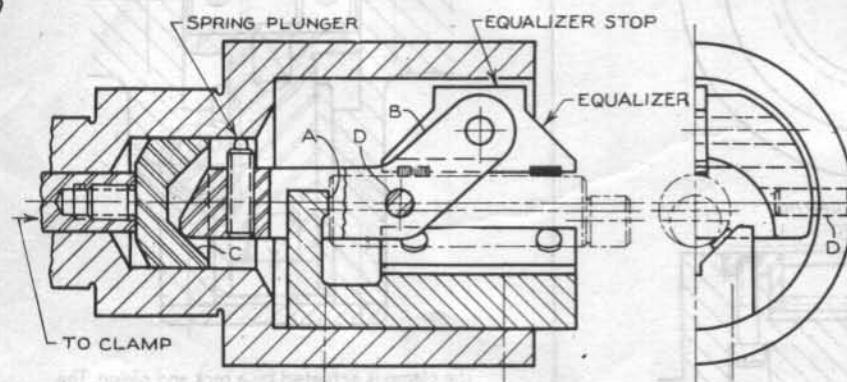


The position of the part when clamped may be changed by turning the L.H. nut to another of its eight locking positions.

8

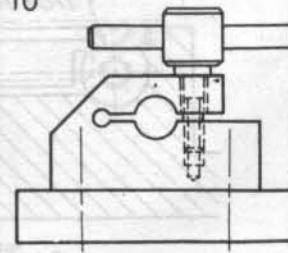


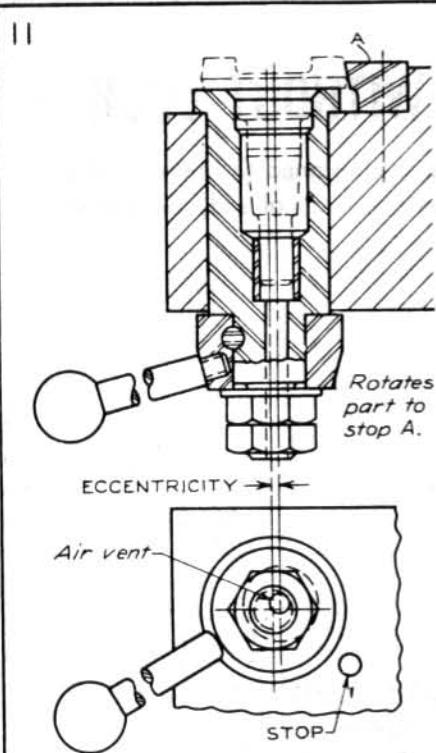
9



The part enters only as far as stop A. Clamp B is actuated by internal cone C. Observe how the pivots for clamp B are devised.

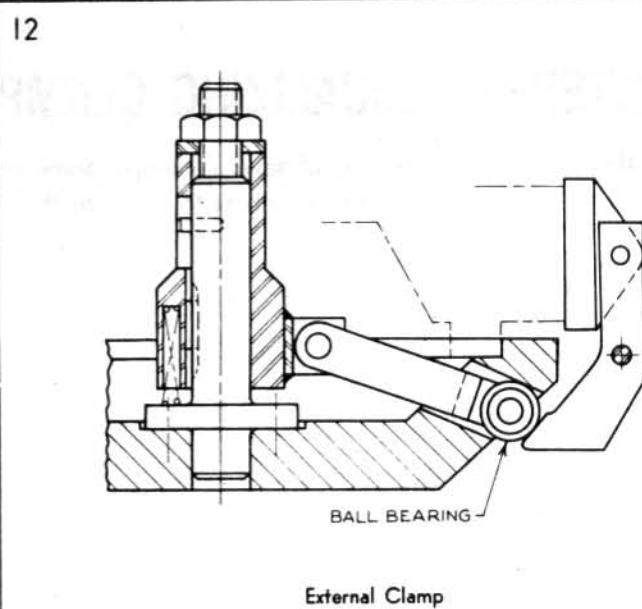
10



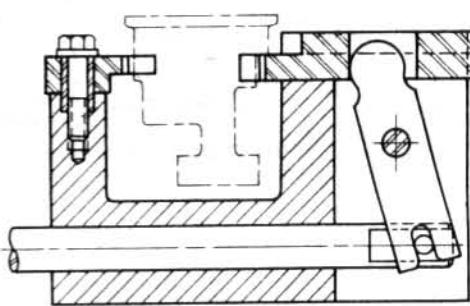


The eccentric rotates the part until it clamps against A. Note the air vent and the unclamping stop.

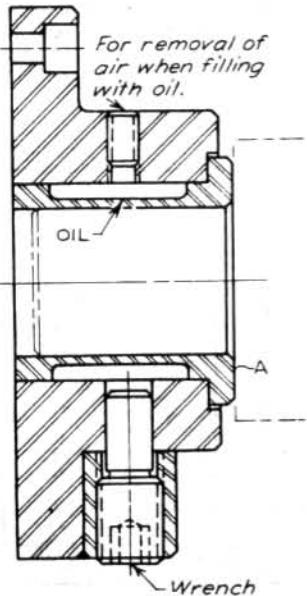
External Clamp.



External Clamp

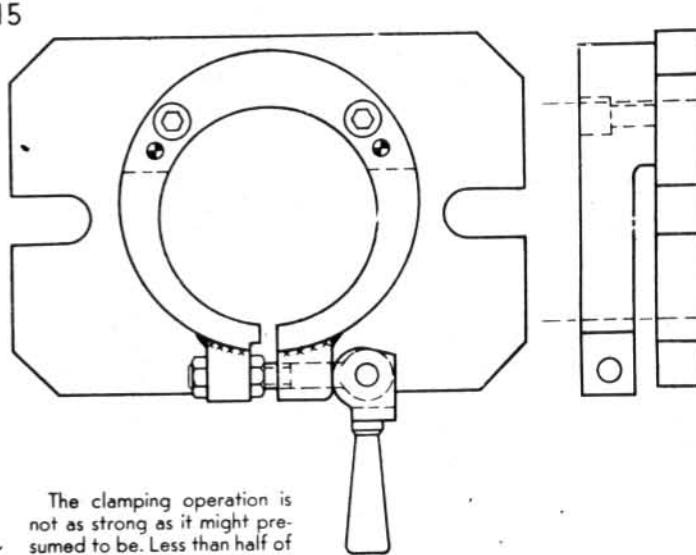


External Clamp



A is brazed in position to prevent leakage, its thin wall squeezing the closefitting part. The threaded piston must have close tolerance.

External Clamp



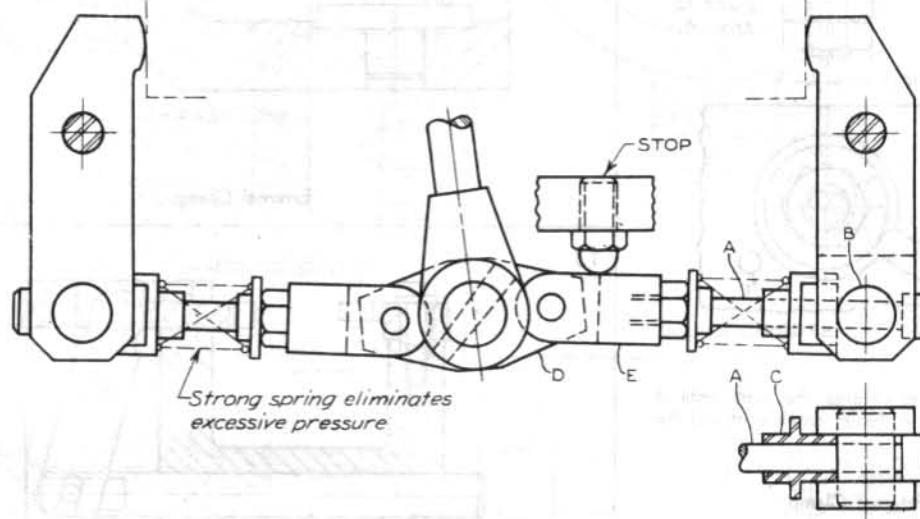
The clamping operation is not as strong as it might be presumed to be. Less than half of the clamp bends in the clamping operation.

External Clamp

EXTERNAL EQUALIZING CLAMPS WITHOUT LOCK

A fixture may be comprised of several clamps. Some clamps are designed to centralize the part or an important portion of it, others to equalize themselves about an already positioned portion of the part.

16



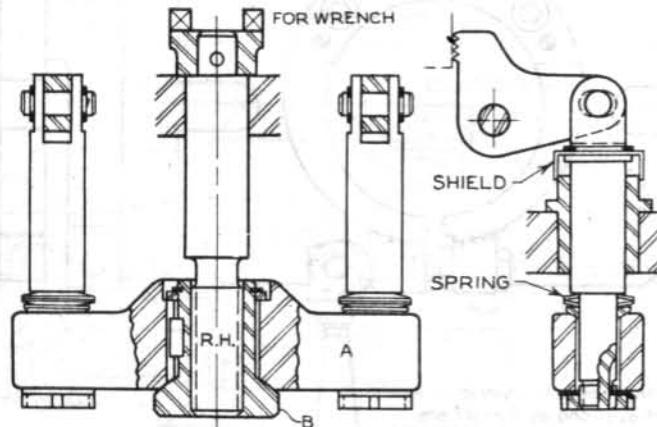
The springs allow the clamps to equalize. If a portion of the part is a bit to the right of center, the springs will accommodate the portion that is off center.

The illustrated spring forces C against pin B and moves the clamp to the part. In clamp position the head of cap

screw A is free of pin B, but in unclamp position the spring moves B to the head of A to limit the expansion of the spring and to retract the clamp. This toggle type of clamp invariably needs a stop.

External Equalizing Without Lock

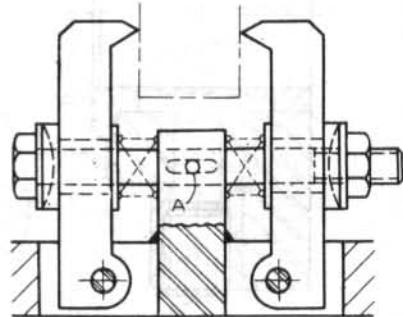
17



Rocker arm A can rock about nut B, the clearance and spherical base of the nut permitting it to do so. The washer-type springs prevent excessive clamp pressure.

External Equalizing Without Lock

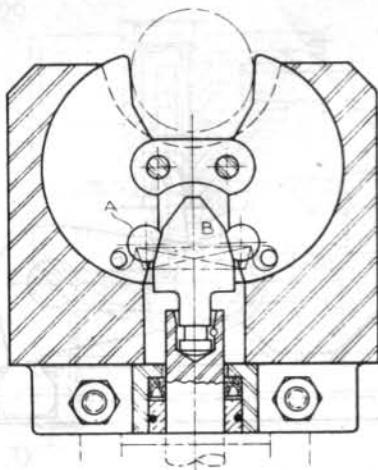
18



When pin A is in the slot in the bolt, the bolt is prevented from turning.

External Equalizing Without Lock

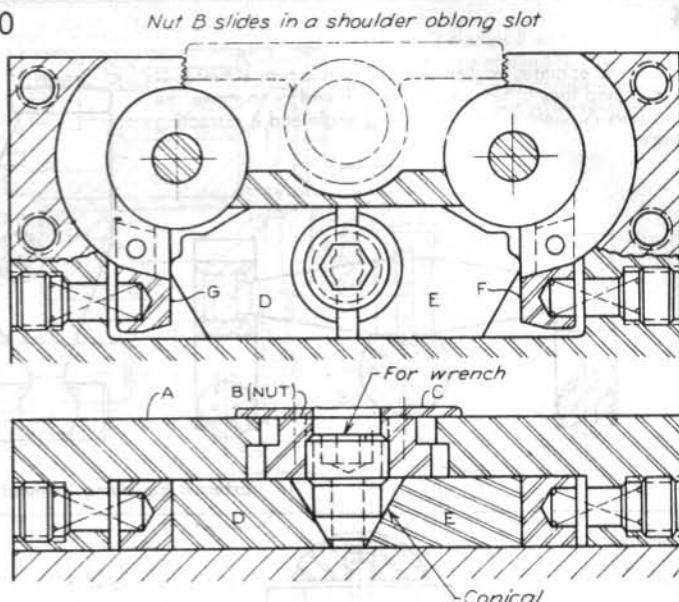
19



Pin A rotates. B is free to move to the left or the right.

External Equalizing Without Lock

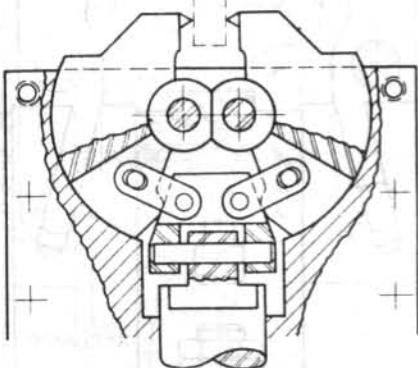
20



Nut B slides to the left and right in an oblong T-slot, thereby allowing D and E to equalize and force clamps F and G to clamp.

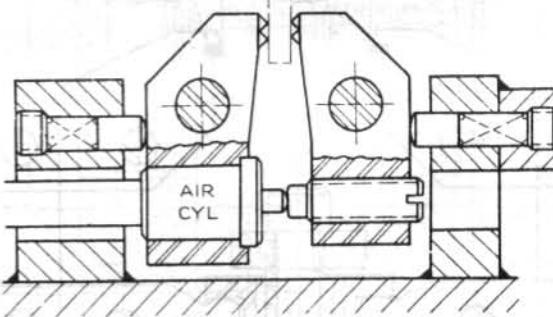
External Equalizing Without Lock

21



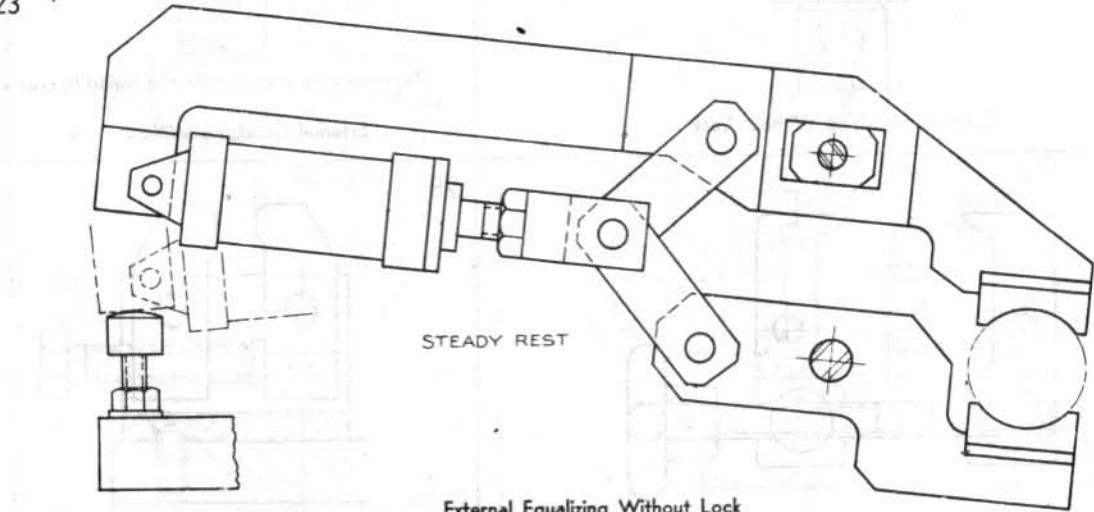
External Equalizing Without Lock

22



External Equalizing Without Lock

23

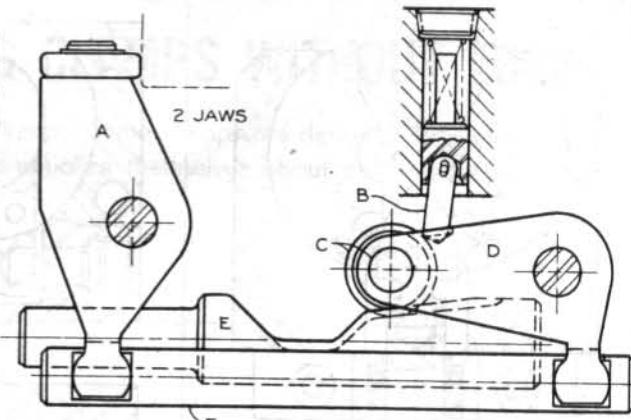
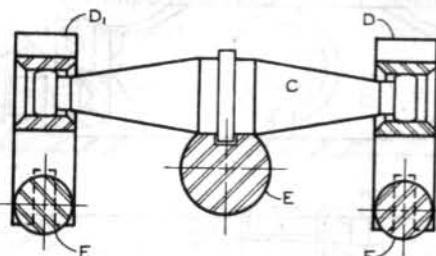


External Equalizing Without Lock

24-28

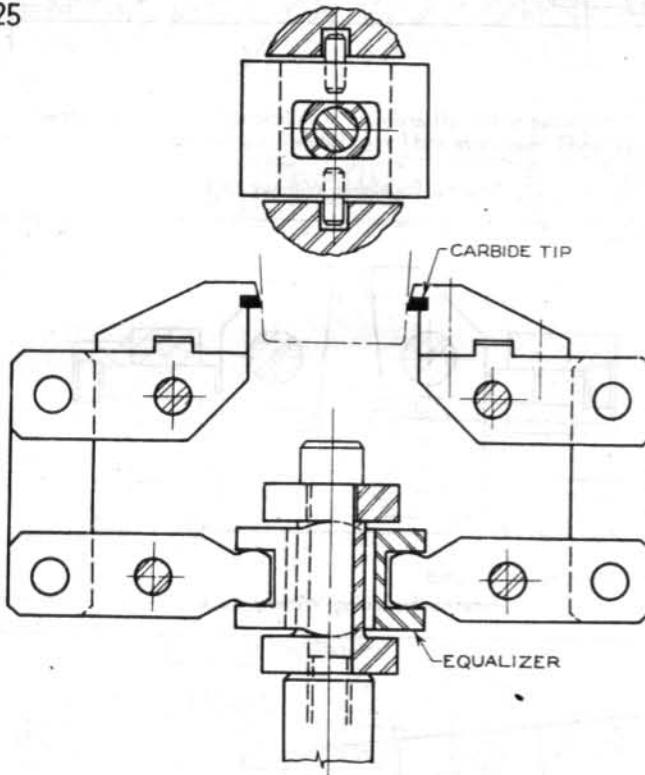
24

Cam E actuates rocker arm C which in turn actuates D and D₁ and they in turn cause shafts F and F₁ to move the two jaws A. Cam E has a clamping angle and a retracting angle.



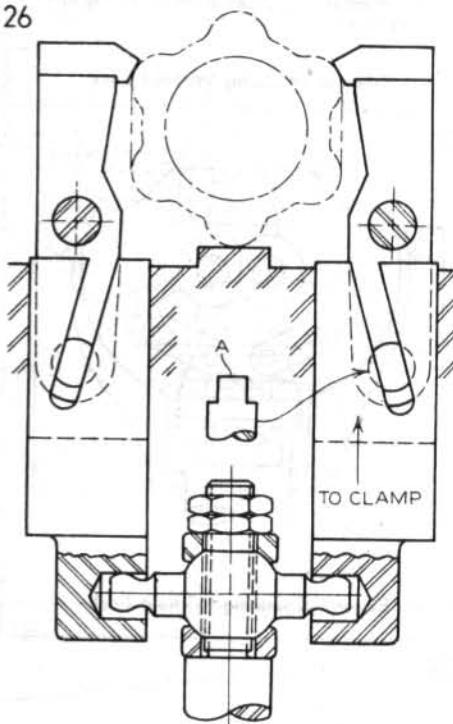
External Equalizing Without Lock

25



External Equalizing Without Lock

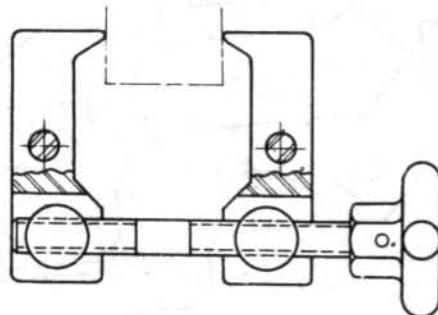
26



Note how the end of shaft A is milled to create key A.

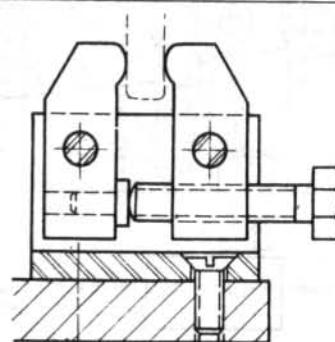
External Equalizing Without Lock

27



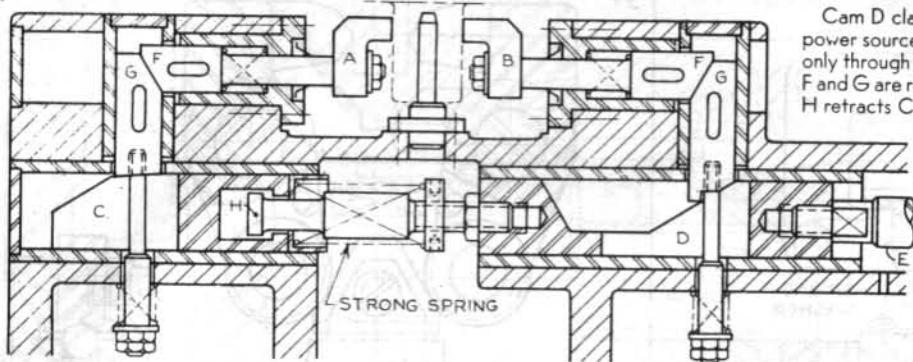
External Equalizing Without Lock

28



External Equalizing Without Lock

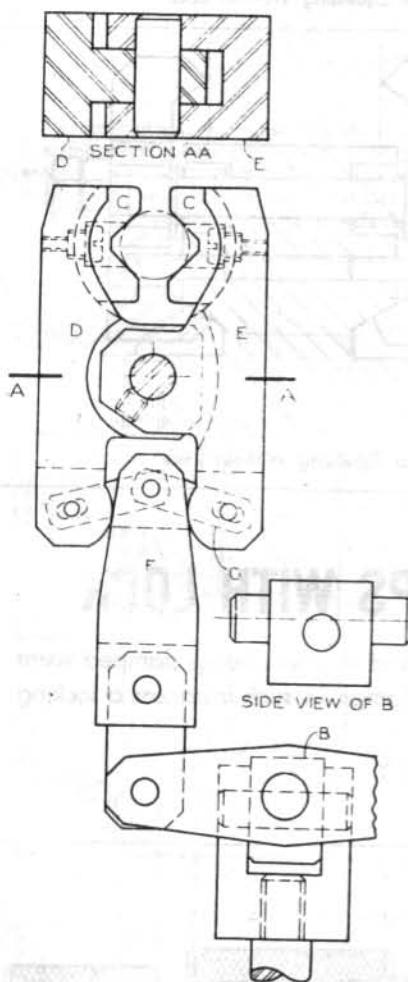
29



Cam D clamps B as C clamps A. The power source applied to E moves D and only through the strong spring moves C. F and G are retracted by smaller springs. H retracts C.

External Equalizing Without Lock

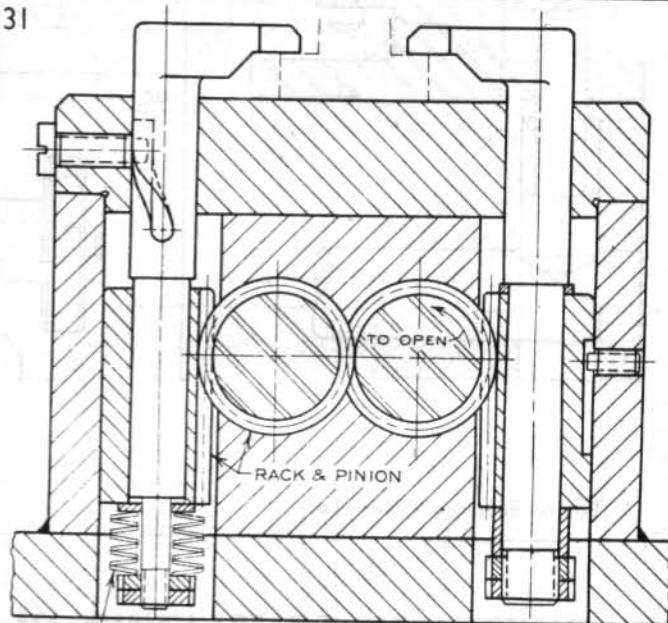
30



B, C, and F are equalizers. Observe how D and E utilize the same shaft in a tongue and groove manner. G retracts the clamps. Gimbal B equalizes a pair of clamps.

External Equalizing Without Lock

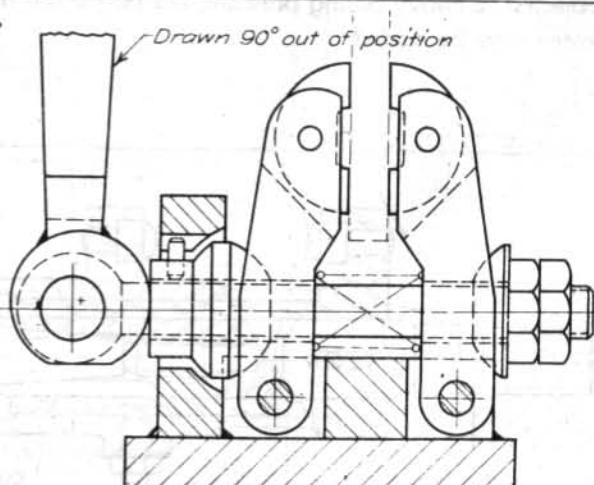
31



The springs allow the clamps to be equalized.

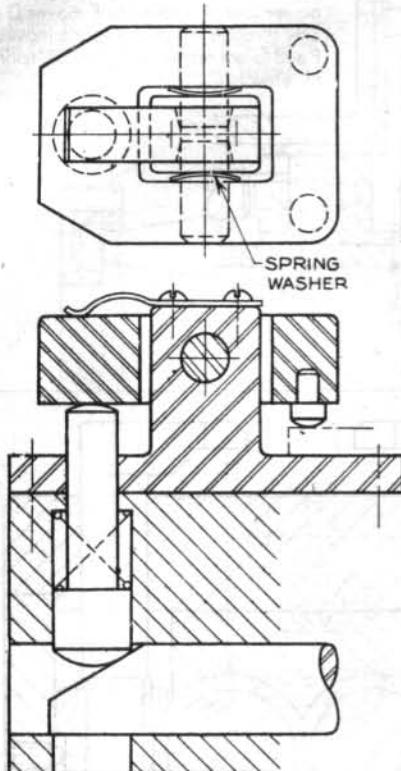
External Equalizing Without Lock

32



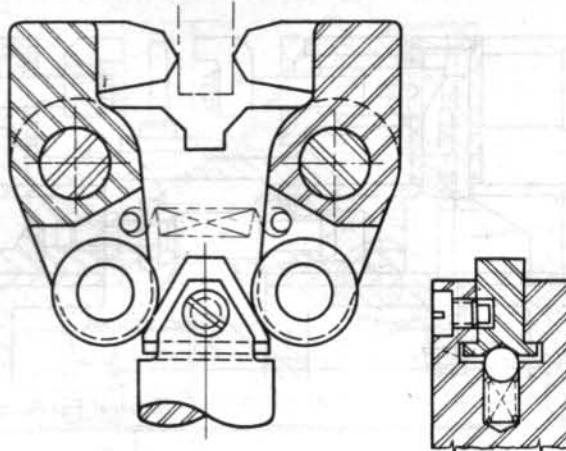
External Equalizing Without Lock

33



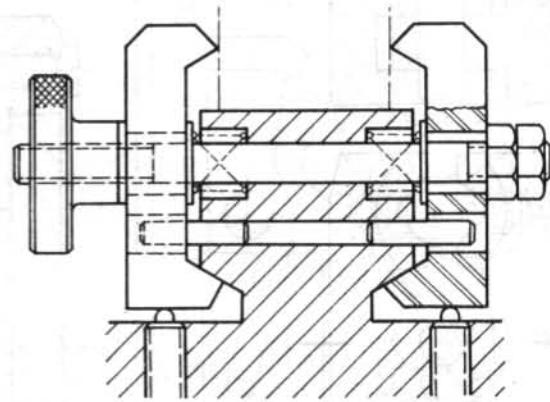
External Equalizing Without Lock

34



External Equalizing Without Lock

35

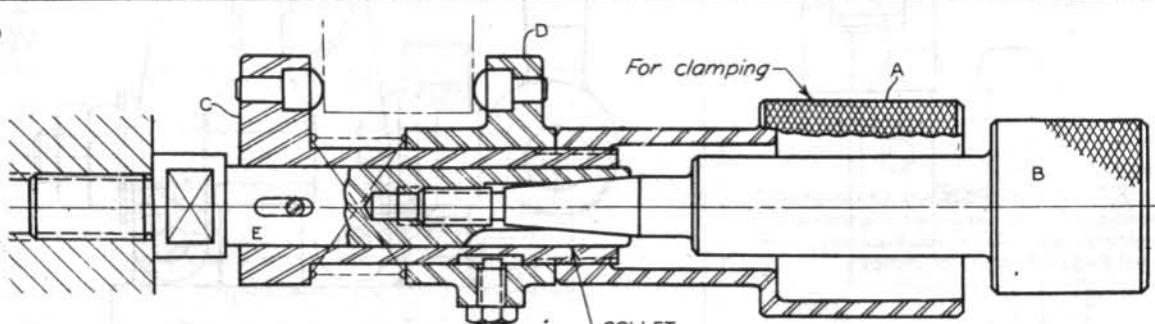


External Equalizing Without Lock

EXTERNAL EQUALIZING CLAMPS WITH LOCK

Many equalizing clamps have limited rigidity. If the portion of the part being clamped were subjected to heavy cutting pressure, the part could move the clamps. In such instances a locking device may be added.

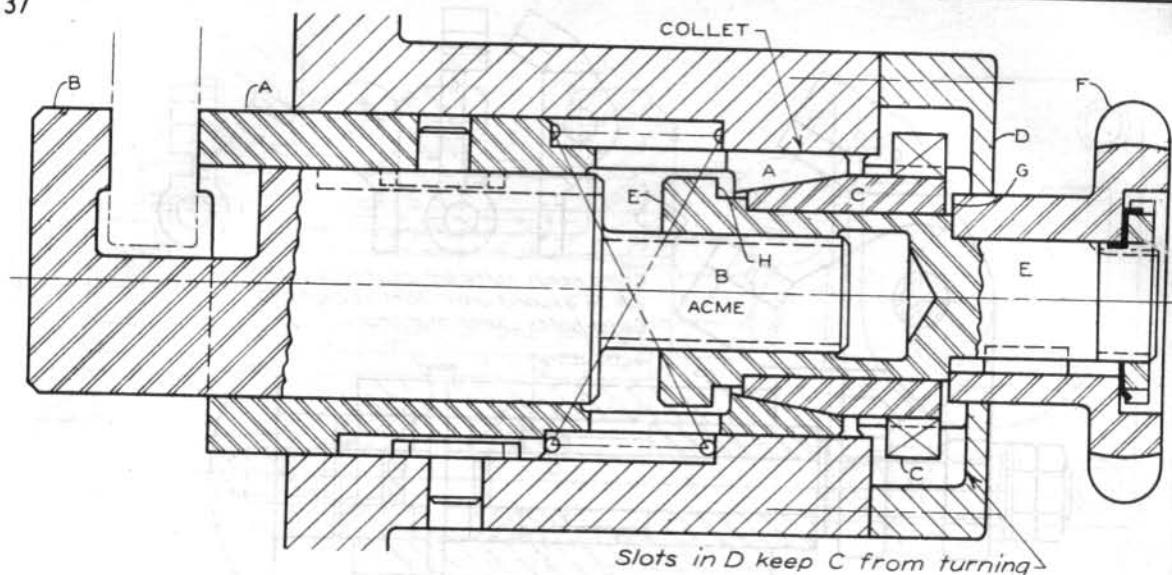
36



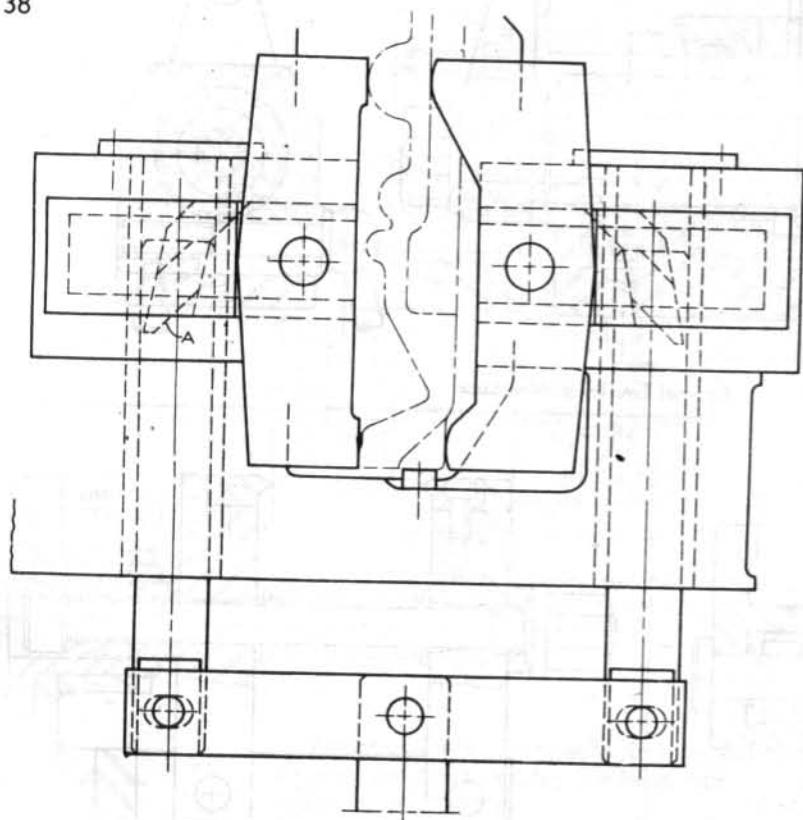
C is set screwed to E and D to C. A clamps the jaws. B locks the collet.

External Equalizing With Lock

37



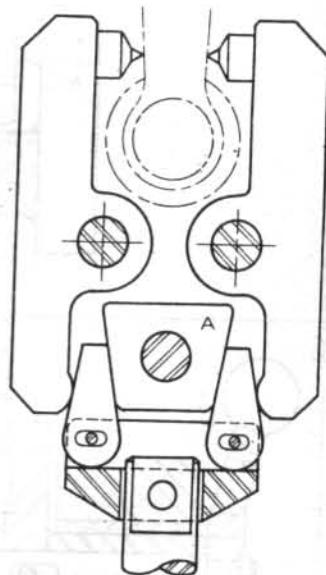
38



See Power Sources for Clamp Posts category for larger illustrations of the cam wedge A lock. The jaws move horizontally.

External Equalizing With Lock

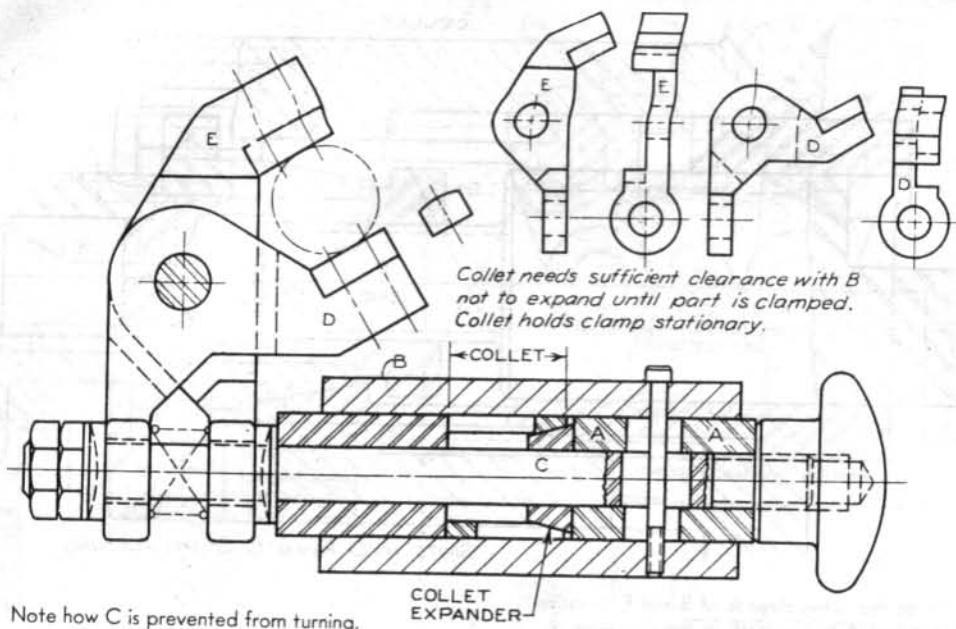
39



Wedge A, which revolves, acts as a lock during the clamping operation.

External Equalizing With Lock

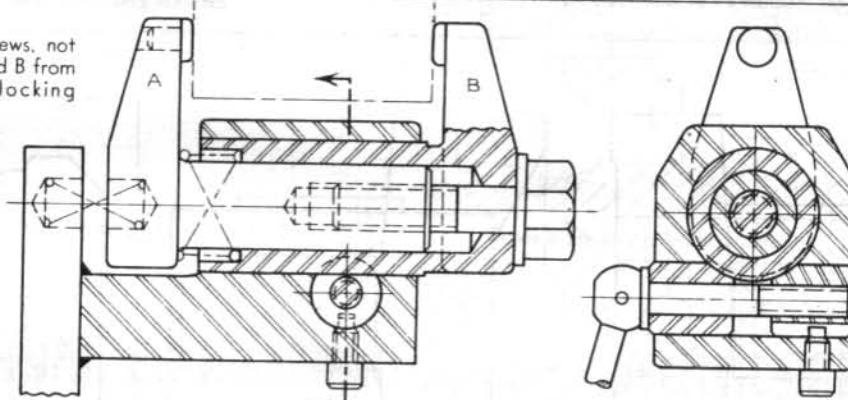
40



External Equalizing With Lock

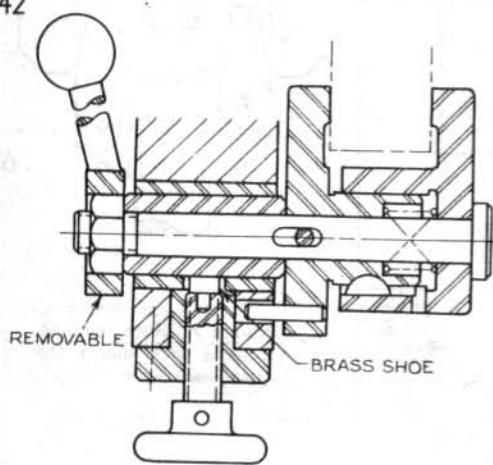
41

Dog point set screws, not shown, prevent A and B from turning. Note the locking method.



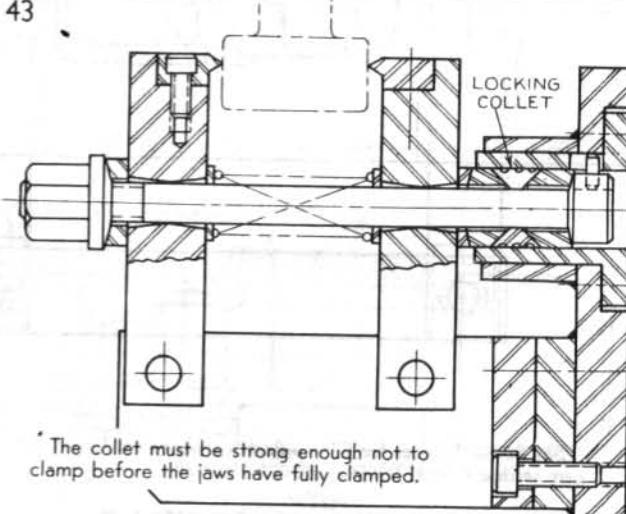
External Equalizing With Lock

42



External Equalizing With Lock

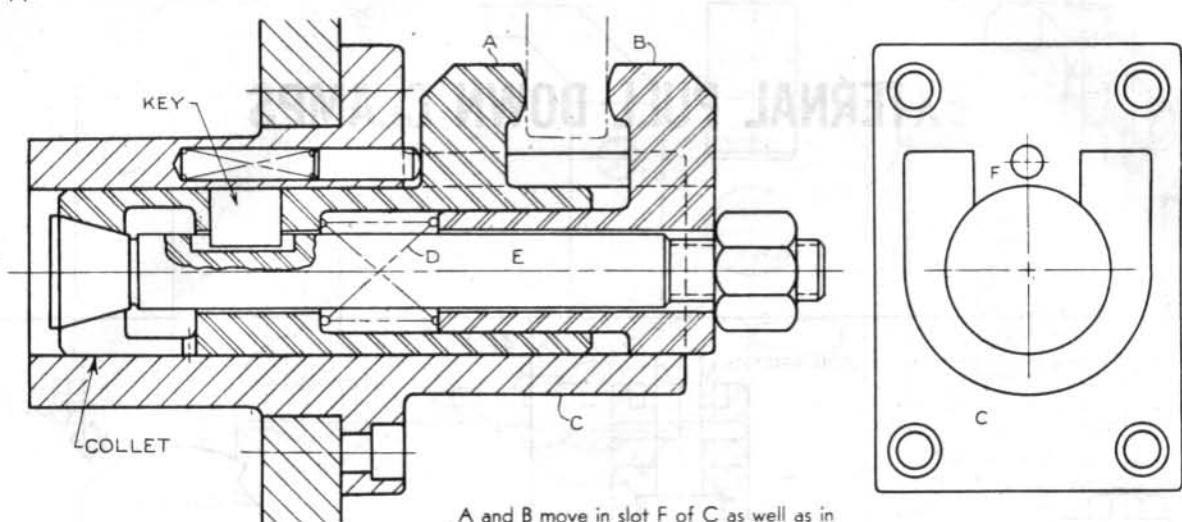
43



External Equalizing With Lock

45

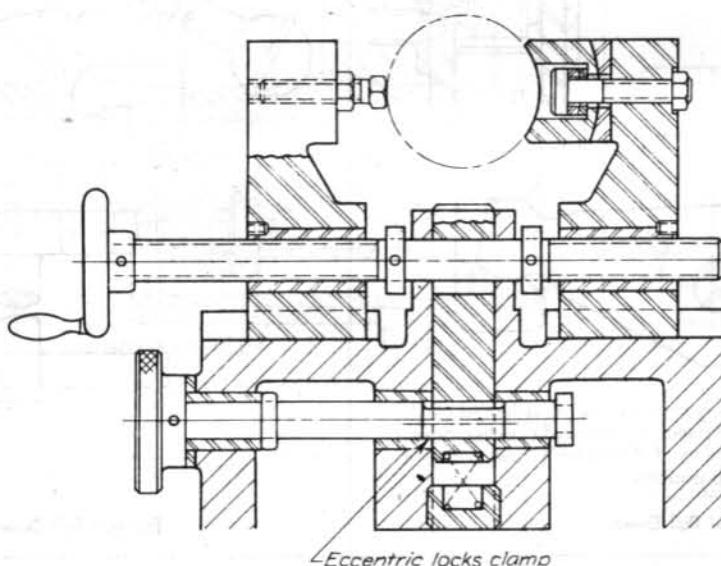
44



A and B move in slot F of C as well as in the bore. Spring D spreads the jaws. During the clamping operation the strong collet locks the clamps. The key prevents E from turning.

External Equalizing With Lock

45

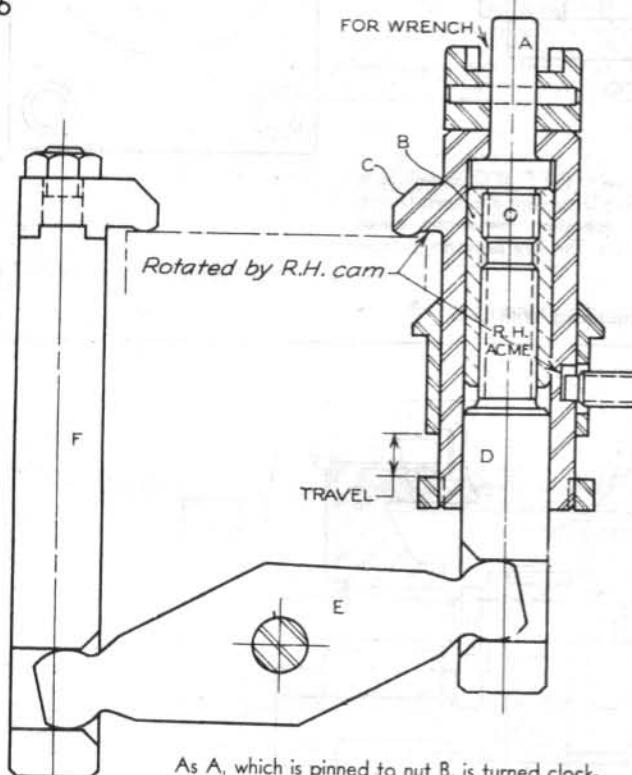


External Equalizing With Lock

"I think and think, for months, for years, ninety-nine times the conclusion is false. The hundredth time I am right." ALBERT EINSTEIN

EXTERNAL PULL DOWN CLAMPS

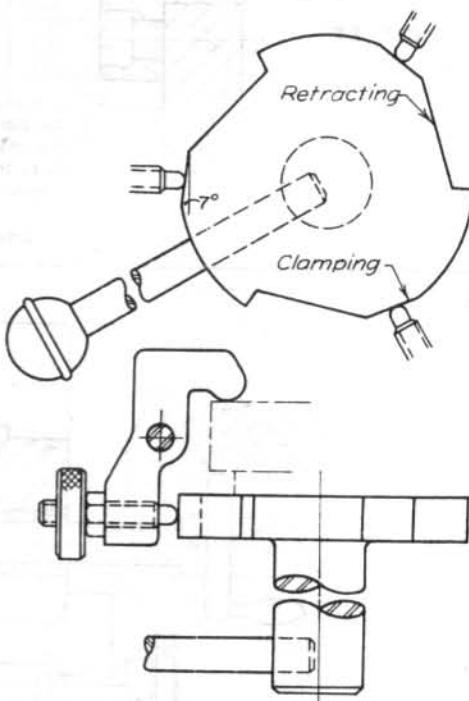
46



As A, which is pinned to nut B, is turned clockwise it pulls D up and, by means of E, pulls F down. Continued turning of A rotates C and pushes it down to clamp position.

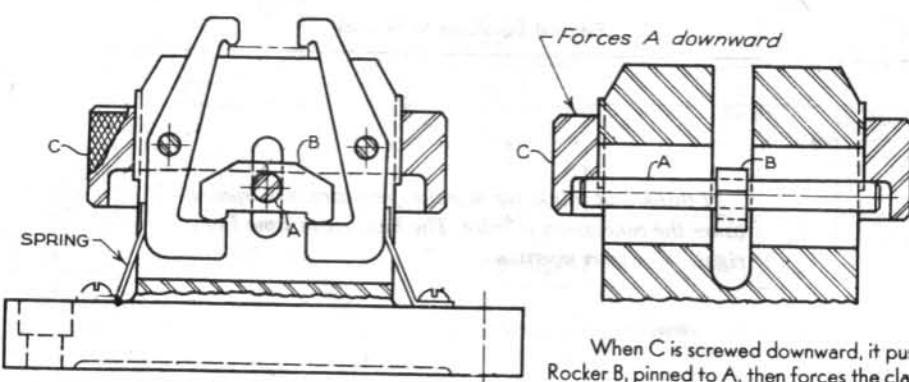
External Pull Down

47



External Pull Down

48



When C is screwed downward, it pushes pin A down. Rocker B, pinned to A, then forces the clamps to function.

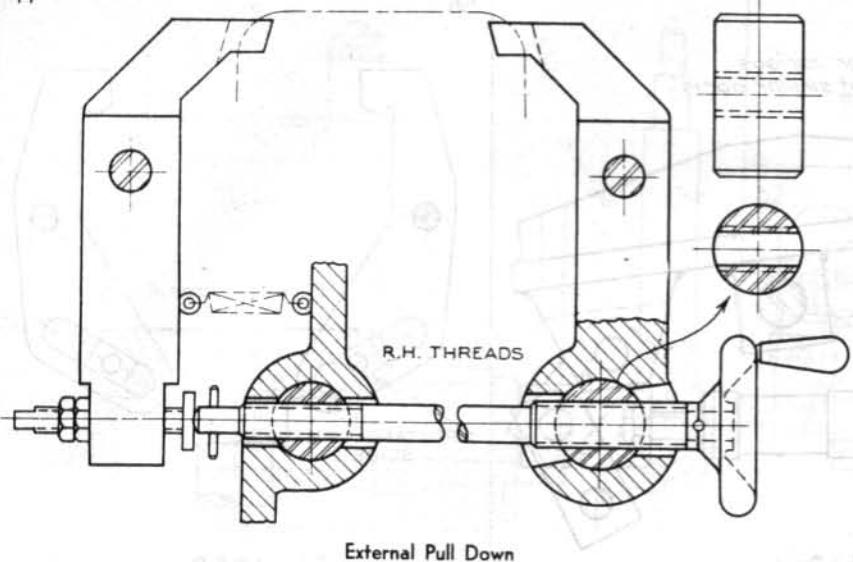
External Pull Down

49

51

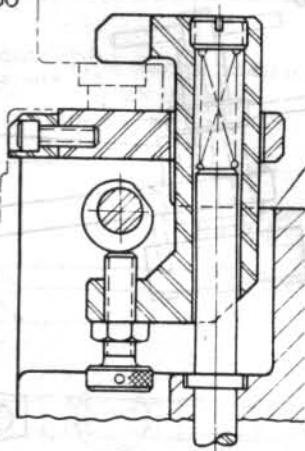
After rotate

49



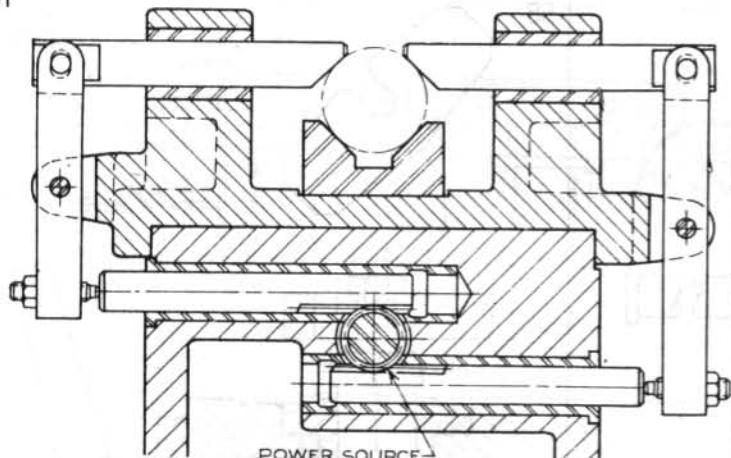
External Pull Down

50



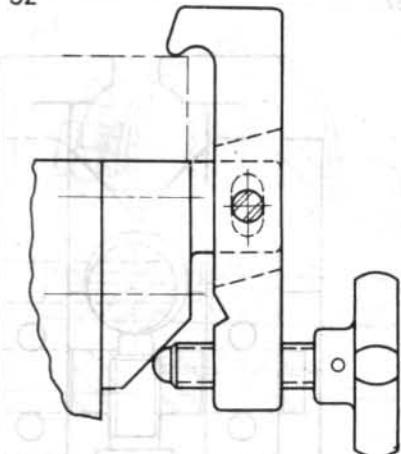
External Pull Down

51



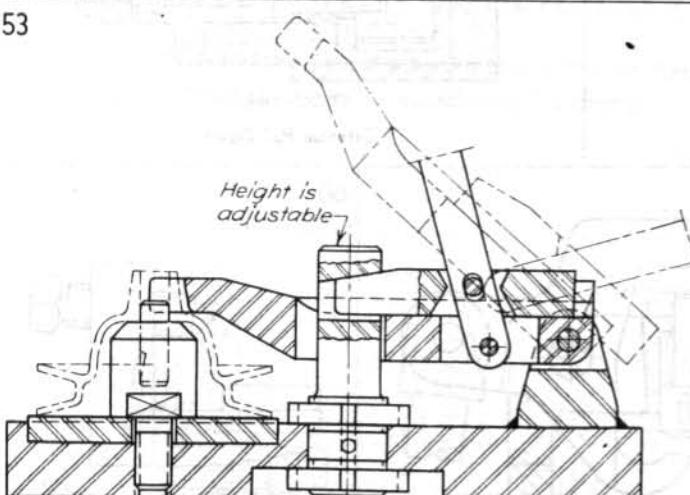
External Pull Down

52



External Pull Down

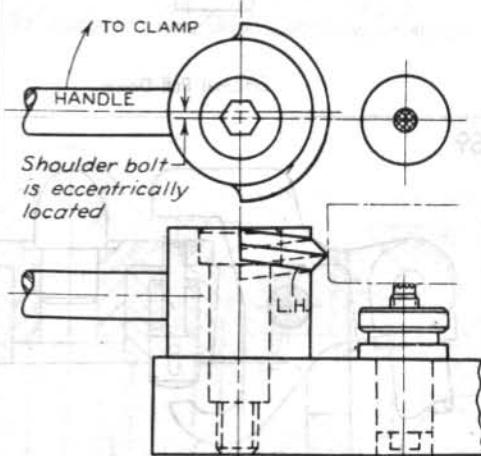
53



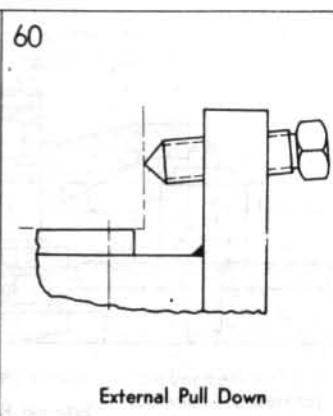
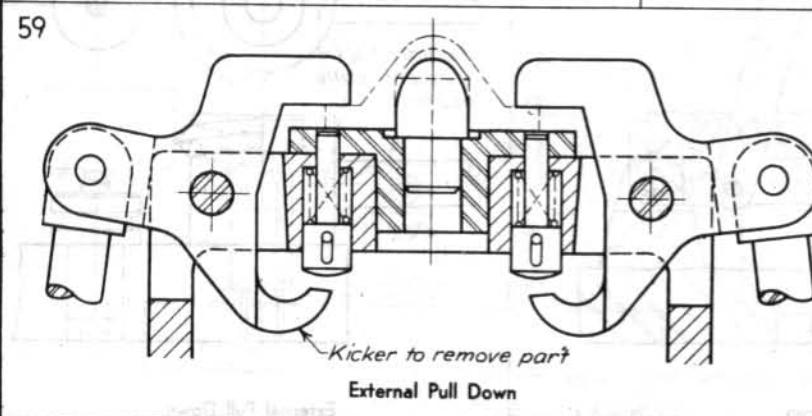
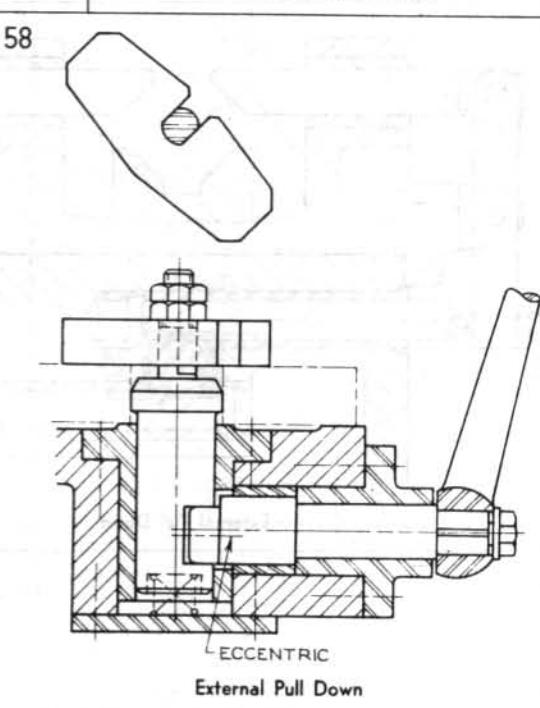
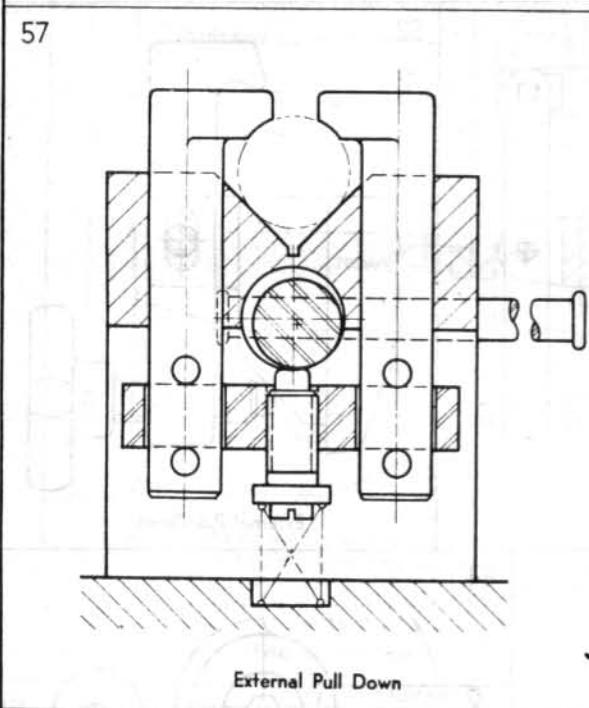
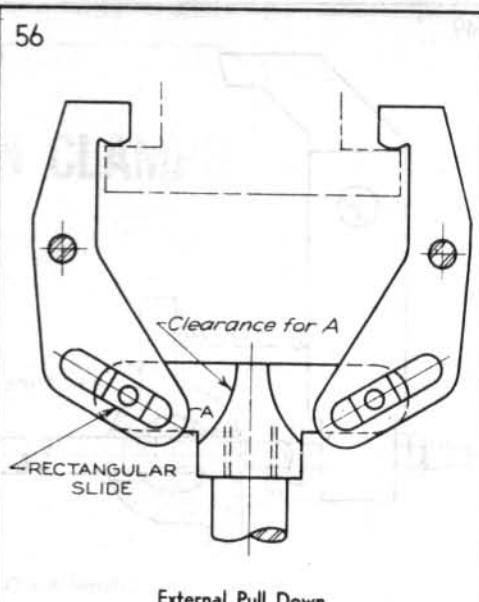
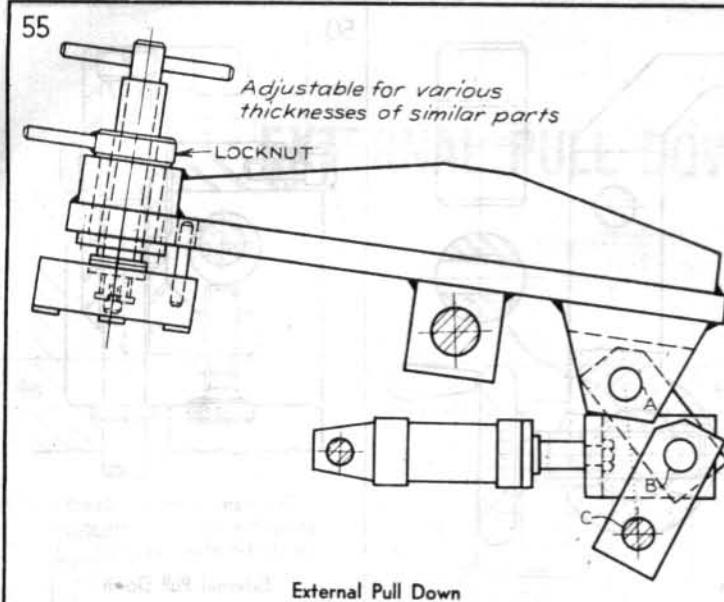
After the handle pulls back the clamping wedge, the clamp may be rotated as indicated.

External Pull Down

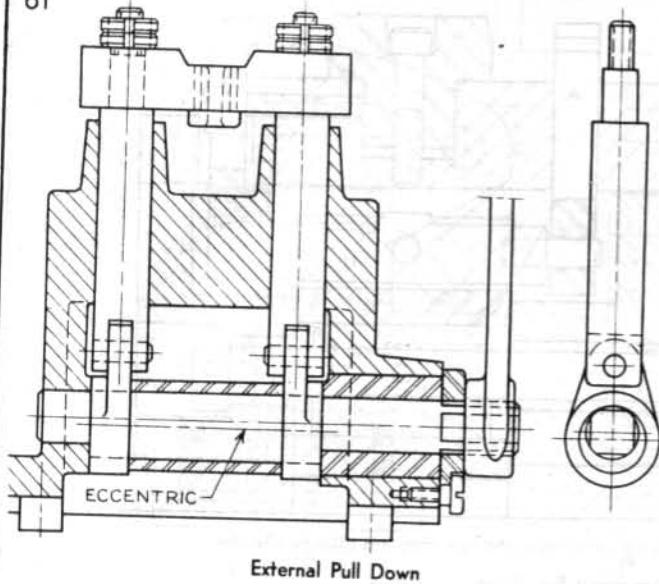
54



External Pull Down



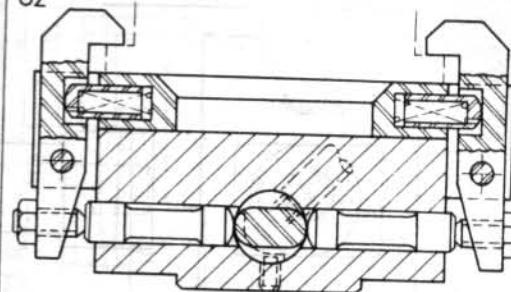
61



External Pull Down

"One man with courage makes a majority." - ANDREW JACKSON

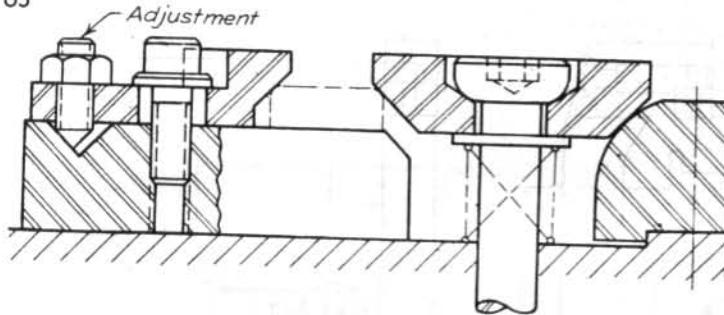
62



Note the use of the set screw and groove to limit the movement of the cam.

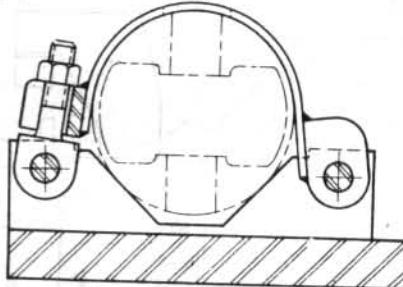
External Pull Down

63



External Pull Down

64

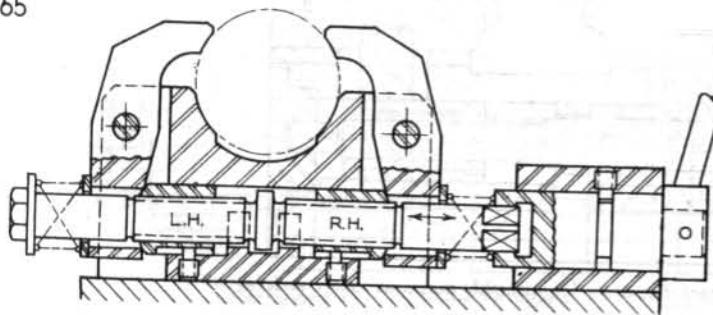


External Pull Down

EXTERNAL EQUALIZING PULL DOWN CLAMPS

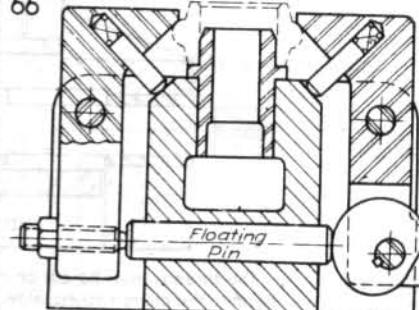
Observe the use of spreaders, rocker arms, wobble links, floating pins, shaft endplay, or spherical trunnions as means of equalizing the clamps.

65



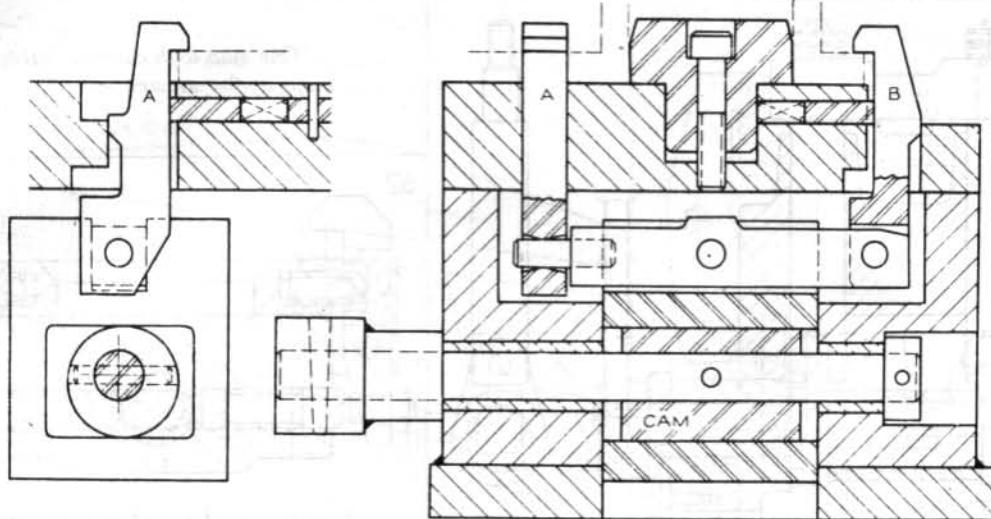
External Equalizing Pull Down

66



External Equalizing Pull Down

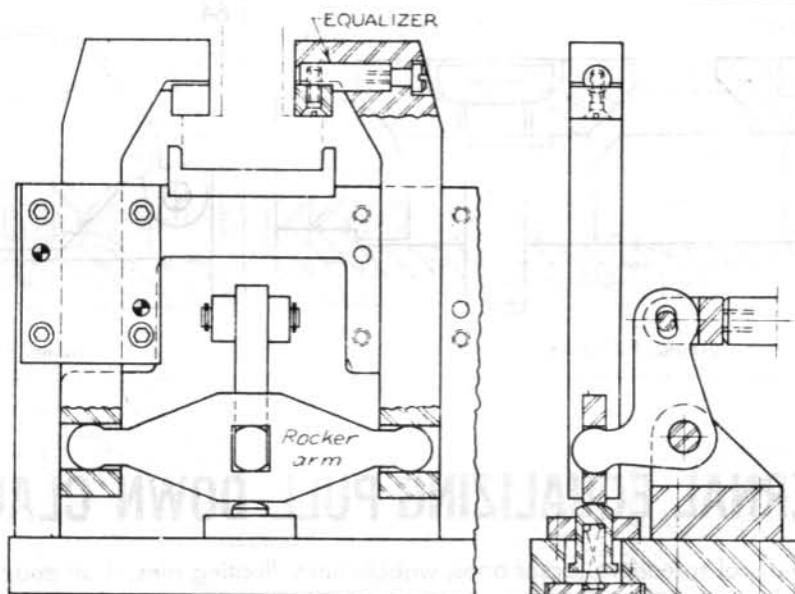
67



Note that A and B clamp in perpendicular directions and how they are attached to the rocker arm.

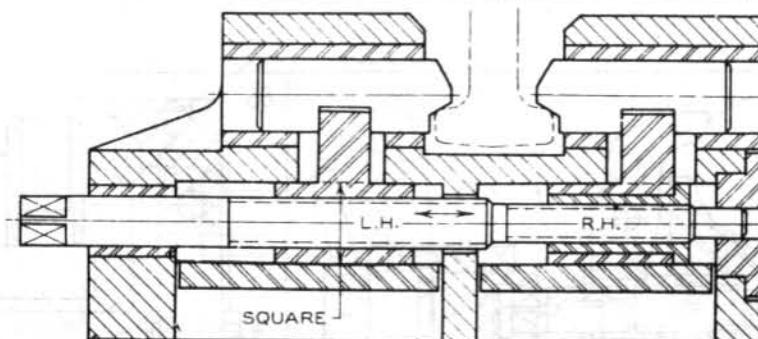
External Equalizing Pull Down

68



External Equalizing Pull Down

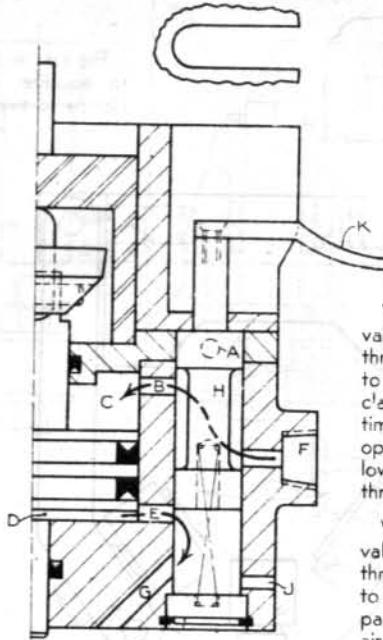
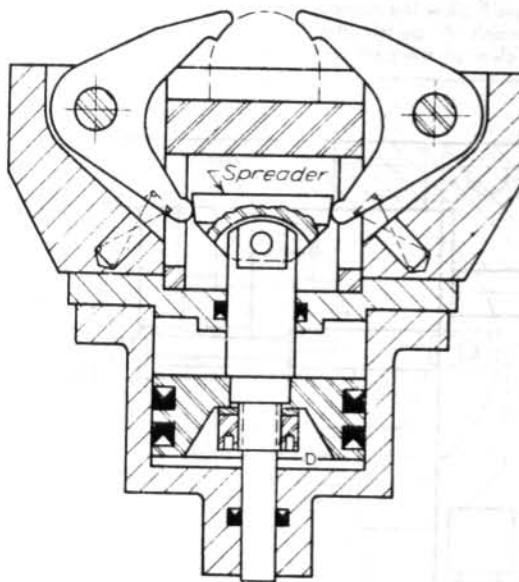
69



The threads must be cut on different diameters for assembly purposes. Shaft endplay permits the clamps to equalize.

External Equalizing Pull Down

70

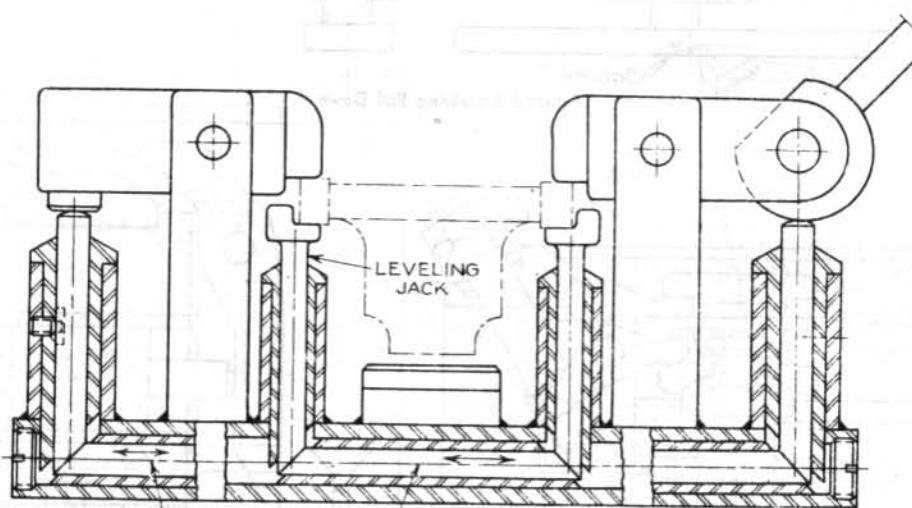


External Equalizing Pull Down

When handle K is raised, valve H allows air to enter through F and pass through B to the piston's chamber C to clamp the part. At the same time, the valve passes release opening E, allowing the air in lower chamber D to escape through G.

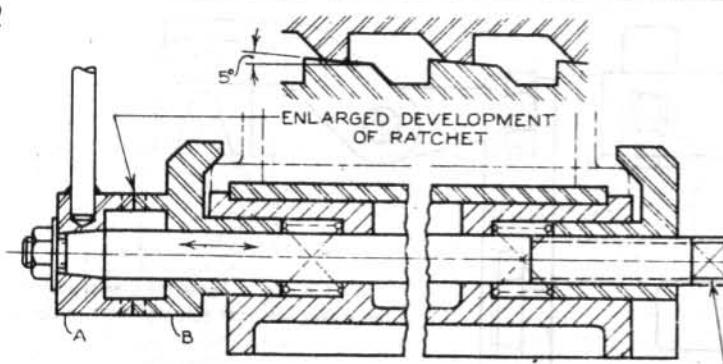
When the handle is lowered, valve H permits air to enter through F and pass through E to chamber D to unclamp the part. At the same time, the air in chamber C passes out through B and A.

71



External Equalizing Pull Down

72



Flats are for turning of screw for adjustment
External Equalizing Pull Down

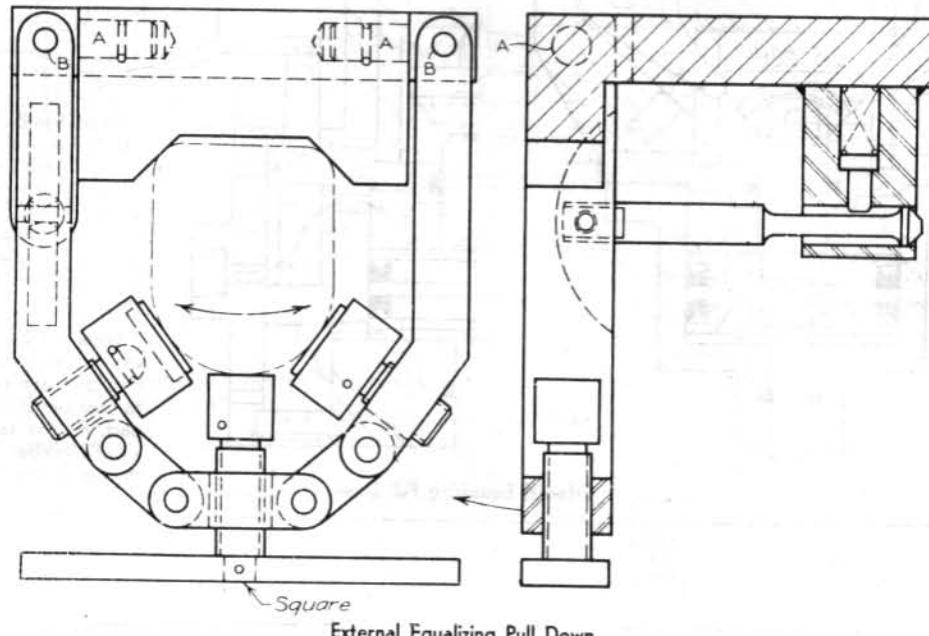
"Cooperation is not a sentiment - it is an economic necessity."

CHARLES STEINMETZ

73

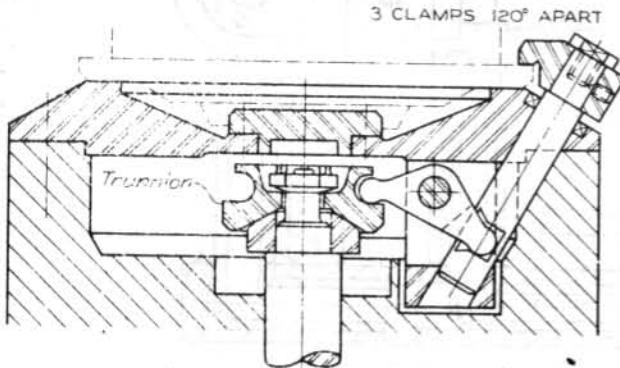


The links and pins B allow the clamps to equalize. Gimbals A permit the clamps to swing clear of the part.



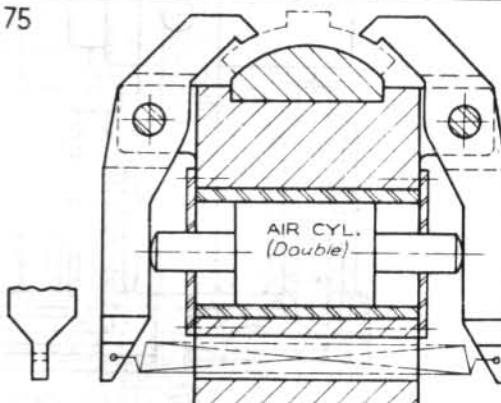
External Equalizing Pull Down

74



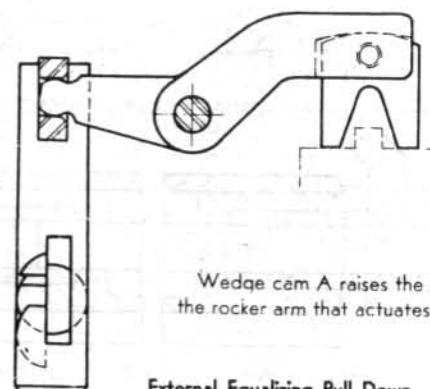
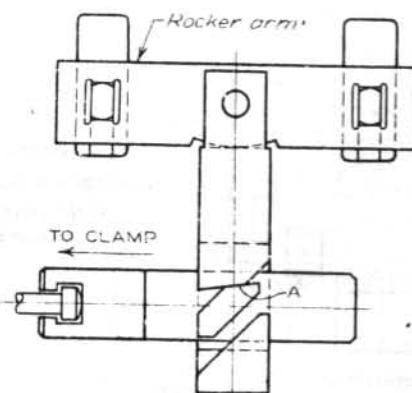
External Equalizing Pull Down

75



External Equalizing Pull Down

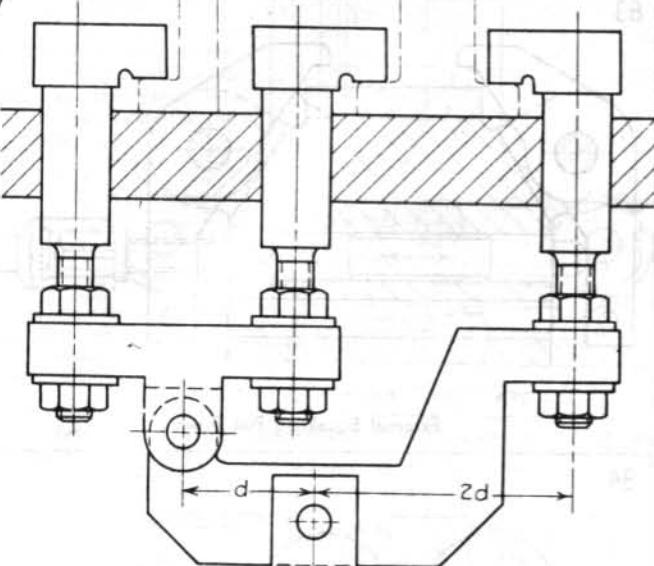
76



Wedge cam A raises the clamp post and the rocker arm that actuates the two clamps.

External Equalizing Pull Down

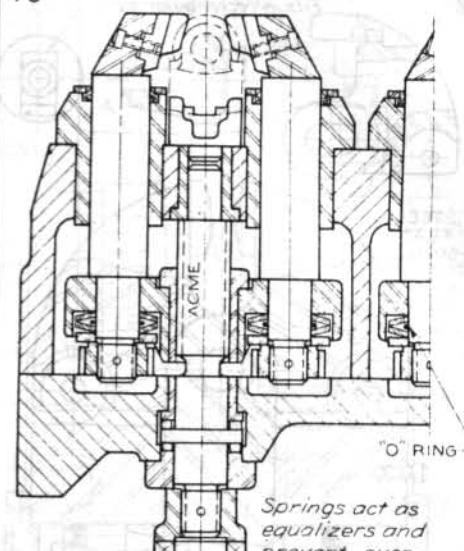
77



Multiple Parallel Clamping of a Part.

External Equalizing Pull Down

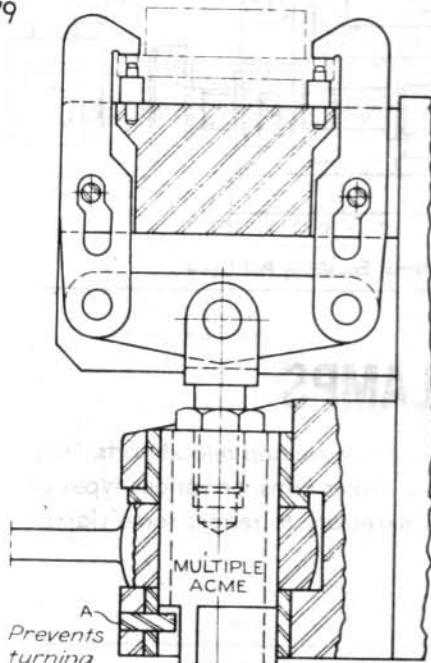
78



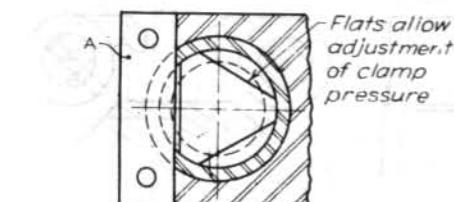
Springs act as
equalizers and
prevent over-
clamping

External Equalizing Pull Down

79



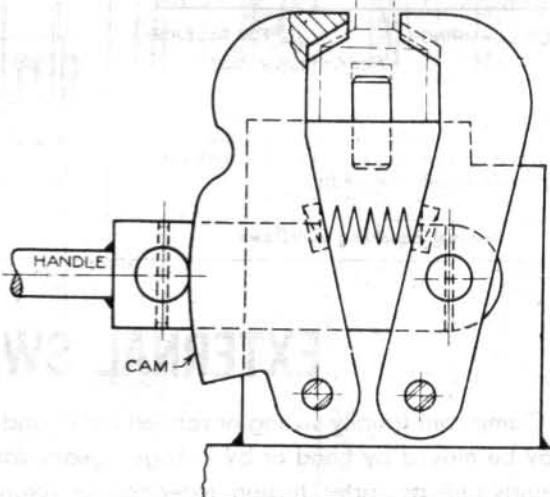
Prevents
turning



The three flats on the bolt allow 1/3 pitch adjustment of the clamp post.

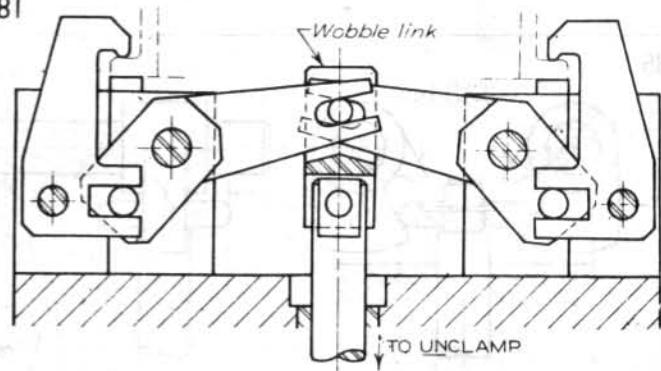
External Equalizing Pull Down

80

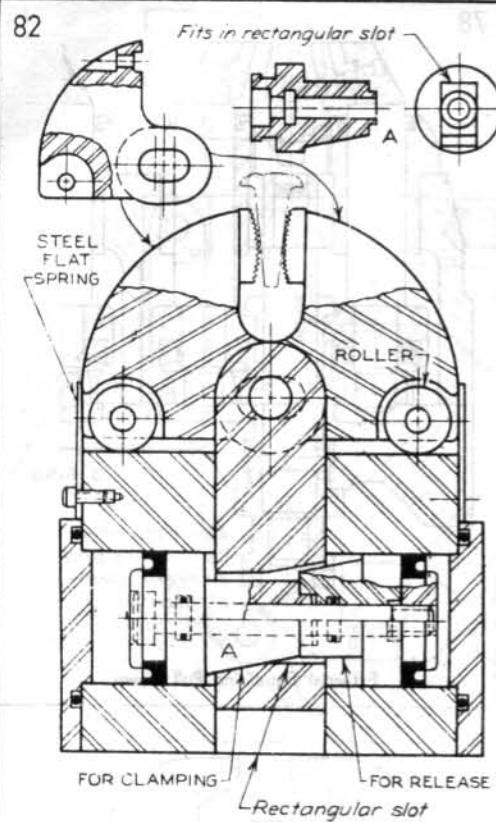


External Equalizing Pull Down

81

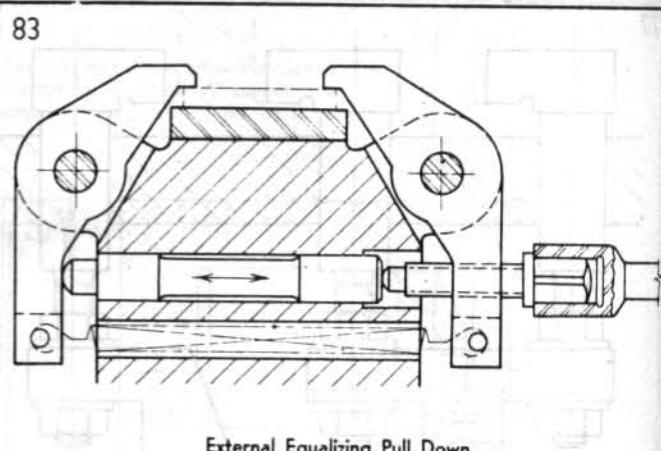


External Equalizing Pull Down

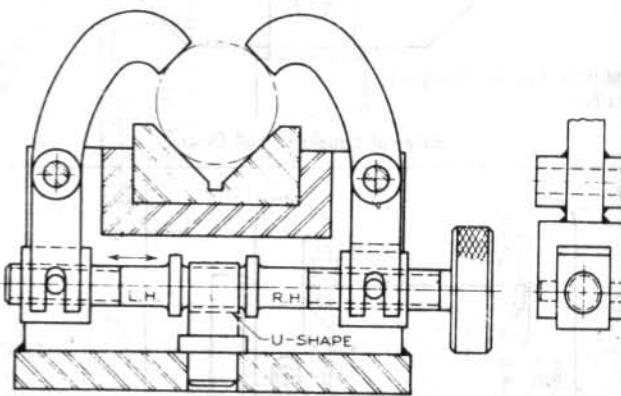


Wedge A's action or the clamp post pulls down the two jaws, allowing them to pivot about the rollers. Note the release wedge on the right. Two air cylinders actuate the wedges.

External Equalizing Pull Down



84

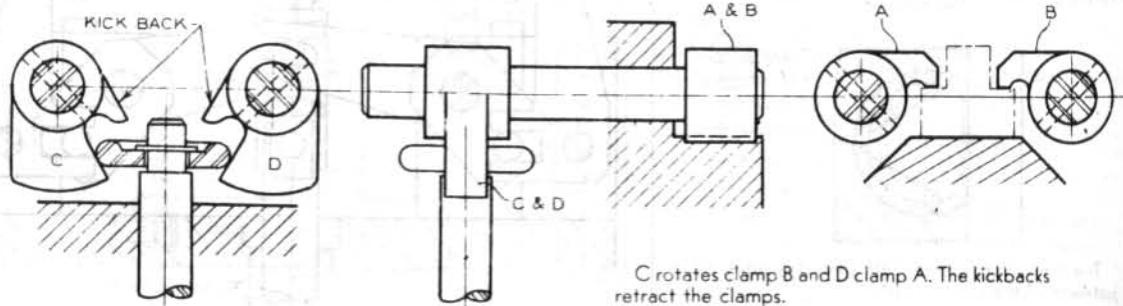


External Equalizing Pull Down

EXTERNAL SWING CLAMPS

Clamps are usually swung or rotated out of and into position to remove and reload parts. They may be moved by hand or by linkages, gears, cams, kickbacks, rocker arms, or various types of springs such as garter, torsion, extension, or compression. It is necessary to retract some clamps a considerable distance from the clamping area.

85

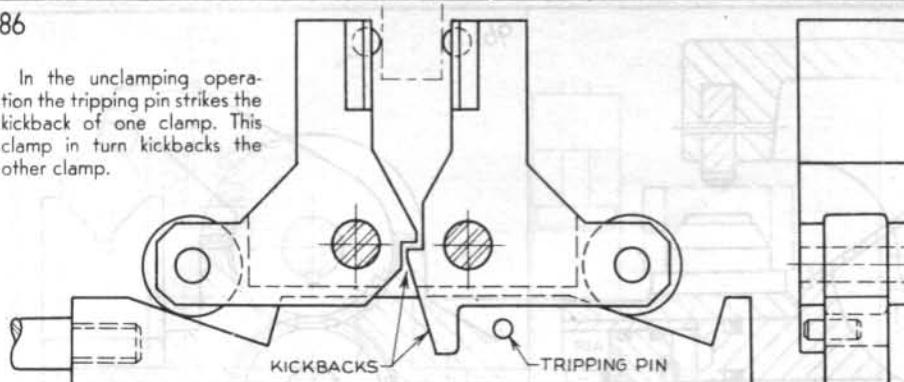


C rotates clamp B and D clamp A. The kickbacks retract the clamps.

External Swing Clamp

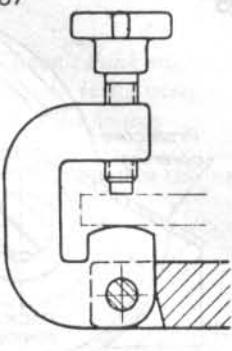
86

In the unclamping operation the tripping pin strikes the kickback of one clamp. This clamp in turn kickbacks the other clamp.



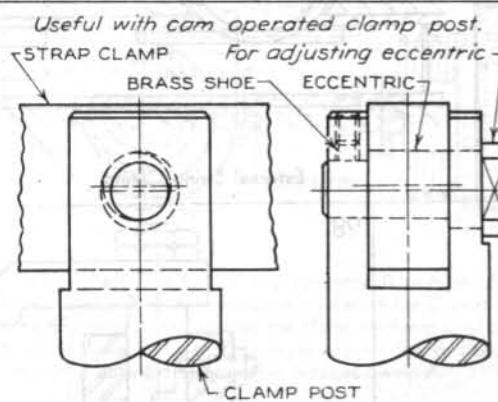
External Swing Clamp

87



External Swing Clamp

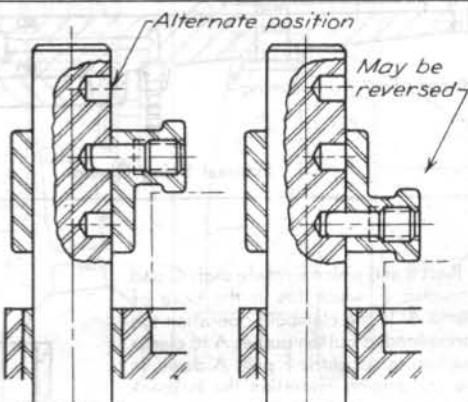
88



The eccentric pin provides adjustment if a cam or other power source becomes worn.

External Swing Clamp

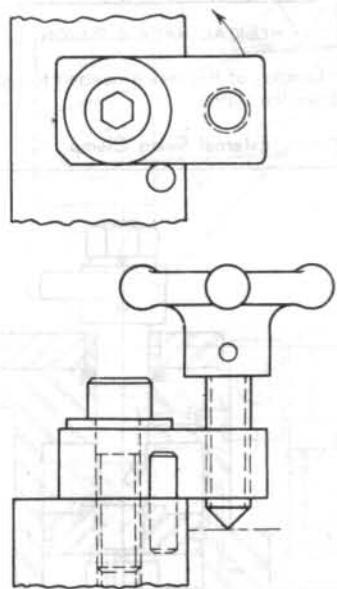
89



In some instances the same fixture may be used for similar parts of varying heights. This design accommodates several height variations.

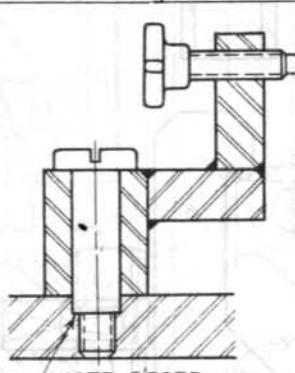
External Swing Clamp

90



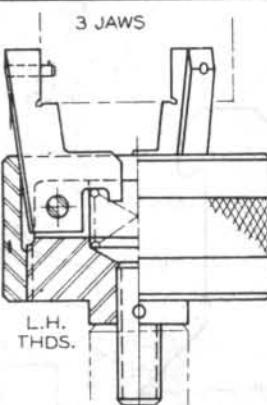
External Swing Clamp

91



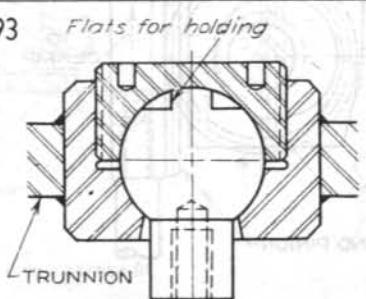
External Swing Clamp

92



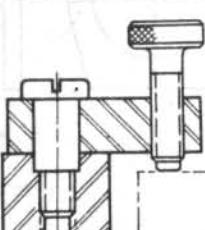
External Swing Clamp

93



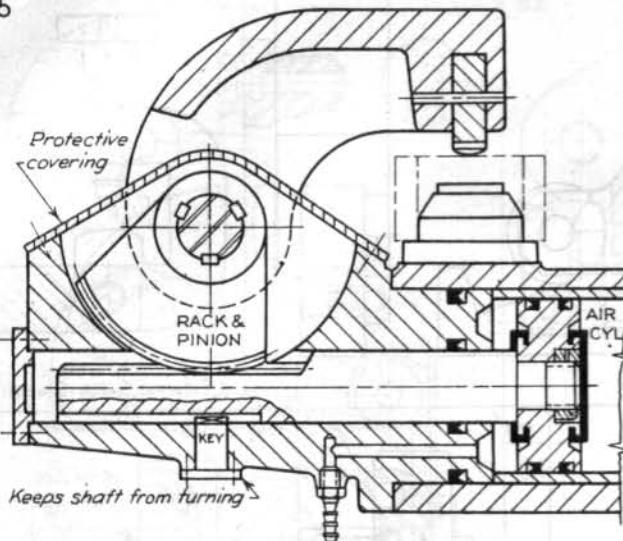
External Swing Clamp

94



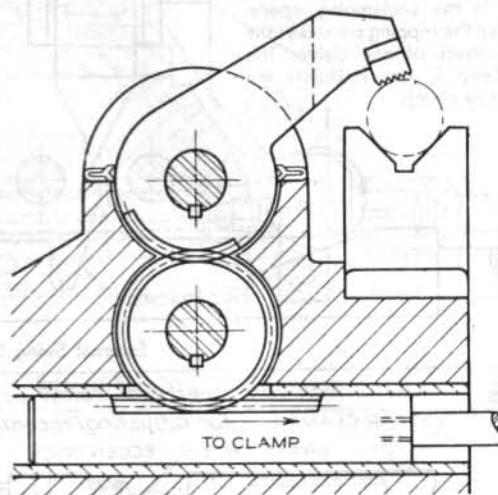
External Swing Clamp

95



External Swing Clamp

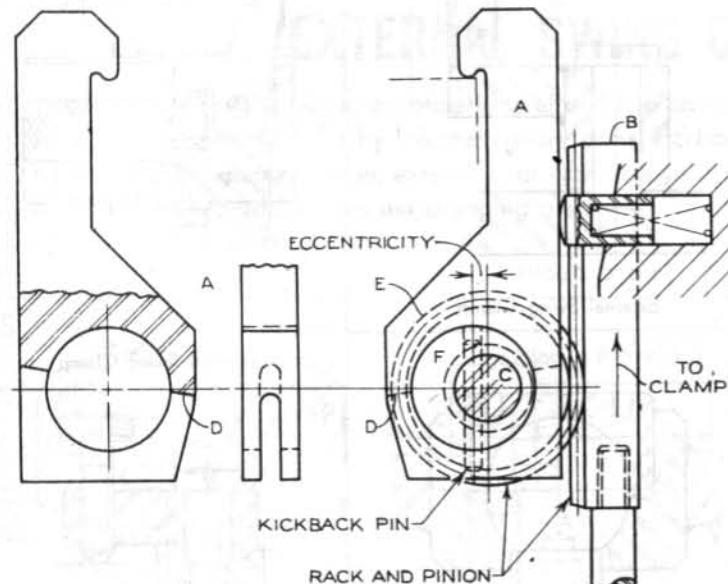
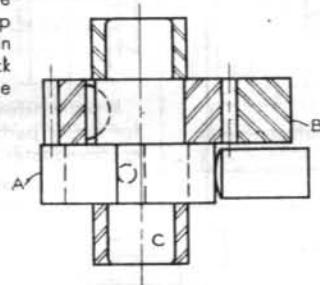
96



External Swing Clamp

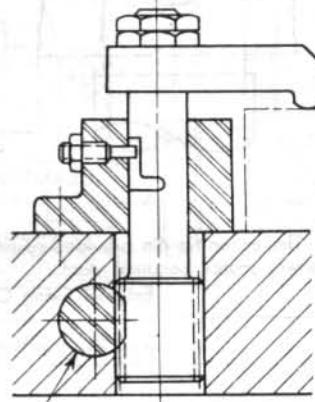
97

Rack B and pinion E rotate shaft C and eccentric F, which fits in the bore of clamp A. In the clamping operation the spring-loaded button pushes A to clamp position as eccentric F pulls A down. In the unclamping operation the kickback pin that fits in a slot of A strikes D of the slot and swings A outward.



External Swing Clamp

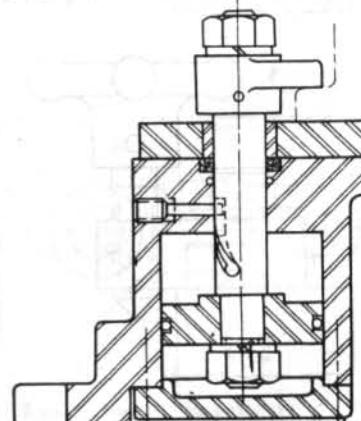
98



Endplay of the rack is needed to pull down the clamp.

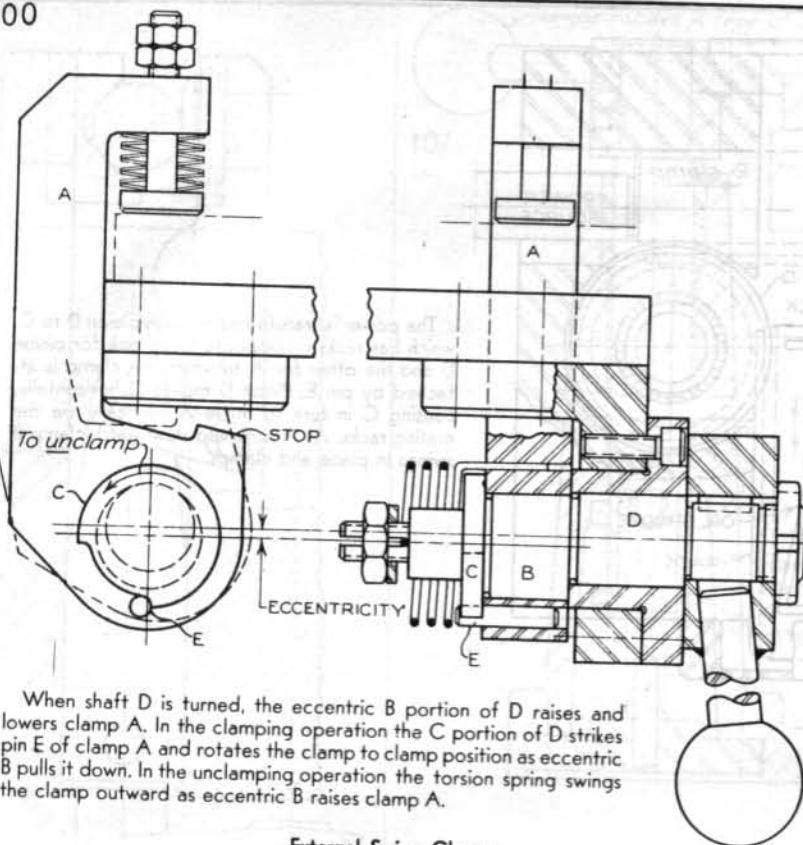
External Swing Clamp

99



External Swing Clamp

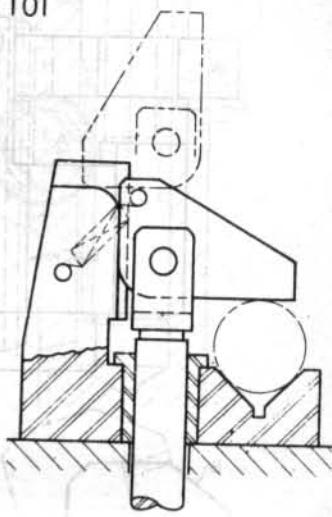
100



"I don't think much of a man who is not wiser today than he was yesterday."

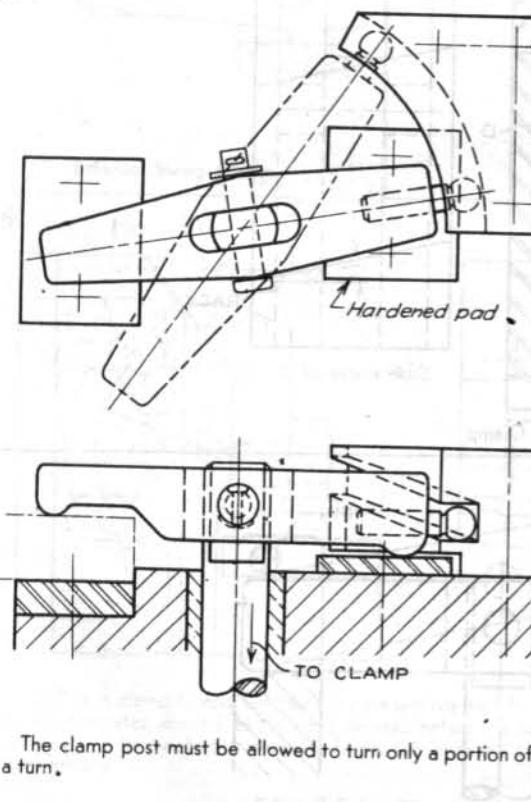
ABRAHAM LINCOLN

101

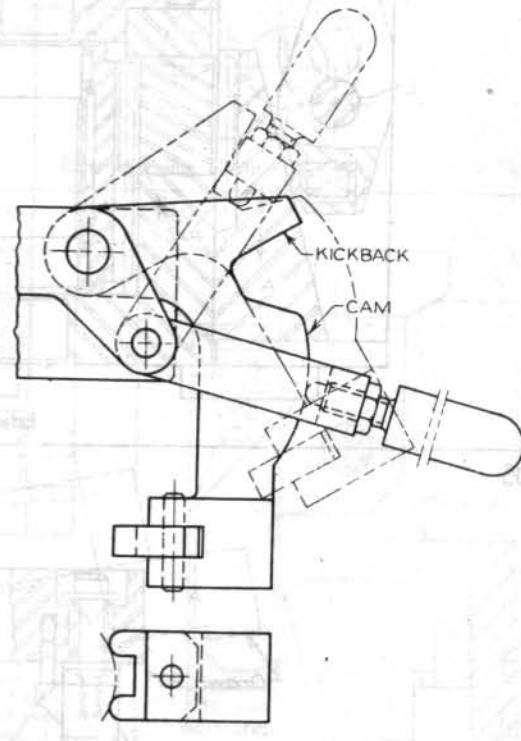


External Swing Clamp

102



103

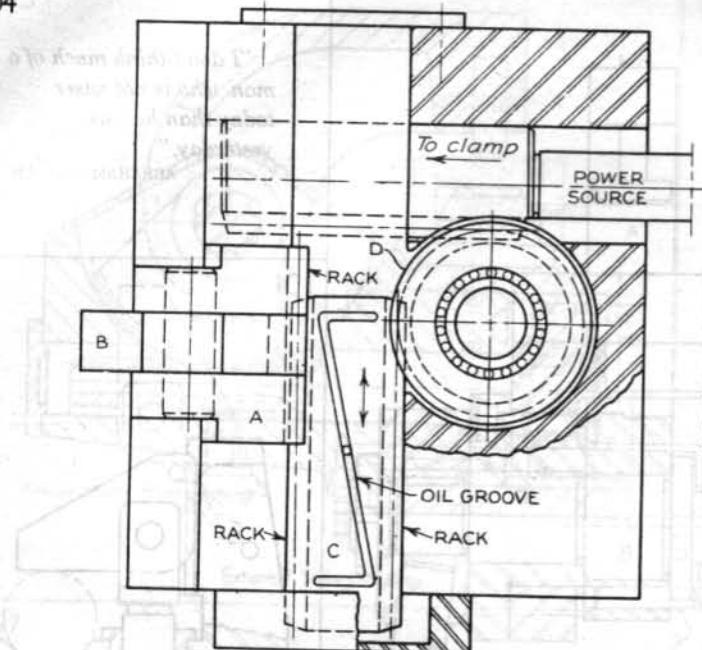


The clamp post must be allowed to turn only a portion of a turn.

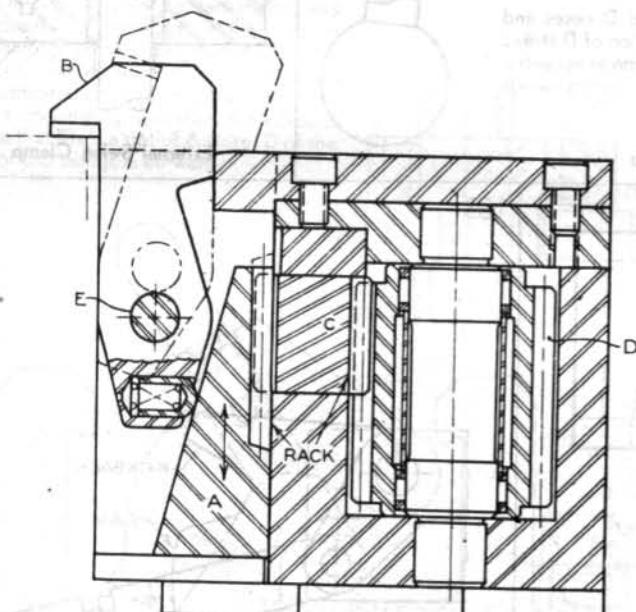
External Swing Clamp

External Swing Clamp

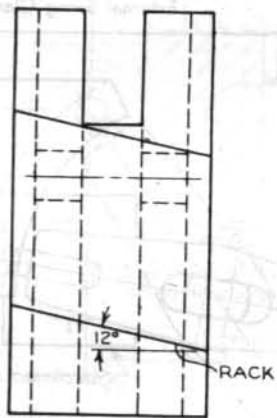
104



The power is transferred through pinion D to C, which has racks on opposite sides, one for pinion D and the other for A to which the clamp is attached by pin E. Pinion D moves C horizontally, causing C in turn to move A vertically via the mating racks. As A is moved downward, clamp B swings in place and clamps.

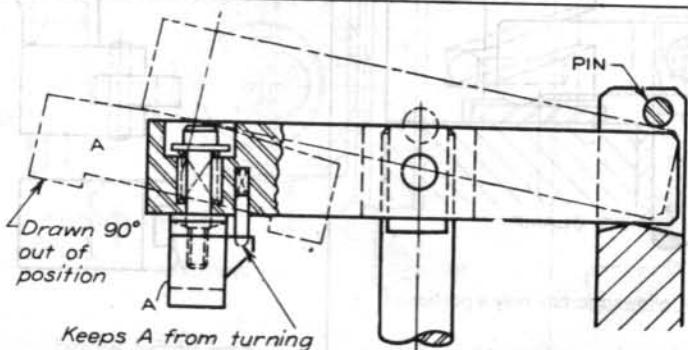


External Swing Clamp



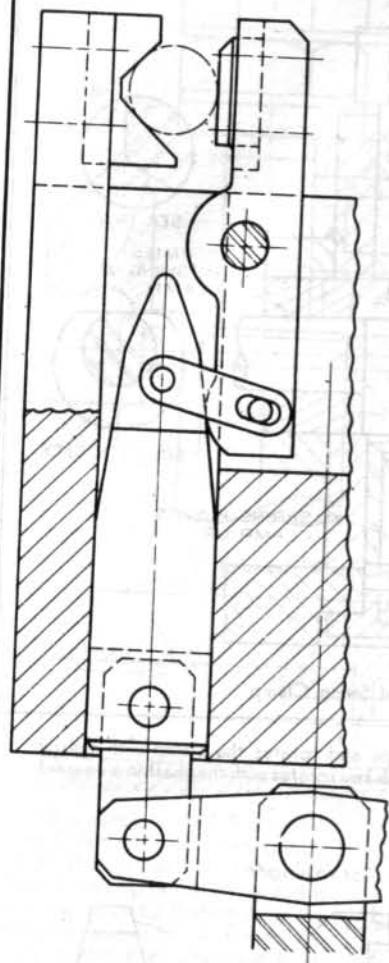
Side view of A

105



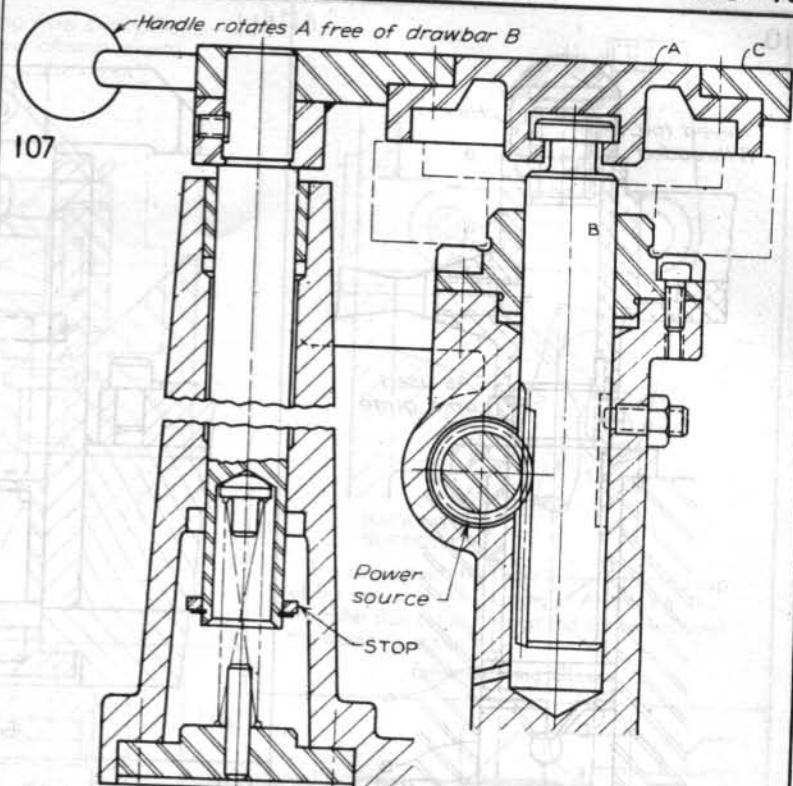
External Swing Clamp

106

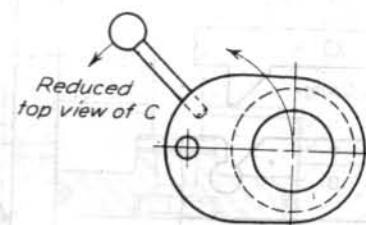


External Swing Clamp

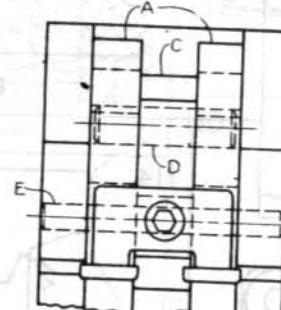
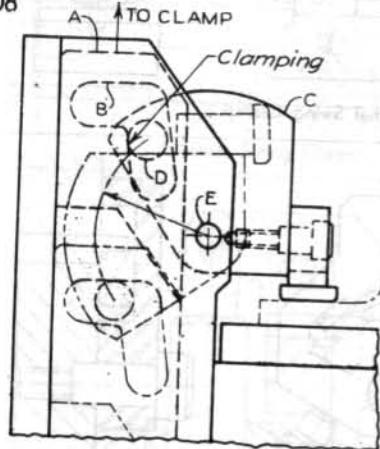
106-109



External Swing Clamp



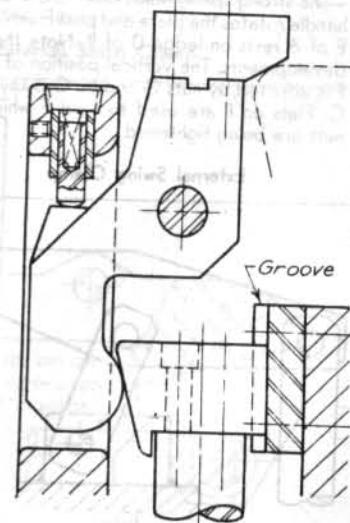
108



Pin D is in clamp C and functions in cam groove B of A. When A is raised, pin D, which rotates about E as the arc indicates, enters the inclined (cam) portion of groove B to create the clamping force. Observe the clamping angle of the cam groove.

External Swing Clamp

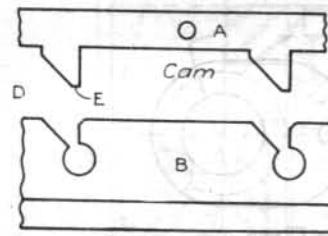
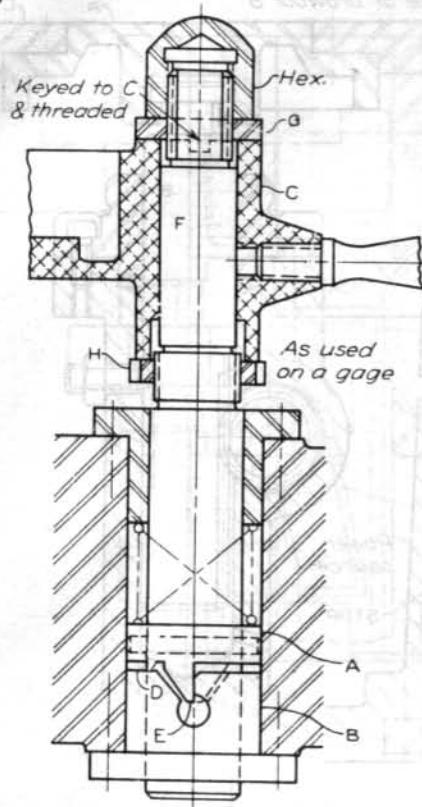
109



External Swing Clamp

110-114

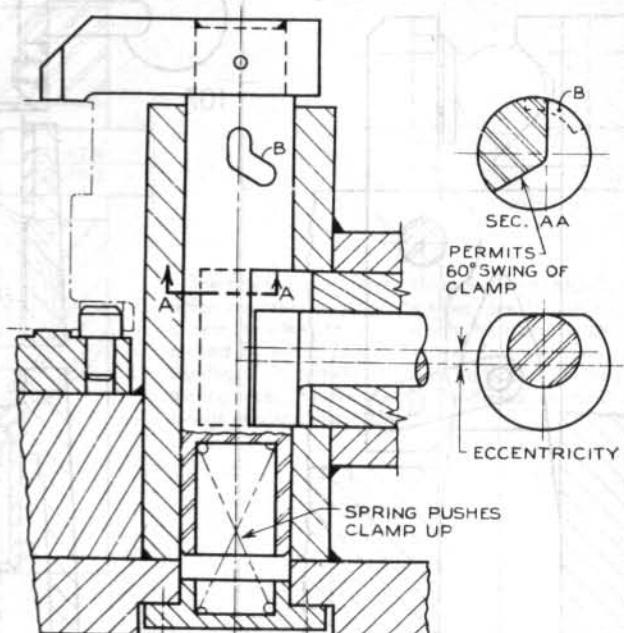
110



The strong spring holds down plate C. The handle rotates the plate and post F until point E of A rests on ledge D of B. Note the two developments. The vertical position of C on F is adjusted by nuts G and H. G is keyed to C. Flats on F are used to hold F while the nuts are being tightened.

External Swing Clamp

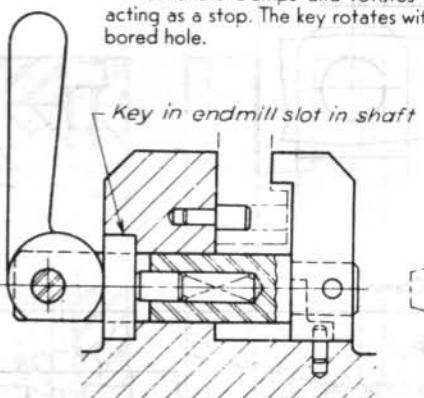
111



External Swing Clamp

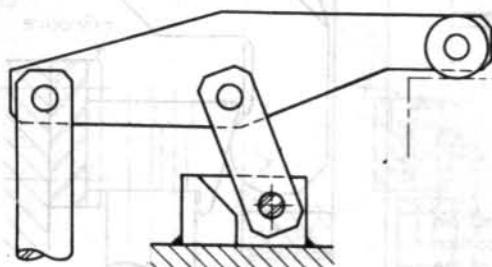
112

The handle clamps and rotates the clamp with the pin acting as a stop. The key rotates with the shaft in a counter-bored hole.



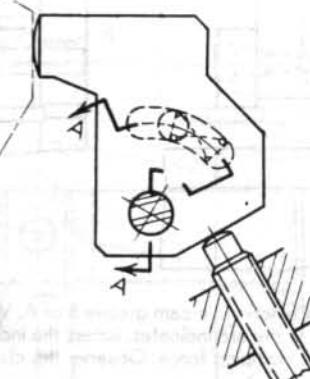
External Swing Clamp

113

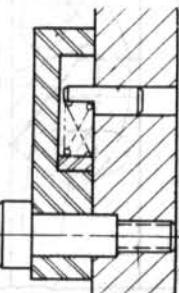


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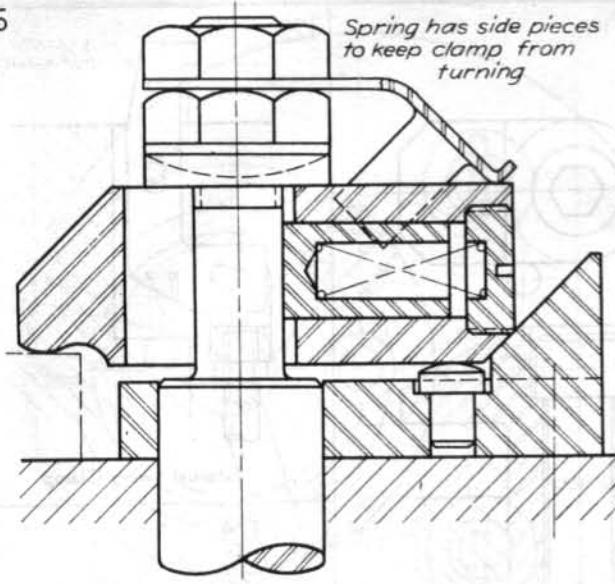
114



External Swing Clamp



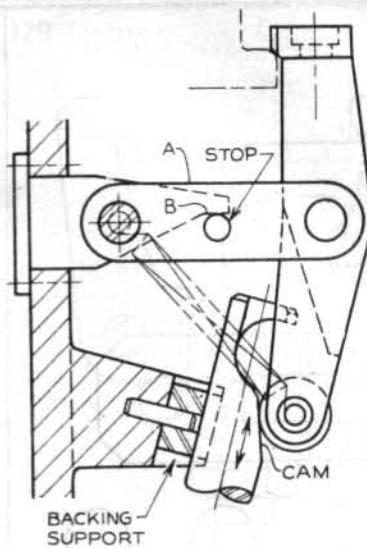
115



Spring has side pieces to keep clamp from turning

External Swing Clamp

116

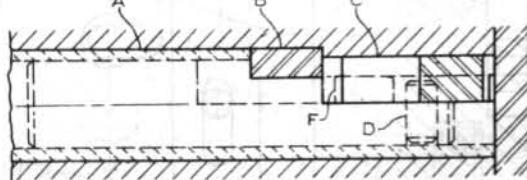


BACKING SUPPORT

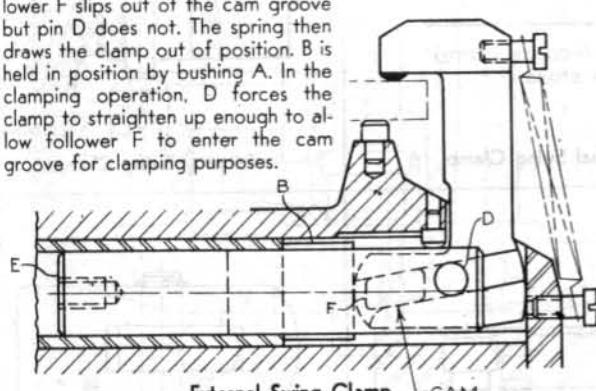
The spring holds the roller in the retracting cup of the cam until the stop pin of A strikes B. Then the roller slips out of the cup and the cam initiates the clamping action.

External Swing Clamp

117

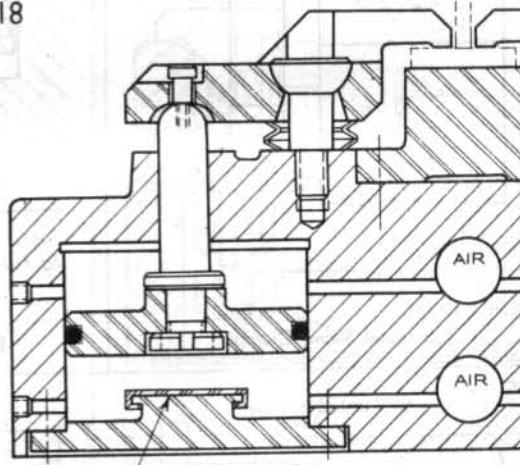


As E is pulled to the left, cam follower F slips out of the cam groove but pin D does not. The spring then draws the clamp out of position. B is held in position by bushing A. In the clamping operation, D forces the clamp to straighten up enough to allow follower F to enter the cam groove for clamping purposes.

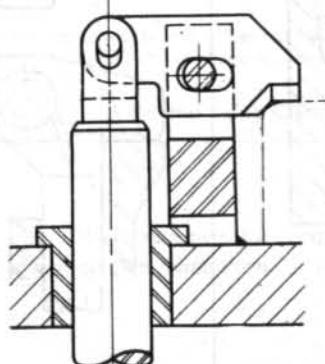


External Swing Clamp CAM

118

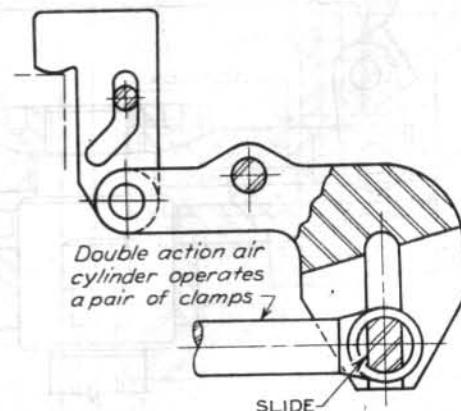
External Swing Clamp
RUBBER CUSHION

119



External Swing Clamp

120

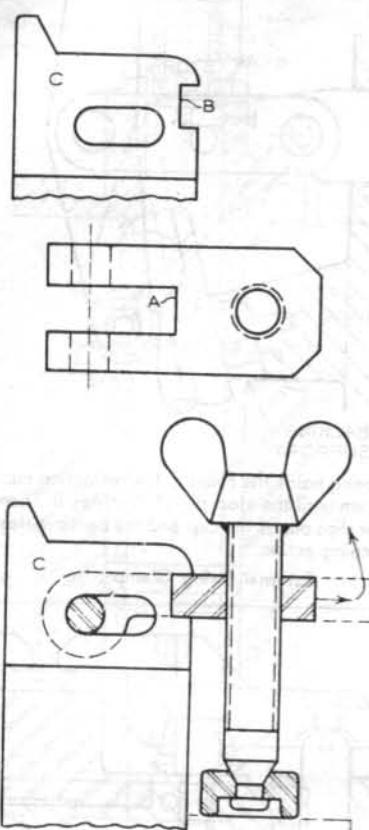


Double action air cylinder operates a pair of clamps

SLIDE

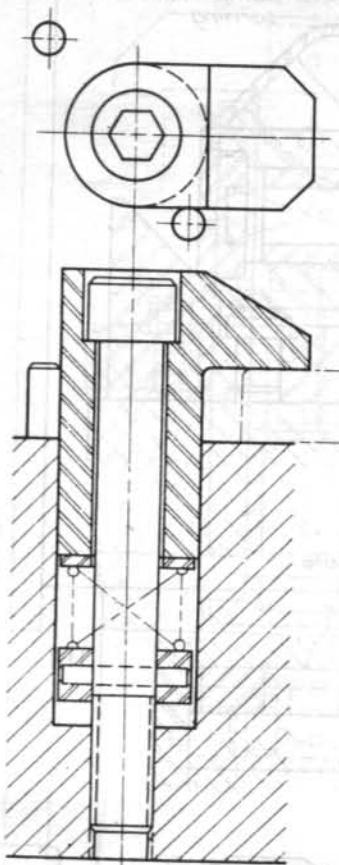
External Swing Clamp

121



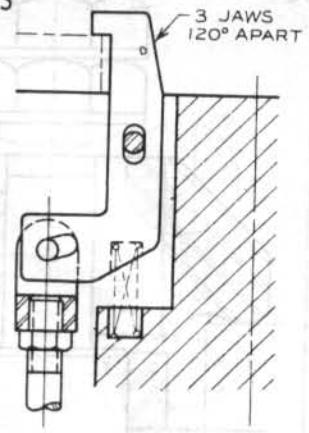
External Swing Clamp

122



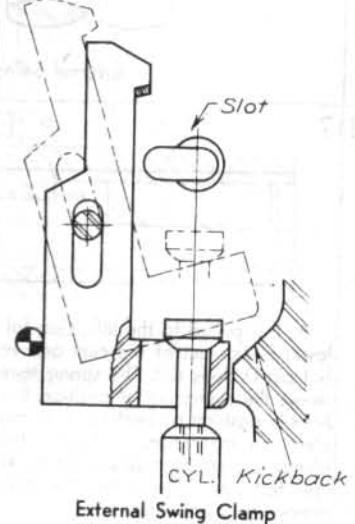
External Swing Clamp

123



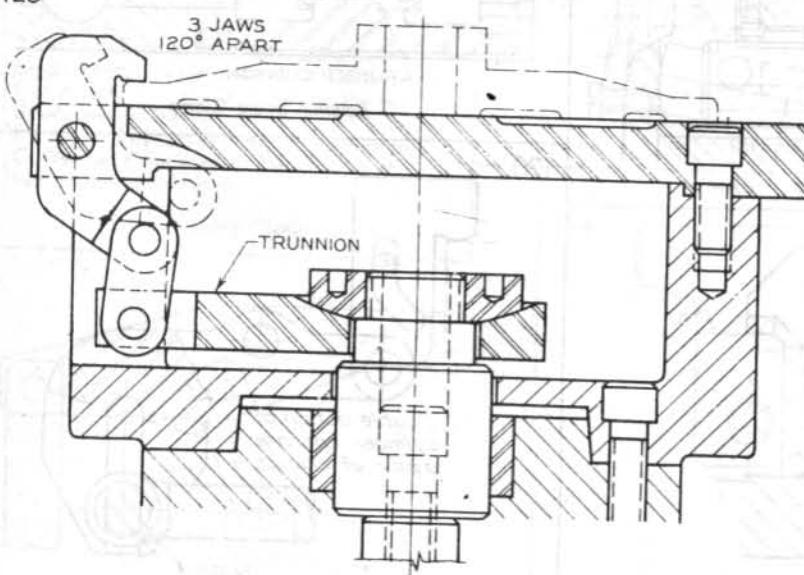
External Swing Clamp

124



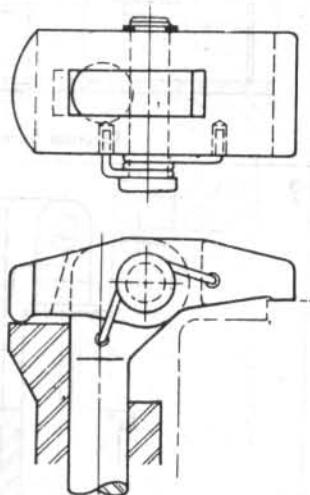
External Swing Clamp

125



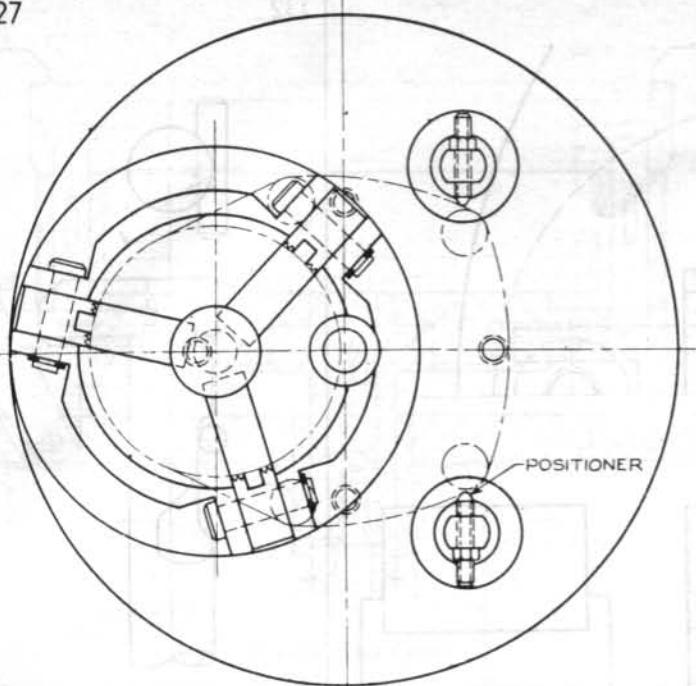
External Swing Clamp

126

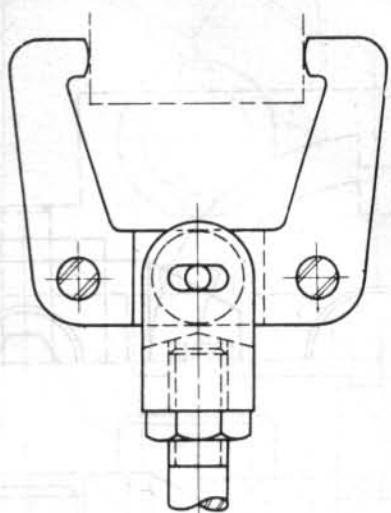


External Swing Clamp

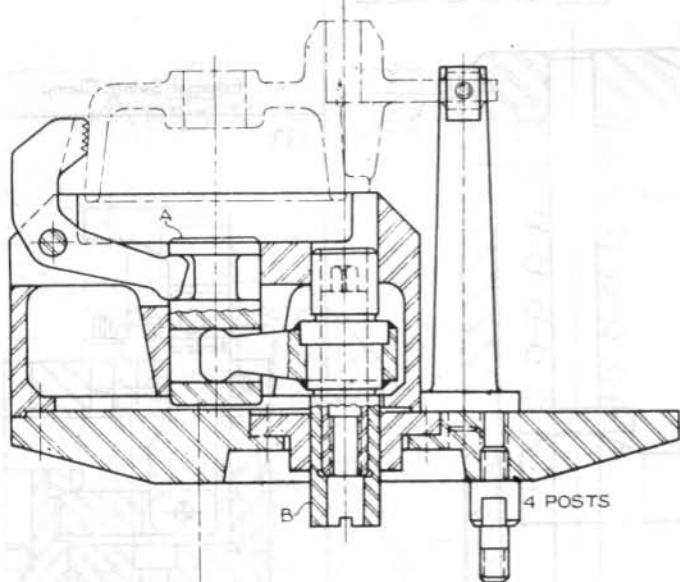
127



128



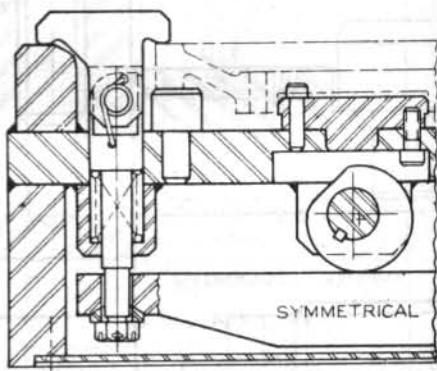
External Swing Clamp



Note that the power post is offset from the center of the clamping. This reduces the height of the clamping device.

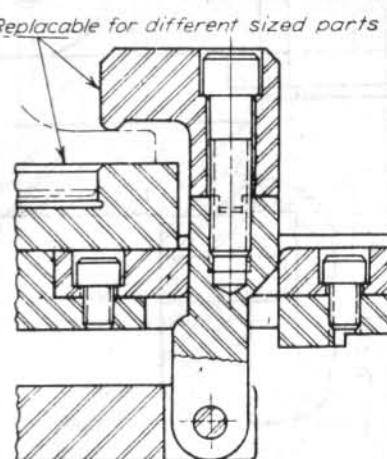
External Swing Clamp

129



External Swing Clamp

130

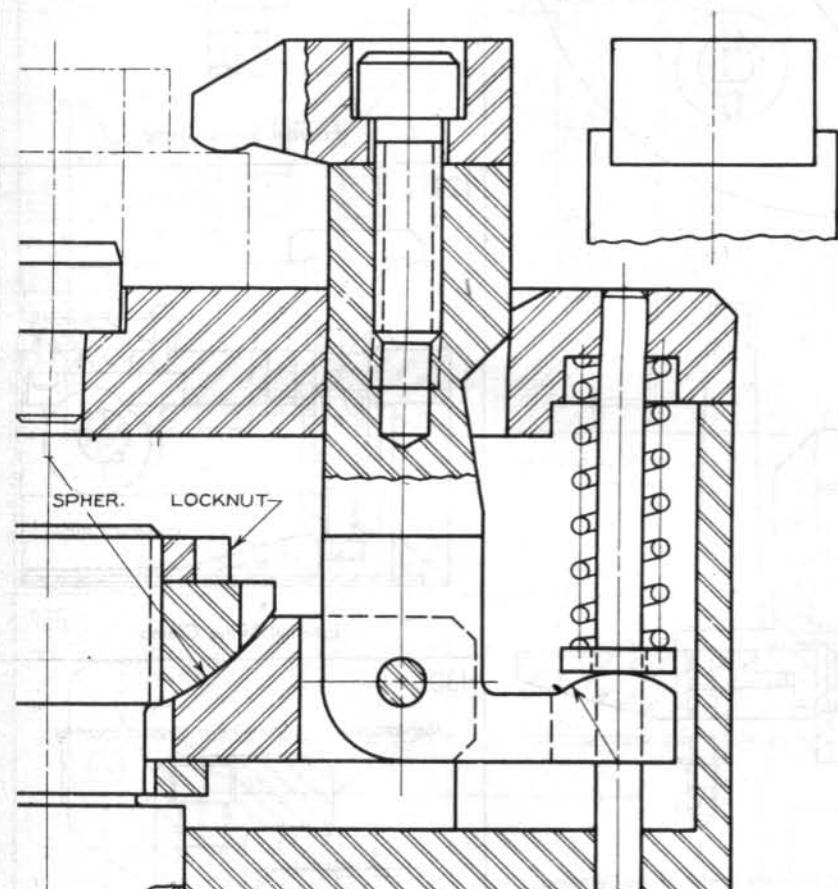
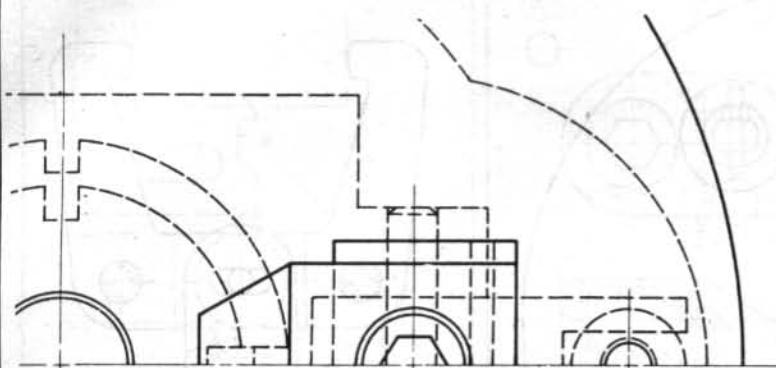


External Swing Clamp

*"Weak men wait for opportunities;
strong men make them."* ANONYMOUS

131-133

131

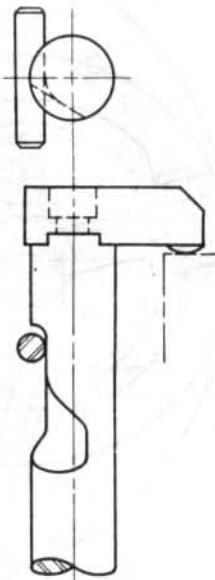


→ To clamp

VIEW A

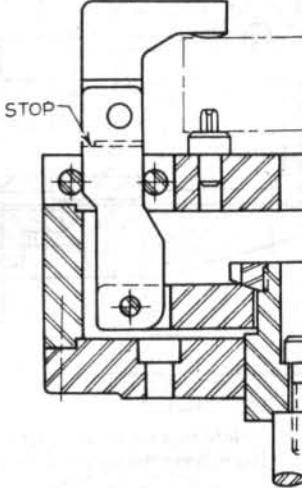
External Swing Clamp

132



External Swing Clamp

133



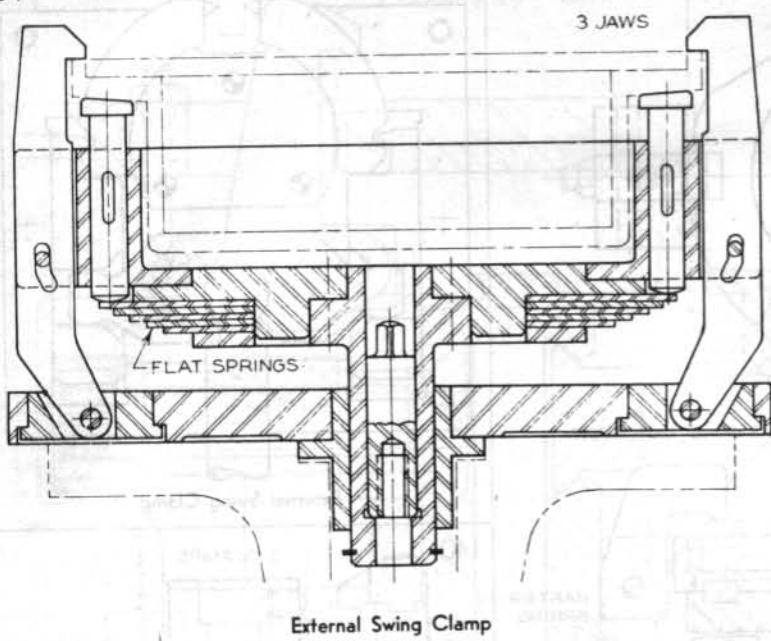
External Swing Clamp



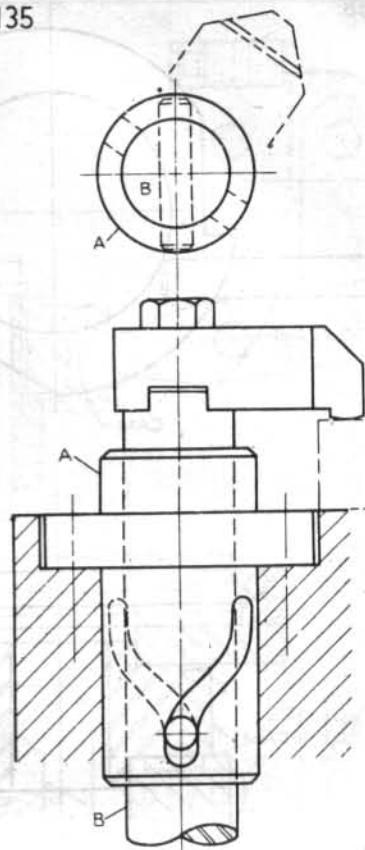
VIEW A

*"I have the simplest tastes.
I am always satisfied with
the best."* OSCAR WILDE

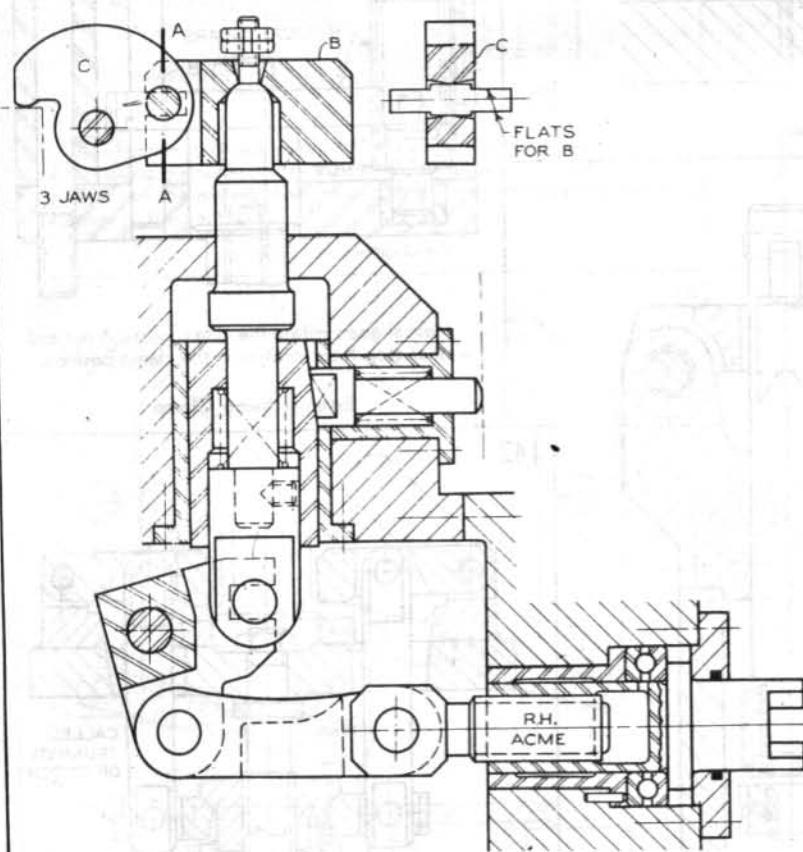
134



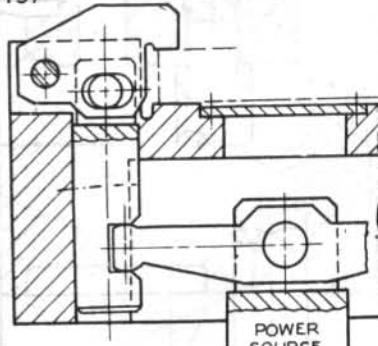
135



136

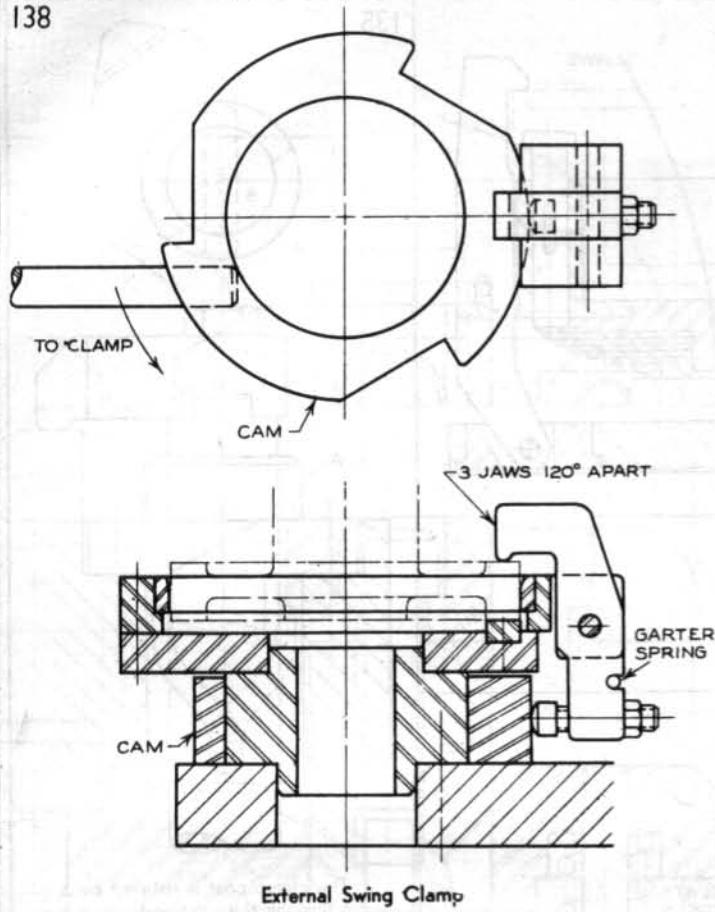


137

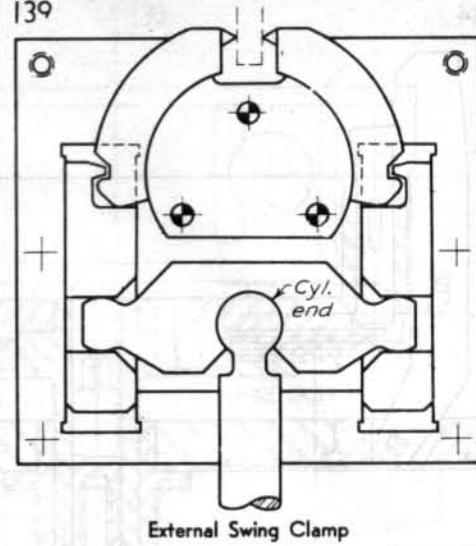


"You must have long-range goals to keep you from being frustrated by short-range failures." CHARLES C. NOBLE

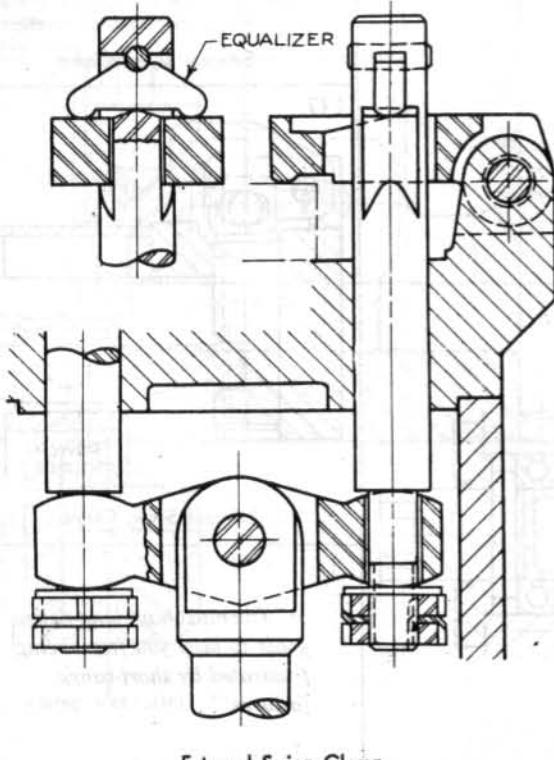
138



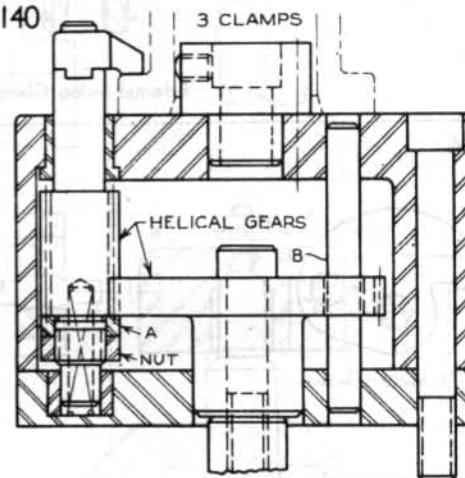
139



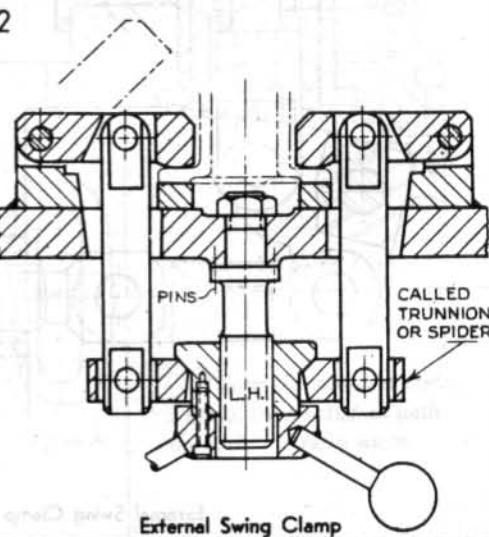
141



140



142

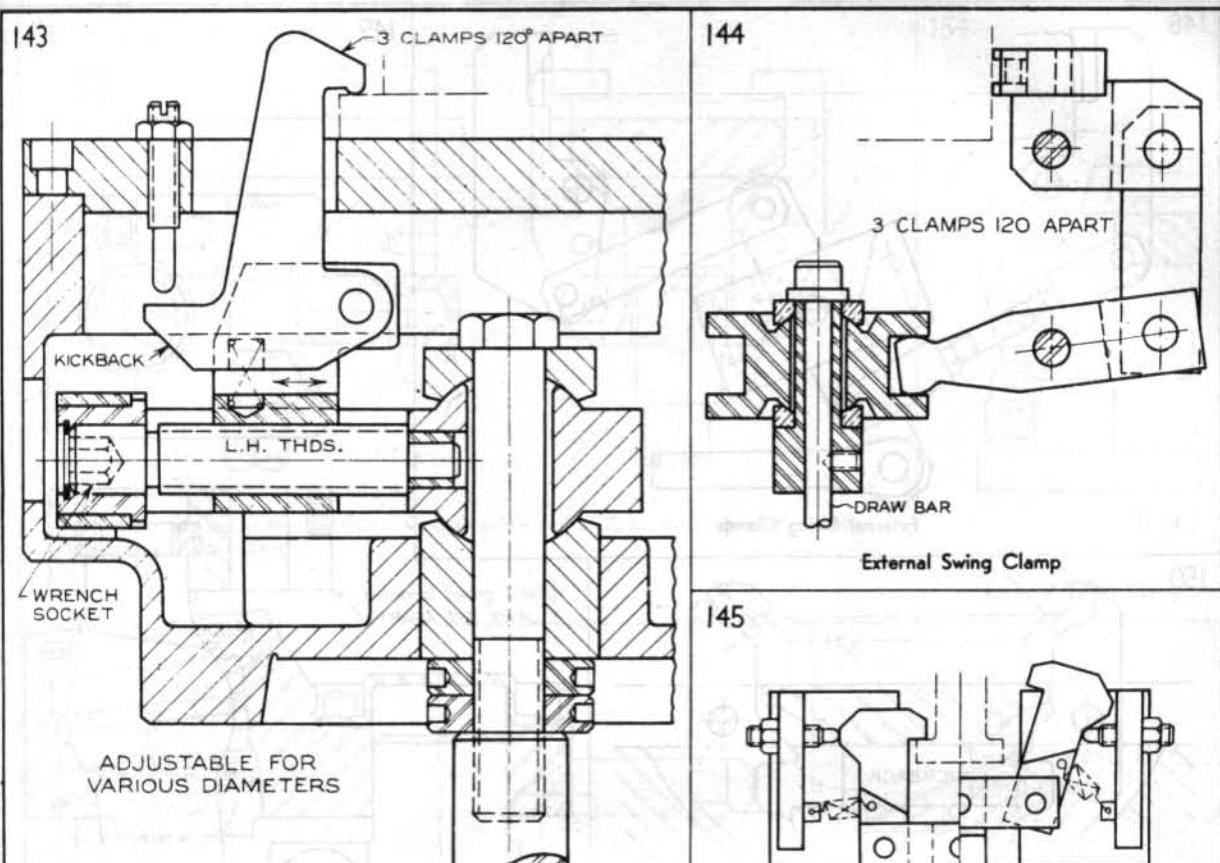


143



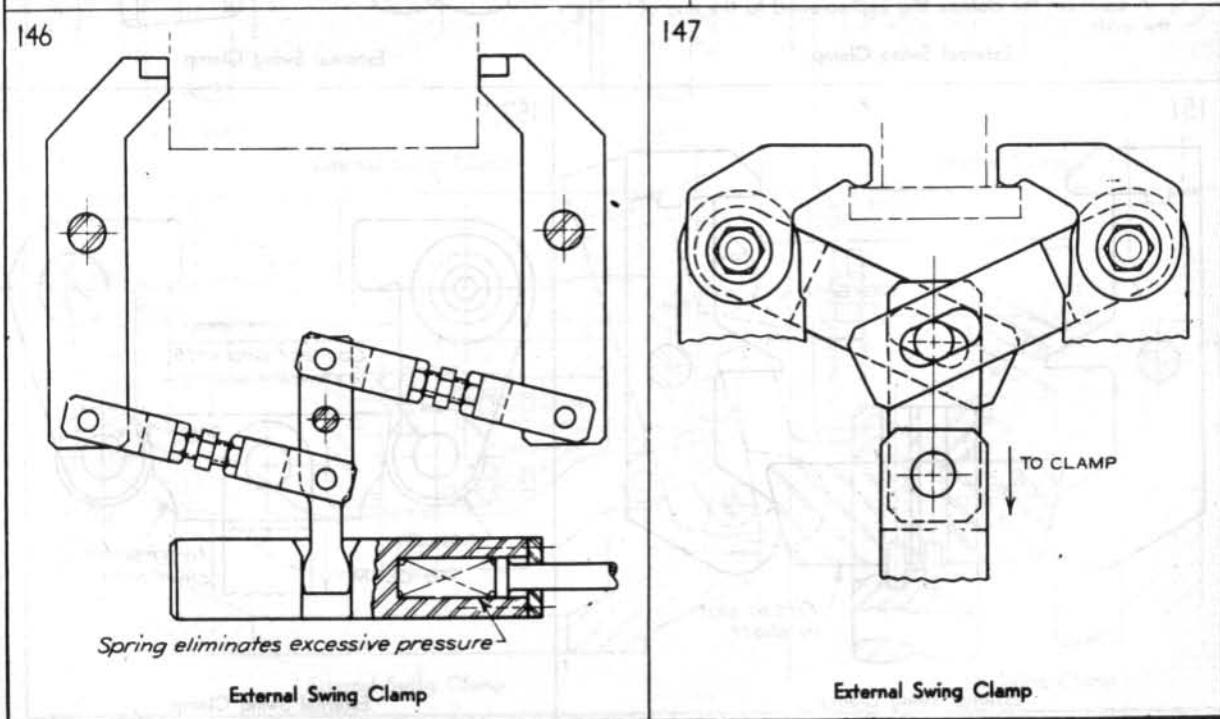
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144

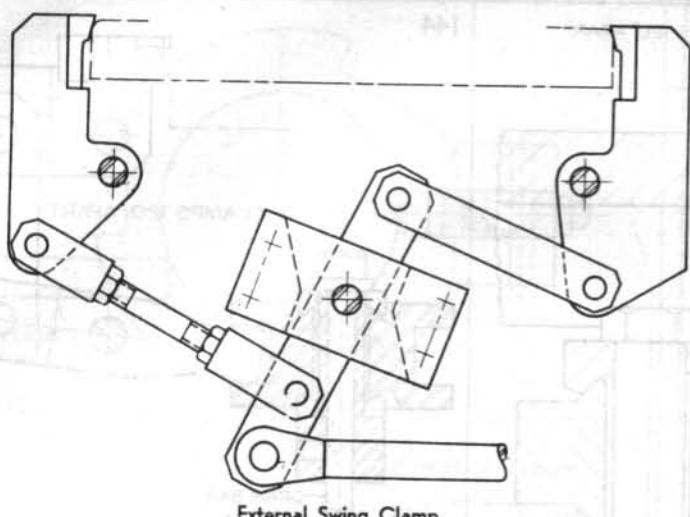


The clamp may be adjusted with a wrench to accommodate parts with varying diameters. Note the use of two locknuts to control the snugness of the mating spherical surfaces. The wrench opening needs a cover to keep out dirt.

External Swing Clamp

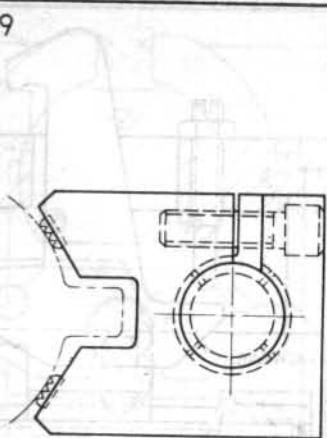


148

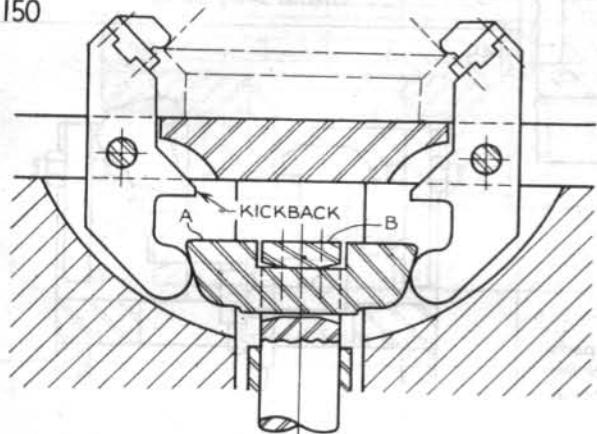


External Swing Clamp

149



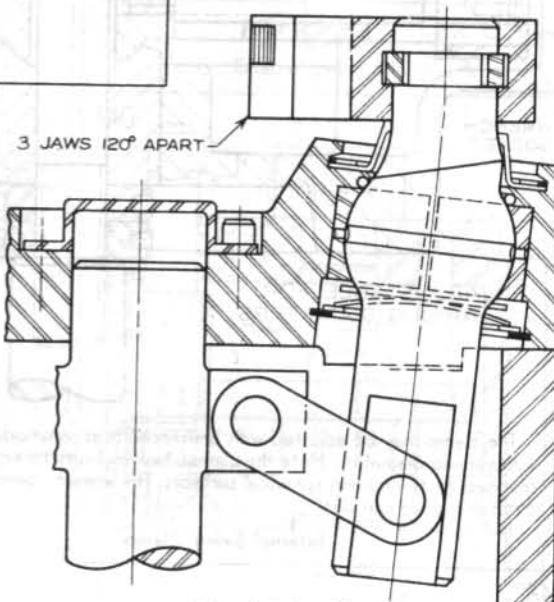
150



A equalizes the clamps. B is cap screwed to the end of the shaft.

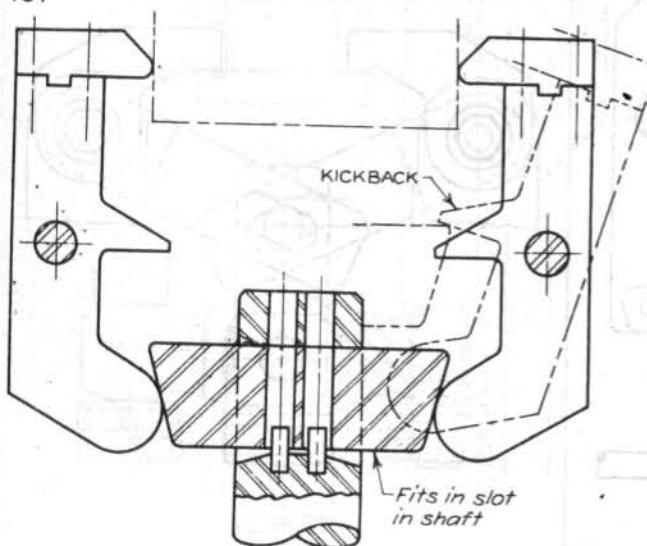
External Swing Clamp

3 JAWS 120° APART



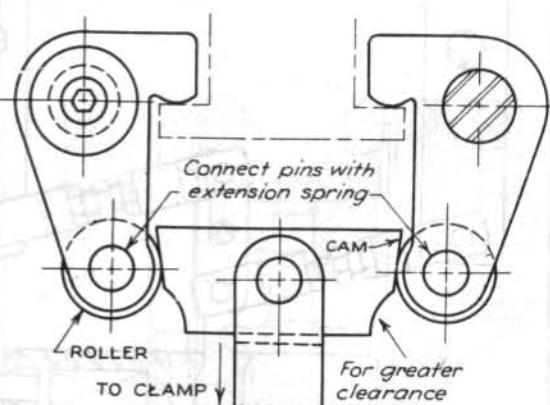
External Swing Clamp

151



External Swing Clamp

152



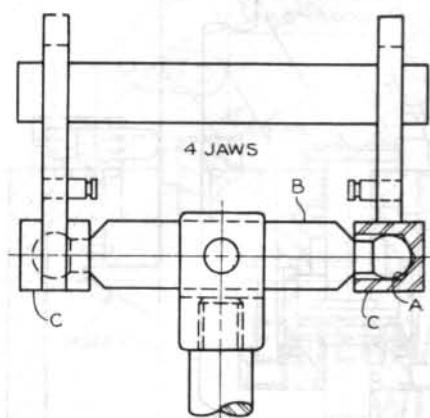
External Swing Clamp

153

155

157

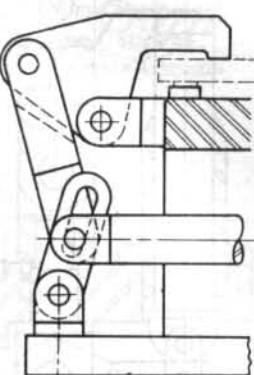
153



Force is applied to the two links C, one at either end of B, by the ends of B, thereby equalizing the four clamps.

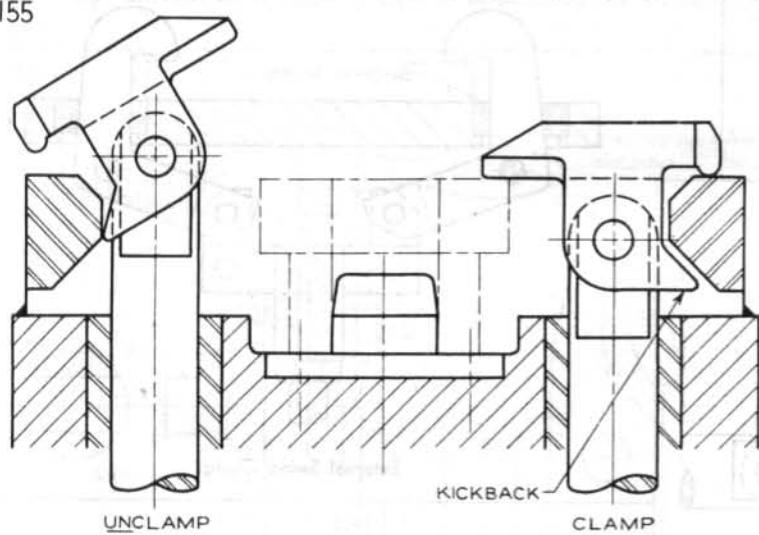
External Swing Clamp

154



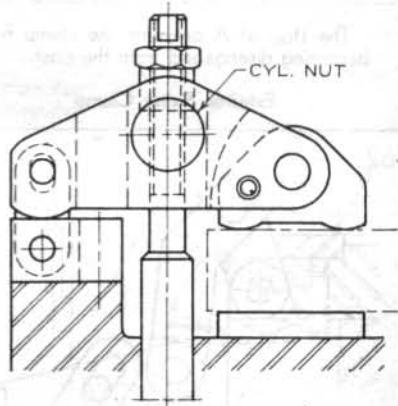
External Swing Clamp

155



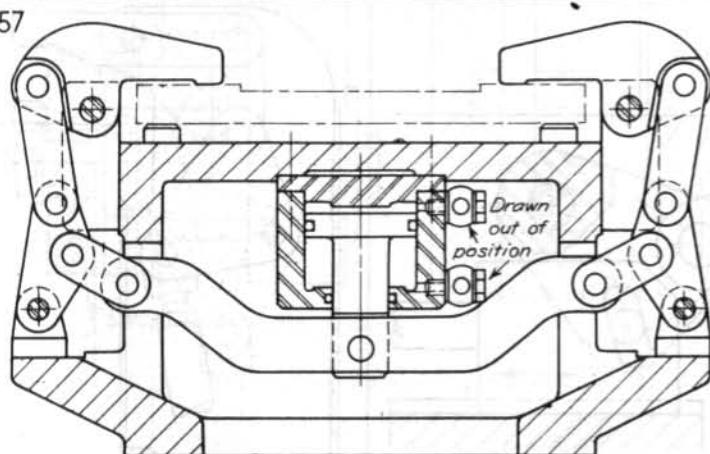
External Swing Clamp

156



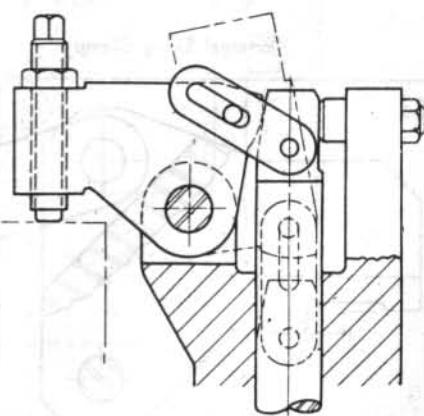
External Swing Clamp

157

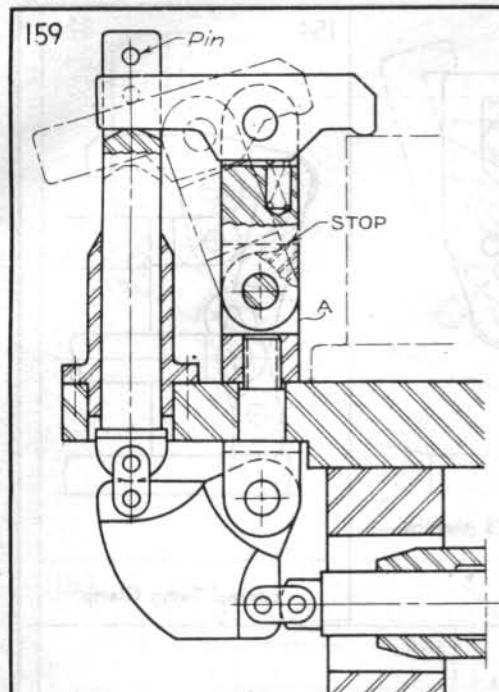


External Swing Clamp

158

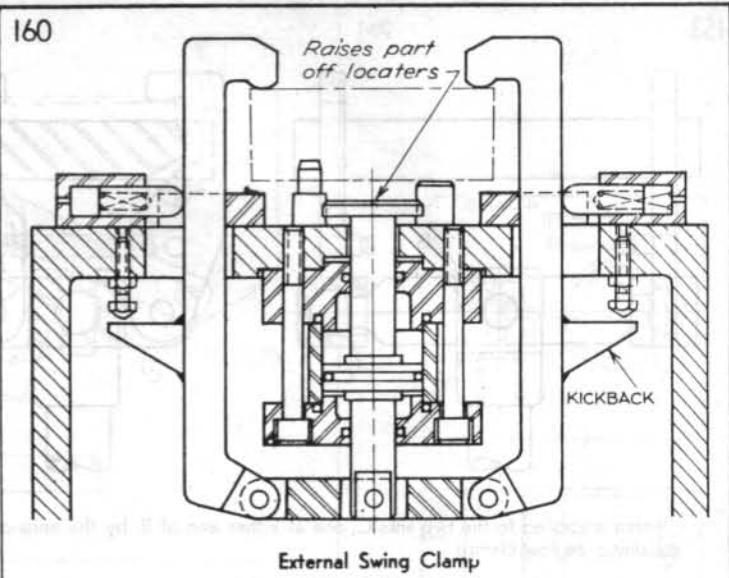


External Swing Clamp

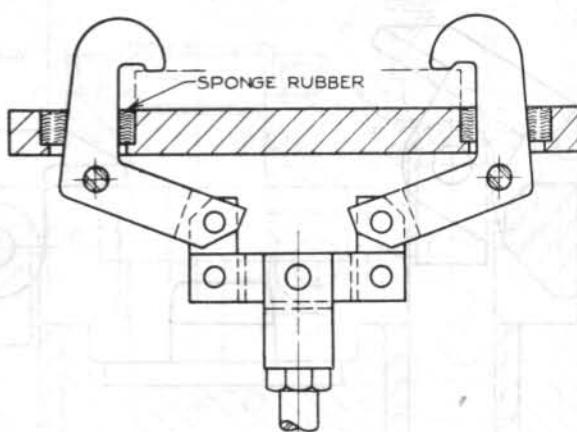


The stop of A prevents the clamp from becoming disengaged from the post.

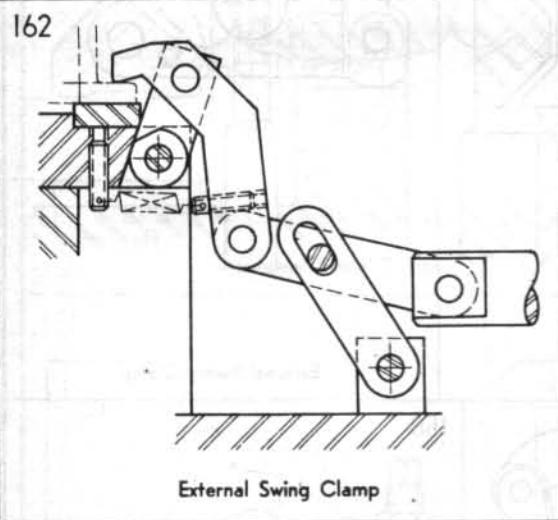
External Swing Clamp



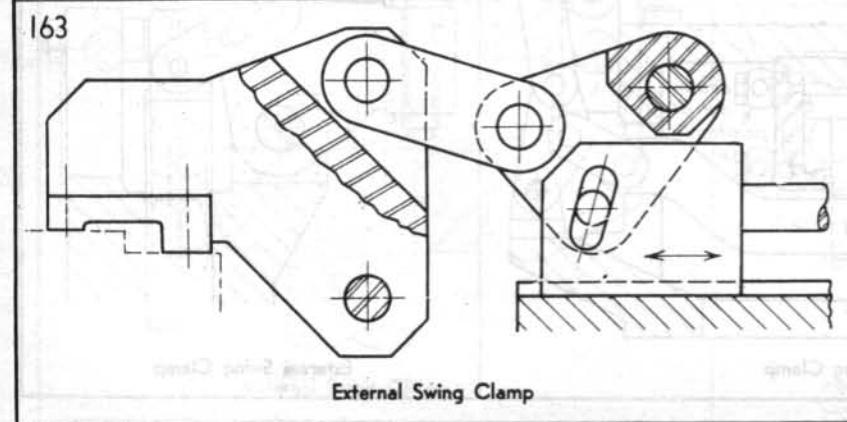
161



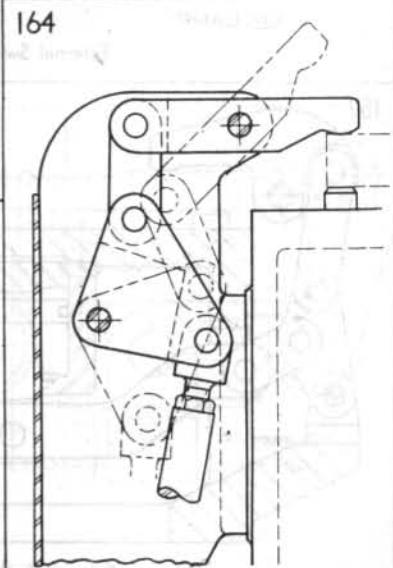
External Swing Clamp



External Swing Clamp

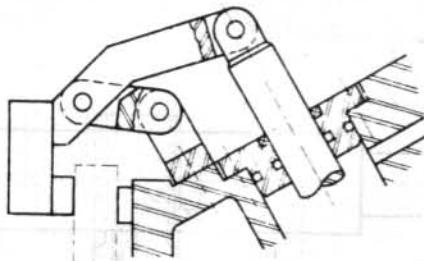


External Swing Clamp



External Swing Clamp

165



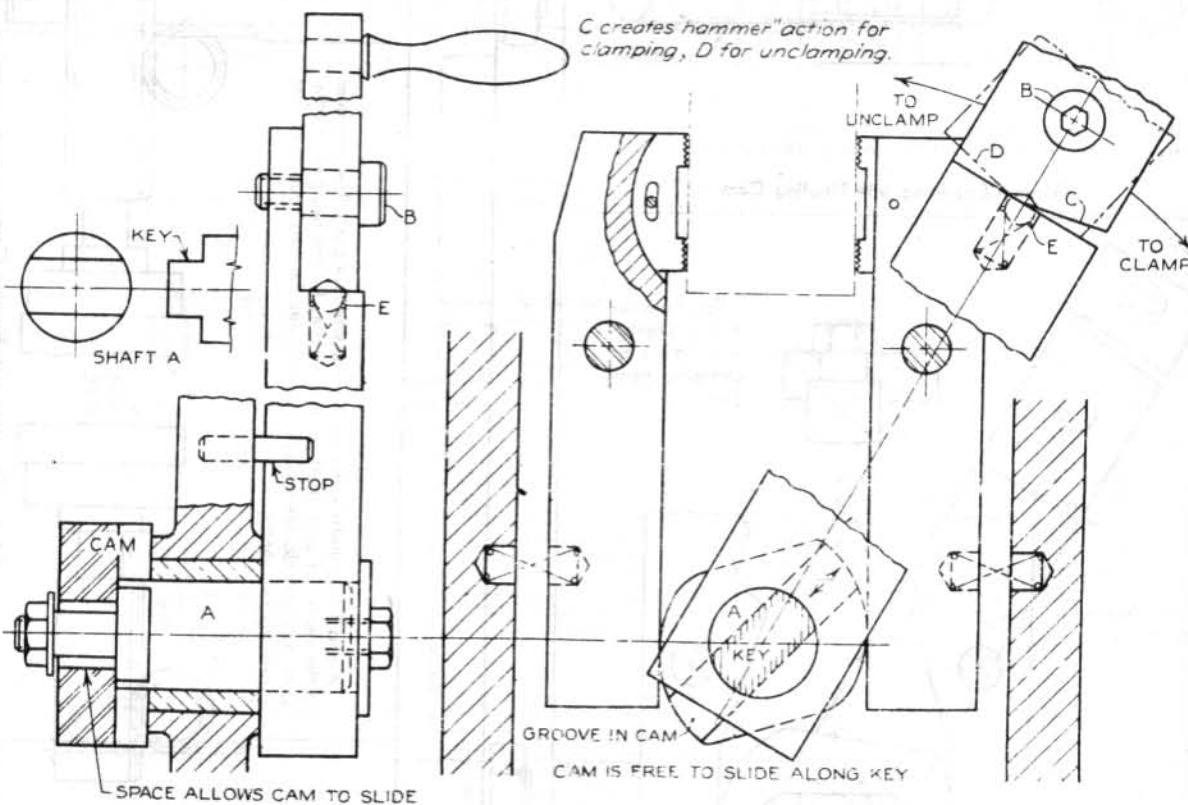
External Swing Clamp

"The three great essentials to achieve anything worthwhile are first, hard work; second, stick-toitiveness; third, common sense." THOMAS A. EDISON

EXTERNAL EQUALIZING CLAMPS WITH FLOATING CAM

A floating cam is a means of equalizing the clamping action that allows the cam to adjust itself to the clamps instead of the clamps to the cam. When a helical rack and pinion, which may be considered to be a wedge cam, is combined with the endplay of the pinion's shaft, they function as a floating cam in equalizing the clamping action.

166

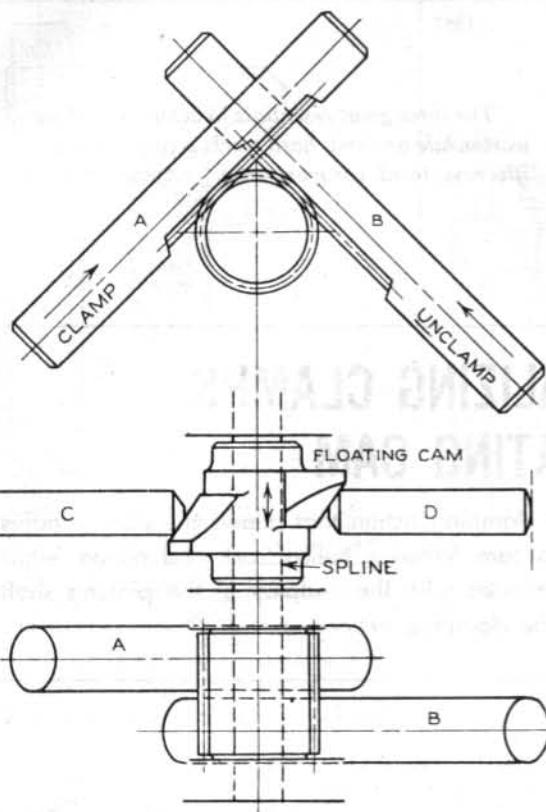


Note how the end of shaft A is milled to create the key. Also note the hammer action.

External Equalizing with Floating Cam

167-169

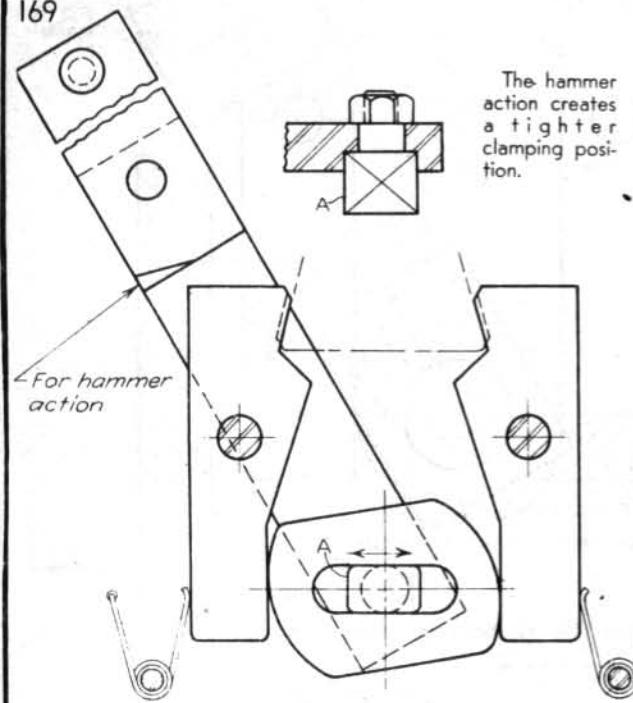
167



Shafts A and B, alternately moved by cylinders, rotate the pinion and the cam which are on the same shaft. The cam can move freely along the splined shaft, thereby equalizing clamps C and D.

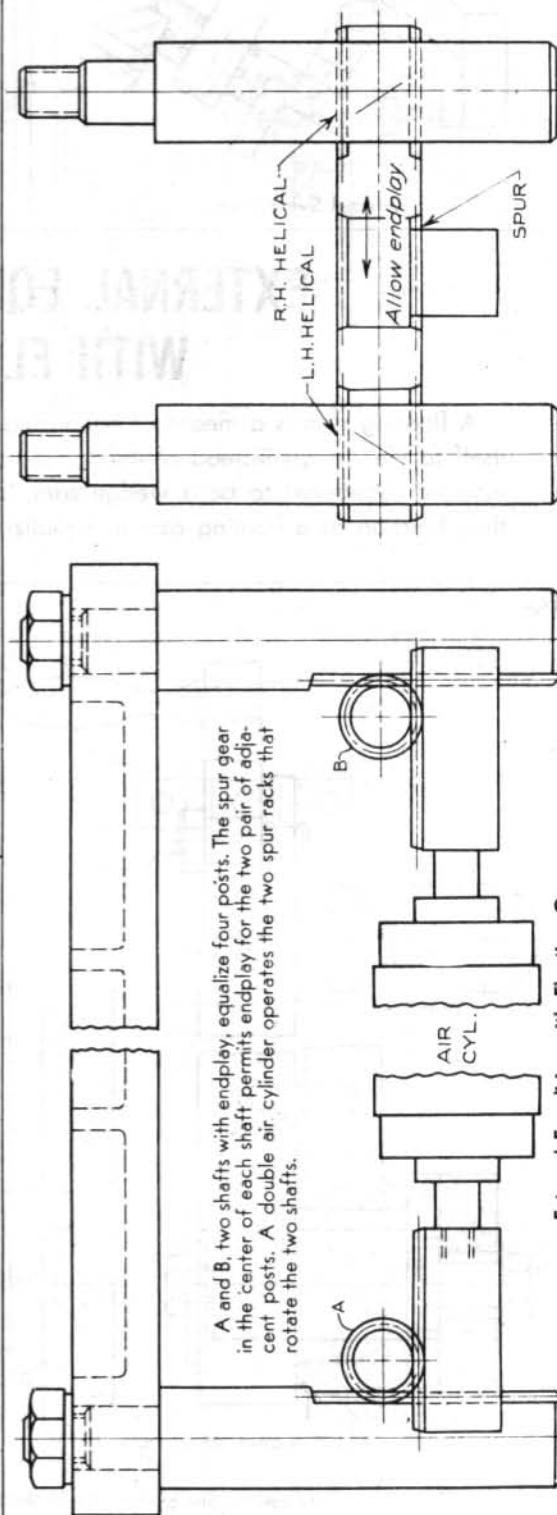
External Equalizing with Floating Cam

169



External Equalizing with Floating Cam

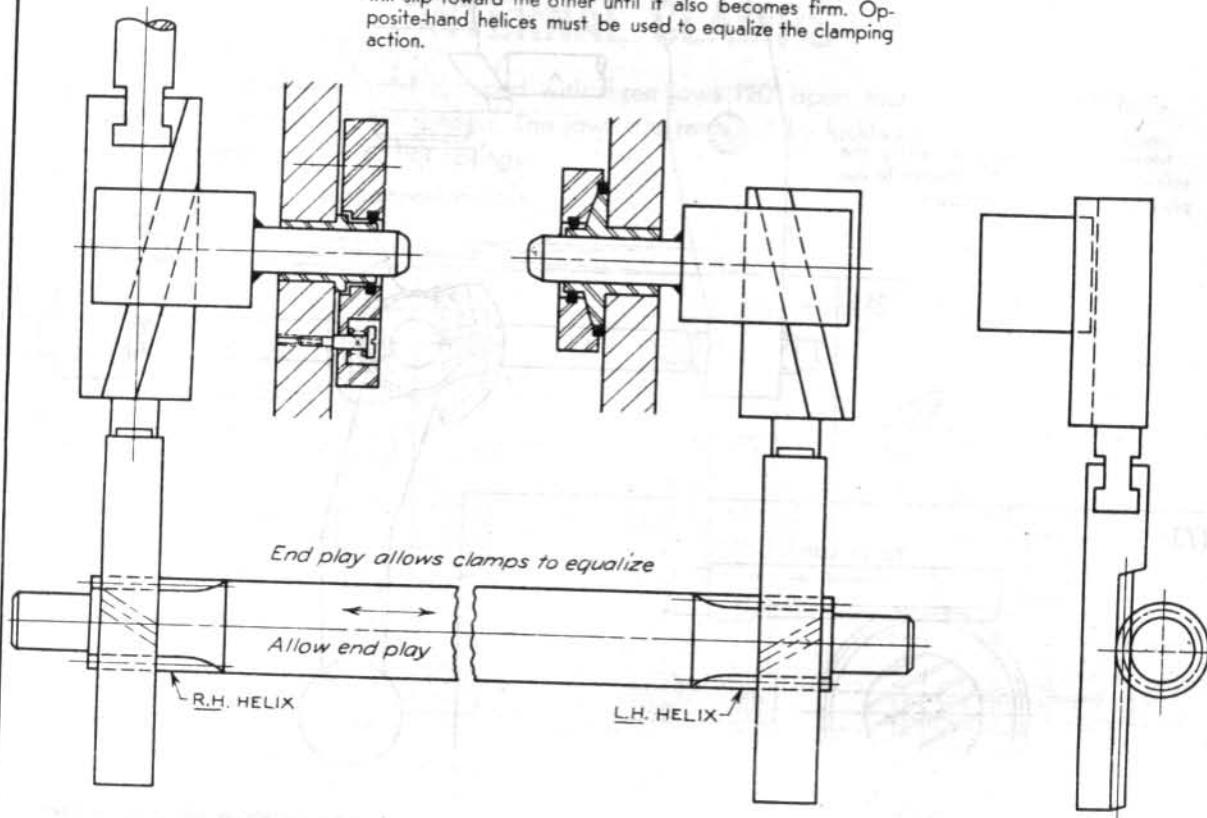
168



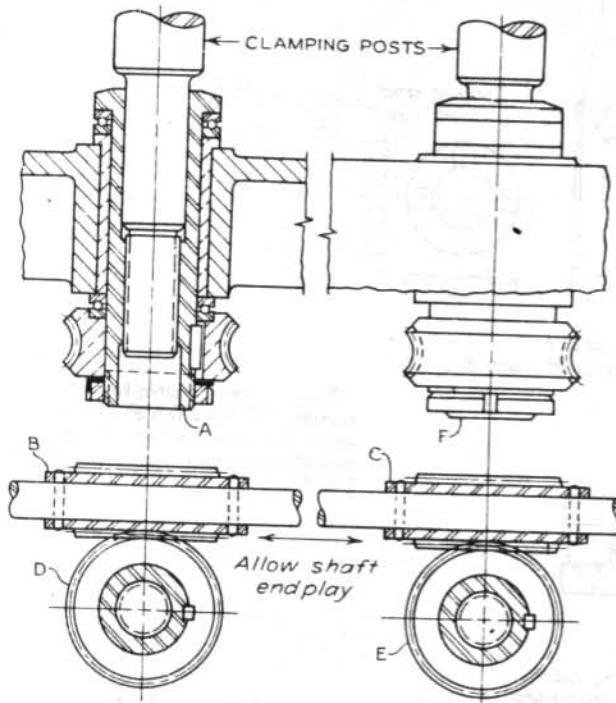
External Equalizing with Floating Cam

170

Endplay allows slippage between the racks and pinions until both clamps are firm. When one clamp is firm, the shaft will slip toward the other until it also becomes firm. Opposite-hand helices must be used to equalize the clamping action.



External Equalizing with Floating Cam

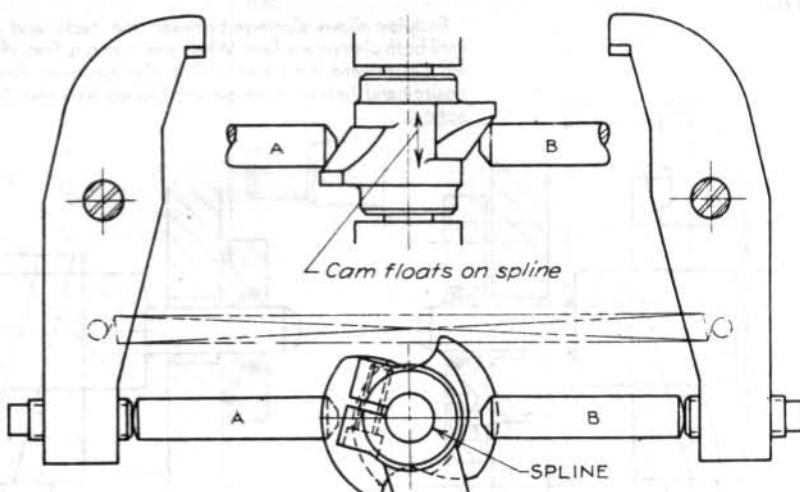


The two worms, B and C, on the endplayed shaft rotate via their worm wheels, D and E, nuts A and F, which are keyed to D and E, thereby actuating the two clamp posts. The clamp posts should be rotated only by cams specially designed to rotate clamp posts.

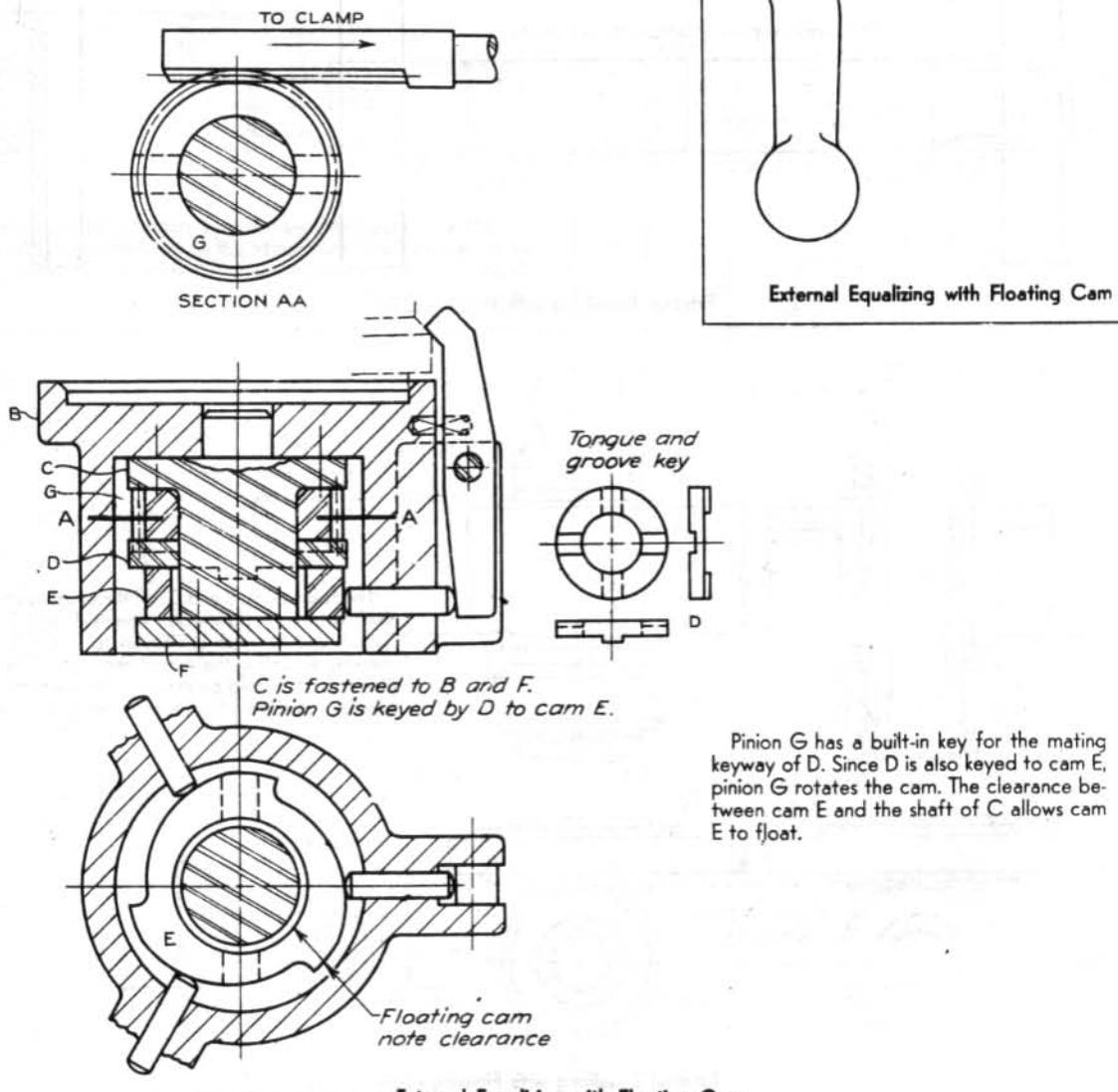
External Equalizing with Floating Cam

172

Movement of the cam along the splined shaft enables the clamps to apply equal pressure on the part.



173

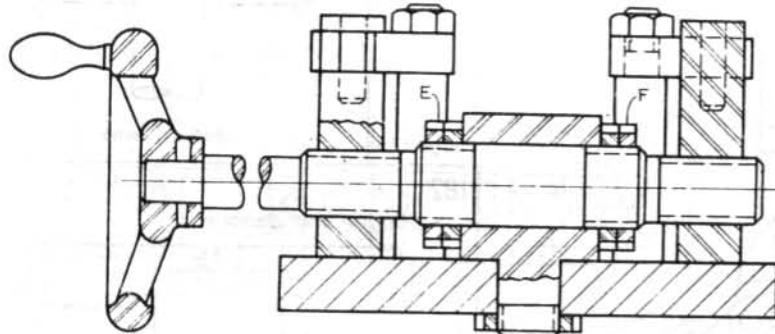
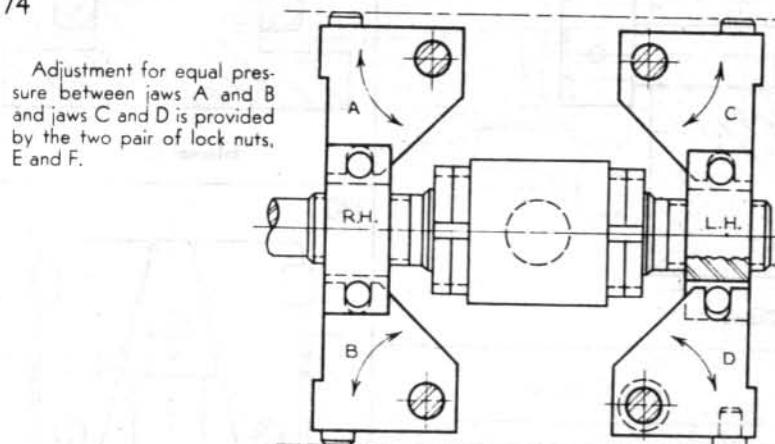


INTERNAL CLAMPS

Round holes are invariably clamped with three jaws 120° apart that are actuated by balls, cones, links, cams, or partial spheres. The jaws are retracted by kickbacks, T-slot cams, or compression, tension, garter, or flat springs.

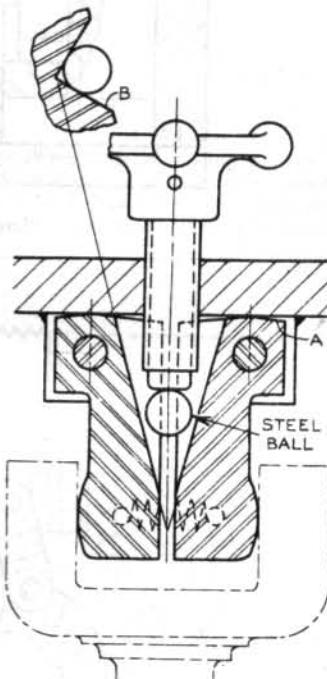
174

Adjustment for equal pressure between jaws A and B and jaws C and D is provided by the two pair of lock nuts, E and F.



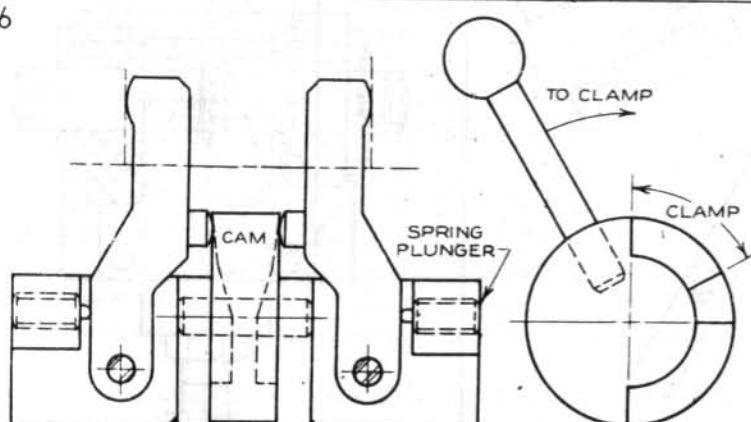
Internal Clamp

175



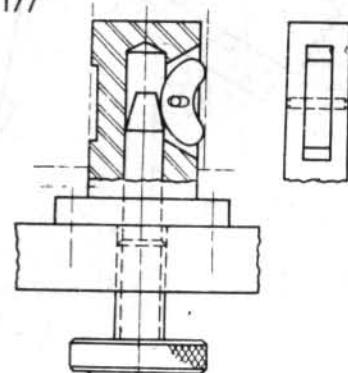
Internal Clamp

176



Internal Clamp

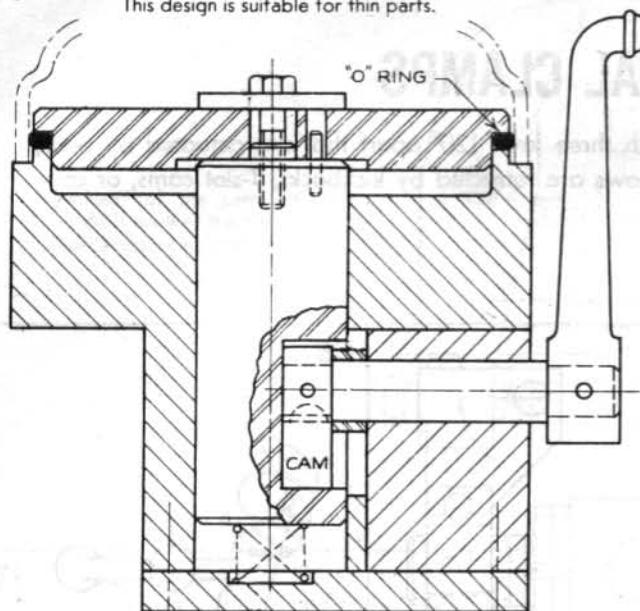
177



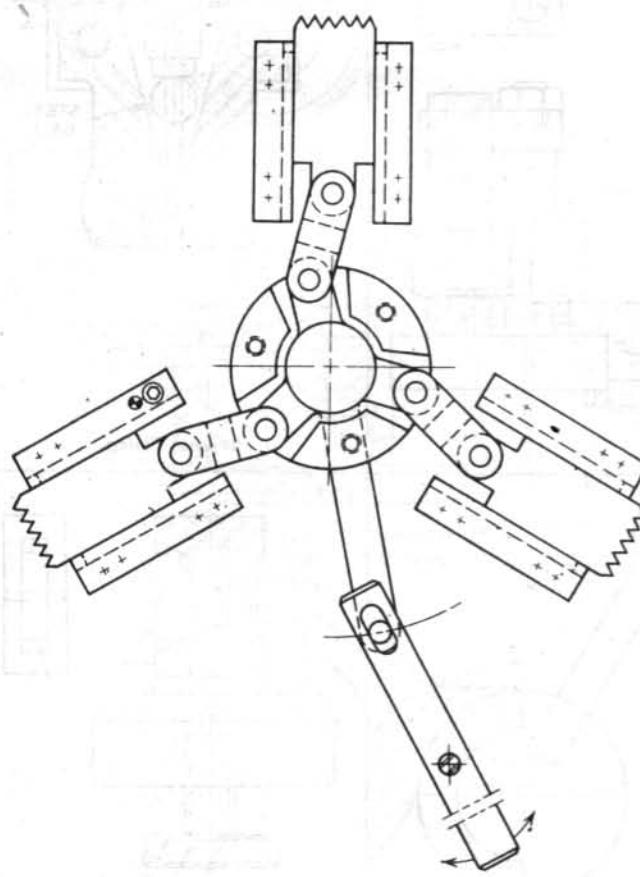
Internal Clamp

178

This design is suitable for thin parts.

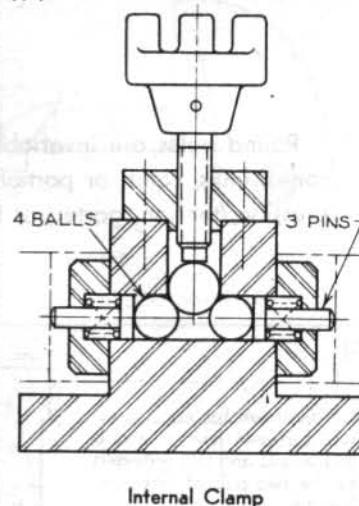


181

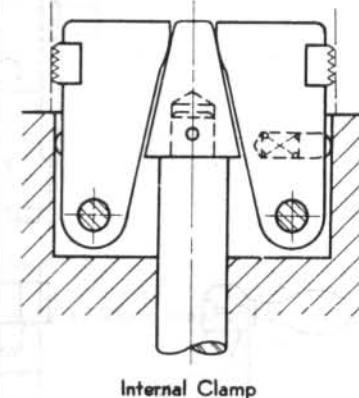


Internal Clamp

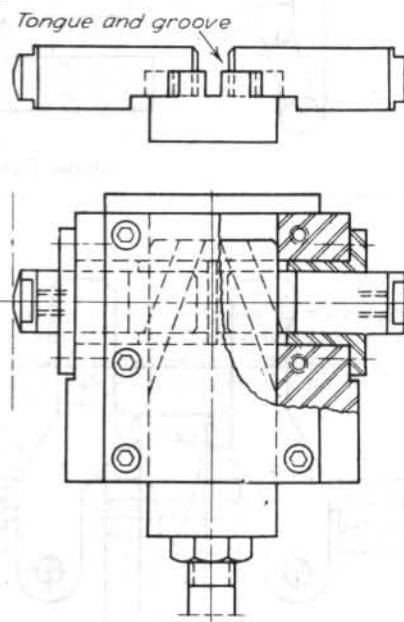
179



180

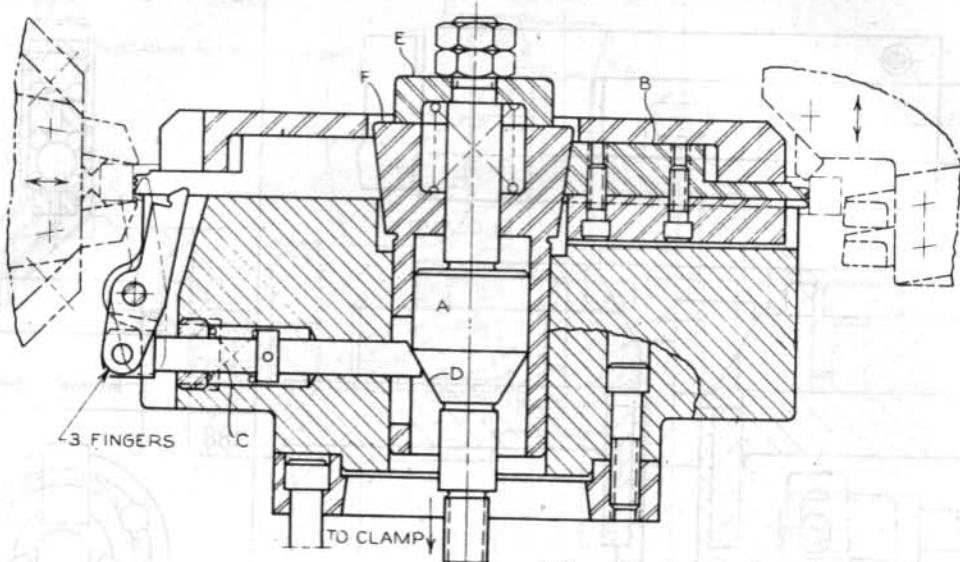


182



Internal Clamp

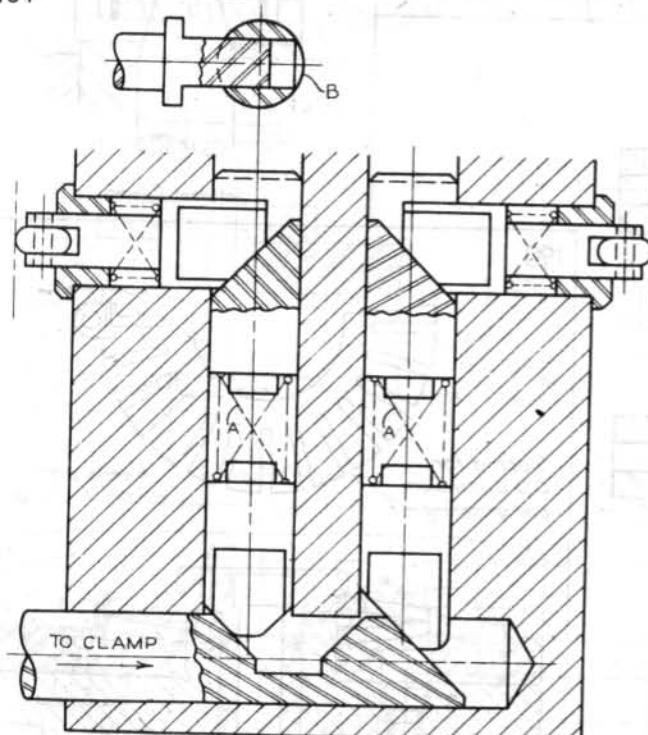
183



When A is raised, the three clamping jaws B retract and the three fingers are moved to the shaded position by springs C to hold the part only until it is lightly clamped. After cone D retracts the fingers, E meets F and full pressure is applied to jaws B. The fingers are called pre-position fingers because they merely locate the part for clamping and are removed when the part is machined.

Internal Clamp

184

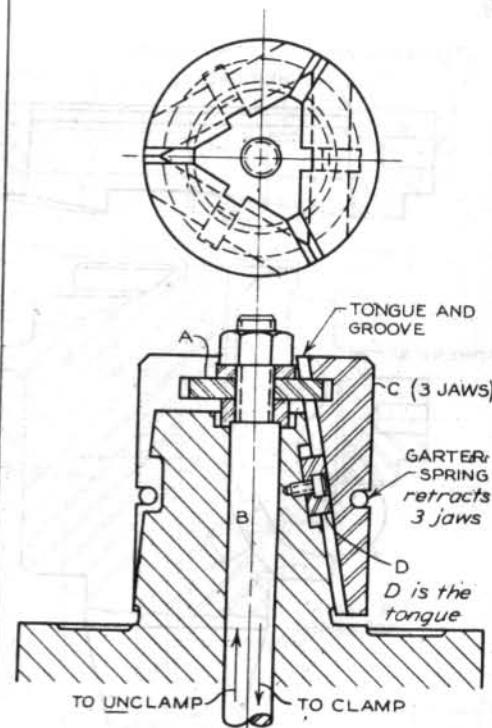


Strong springs A absorb any excessive pressure

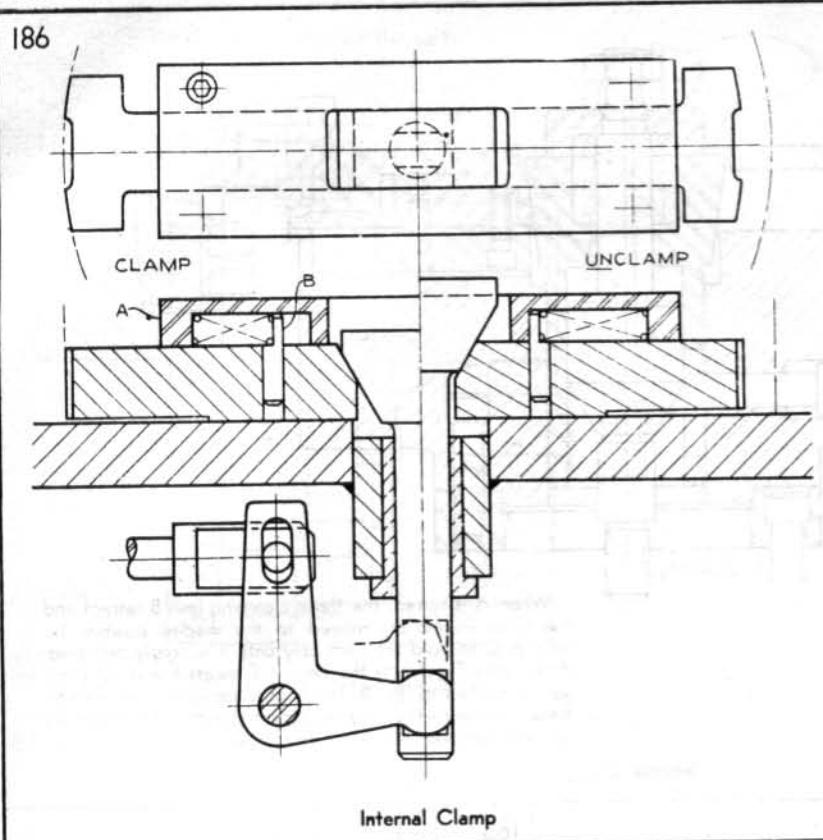
Springs A equalize the clamping action. Slots B prevent rotation of the jaws.

Internal Clamp

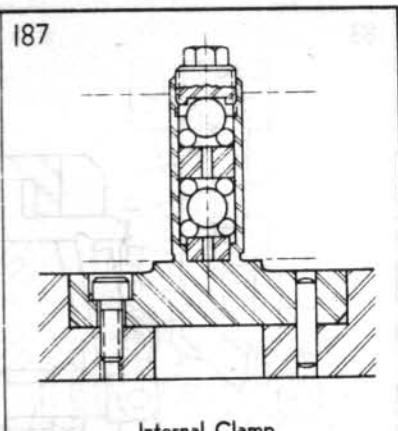
185



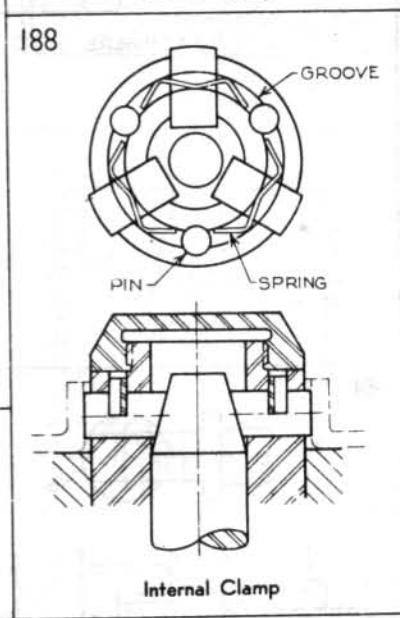
Internal Clamp



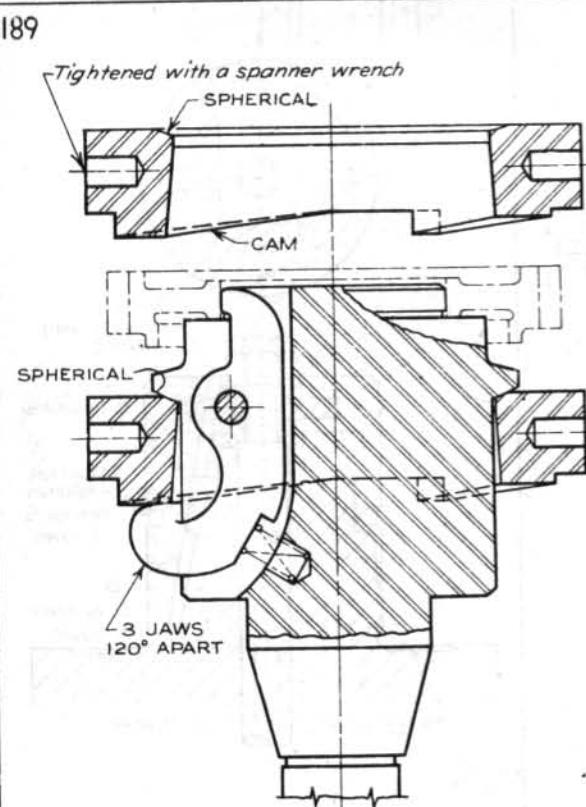
Internal Clamp



Internal Clamp

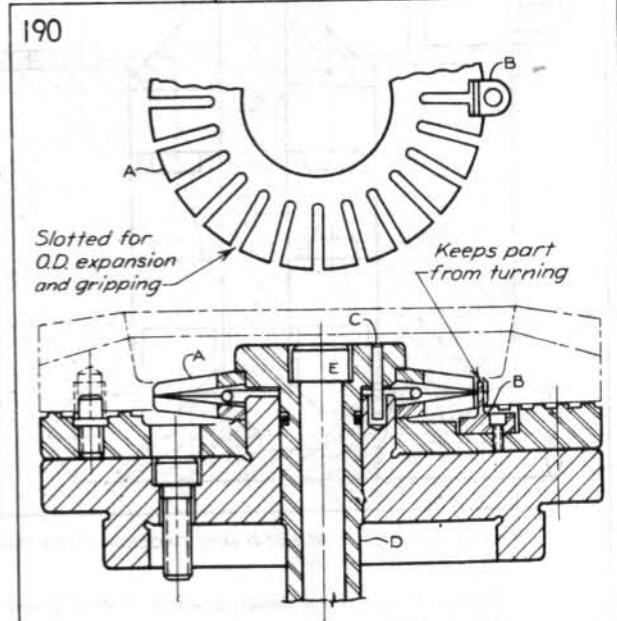


Internal Clamp



Three axial cams apply pressure to the jaws.

Internal Clamp

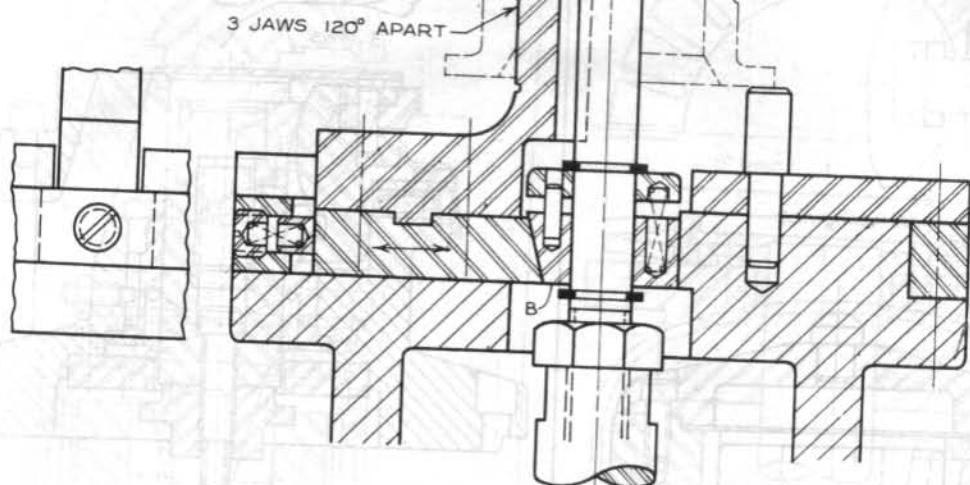


Internal Clamp

191

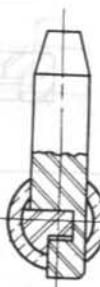
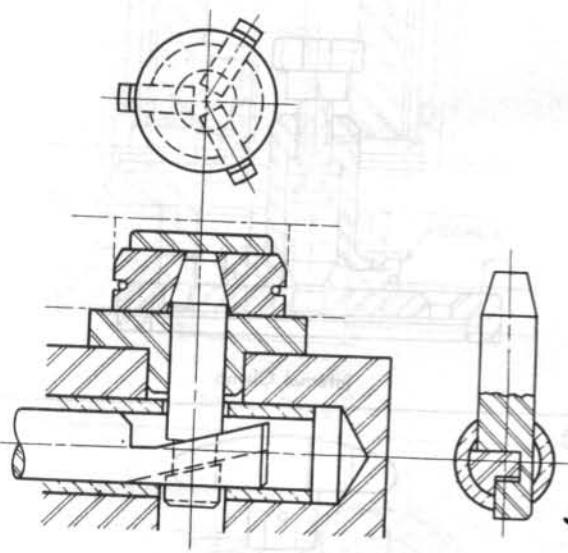
191-195

A and B are expanders for the three jaws.



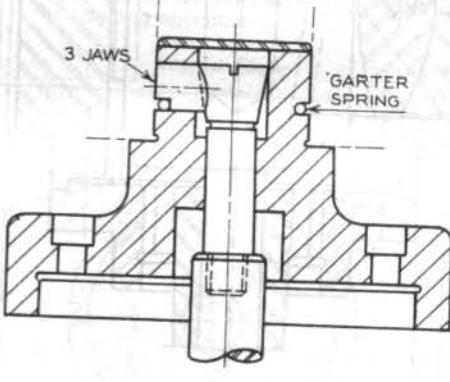
Internal Clamp

192



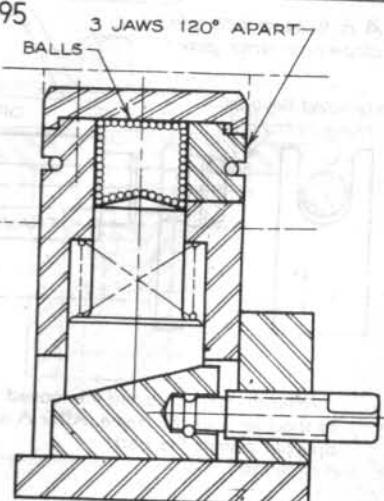
Internal Clamp

193



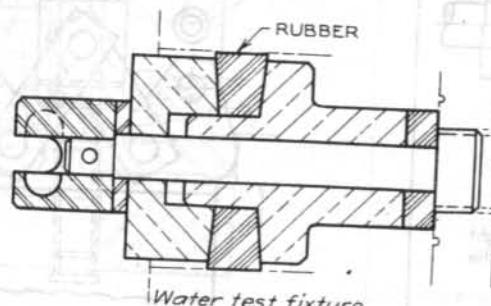
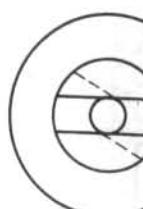
Internal Clamp

195



Internal Clamp

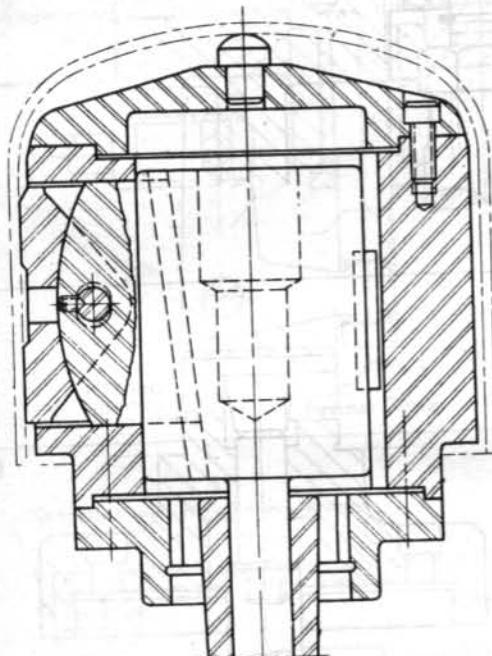
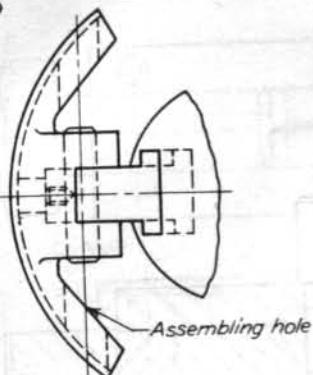
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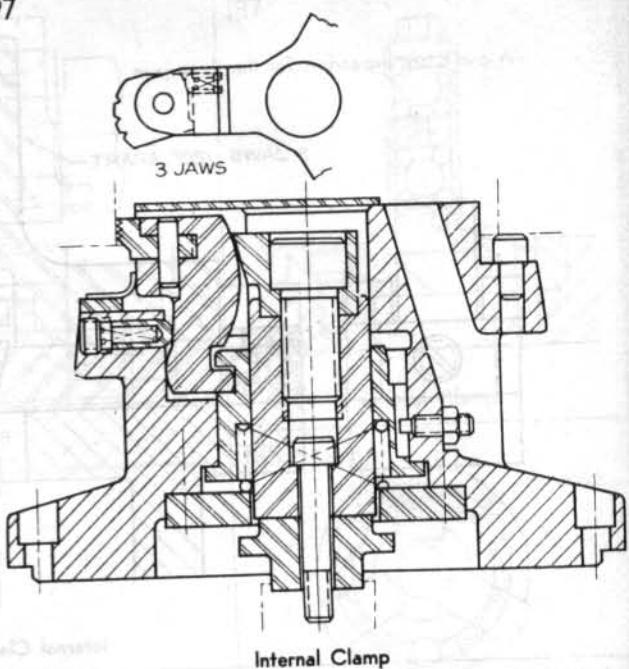
Internal Clamp

196-200

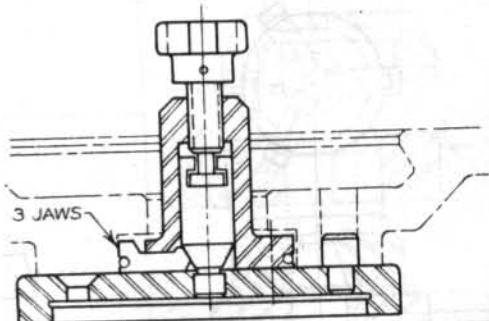
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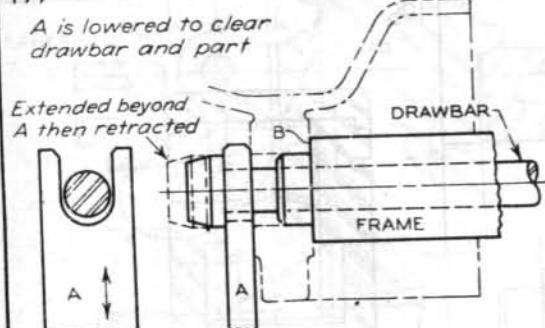
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198



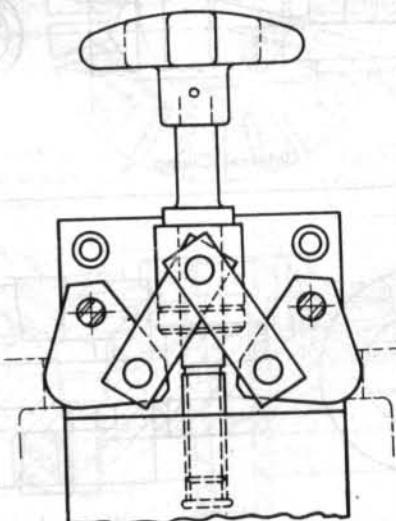
199



After the part is loaded it is moved to the right to shoulder B of the frame. After A is raised, the drawbar clamps the part.

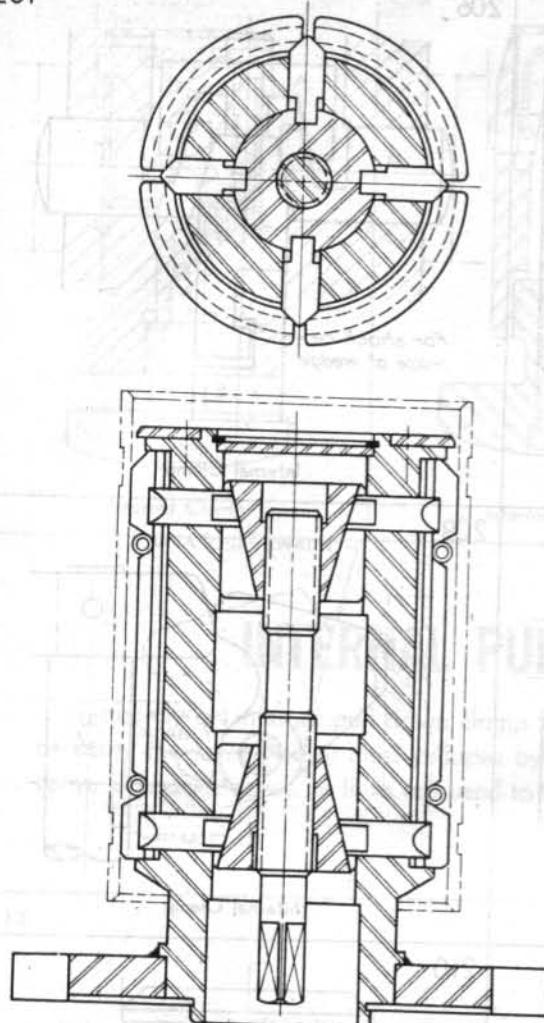
Internal Clamp

200



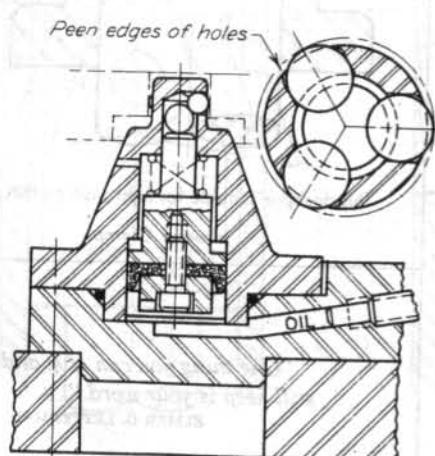
Internal Clamp

201



Internal Clamp

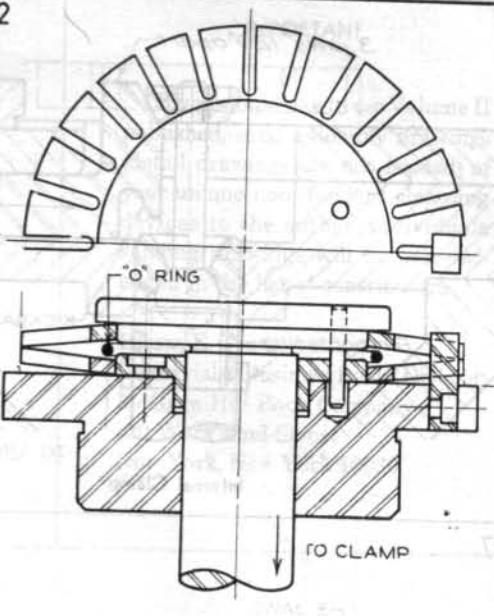
204



Internal Clamp

201-204

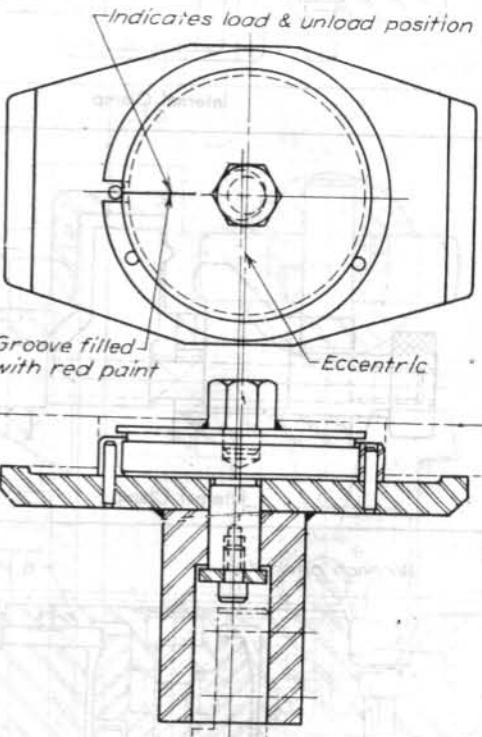
202



Heavy machining might rotate the part and the springs if they were not keyed by B. The "O" ring prevents the springs from reversing themselves when excessive pressure is applied in the clamping operation.

Internal Clamp

203

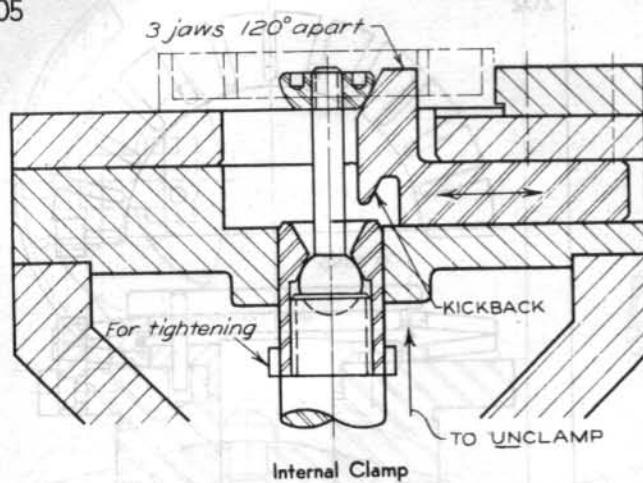


The eccentric expands the split ring which is pinned in two places.

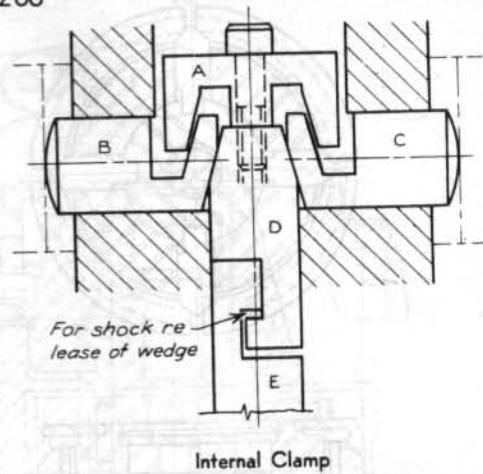
Internal Clamp

205-211

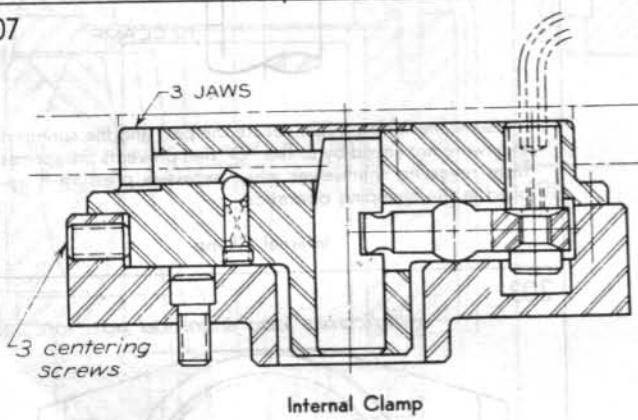
205



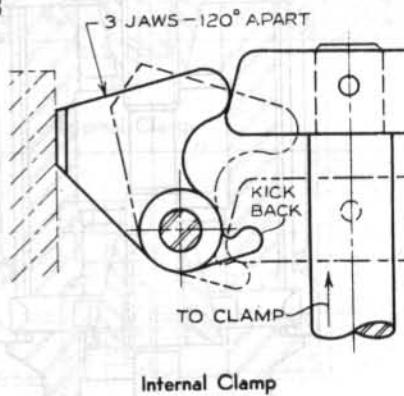
206



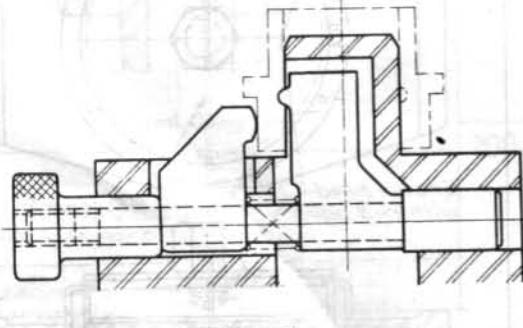
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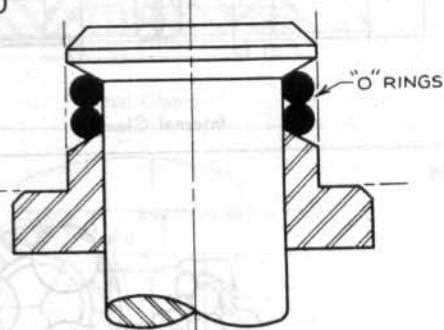
208



209



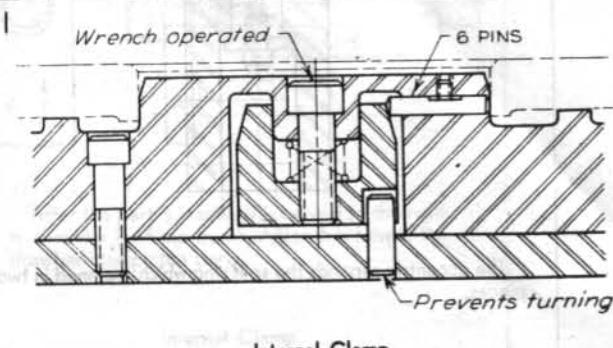
210



This design is suitable for light work on thin parts.

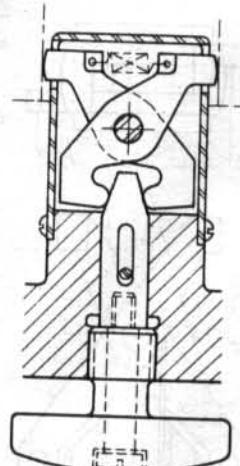
Internal Clamp

211



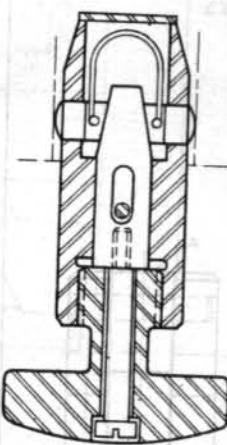
*"One thing you can give and
still keep is your word."*
ELMER G. LETTERMAN

212



Internal Clamp

213



Internal Clamp

212-215

IMPORTANT

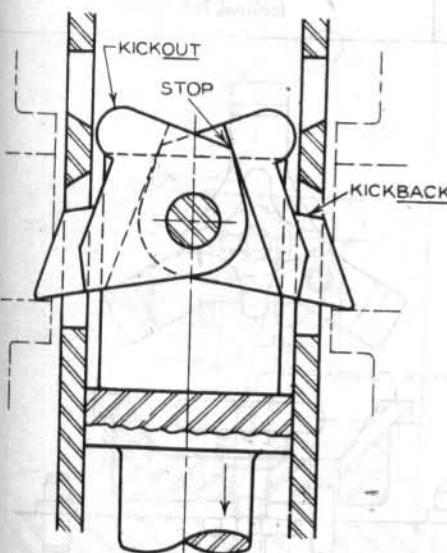
If you would like to see Volume II published, send assembly drawings (detail drawings are not needed) of your unique non-standard clamping devices to the author. Individuals sending drawings will be acknowledged in the list of contributors.

Hiram E. Grant, Author
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 330 West 42nd Street
 New York, New York 10036

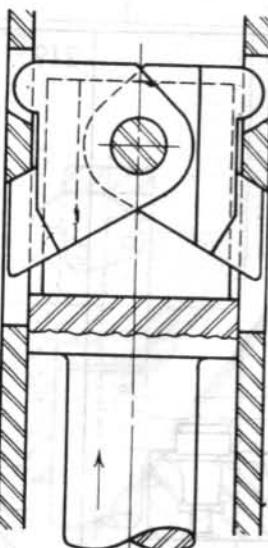
INTERNAL PULL DOWN CLAMPS

Frequently an internal pull down clamp hooks onto an internal shoulder or a top surface. By necessity the jaws (hooks) must collapse by swinging inward or retracting horizontally. Springs, cams, kickbacks, cones, or links are used to move the jaws.

214



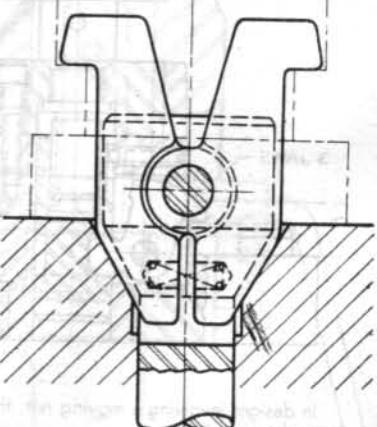
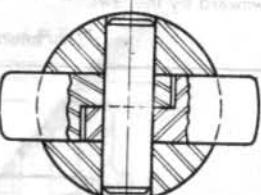
KICKBACK



Note the use of kickbacks to retract the hooks and kickouts to spread them.

Internal Pull Down

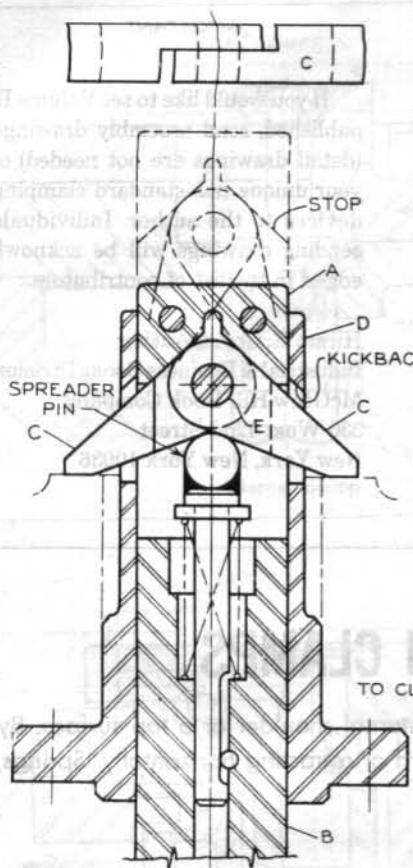
215



Internal Pull Down

216-219

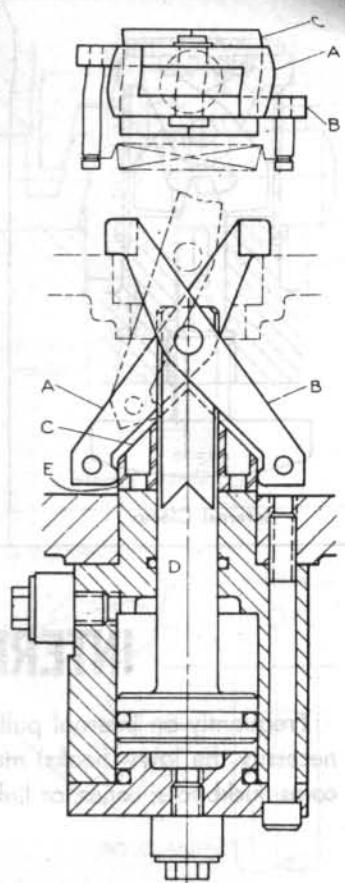
216



A is the clamping stop for the two jaws C. When B is raised, jaws C are retracted by the kickbacks in the wall of D. The spreader pin is forced downward by the jaws.

Internal Pull Down

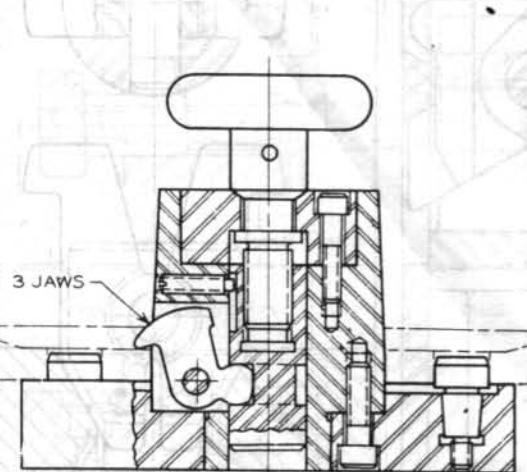
217



When D is raised, the spring retracts A and B. Cams C spread the hooks to the clamp position. Note the vertical pull down portions E.

Internal Pull Down

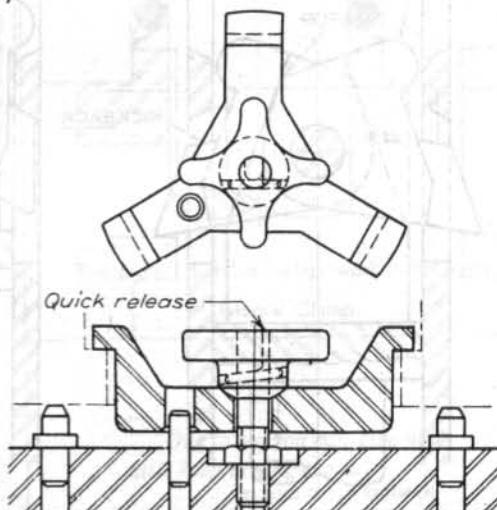
218



In designs involving a moving nut, the nut must not be allowed to rotate.

Internal Pull Down

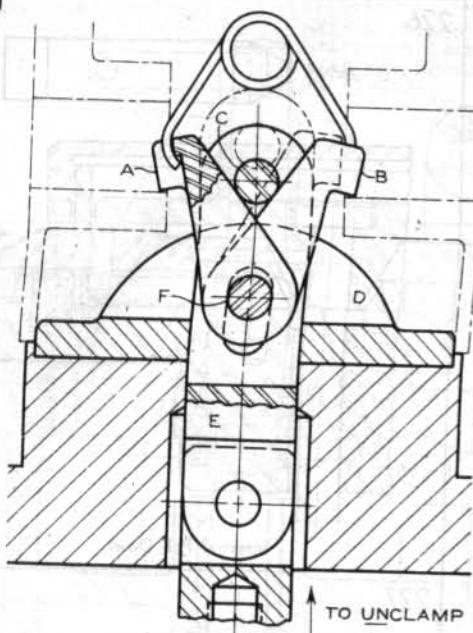
219



In designs involving a moving nut, the nut must not be allowed to rotate.

Internal Pull Down

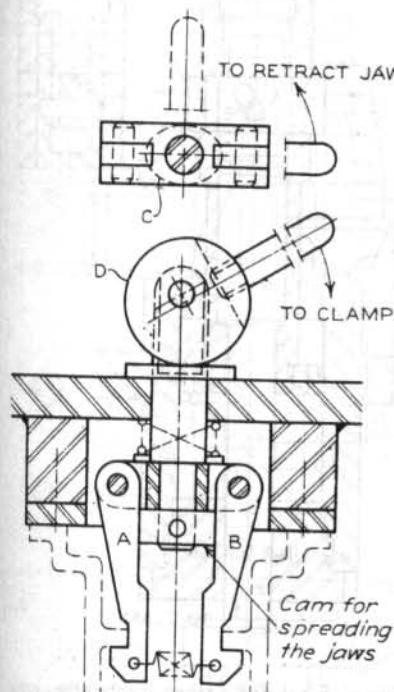
220



Hooks A and B are pinned to D by F. As E is raised in the unclamping operation, spreader pin C in E also rises, allowing the spring to collapse the hooks.

Internal Pull Down

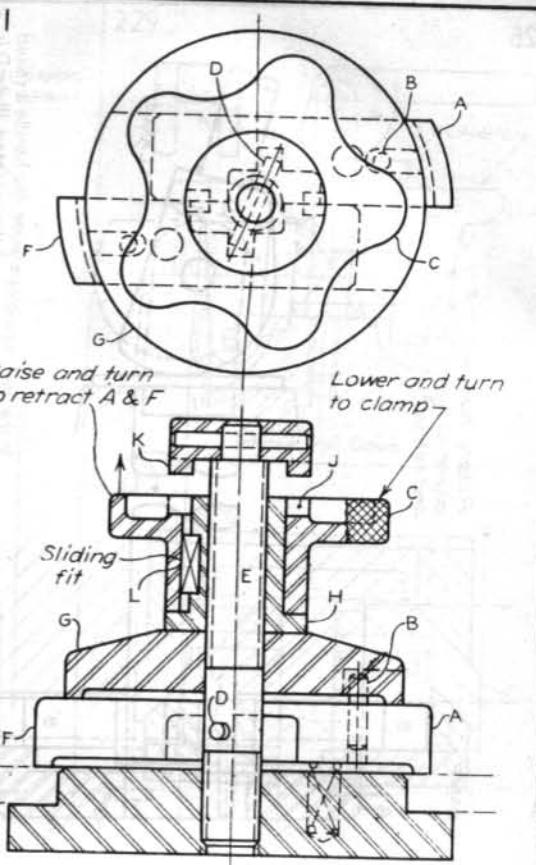
222



Before the part is raised by hooks A and B, they are spread by cam C. Then cam D raises and clamps the part.

Internal Pull Down

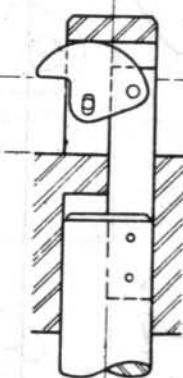
221



C is turned counter clockwise to unclamp G and then is raised to engage keys K with keyways J. C is again turned counterclockwise in its raised position, thereby turning E and its pin D, which retracts jaws A and F.

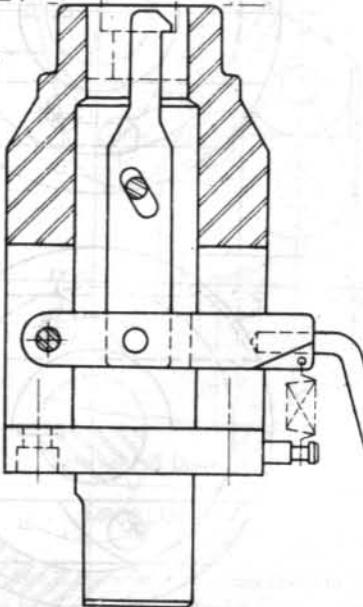
Internal Pull Down

223



Internal Pull Down

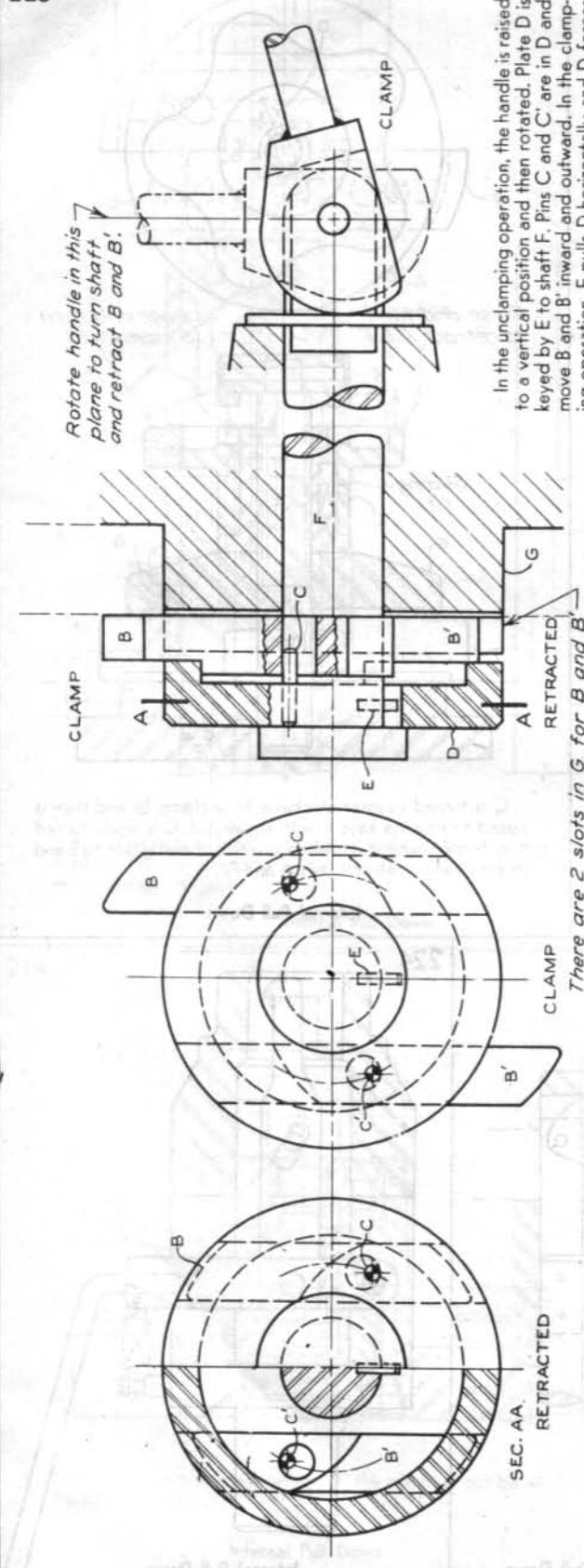
224



Internal Pull Down

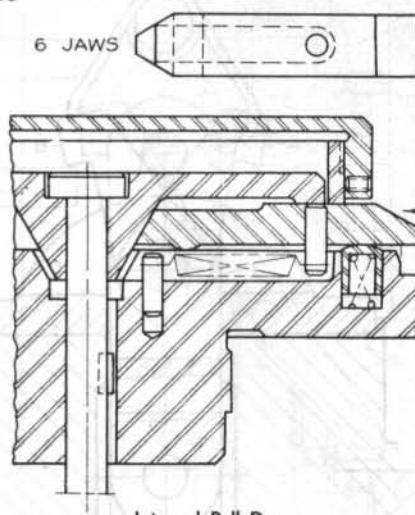
220-224

225



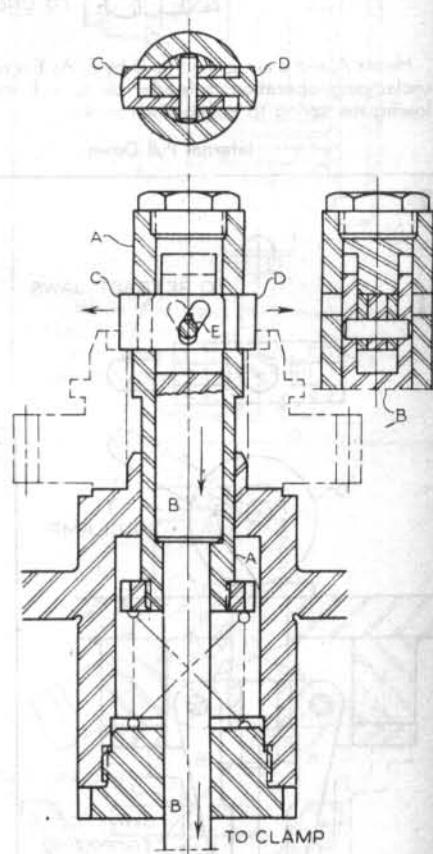
In the unclamping operation, the handle is raised to a vertical position and then rotated. Plate D is keyed by E to shaft F. Pins C and C' are in D and move B and B' inward and outward. In the clamping operation, F pulls D horizontally and D forces B and B' against the part.

226



Internal Pull Down

227

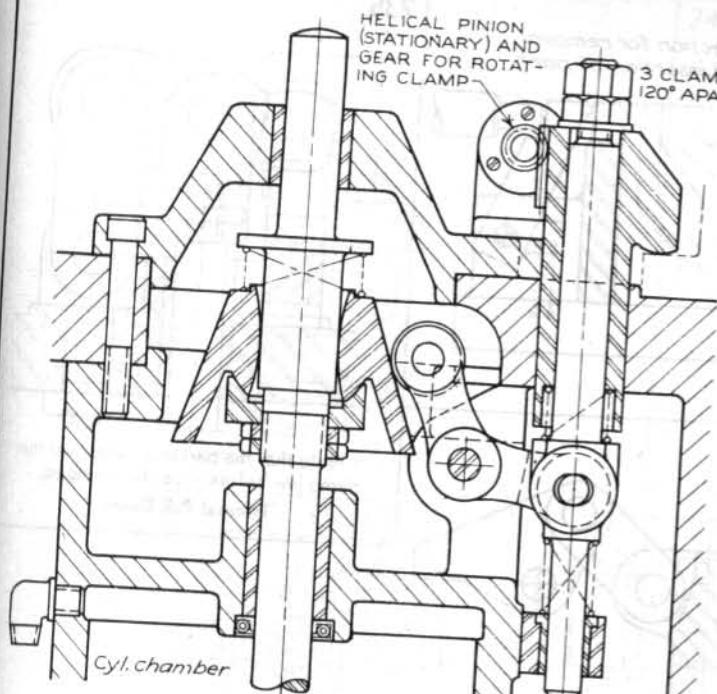


Internal Pull Down

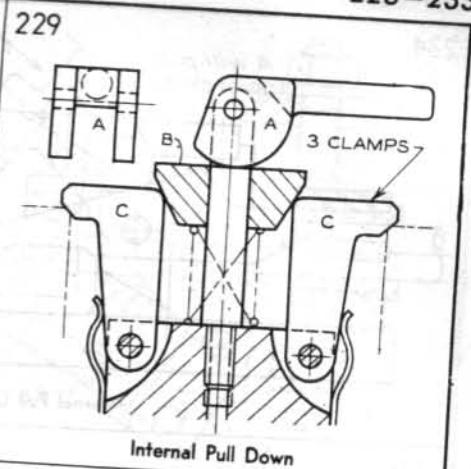
When pin E in shaft B is raised, it enters the cams of C and D to retract them. Simultaneously, the spring raises A. In the clamping operation, E is pulled down into the vertical portion of the cam grooves, spreading C and D. Continued pull down of shaft B causes A to clamp C and D.

Internal Pull Down

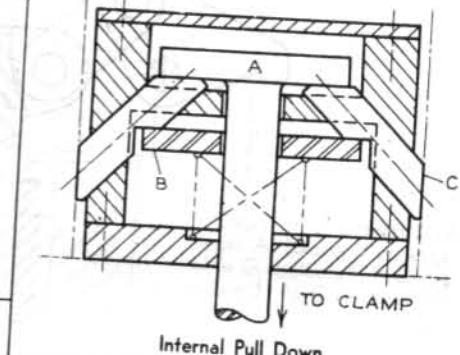
228



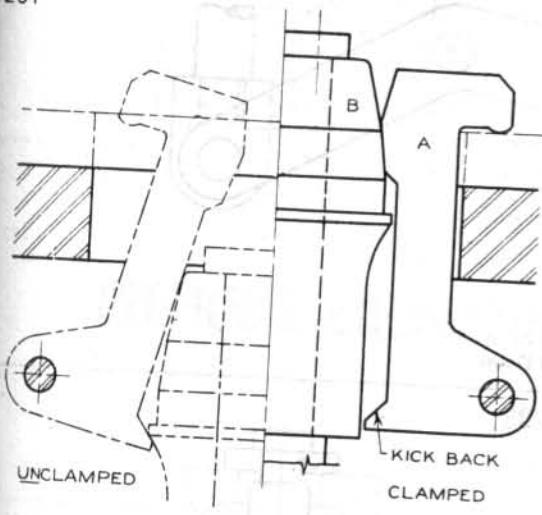
228-233



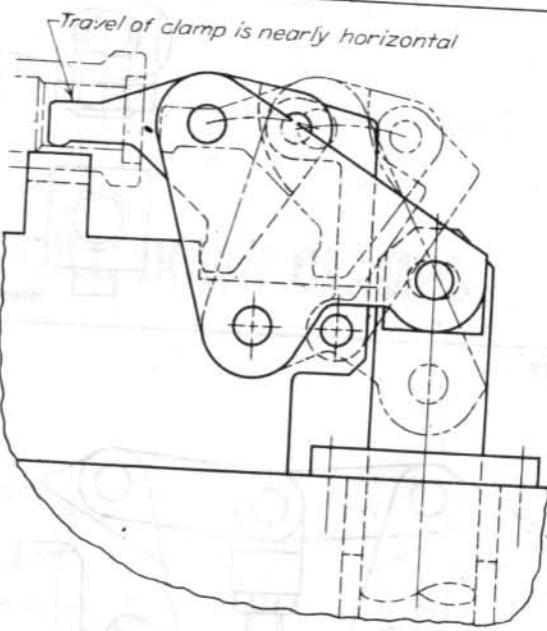
230



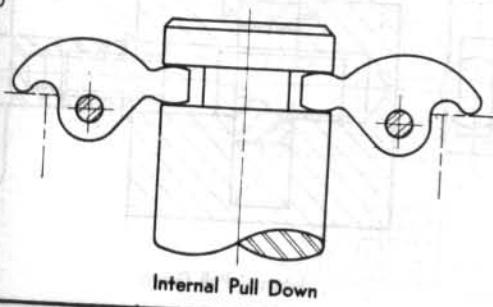
231



232



233

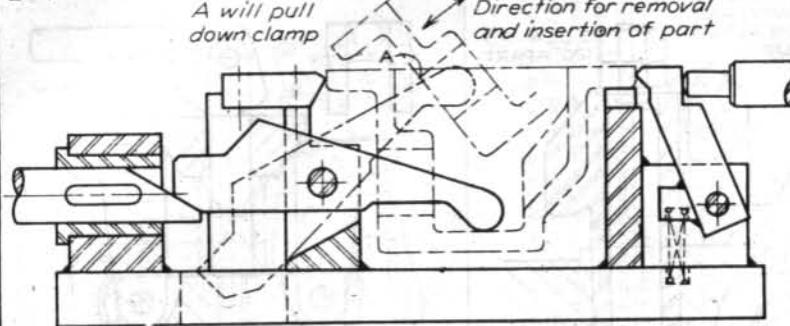
**IMPORTANT**

The preface is the author's only opportunity to explain his book to its readers. Read it.

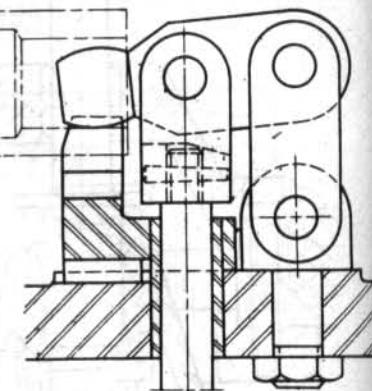
234-238

234

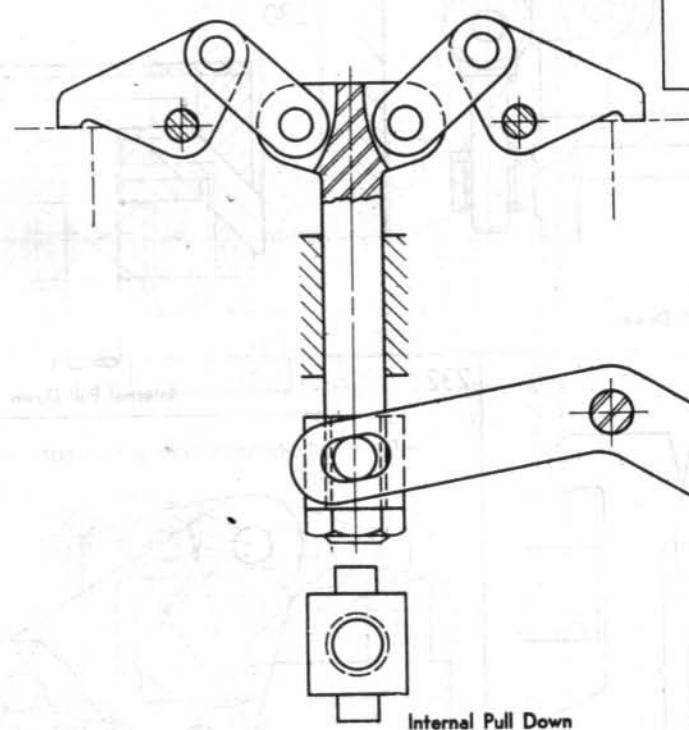
A will pull down clamp *Direction for removal and insertion of part*



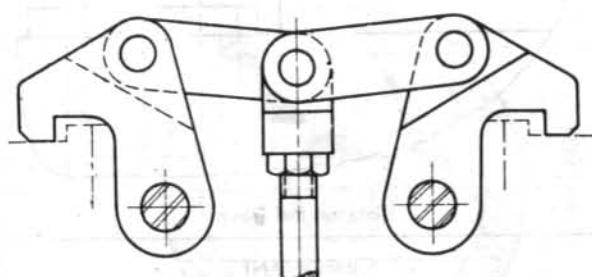
235



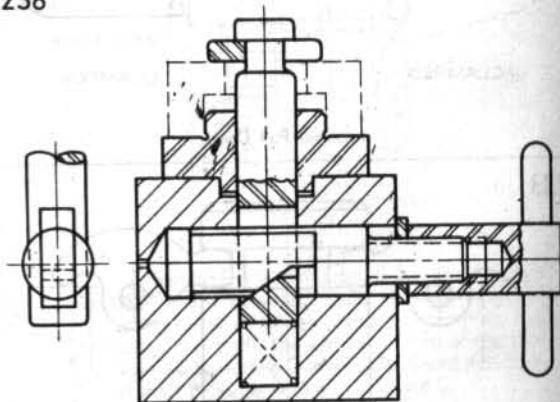
236



237



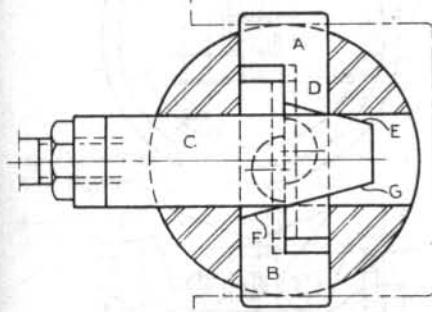
238



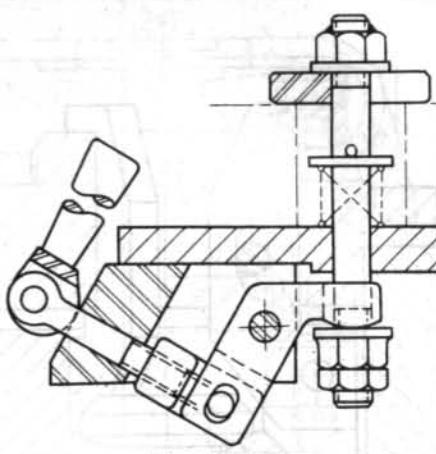
Internal Pull Down

Internal Pull Down

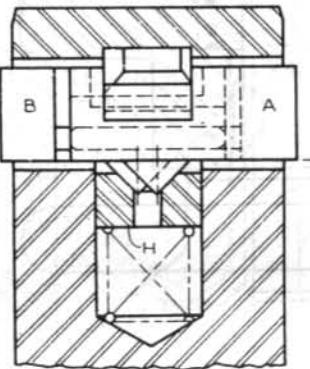
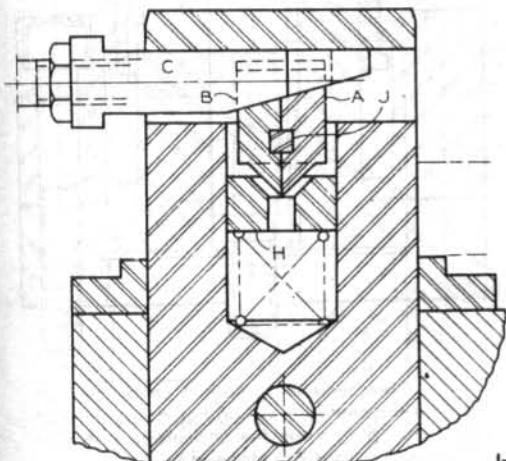
239



240



Internal Pull Down

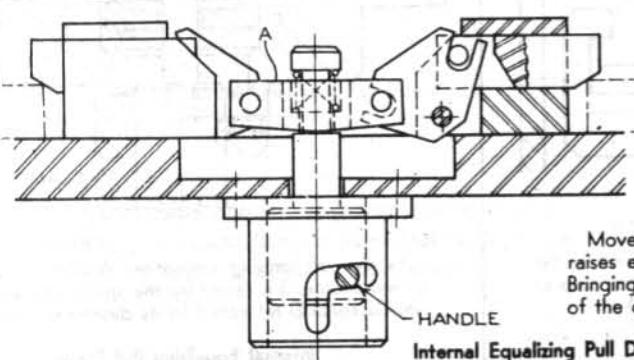


Cam E of C contacts D of finger A, forcing it outward, while G contacts F, forcing B outward. As C is retracted, pressure from spring-loaded H on the half cones of A and B retracts A and B. Key J keeps A and B in line.

Internal Pull Down

INTERNAL EQUALIZING PULL DOWN CLAMPS

241

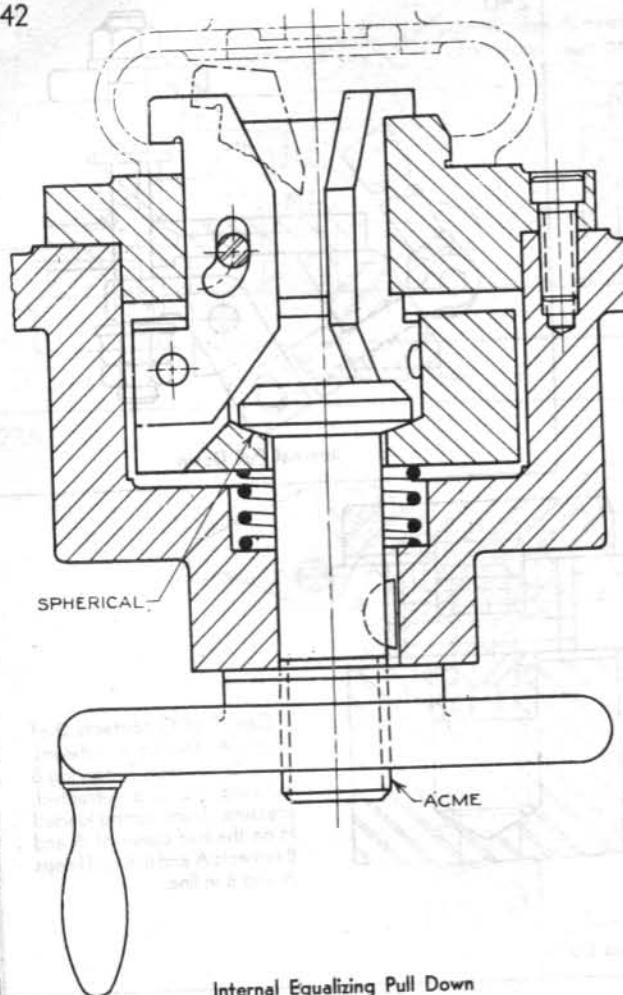


Movement of the handle in the cam groove raises equalizing trunnion A, clamping the jaws. Bringing the handle down into the vertical portion of the groove lowers A, retracting the jaws.

Internal Equalizing Pull Down

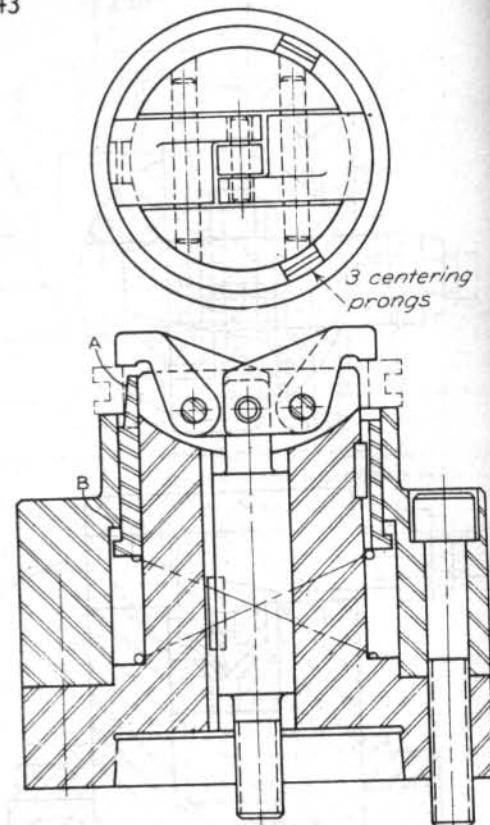
242-245

242



Internal Equalizing Pull Down

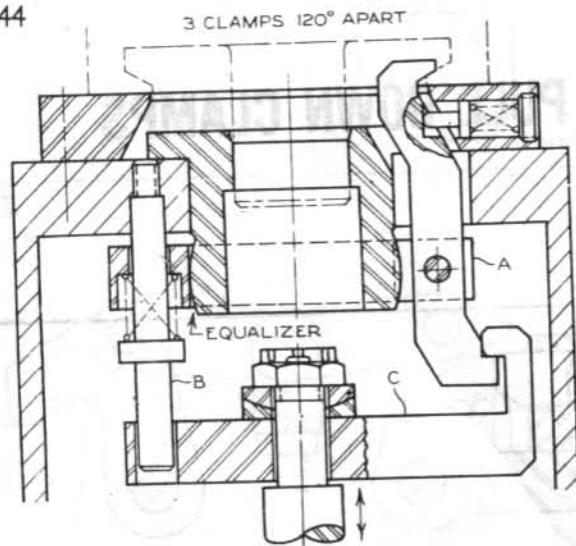
243



The three centering prongs A center the part before the clamps lower prongs A and the part to clamp position. In the unclamping operation the rise of prongs A is stopped by B.

Internal Equalizing Pull Down

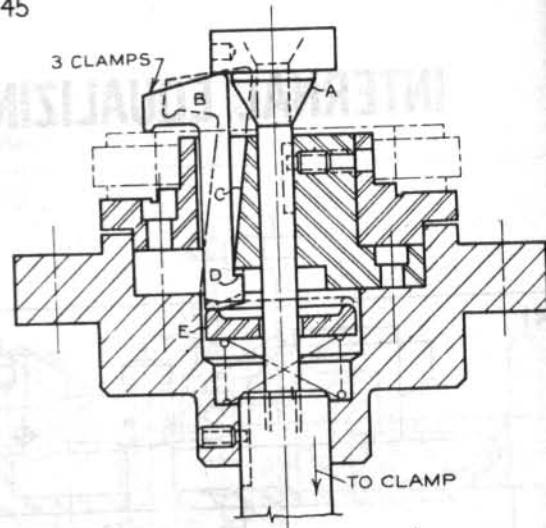
244



In the unclamping operation trunnion A is raised by the spring and then the clamps swing inward. B is the base of the spring and prevents C from turning.

Internal Equalizing Pull Down

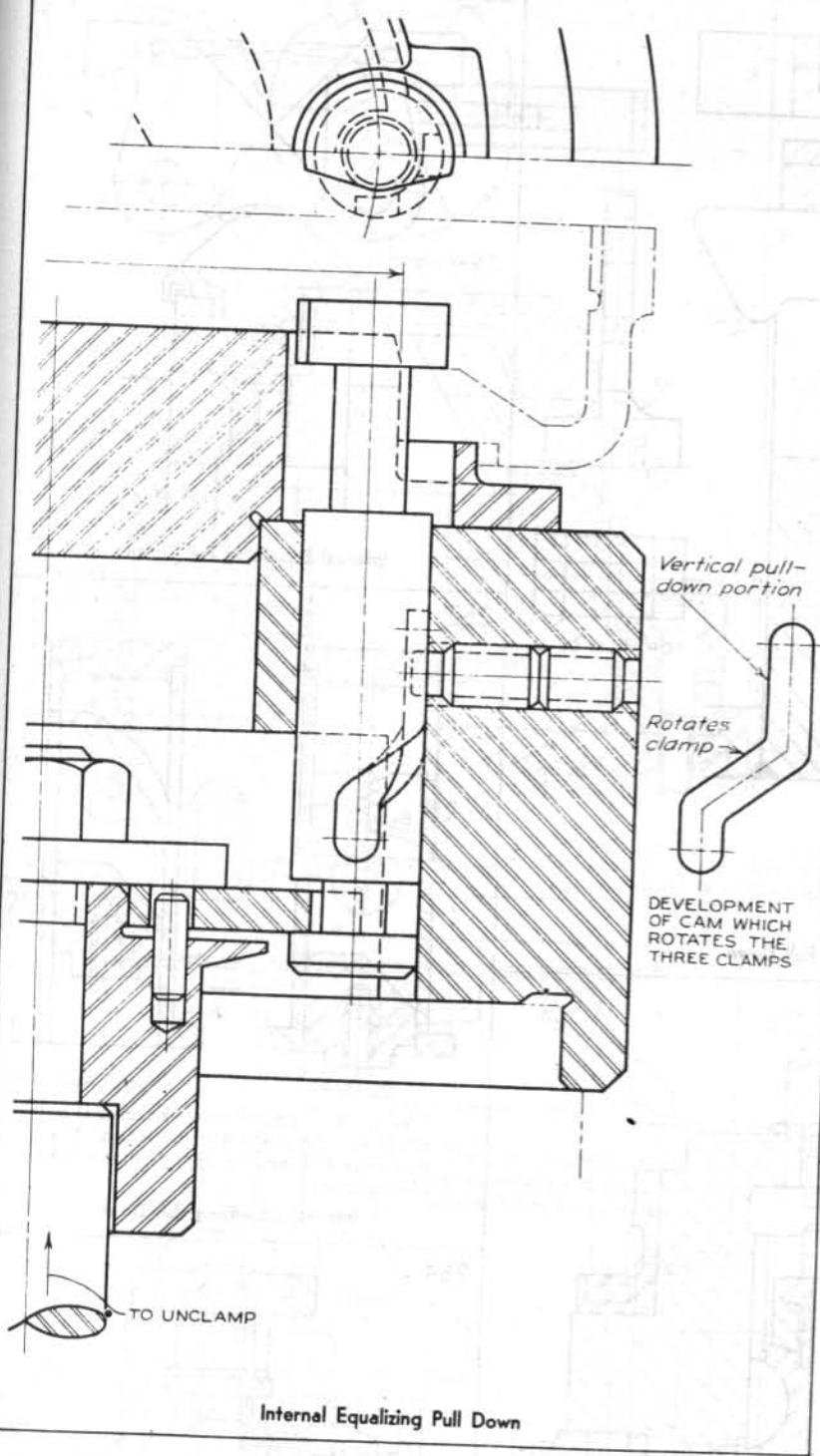
245



In the unclamping operation, A is raised by the power source. B is raised by the spring and washer E until kickback D retracts B to its dashed position.

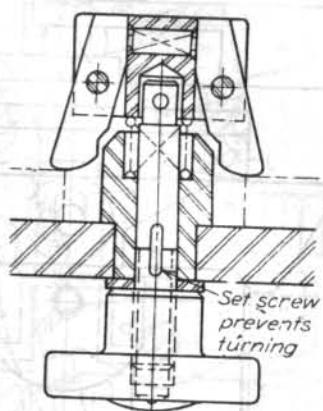
Internal Equalizing Pull Down

246



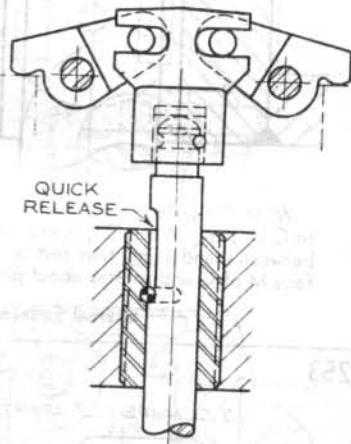
246-249

247



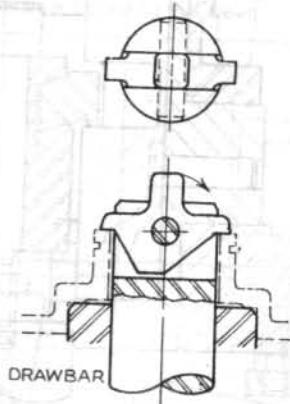
Internal Equalizing Pull Down

248



Internal Equalizing Pull Down

249

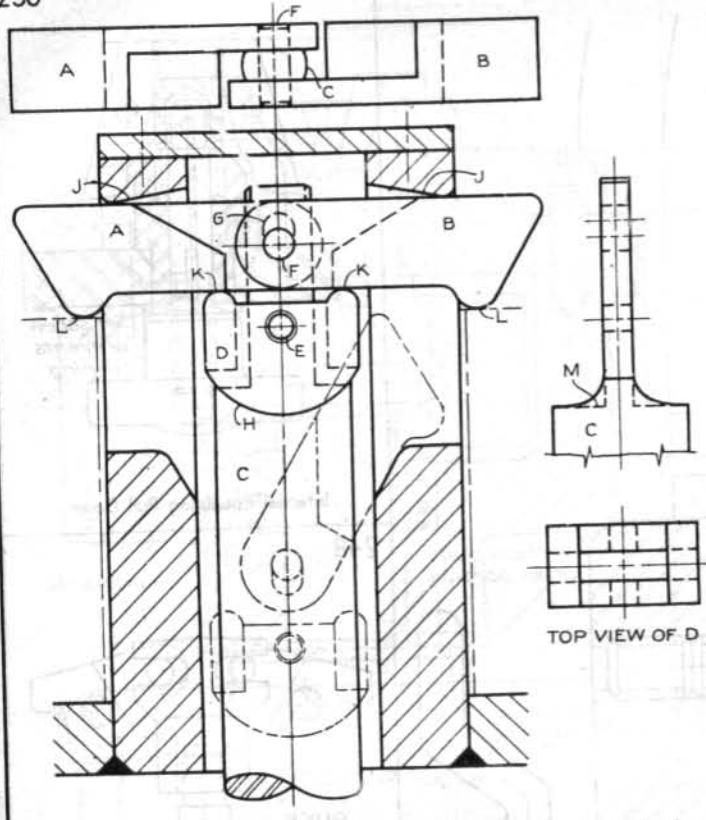


Internal Equalizing Pull Down

"Queer thing, but we always think every other man's job is easier than our own. And the better he does it, the easier it looks." EDEN PHILLPOTTS

250-254

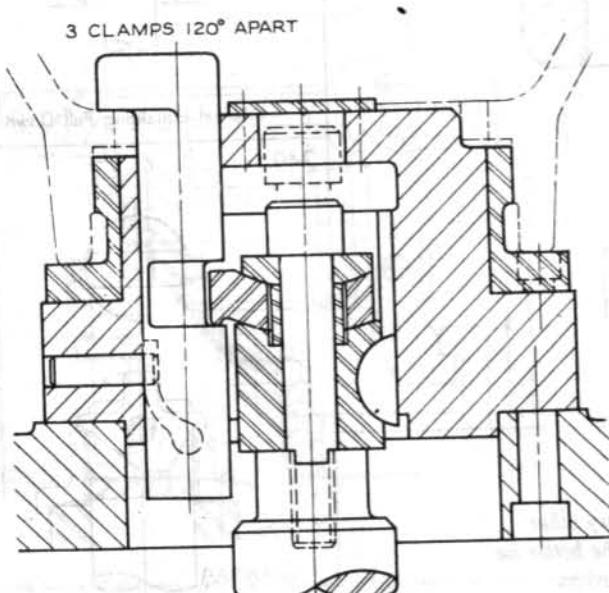
250



When C is pulled down, it retracts jaws A and B which are attached to C by pin F. When C is raised, the jaws slide through the opening between L and J until they rest on equalizer D at K. D rests on surface M of C and rotates about pin E.

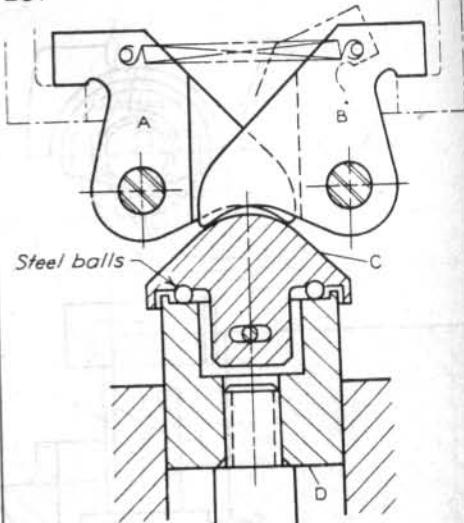
Internal Equalizing Pull Down

253



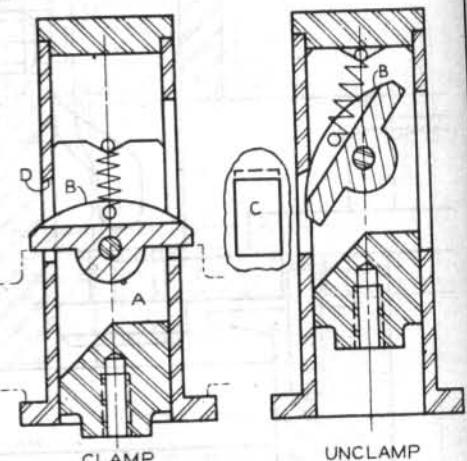
Internal Equalizing Pull Down

251



Internal Equalizing Pull Down

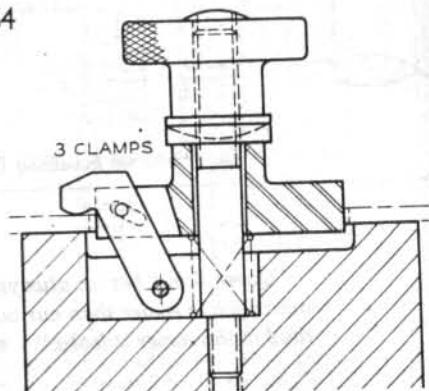
252



When A is raised, B strikes kickback D and tilts B. C is the shape of the opening. When A is pulled down, the spring returns B to clamp position.

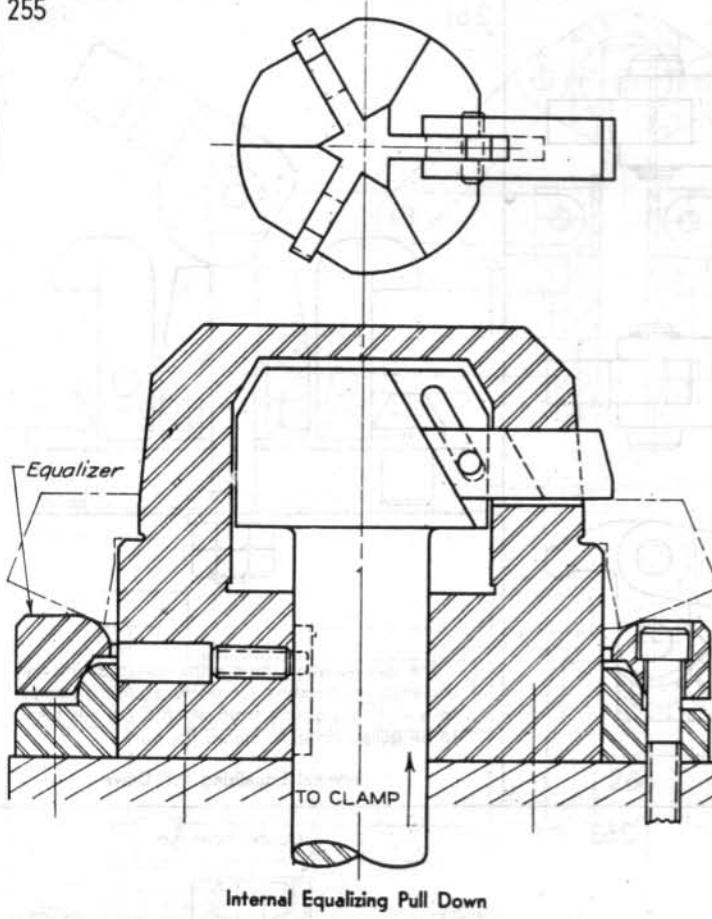
Internal Equalizing Pull Down

254

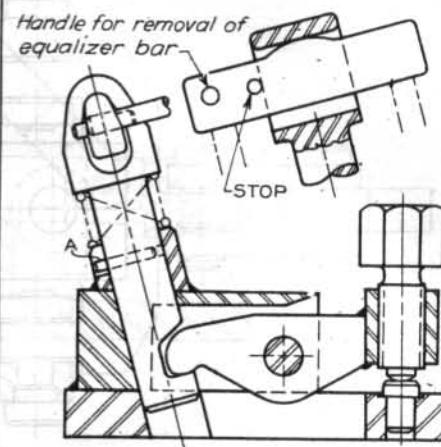


Internal Equalizing Pull Down

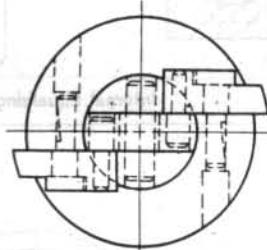
255



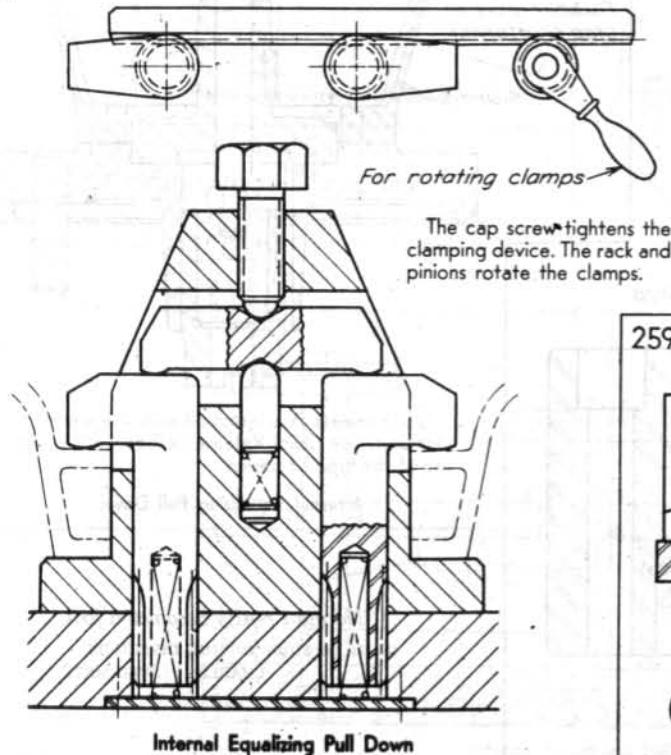
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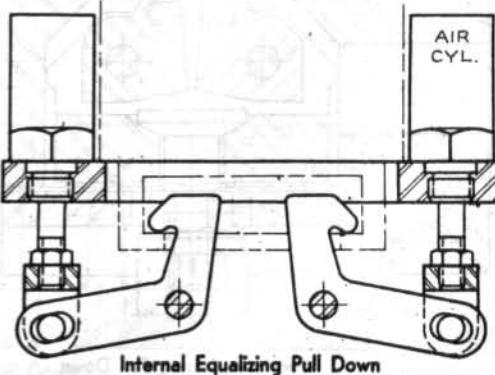
257



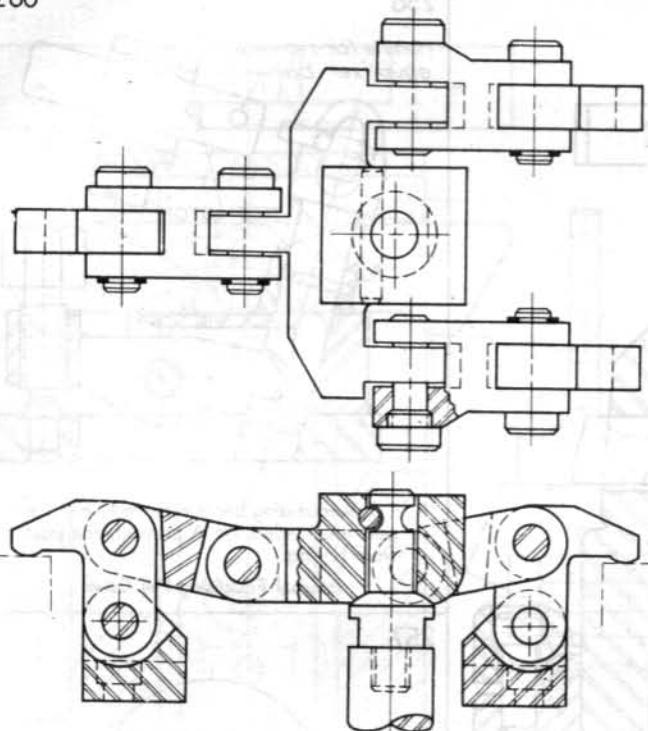
258



259

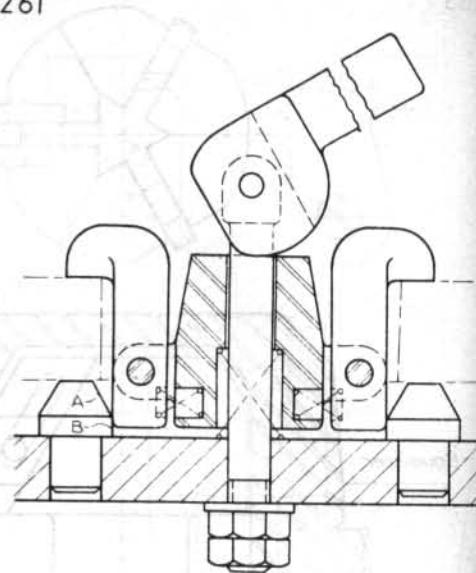


260



Internal Equalizing Pull Down

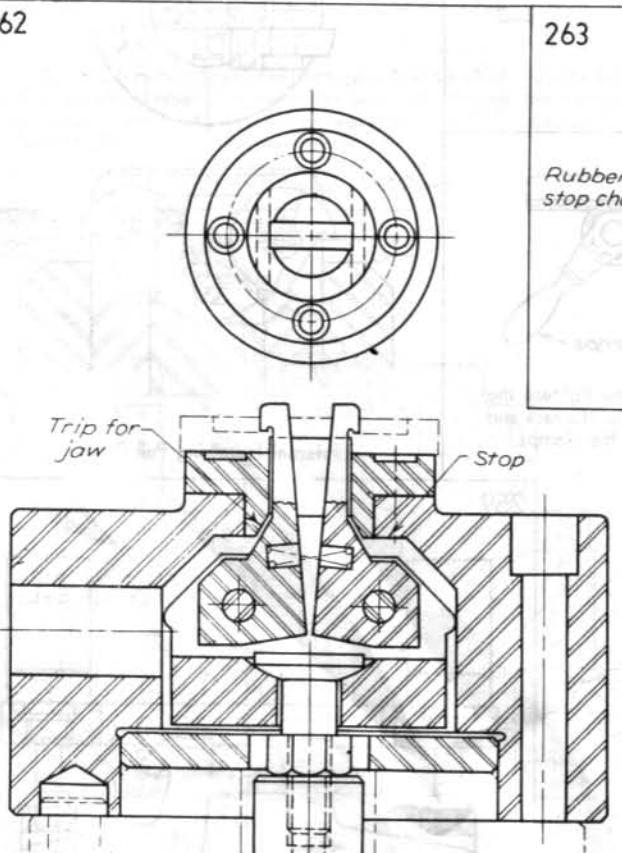
261



The springs swing the clamps inward during the unclamping operation. Cones A return the clamps to a vertical position from which B permits them to be pulled down to clamp the part.

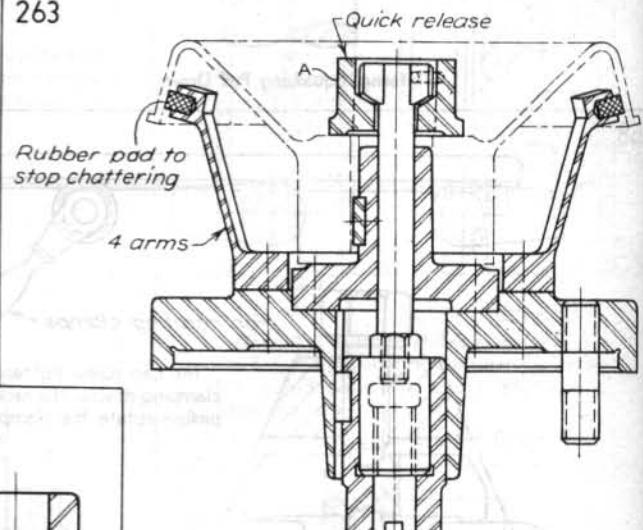
Internal Equalizing Pull Down

262



Internal Equalizing Pull Down

263

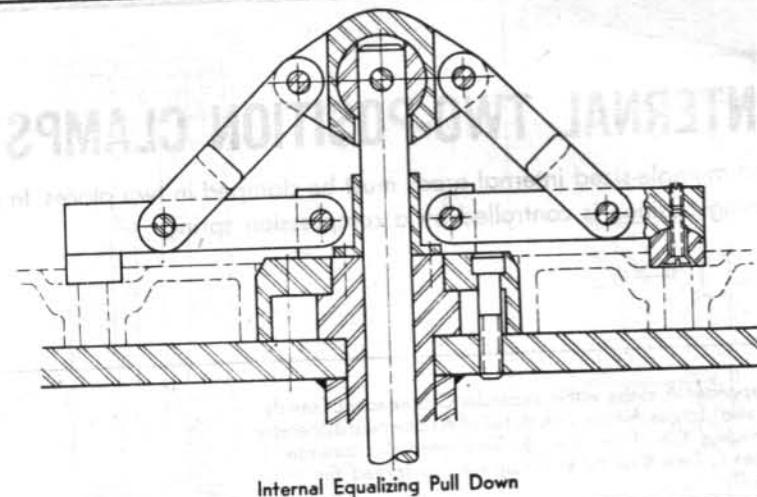


Quick release A is removed when the unit is unclamped. See Quick Release category for a variety of this type of design.

Internal Equalizing Pull Down

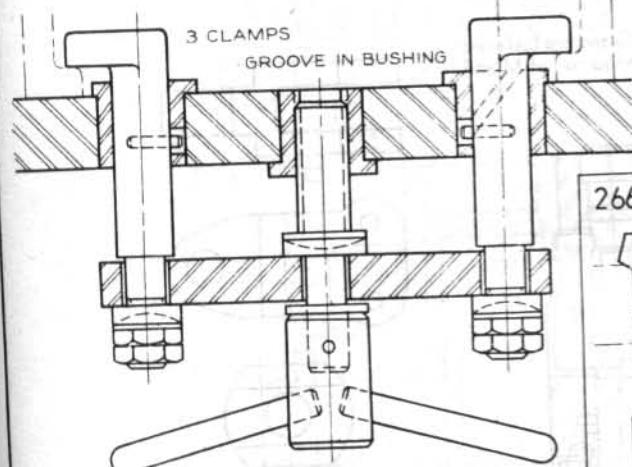
"No man really becomes a fool until he stops asking questions."
CHARLES P. STEINMETZ

264



Internal Equalizing Pull Down

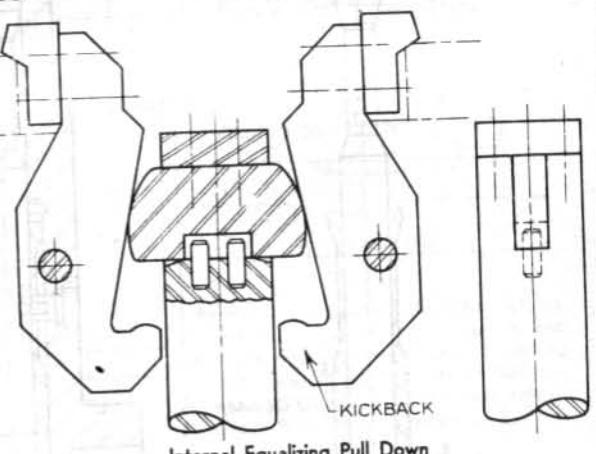
265



Internal Equalizing Pull Down

"The man who follows the crowd will never be followed by a crowd." DONNELL

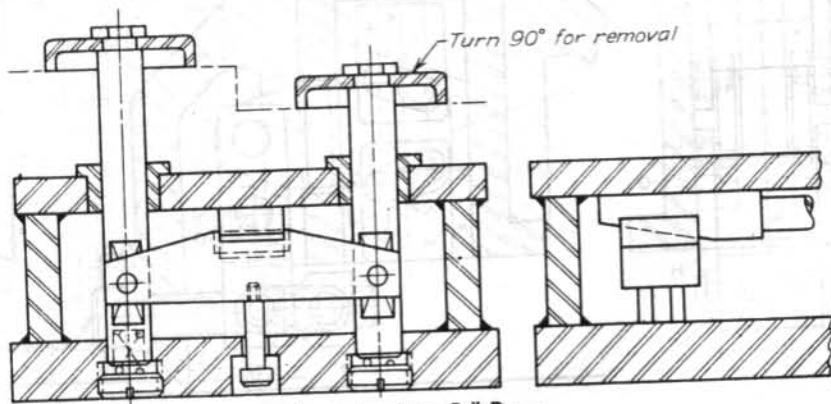
266



Internal Equalizing Pull Down

"Unless you try to do something beyond what you have already mastered, you will never grow." ROBERT O. OSBORN

267



Internal Equalizing Pull Down

Turn 90° for removal

INTERNAL TWO-POSITION CLAMPS

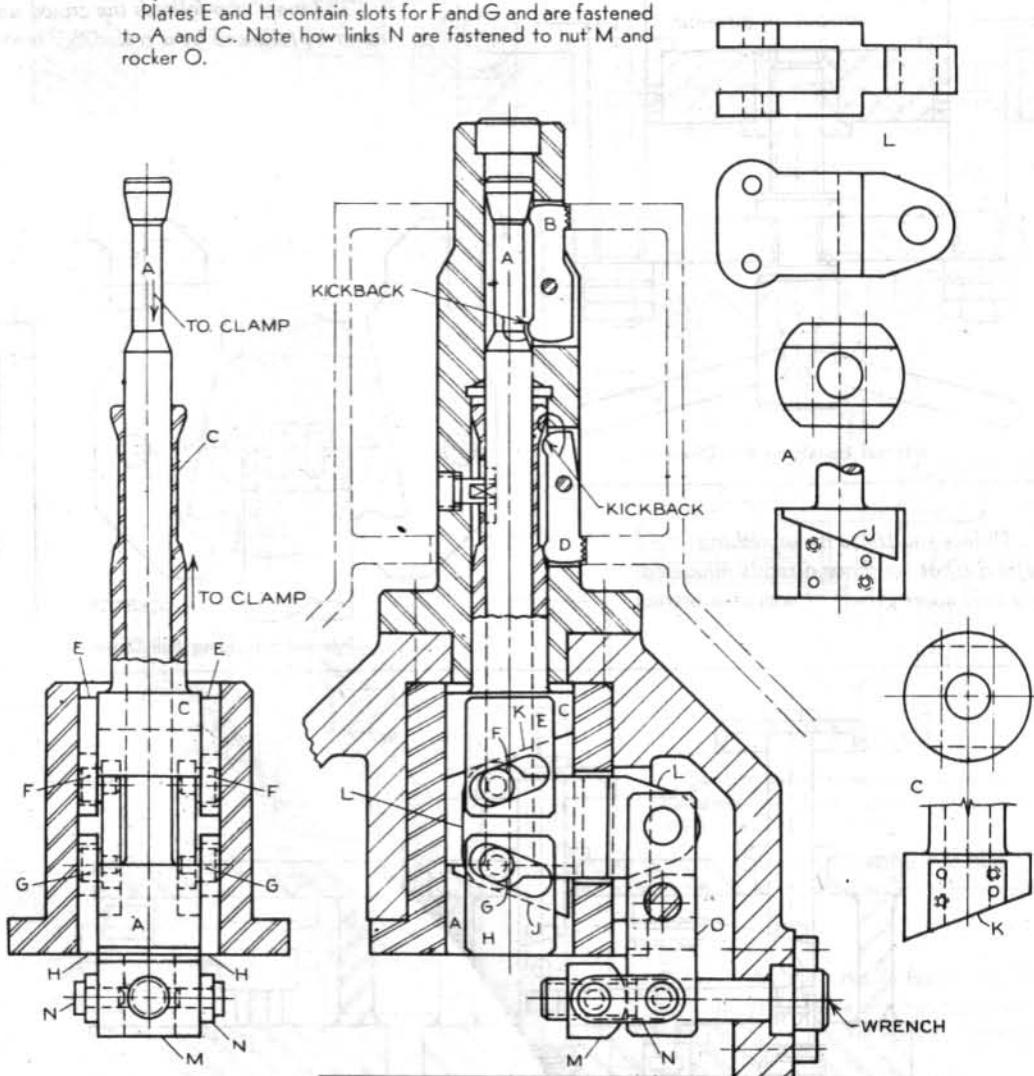
Long bores and multiple-sized internal areas must be clamped in two places. In some instances the second clamping position is controlled by a compression spring.

268

Expander A slides within expander C. Spreader L (see detail also) forces A (see J on detail of A) downward, thereby spreading the three jaws B. Simultaneously, spreader L forces C (see K of detail C) upward to spread the three jaws D.

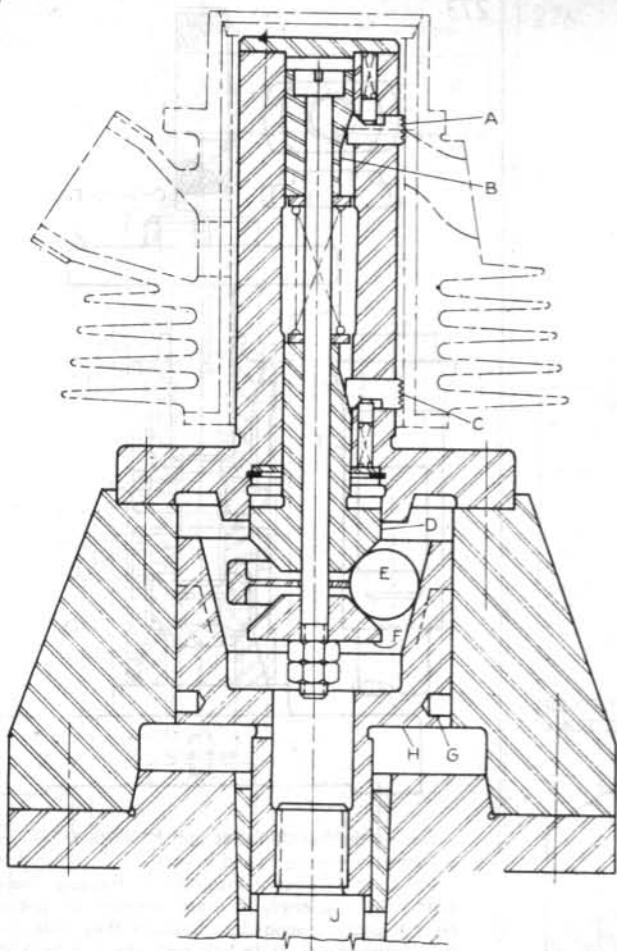
When spreader L retracts to the right, pin F pulls expander C down and its kickback retracts jaws D. At the same time pin G pushes expander A upward and its kickback retracts jaws B.

Plates E and H contain slots for F and G and are fastened to A and C. Note how links N are fastened to nut M and rocker O.



Internal Two-Position Clamp

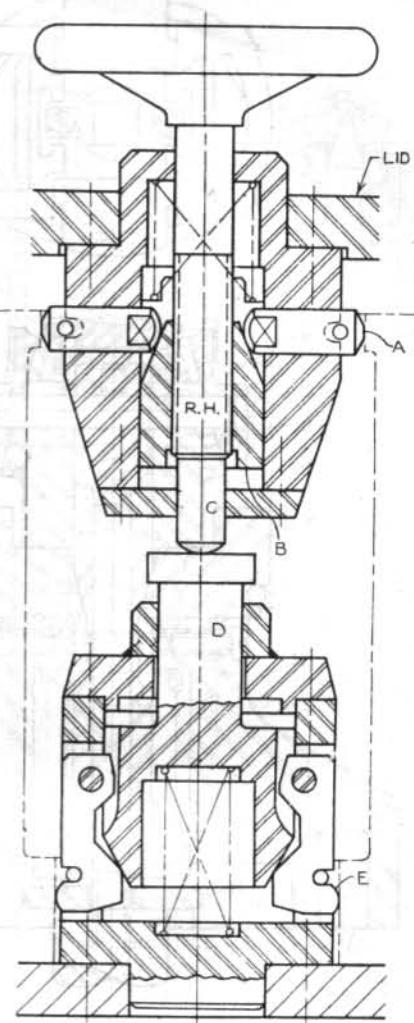
269



When J raises H, the three balls E push D upward and F downward. Expander D spreads the three jaws C while F pulls down on the bolt and expander B, which spreads the three jaws A. Pins inserted in holes G tighten H to J when the unit is assembled.

Internal Two-Position Clamp

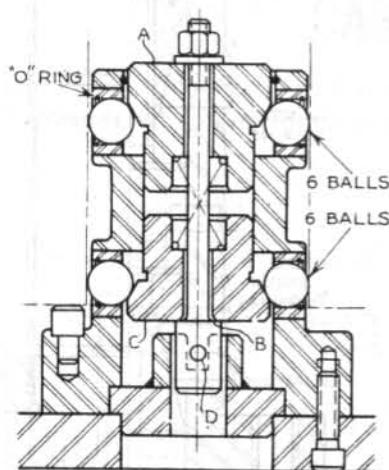
270



As the handle is turned clockwise, nut (expander) B spreads the three jaws A, and screw C forces expander D down to spread the three jaws E. Springs retract both expanders; garter springs retract both sets of jaws. Jaws A function in grooves of B.

Internal Two-Position Clamp

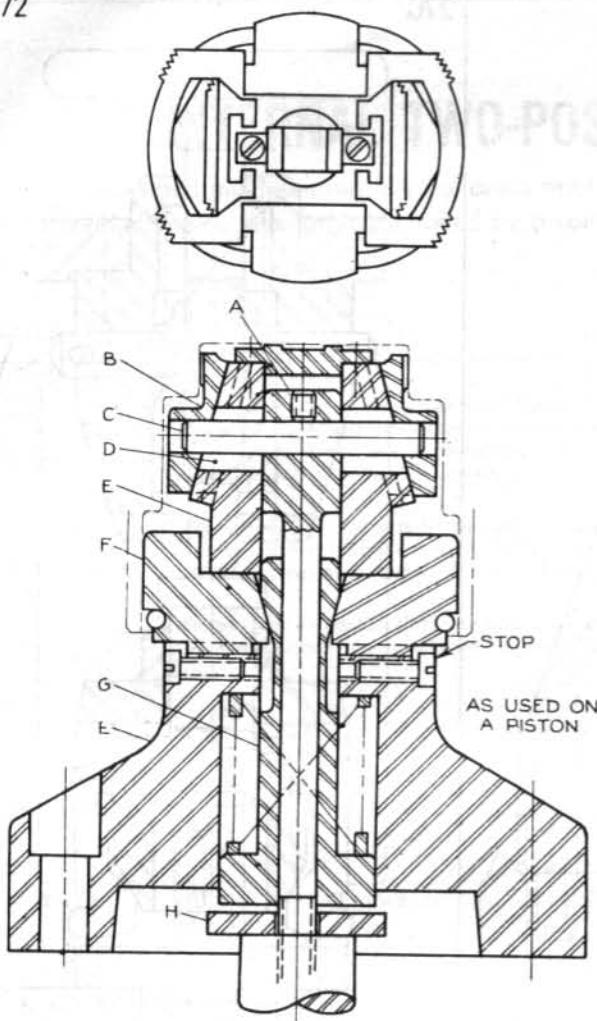
271



As the nut is turned, A is forced down and C is pulled up by means of the shoulder at B. Pin D prevents the bolt from turning.

Internal Two-Position Clamp

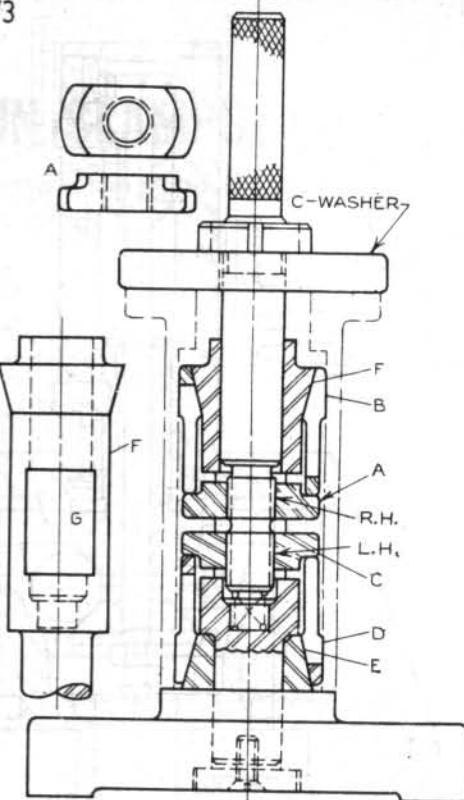
272



When A is pulled down, pin C, which slides in oblong slots in frame E, pulls down the two jaws B which are T-slotted to E. Pulling A down also actuates the strong spring to pull down expander G, spreading the two jaws F. During the unclamping action, washer H raises G, allowing jaws F to retract. When A is pushed up, pin C moves jaws B upward and inward along the T-slots. Note the stops for jaws F. If there were no stops and no part in place when A is pulled down, the strong spring would very likely throw the jaws free of the unit. The spring prevents jaws F from over-clamping.

Internal Two-Position Clamp

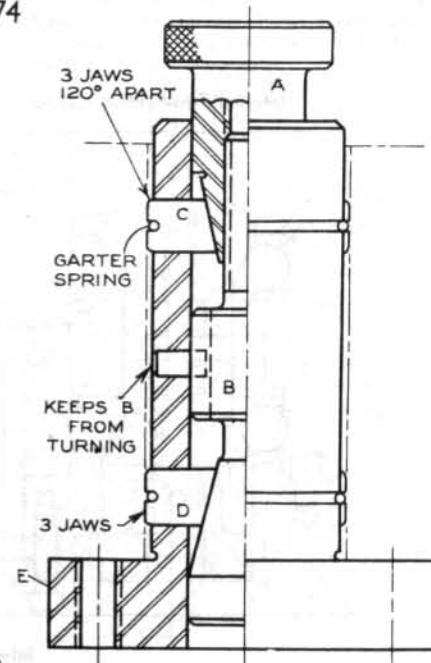
273



Turning the handle raises nut A, which raises collet B against expander F, and lowers nut C, which forces collet D down against expander E, thereby enabling both collets to apply an equal amount of pressure. Nuts A and C cannot turn because they slide in slot G of expander F. Note how expander F is held at its lower end.

Internal Two-Position Clamp

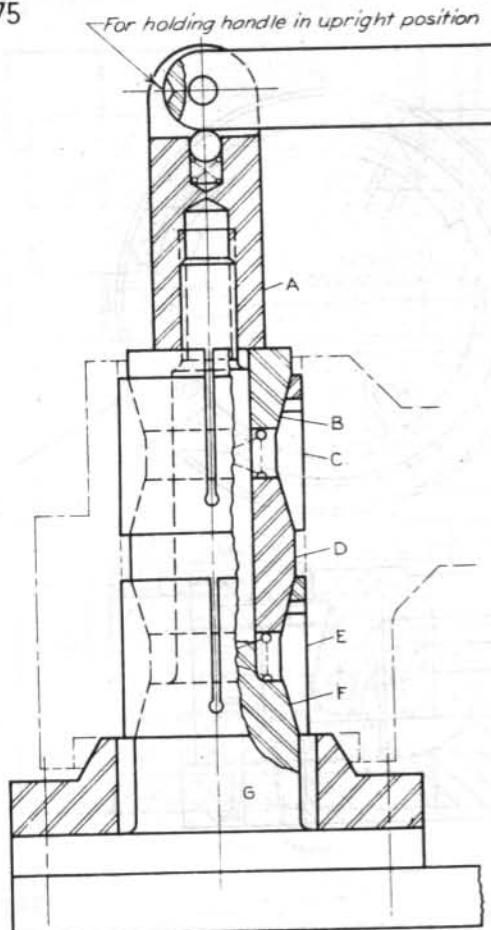
274



As A is turned, it forces the three jaws C outward and pulls upward on B, which forces the three jaws D outward, applying equal pressure on all jaws.

Internal Two-Position Clamp

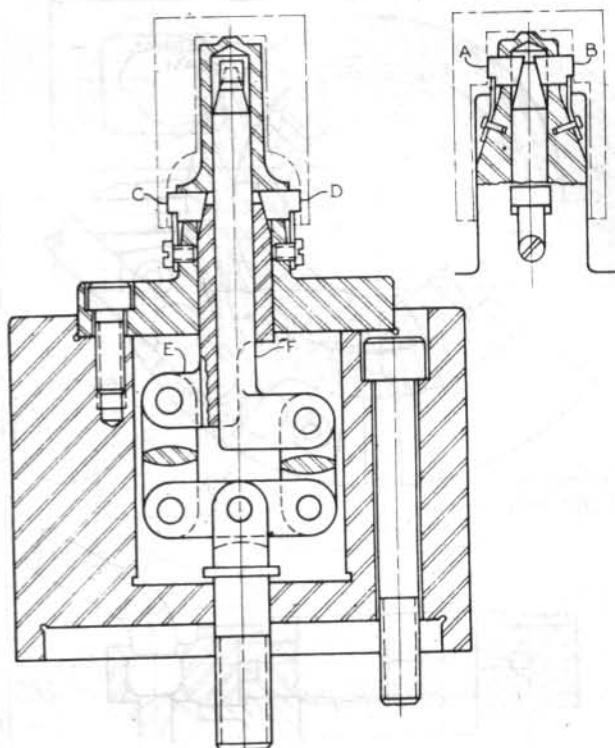
275



A forces expander B down, expanding collet C. Expander D helps to expand collets C and E.

Internal Two-Position Clamp

276



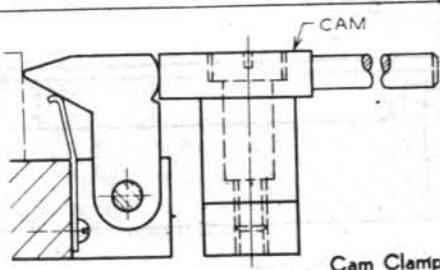
The two jaws, A and B, function at right angles to jaws C and D. Expander F spreads A and B while expander E spreads C and D. The linkage permits equalizing of the four jaws, which are retracted by flat springs.

Internal Two-Position Clamp

CAM CLAMPS

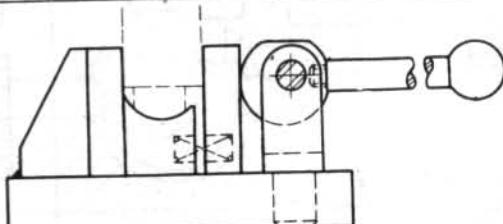
The types of cams commonly used to actuate clamps are eccentric, wedge, radial, and axial as well as threads, which are a form of a cam.

277



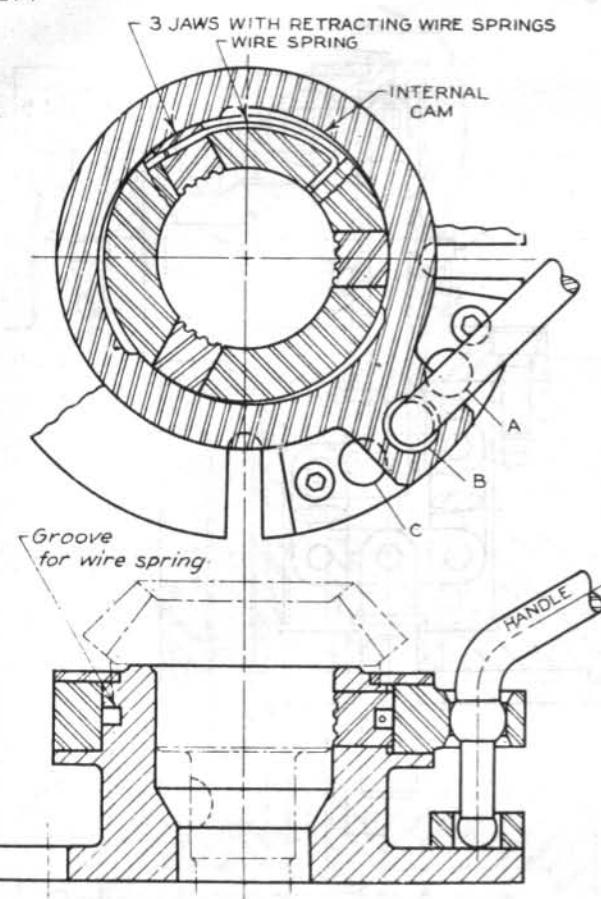
Cam Clamp

278



Cam Clamp

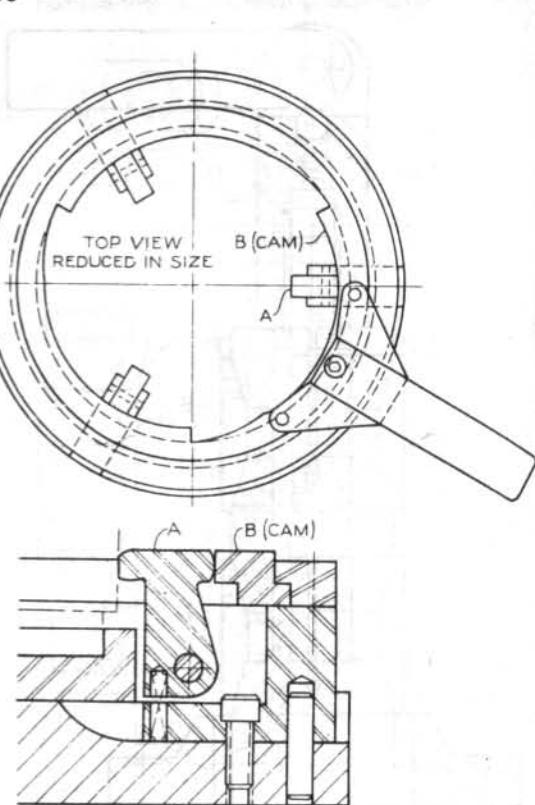
279



The handle may be inserted in hole A, B, or C to rotate the cam.

Cam Clamp

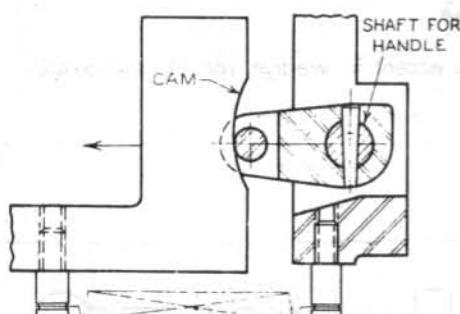
280



This internal radial cam actuates the three jaws.

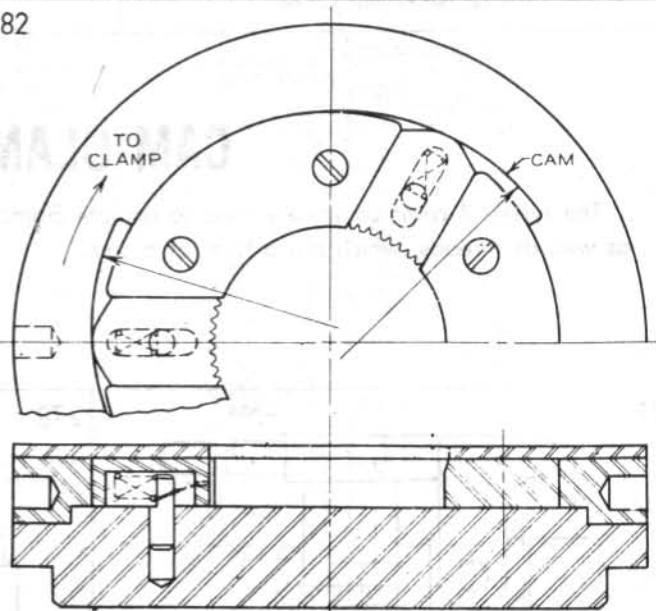
Cam Clamp

281



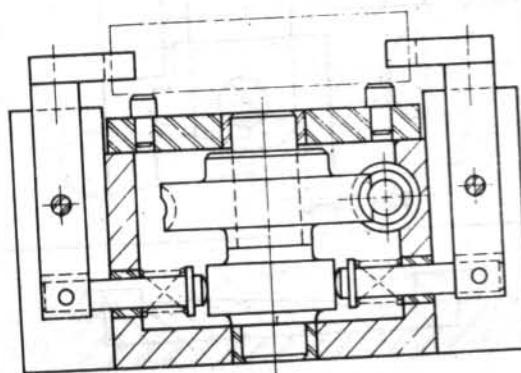
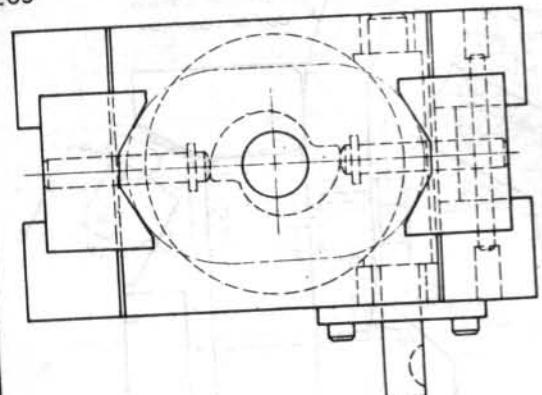
Cam Clamp

282



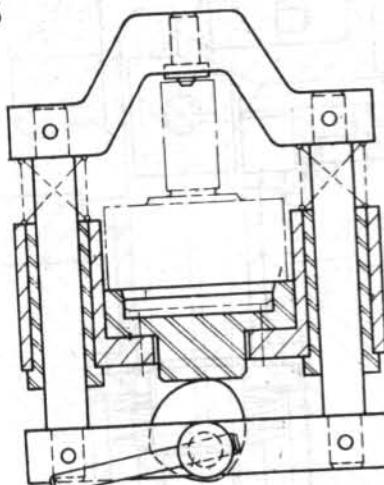
Cam Clamp

283



Cam Clamp

285

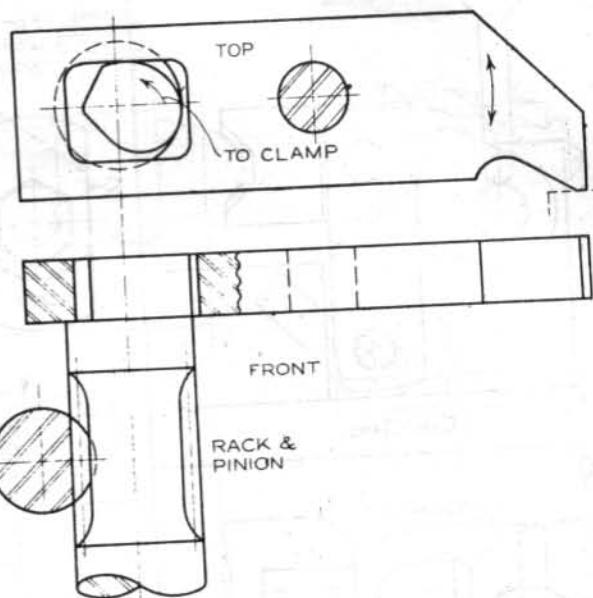


Cam Clamp

"If you are sufficiently disgusted with a present design to do something about it, you are on the right road to creating an invention."

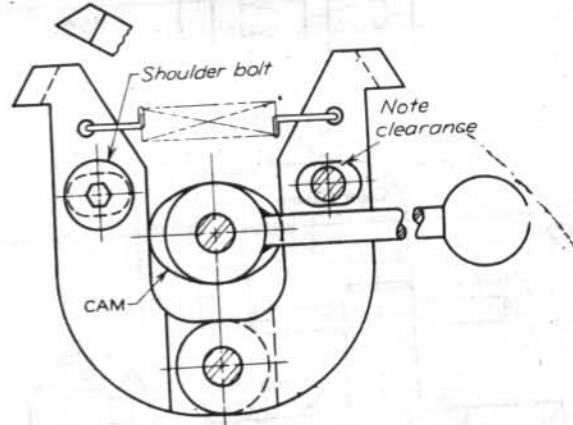
HAROLD CLARKE

284



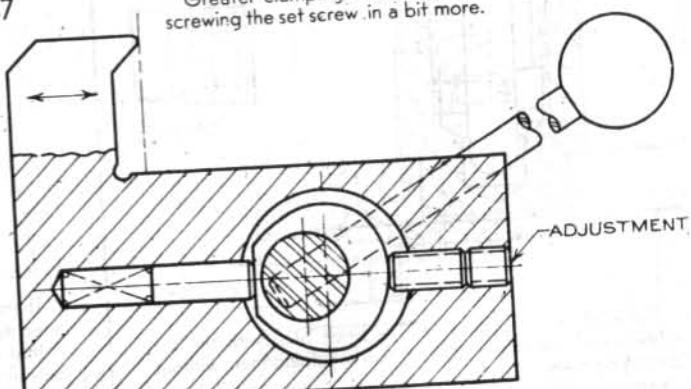
The radial cam actuates a clamp in a horizontal plane.
Cam Clamp

286



Cam Clamp

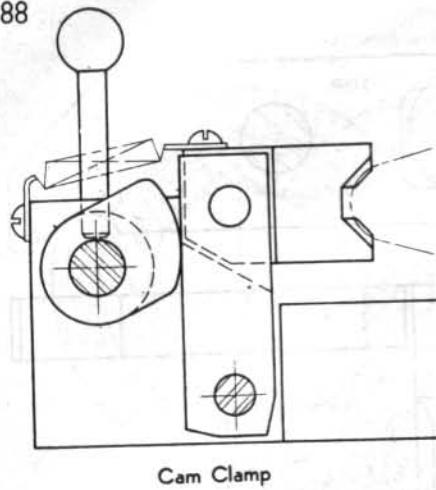
287



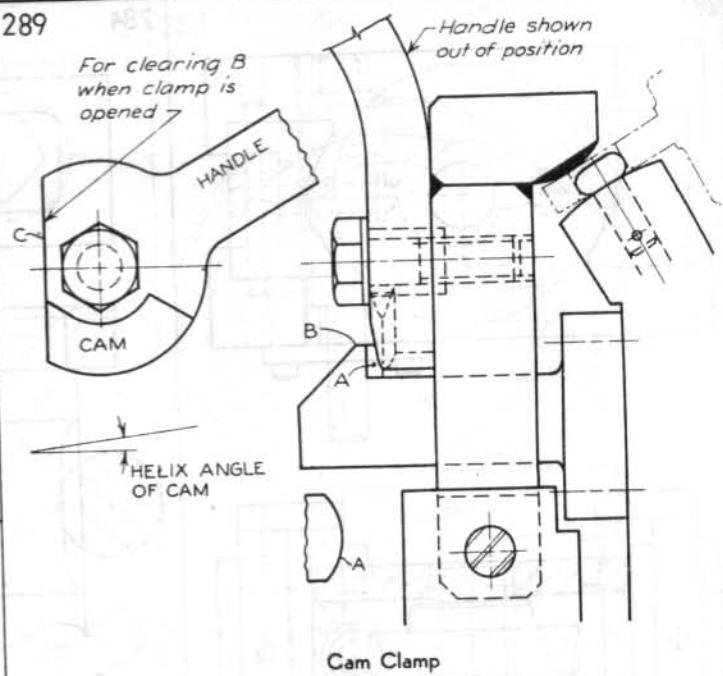
Greater clamping force may be obtained by
screwing the set screw in a bit more.

Cam Clamp

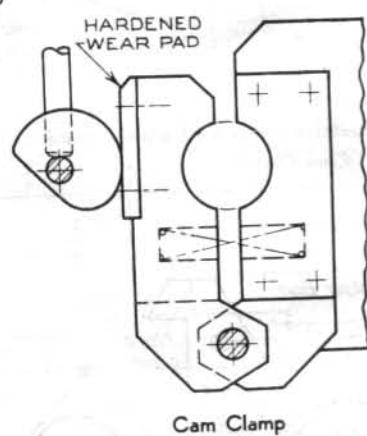
288



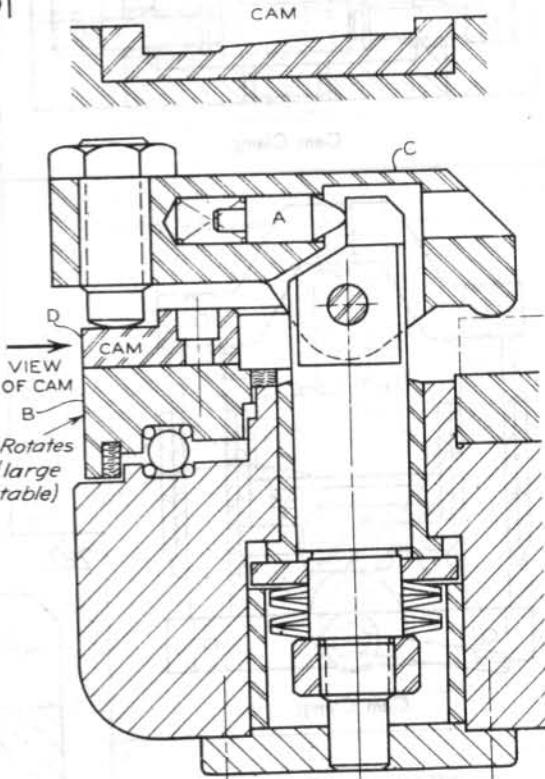
289



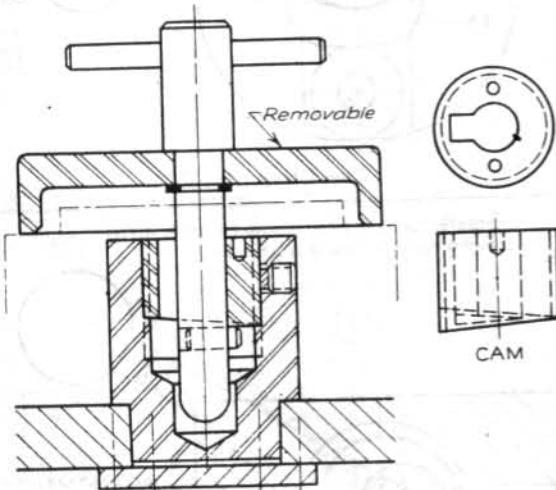
290



291



292

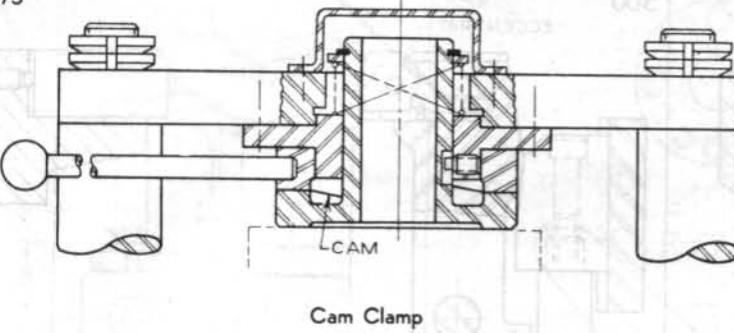


The axial cam is adjustable. The brass plug with the set screw is soft and molds to the threads, holding them without damaging them.

There are several clamps C on the circular fixture. Fastened to the fixture's rotating table B are several axial cams D that actuate clamps C. Note the use of spring-loaded button A to retract clamp C and the washer springs to prevent overclamping.

Cam Clamp

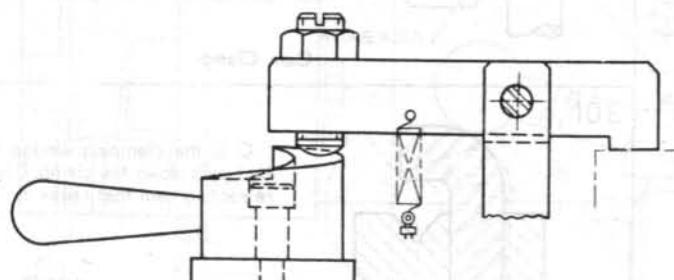
293



294



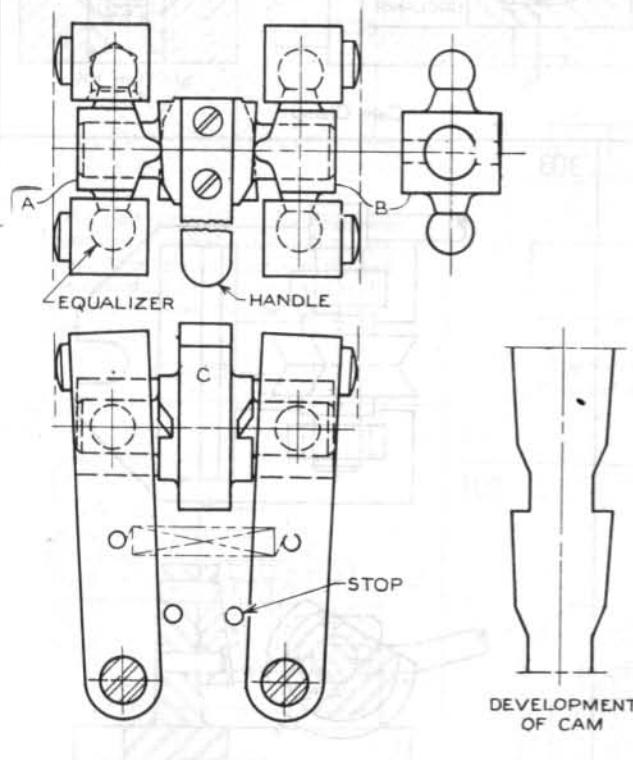
295



This axial cam has a cutoff to clear the part.

Cam Clamp

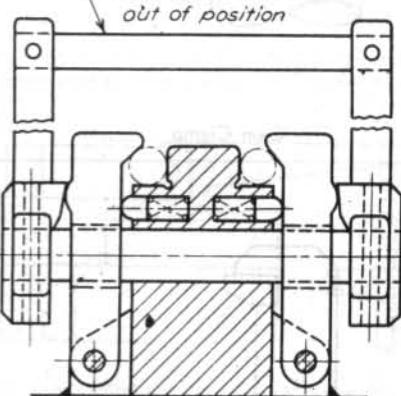
296



Double axial cam C moves the two rocker arms, A and B. Each equalizes a pair of clamps.

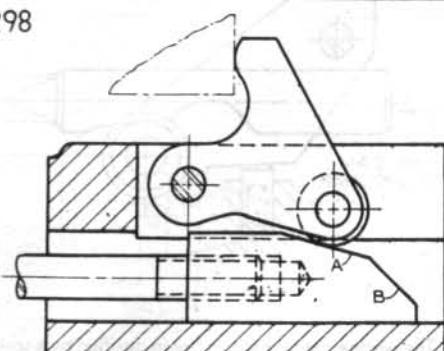
Cam Clamp

297



Cam Clamp

298

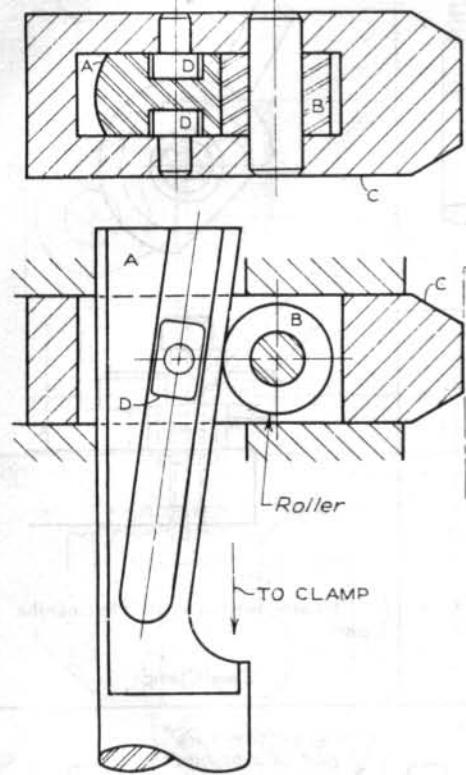


Wedge cam A actuates the clamp; B allows it to retract.

Cam Clamp

299-303

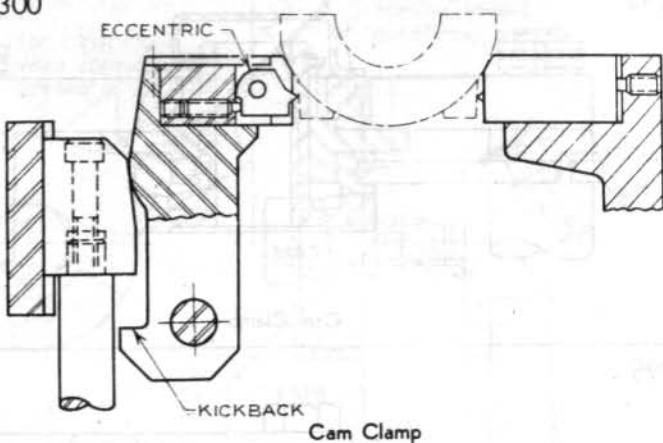
299



Roller B reduces friction between wedge cam A and clamp C. Keys D in endmilled slots retract clamp C.

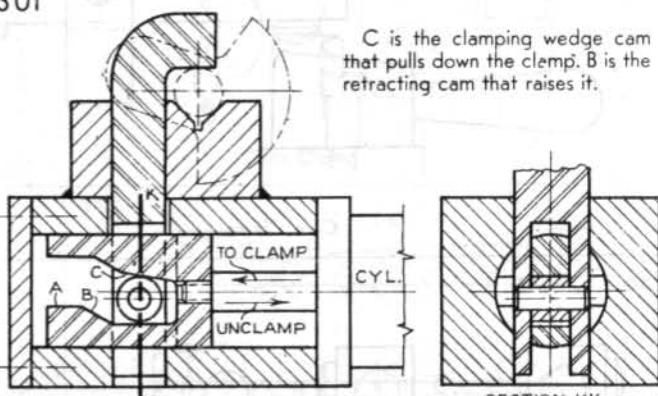
Cam Clamp

300



Cam Clamp

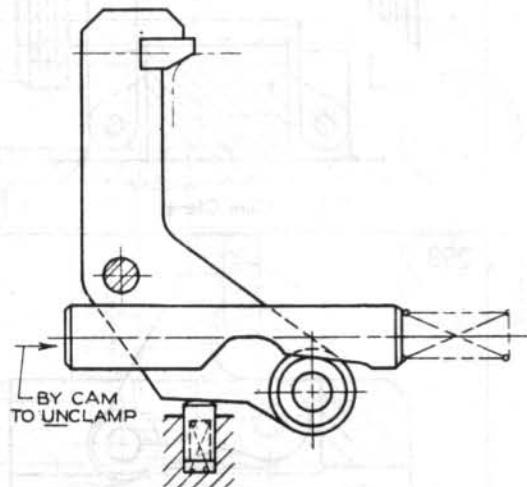
301



C is the clamping wedge cam that pulls down the clamp. B is the retracting cam that raises it.

Cam Clamp

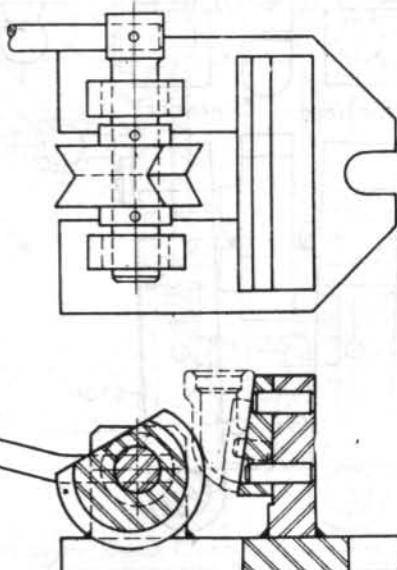
302



The wedge cam is held in clamp position by a spring and is unclamped by a separate cam.

Cam Clamp

303



This is an eccentric v-shaped cam that clamps the part directly.

Cam Clamp

304

STOP
d
d

DIA.
d

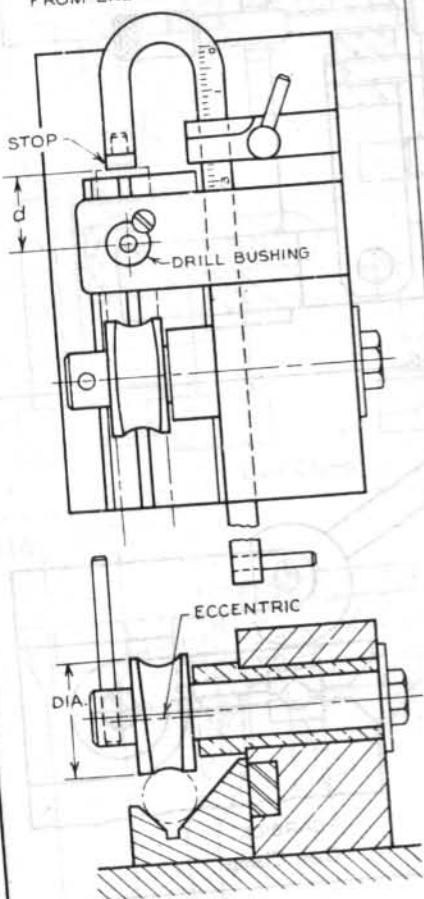
mea
fan
The
will
stop

307

loc

304

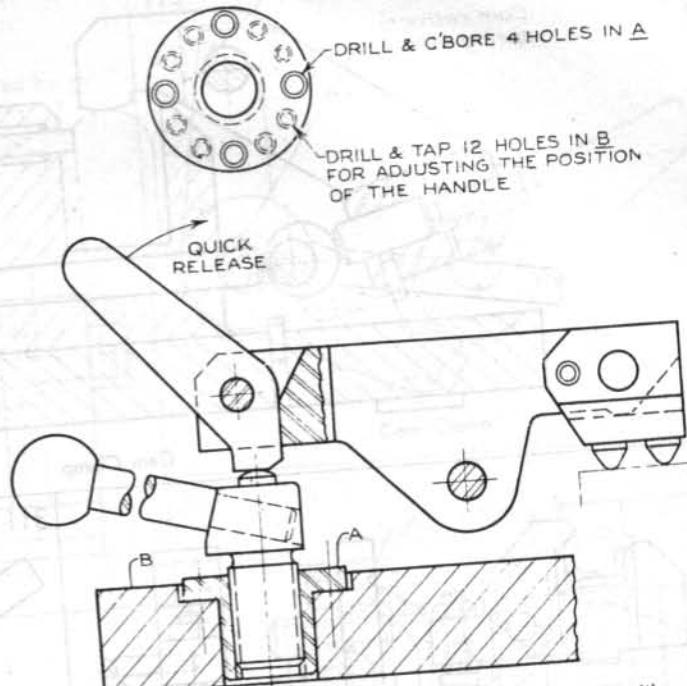
SCALE MEASURES DISTANCES d
DRILLED HOLES ARE TO BE
FROM END OF SHAFT.



The part is moved to the adjustable measuring stop that determines the distance d the hole is drilled from the end. The cam should be so designed that it will tend to move the part toward the stop.

Cam Clamp

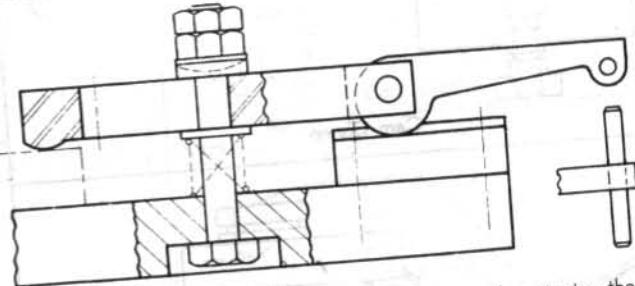
305



Wear will eventually put the handle in an inconvenient position during the clamping operation. Rotating nut A 30° will adjust for the wear. Four cap screws fasten nut A to B. This is a thread type cam.

Cam Clamp

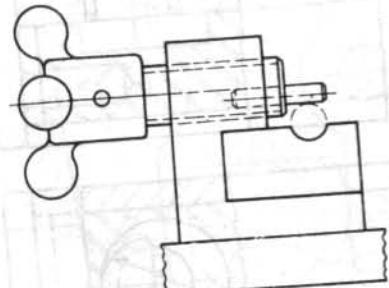
306



The handle, actuated by an eccentric cam, not only actuates the clamp but also retracts it.

Cam Clamp

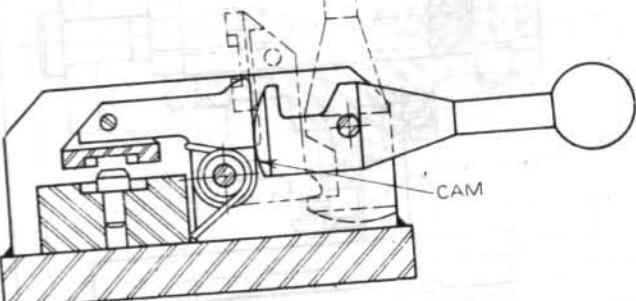
307



This thread cam has an eccentrically located clamp pin.

Cam Clamp

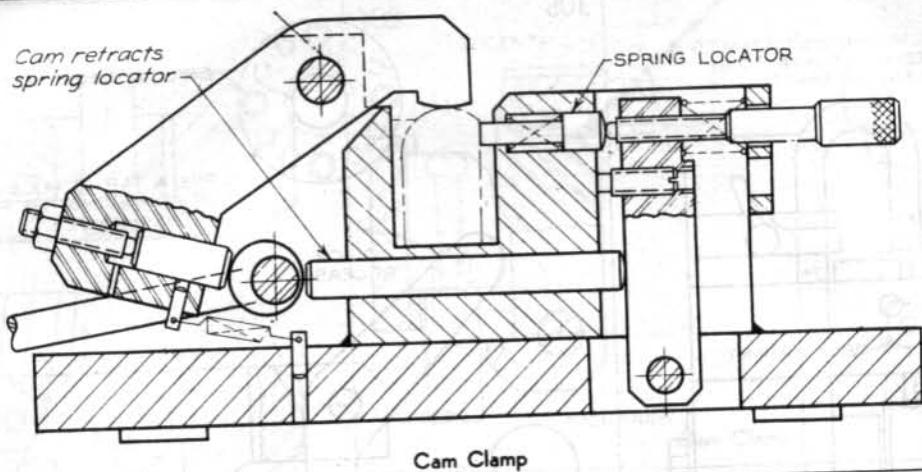
308



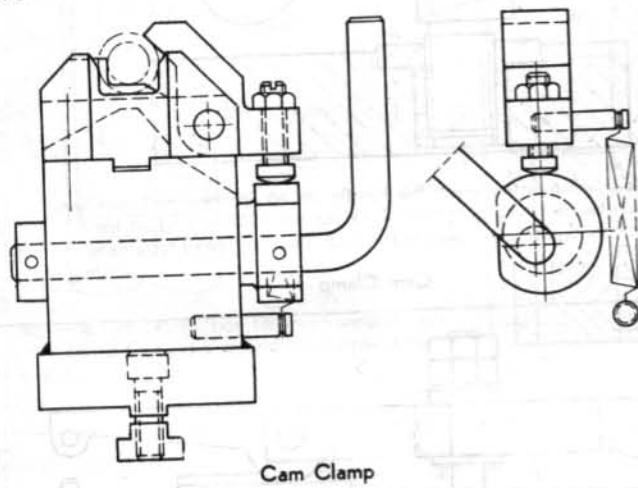
Cam Clamp

309-313

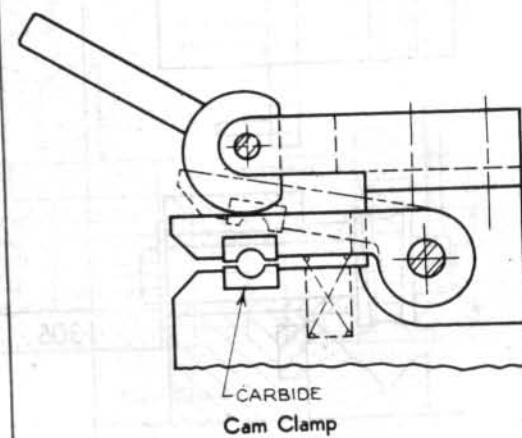
309



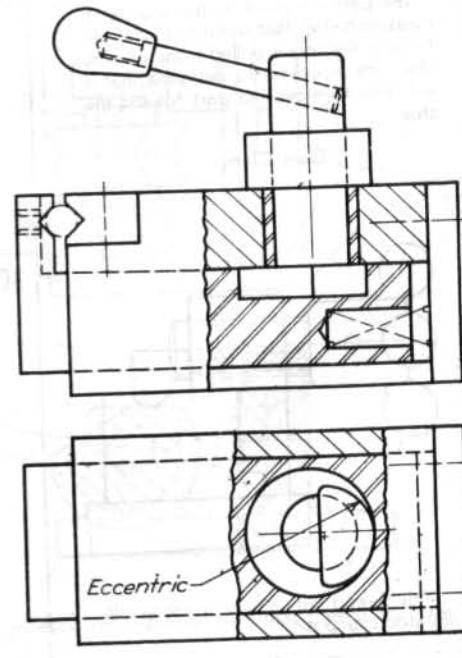
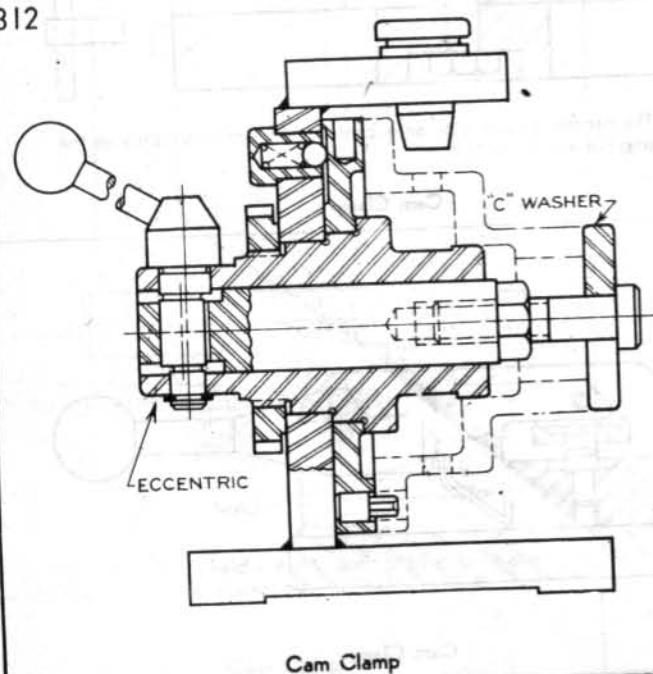
310



311

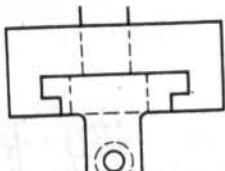


312

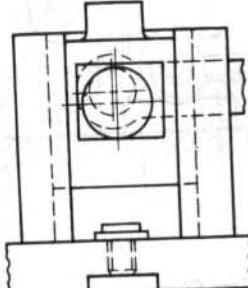


314

314

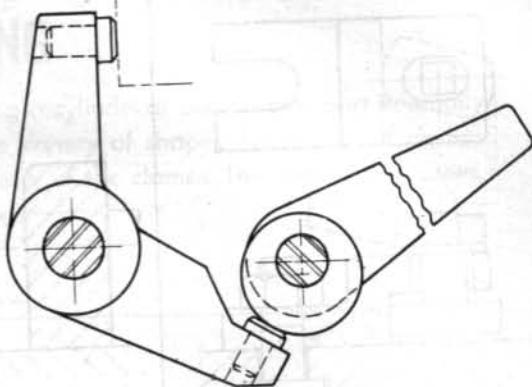


Clamp A, actuated by an eccentric cam, moves in a T-slot.



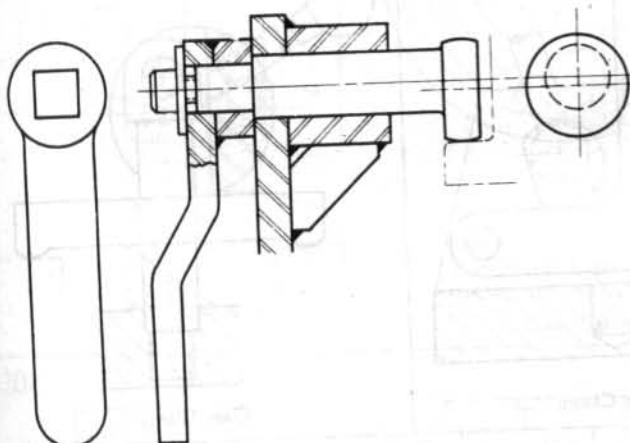
Cam Clamp

315



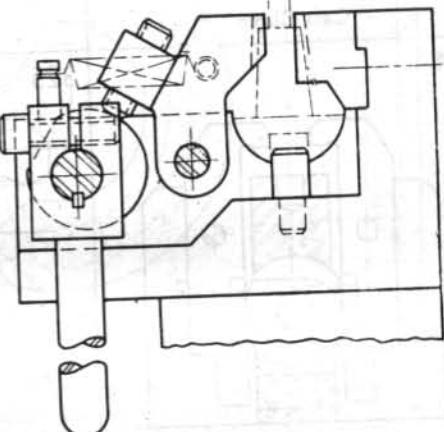
Cam Clamp

316



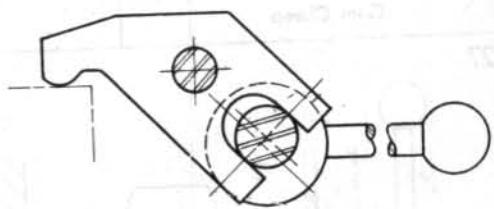
Cam Clamp

317



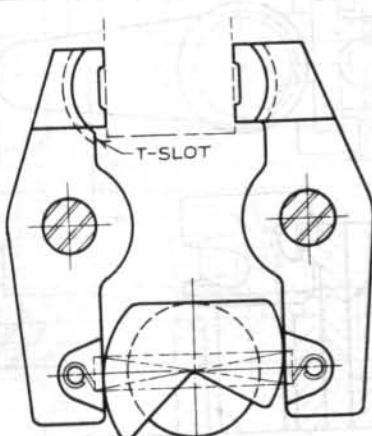
Cam Clamp

319



Cam Clamp

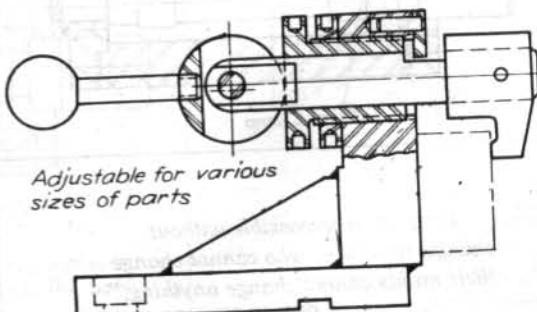
318



Cutout allows greater swing of clamp jaws

Cam Clamp

320

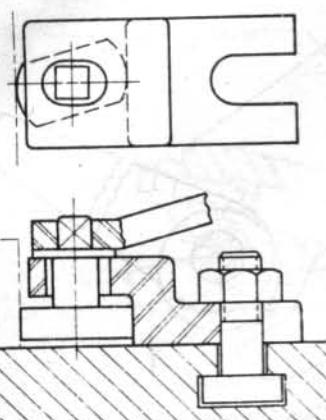


Adjustable for various sizes of parts

Cam Clamp

321-328

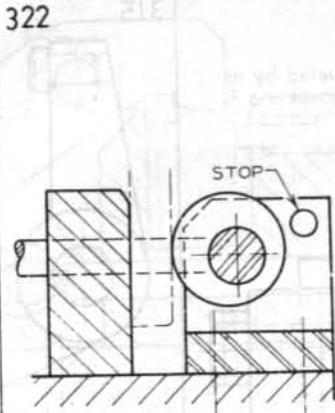
321



This eccentric cam clamps the part directly.

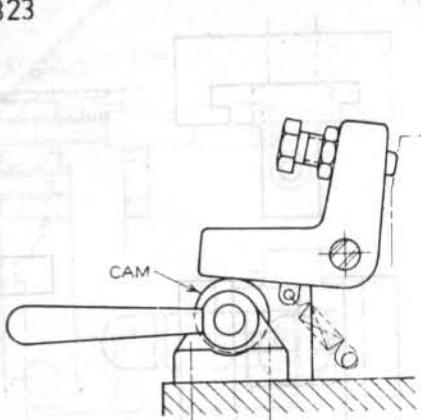
Cam Clamp

322



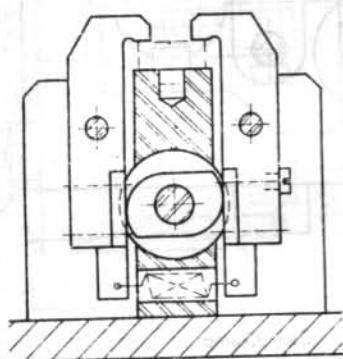
Cam Clamp

323



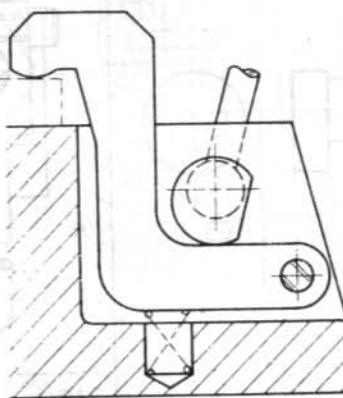
Cam Clamp

324



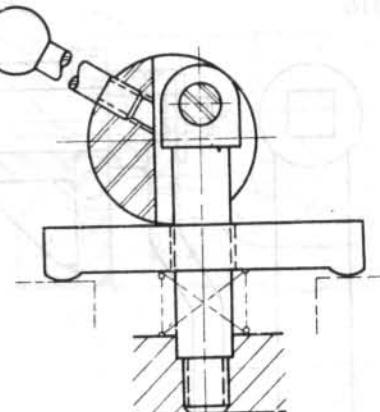
Cam Clamp

325



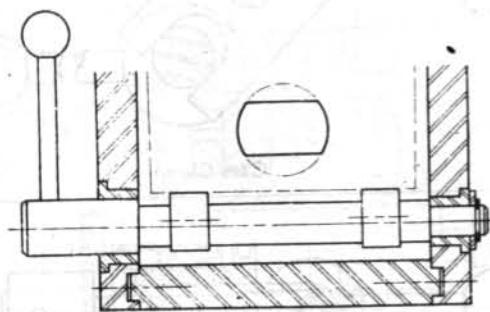
Cam Clamp

326



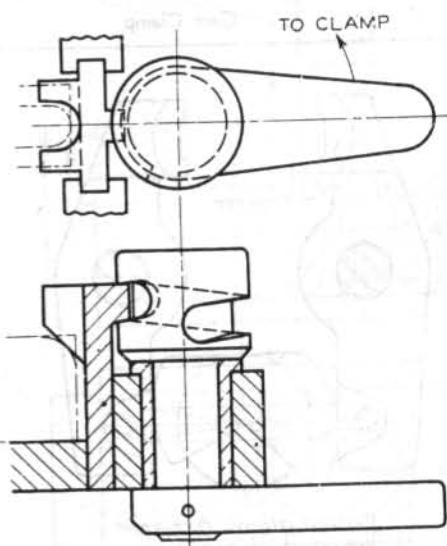
Cam Clamp

327



Cam Clamp

328



A barrel cam is used to actuate the clamp.

Cam Clamp

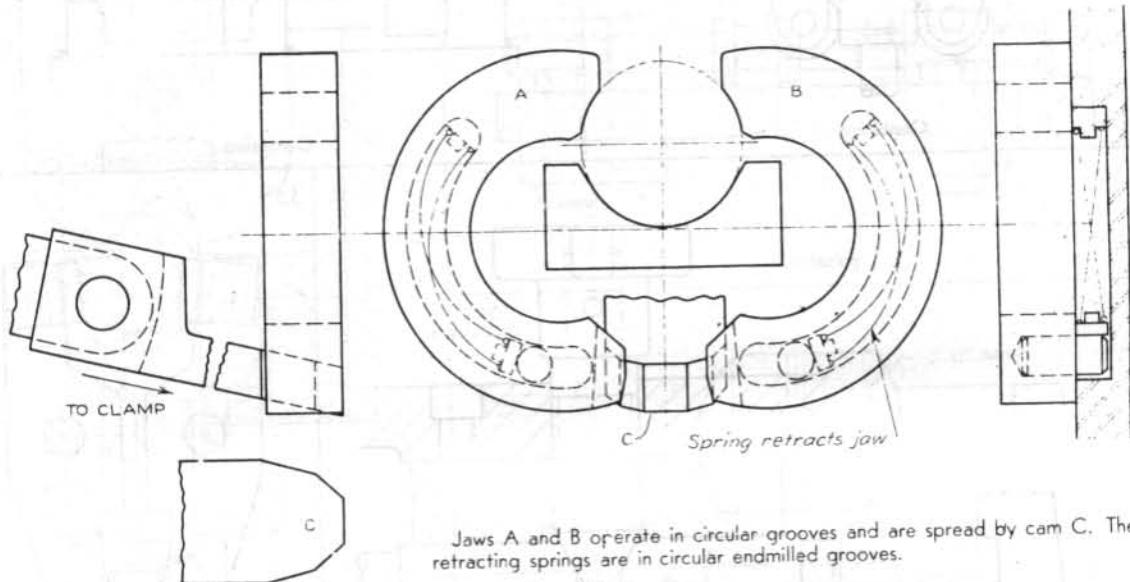
"Progress is impossible without change; and those who cannot change their minds cannot change anything."

GEORGE BERNARD SHAW

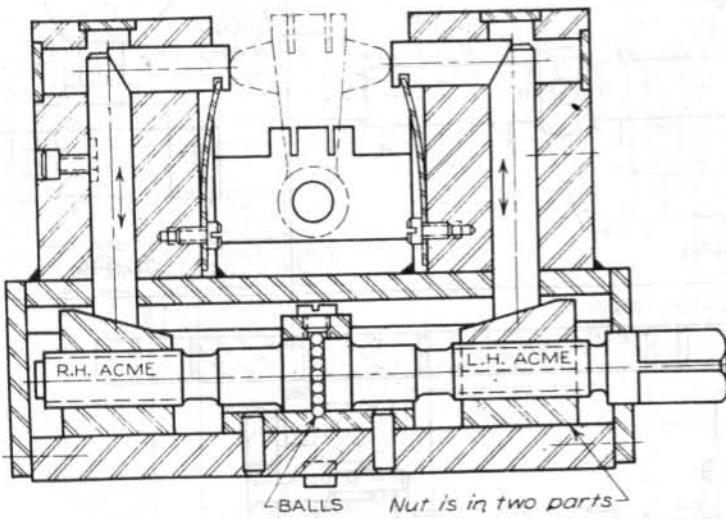
CENTERING

Centering parts involves more than merely clamping a cylindrical portion of a part internally or externally. The portion to be centered may take a variety of shapes. Equalizing of clamps is not included in this operation except possibly the jaws of the clamps. The usual cams, cones, balls, wedges, or gears are used to actuate the clamps.

329



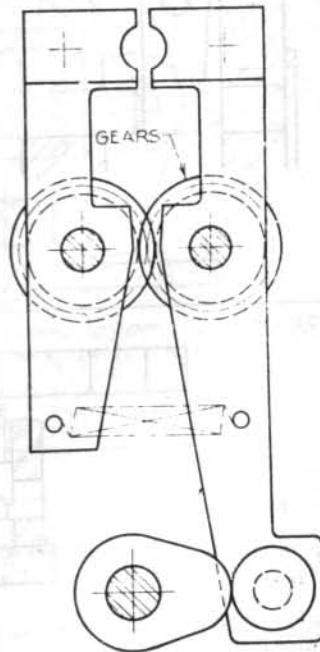
330



A whole nut on the right side could not be assembled, so two half-nuts, shimmed to fill in the sawcut and cap screwed together, are used. The balls reduce friction and prevent endplay.

Centering

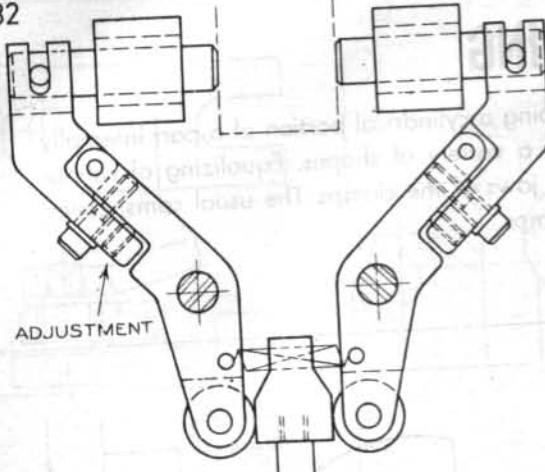
331



Centering

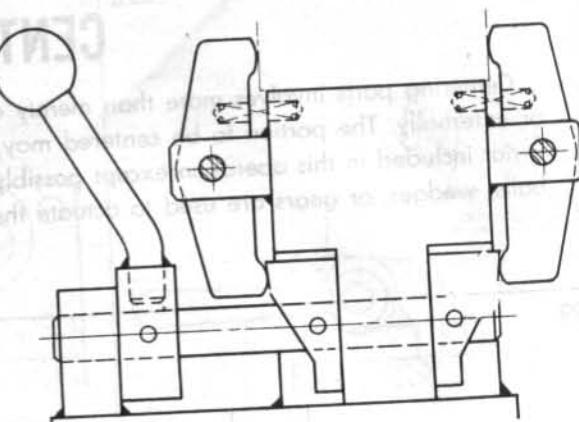
332-336

332



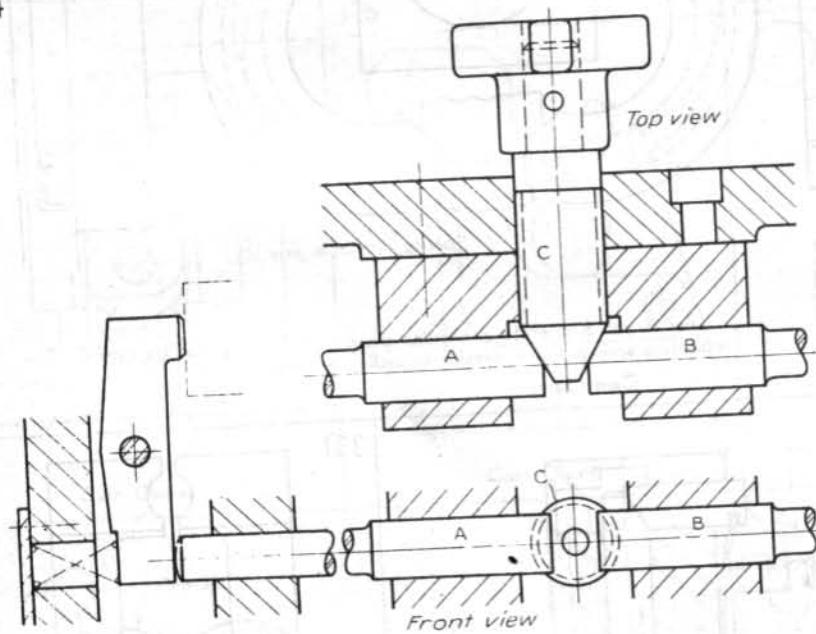
Centering

333

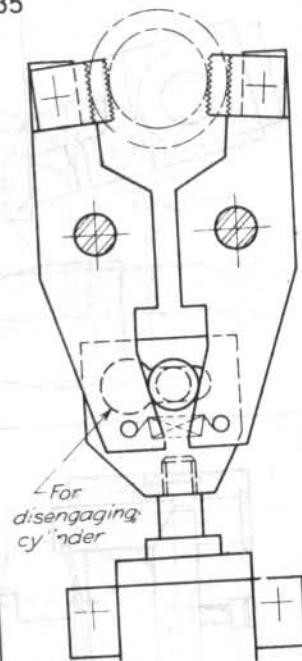


Centering

334

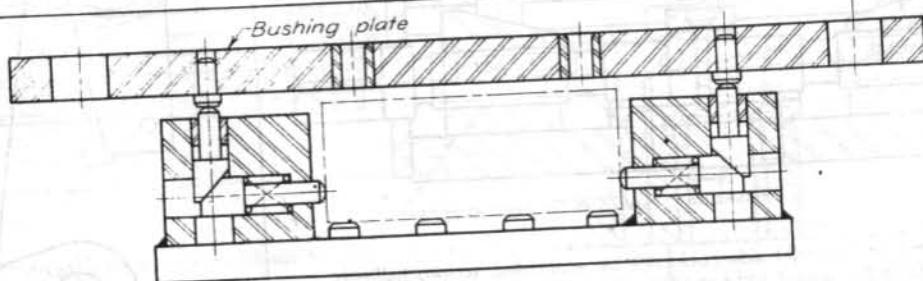


335



Centering

336

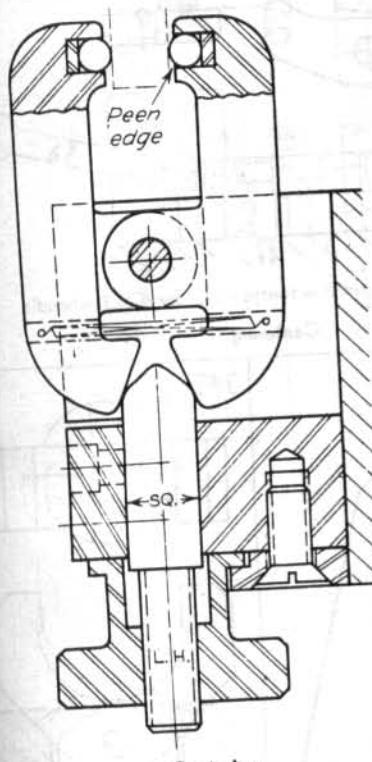
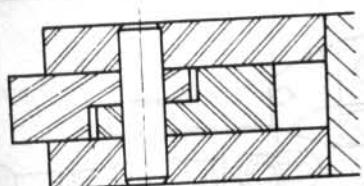


As the bushing plate is lowered, the buttons actuate the centering pins.

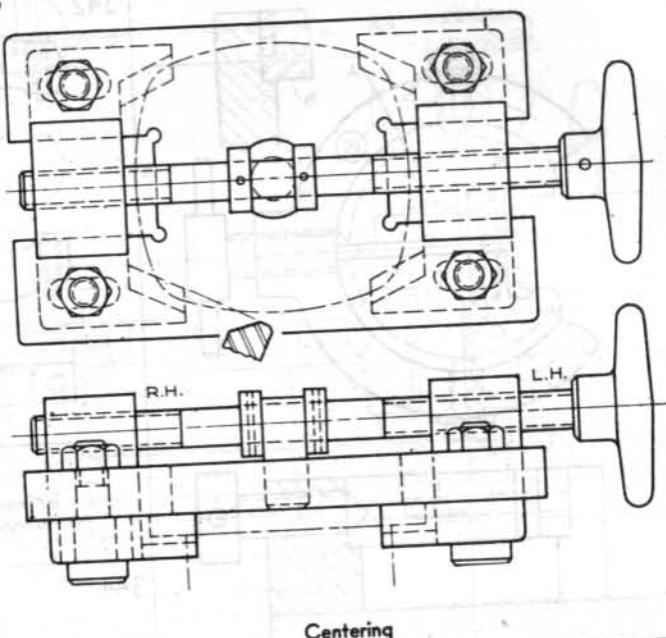
Centering

337

337

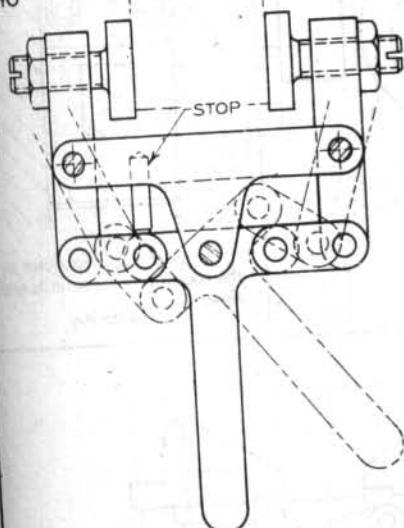


338



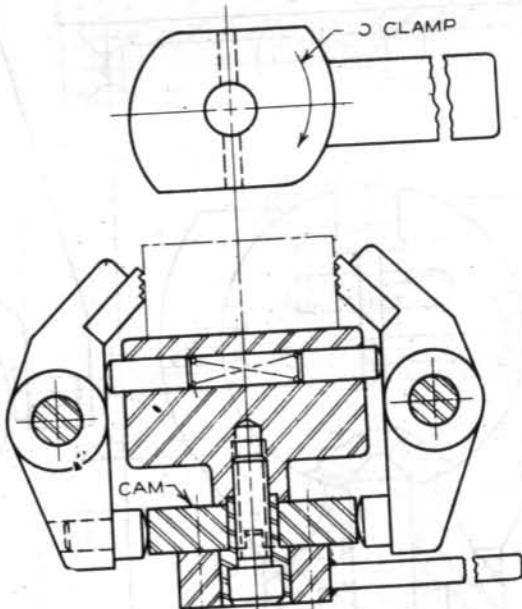
339

340



This is a toggle link clamp. Note the stop. See Toggle Link Clamping category for more of this type.

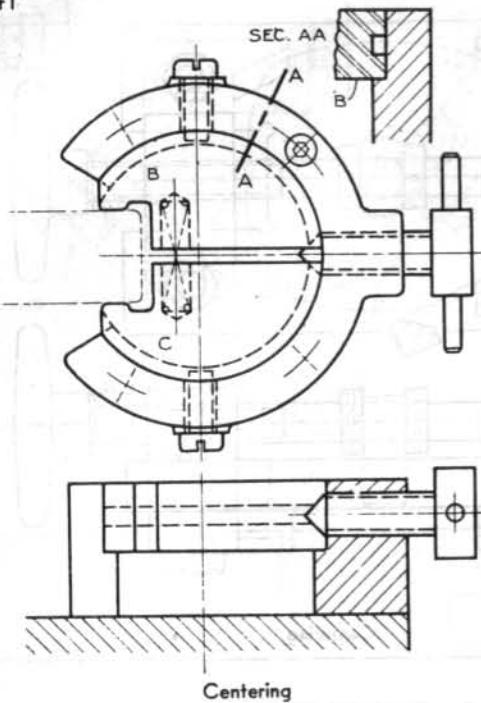
Centering



"The man with a new idea is a crank until the idea succeeds." MARK TWAIN

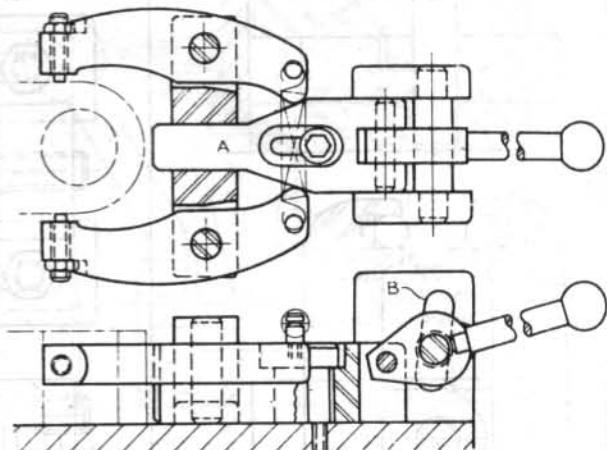
341-346

341



Centering

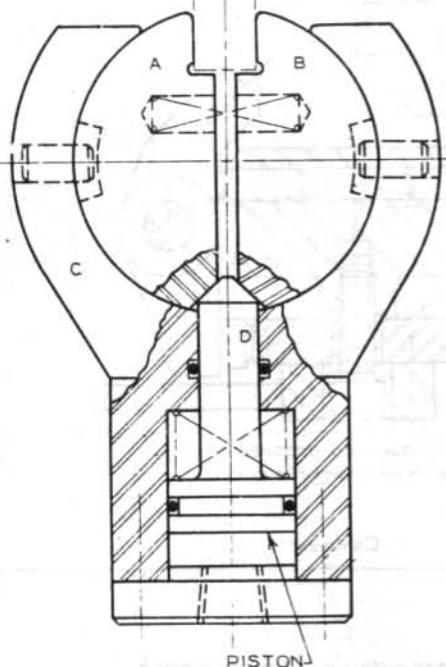
342



Inclined groove cam B actuates expander A as the handle is lowered.

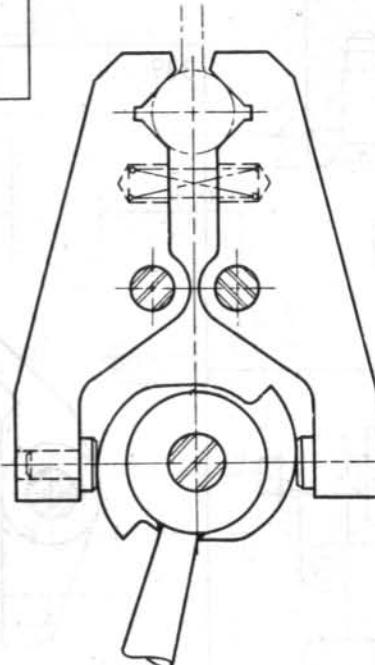
Centering

343



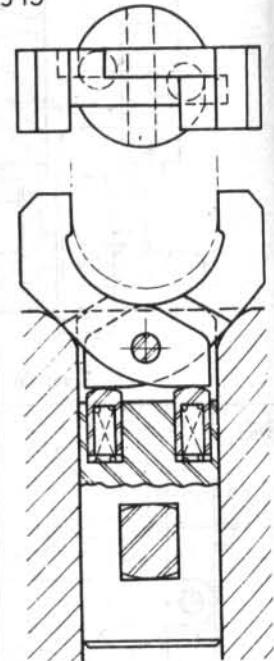
Centering

344



Centering

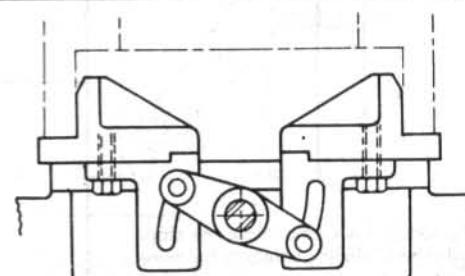
345



The post is pulled down by the rocker arm shown in its end view.

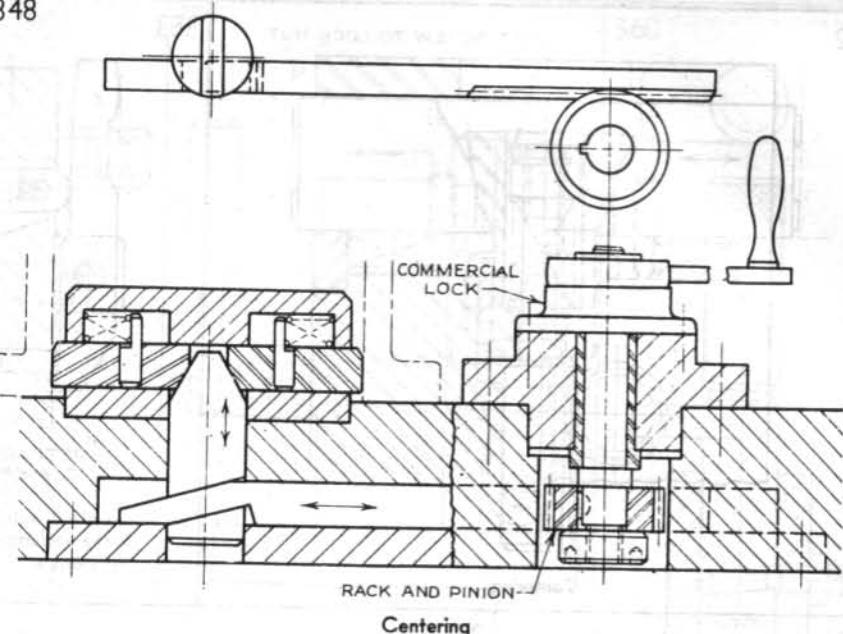
Centering

346



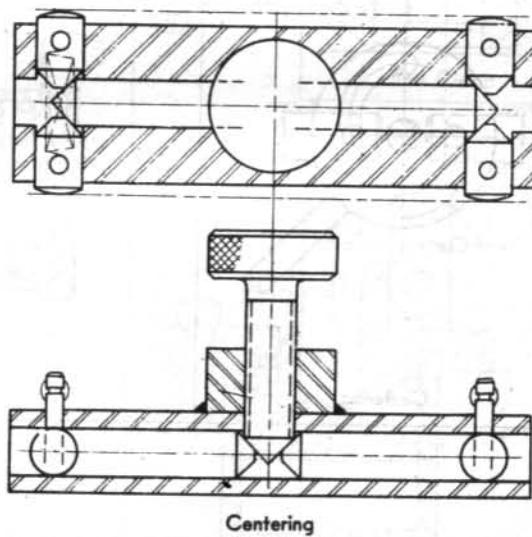
Centering

348

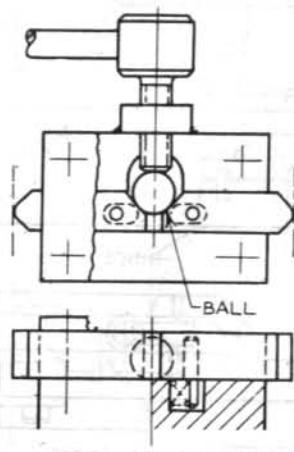


Centering

350

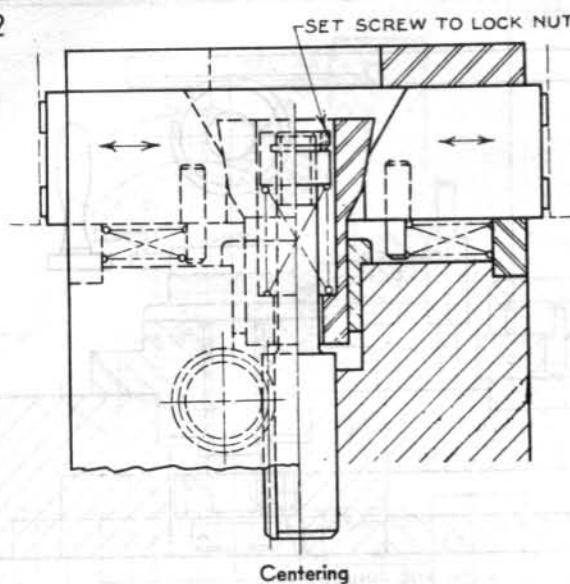


351

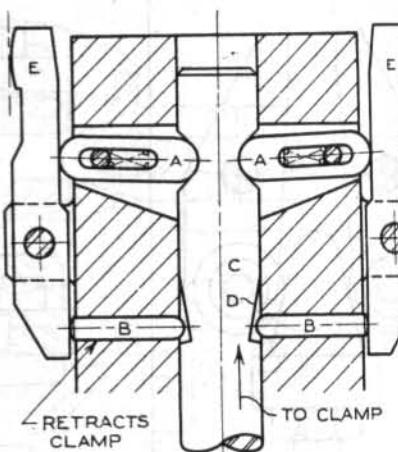


Centering

352

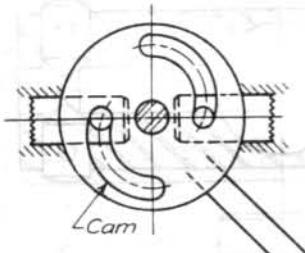


353



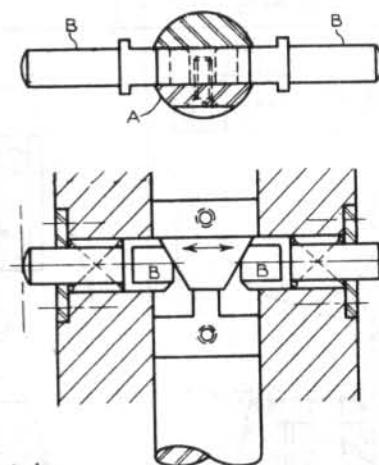
Links A actuate the clamps as post C is raised.
In the unclamping operation, D forces B to retract the clamps.

354



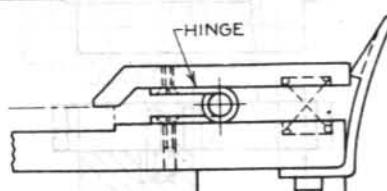
355

Note the flats on centering pins B. Plate A prevents B from turning.

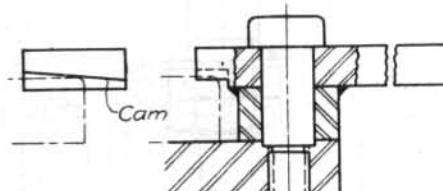


TOE CLAMPS

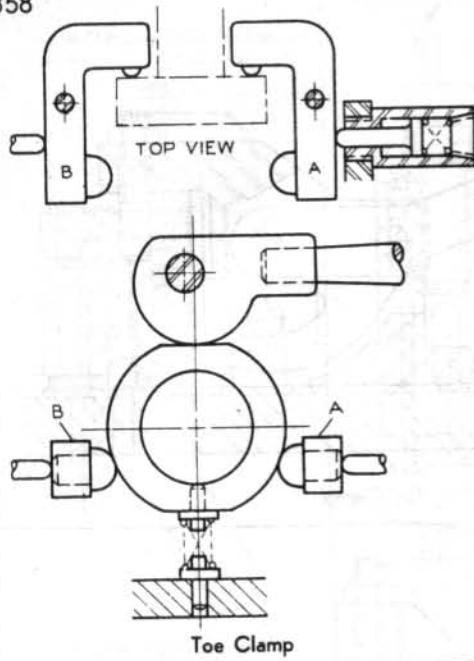
356



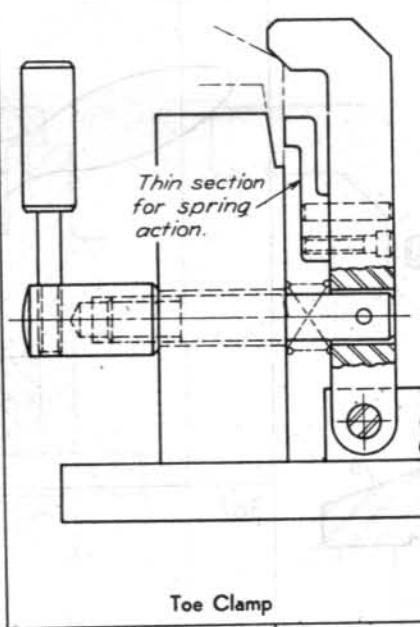
357



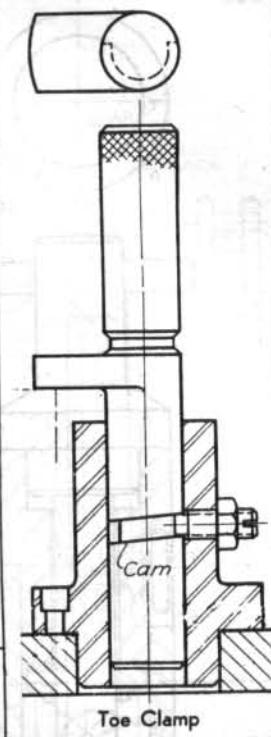
358



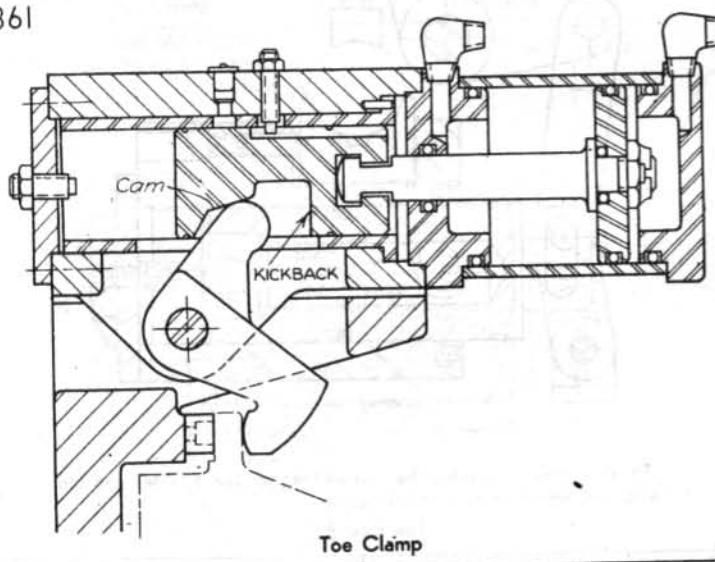
359



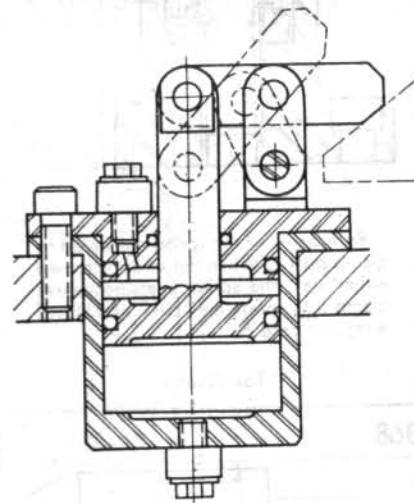
360



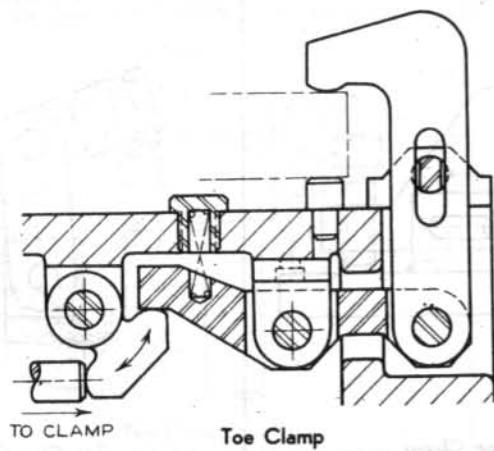
361



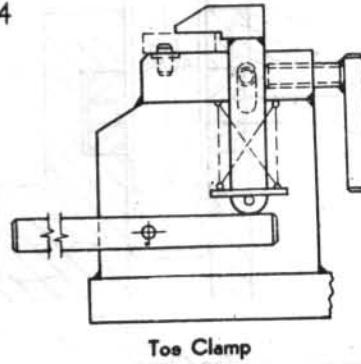
362



363

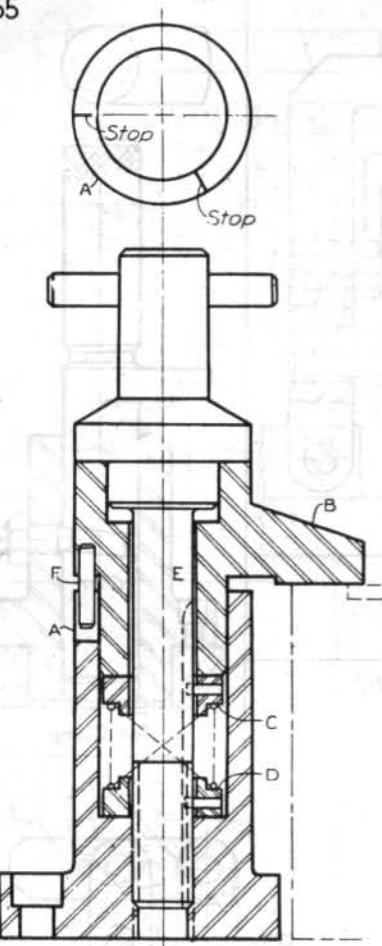


364



365-370

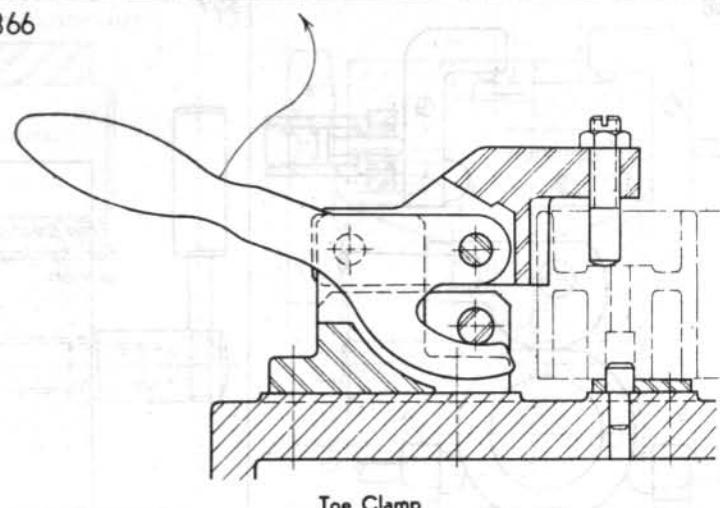
365



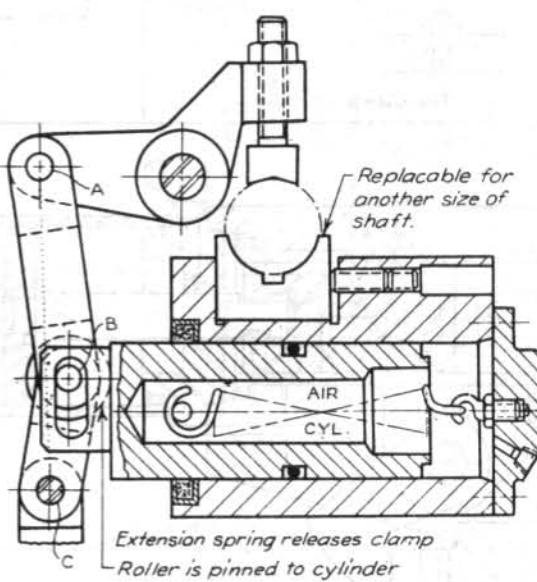
Both bases of the spring are keyed to clamp post E. When the screw is turned either way, the spring pressure causes clamp B to rotate until pin F of B strikes a stop of base A.

Toe Clamp

366



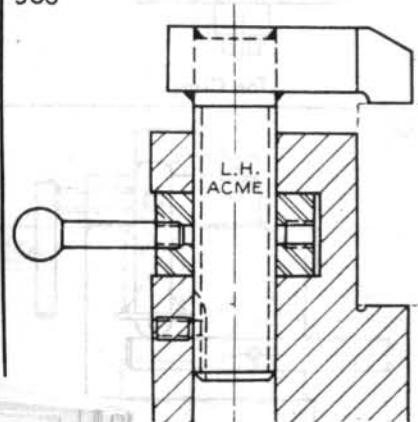
367



An air cylinder operates the toggle linkage. The cylinder and the clamp are retracted by a strong spring.

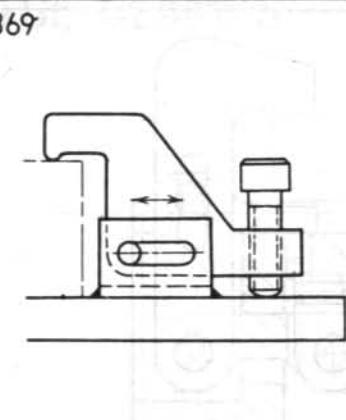
Toe Clamp

368



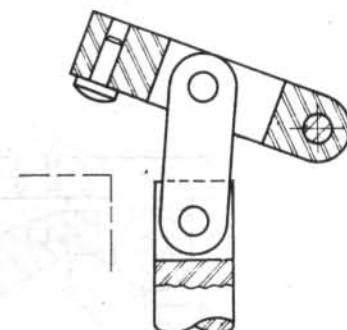
Toe Clamp

369



Toe Clamp

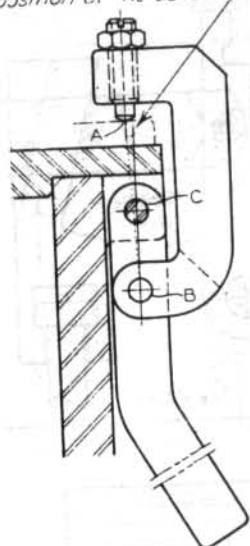
370



Toe Clamp

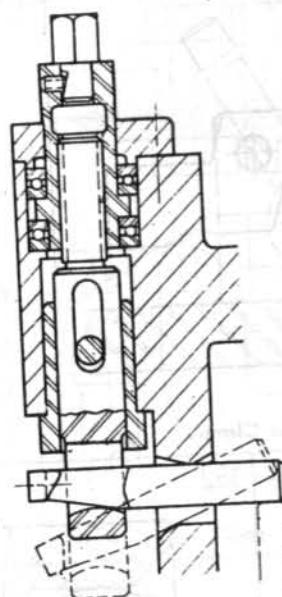
371

Note the beyond center position of the screw

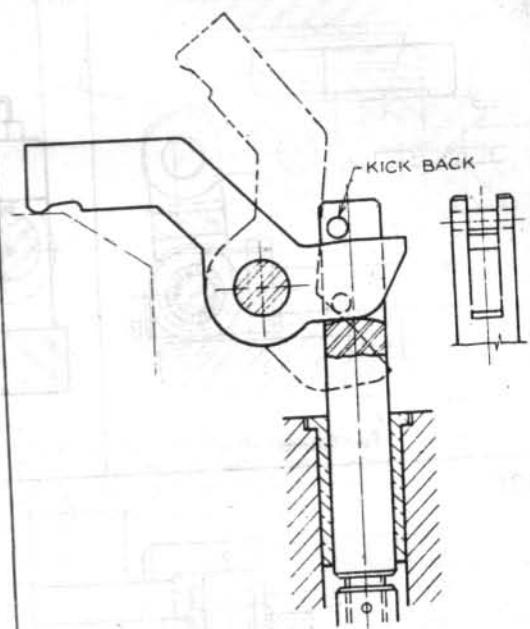


This is a toggle link toe clamp.
Toe Clamp

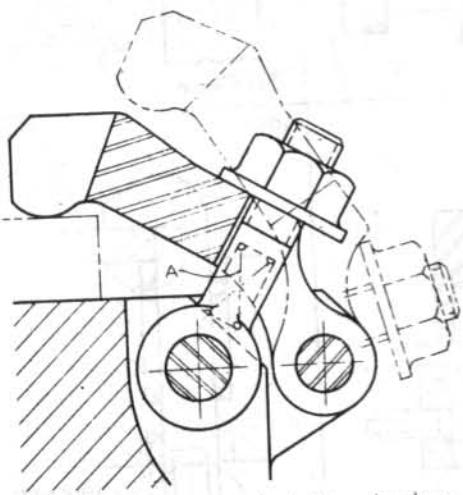
372



373



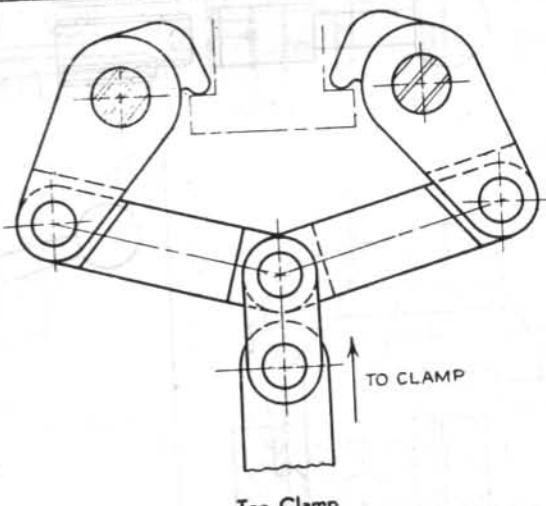
374



Loosening the nut allows the bolt to swing downward and spring A to push the clamp free of the part.

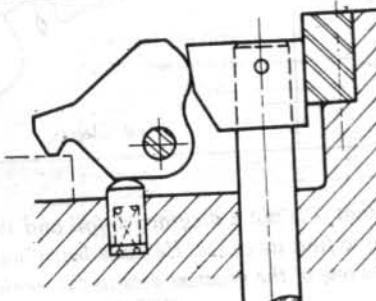
Toe Clamp

375



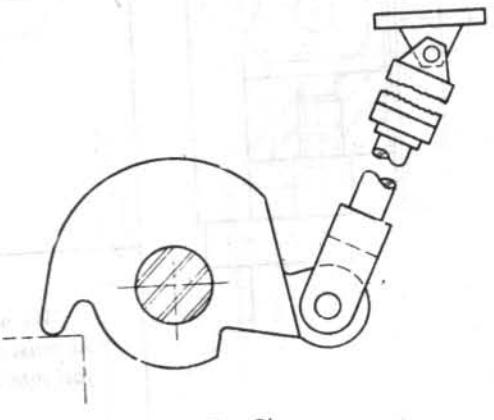
Toe Clamp

376



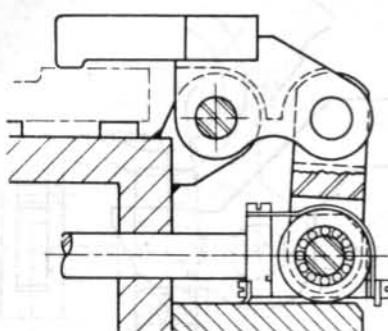
Toe Clamp

377



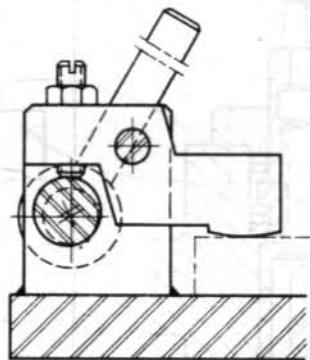
Toe Clamp

378



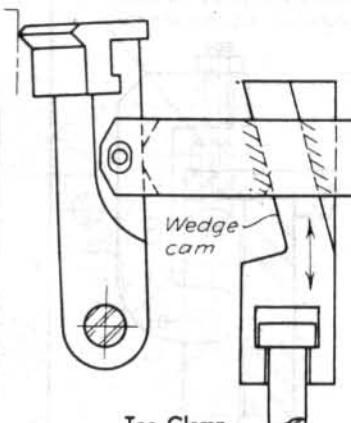
Toe Clamp

379



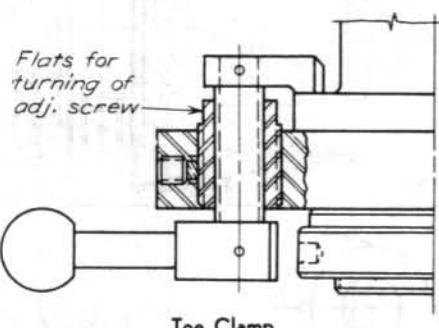
Toe Clamp

380



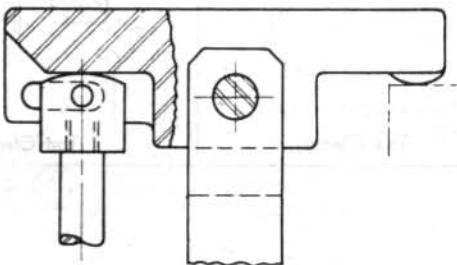
Toe Clamp

381



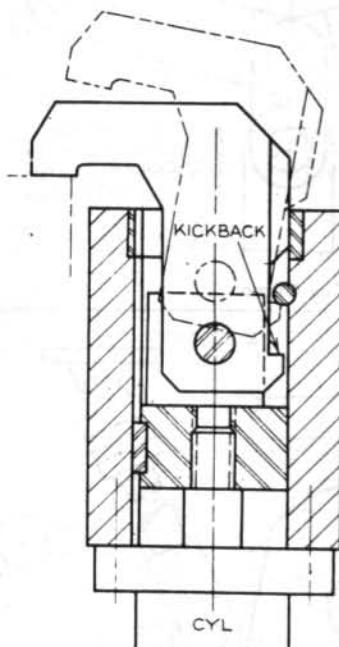
Toe Clamp

382



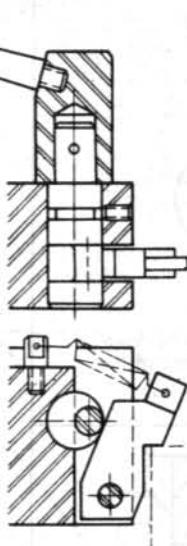
Toe Clamp

383



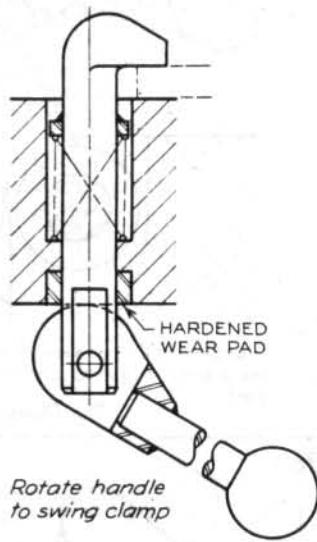
Toe Clamp

384



Toe Clamp

385

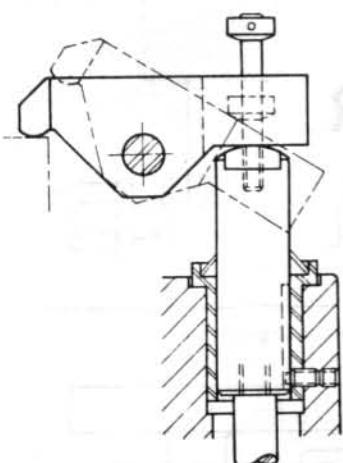


Toe Clamp

"We need to teach a man that it is not a disgrace to fail and that he must analyze every failure to find its cause. He must learn how to fail intelligently, for failing is one of the greatest arts in the world."

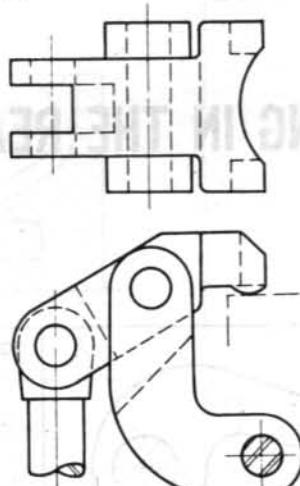
CHARLES F. KETTERING

386



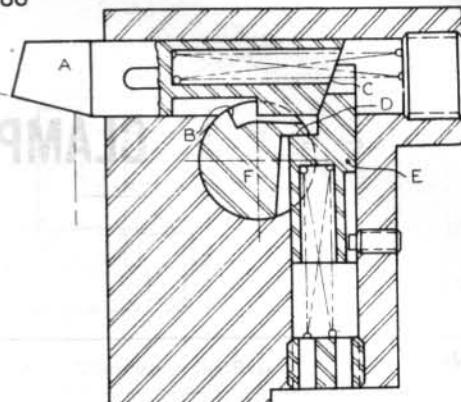
Toe Clamp

387



Toe Clamp

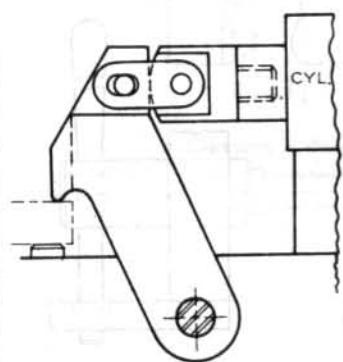
388



As shaft F is rotated, shoulder D pushes E and its cam downward. Then shoulder B moves clamp A to the right. Note that cam C has a cut-out to accommodate the spring.

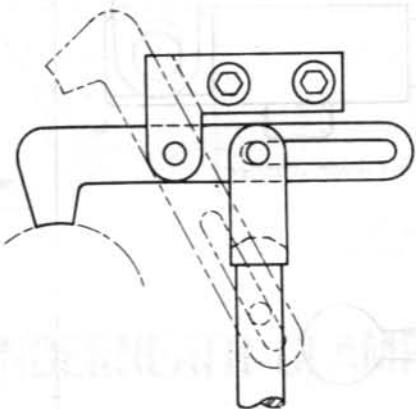
Toe Clamp

389



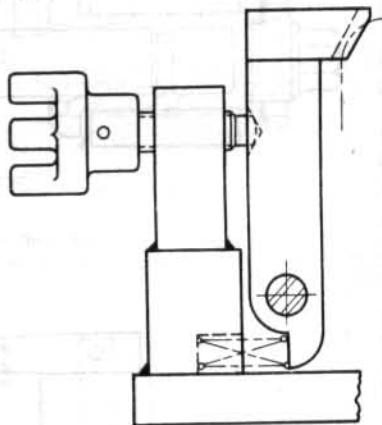
Toe Clamp

390



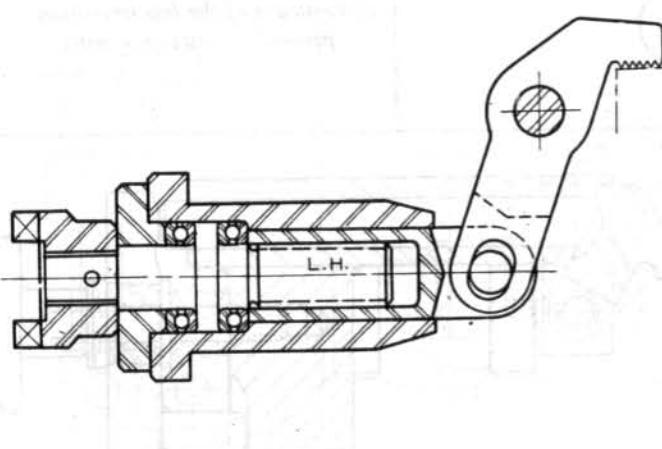
Toe Clamp

391



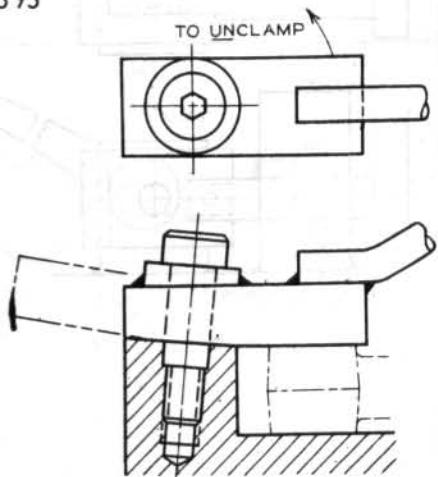
Toe Clamp

392



Toe Clamp

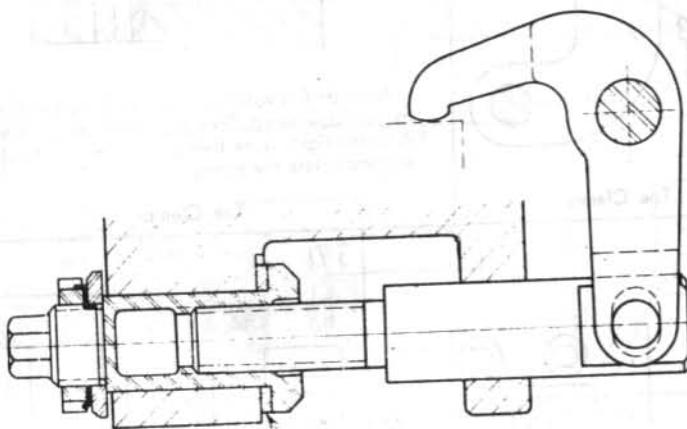
393



Toe Clamp

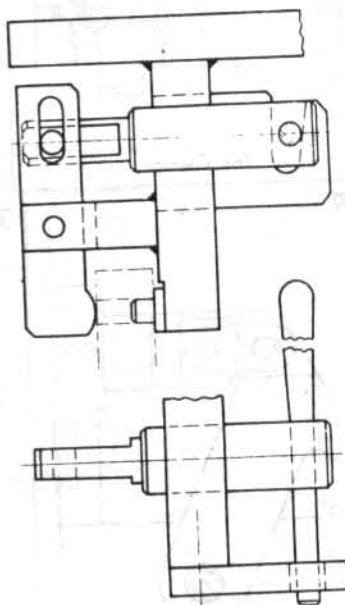
CLAMPING IN THE REAR

394



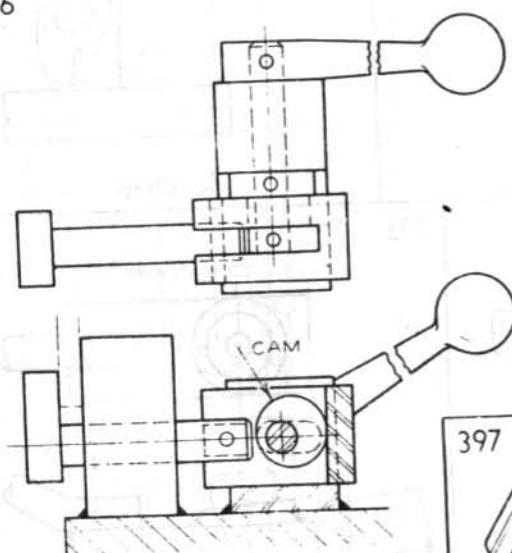
- Hardened wear washer
Clamping in the Rear

395



Clamping in the Rear

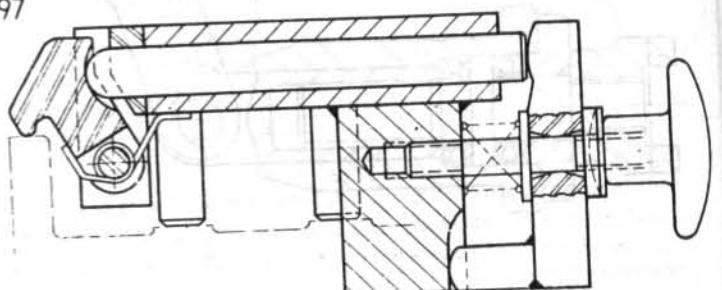
396



Clamping in the Rear

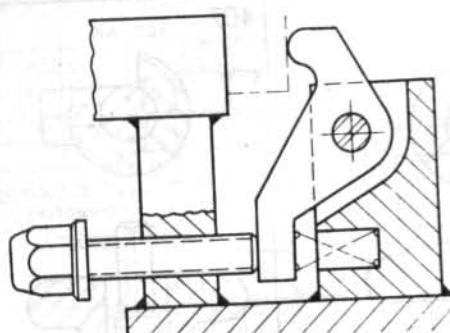
"The successful person must learn to take with grace the jealousy of the less ambitious person." MELVIN B. HART

397



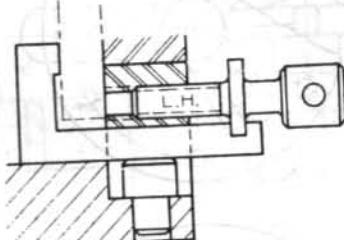
Clamping in the Rear

398



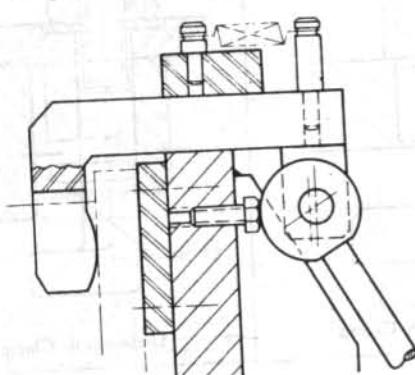
Clamping in the Rear

399



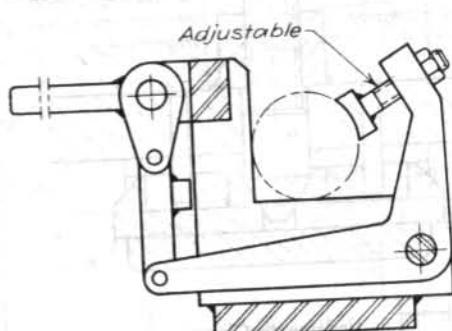
Clamping in the Rear

400



Clamping in the Rear

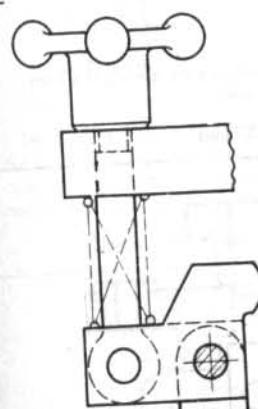
401



Clamping in the Rear

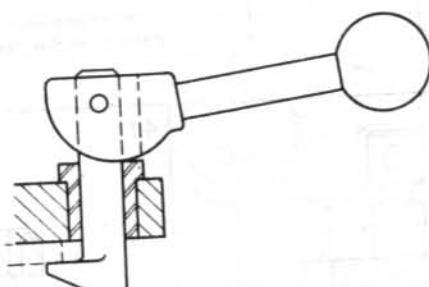
UNDERNEATH CLAMPS

402



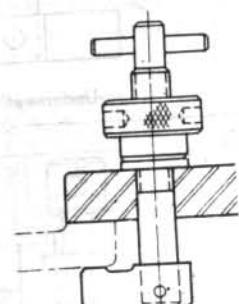
Underneath Clamp

403



Underneath Clamp

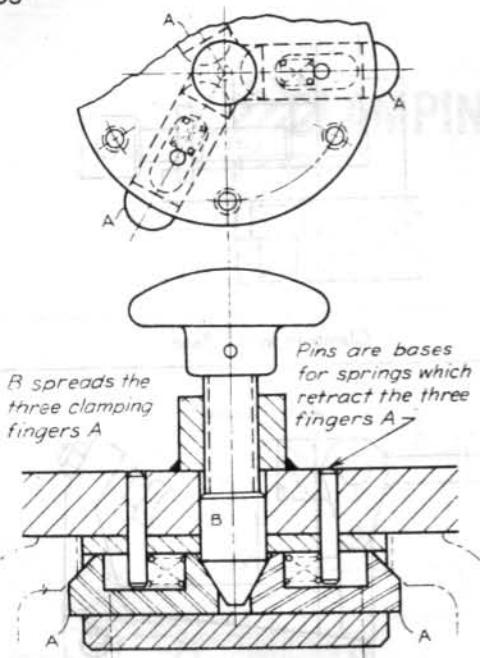
404



Underneath Clamp

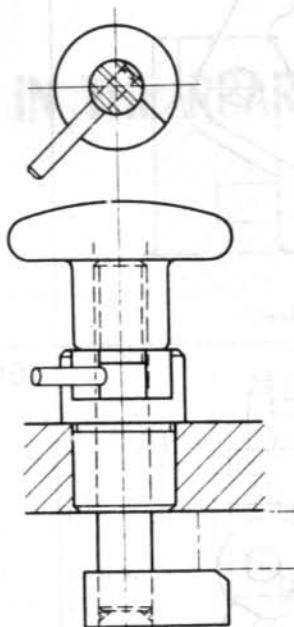
405-411

405



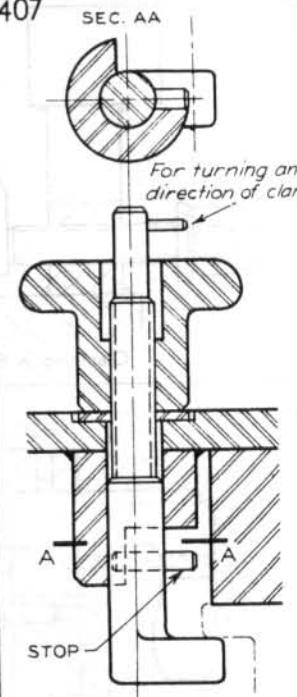
Underneath Clamp

406



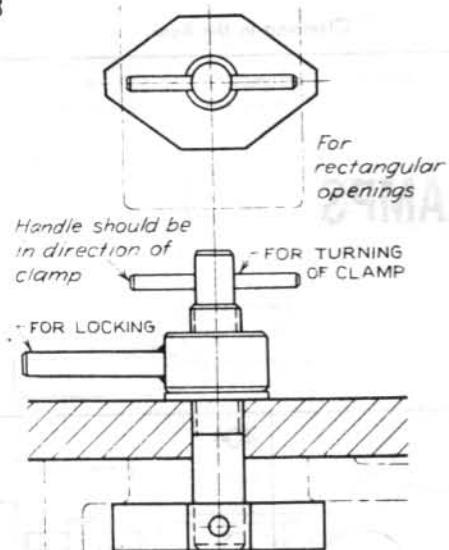
Underneath Clamp

407



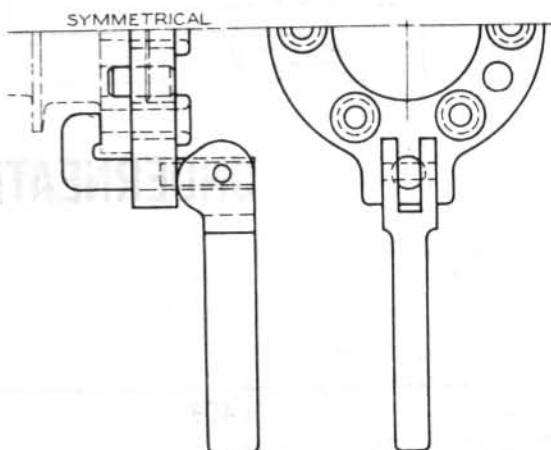
Underneath Clamp

408



Underneath Clamp

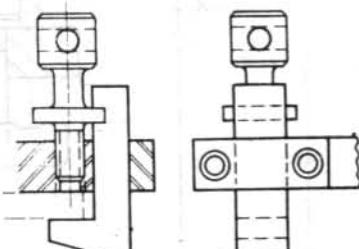
409



Specifying that the handle should be parallel to the hook determines the direction of the hook.

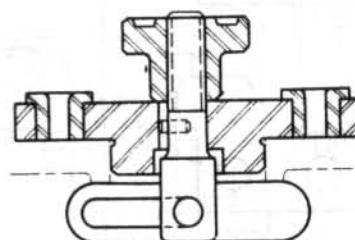
Underneath Clamp

410



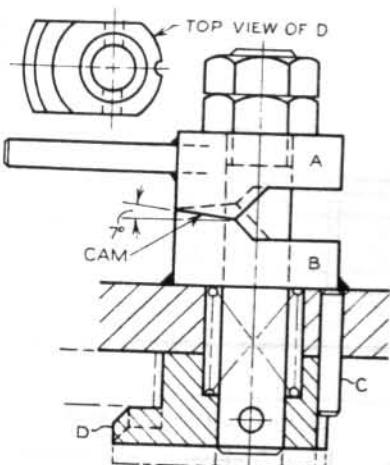
Underneath Clamp

411



Underneath Clamp

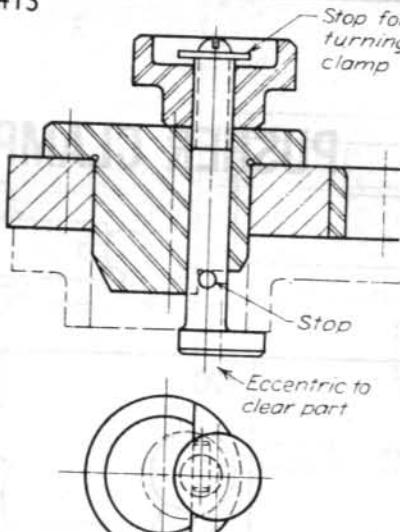
412



The small-angle cam applies a heavy force to clamp D, which C prevents from rotating but not from moving vertically.

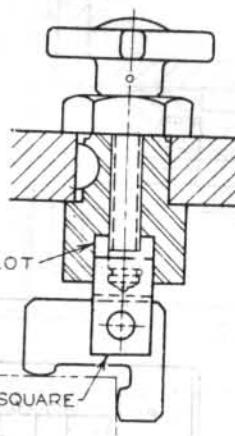
Underneath Clamp

413



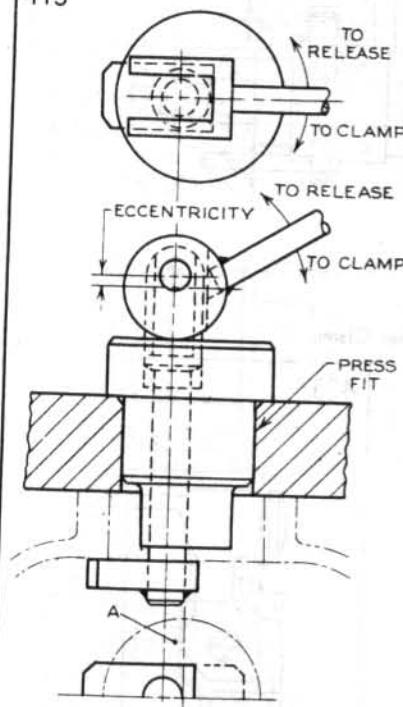
Underneath Clamp

414



Underneath Clamp

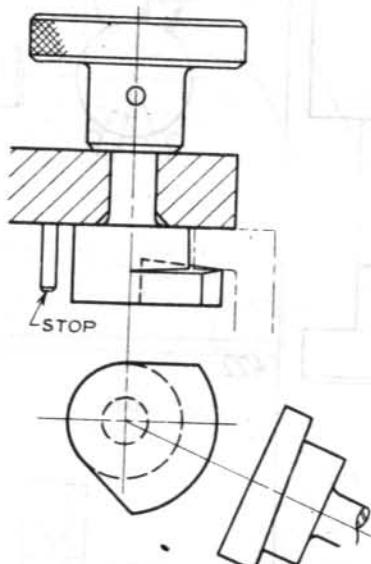
415



The eccentricity of the clamp clears the bore of the part in the unclamping operation. Note the parallelism of the handle and the clamp.

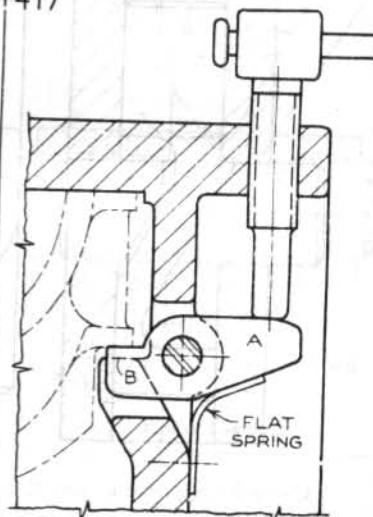
Underneath Clamp

416



Underneath Clamp

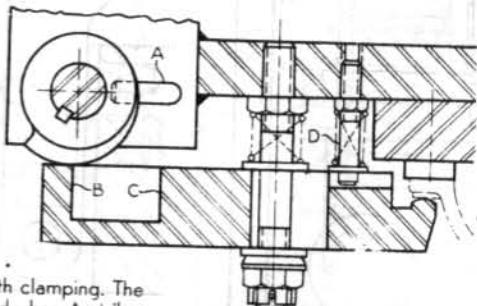
417



B serves as a positioner on which the part rests until it is raised by A.

Underneath Clamp

418

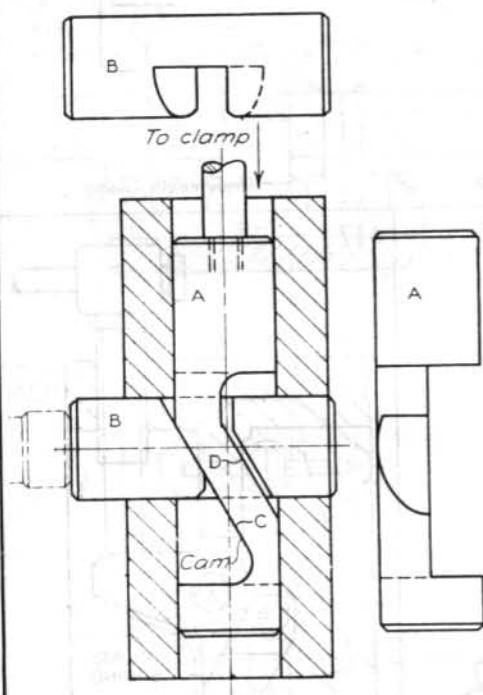


This is a walking strap clamp applied to underneath clamping. The clamp retracts when pin A strikes B; it moves forward when A strikes C. D prevents the clamp from turning.

Underneath Clamp

PUSHER CLAMPS

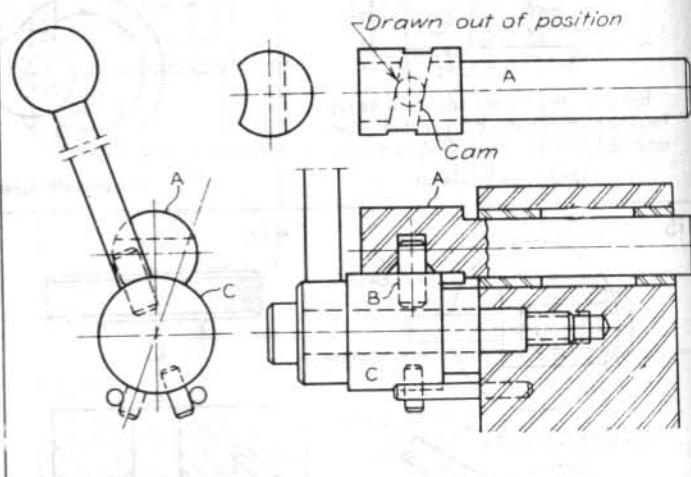
419



Clamp B is actuated by cam C of A and retracted by cam D.

Pusher Clamp

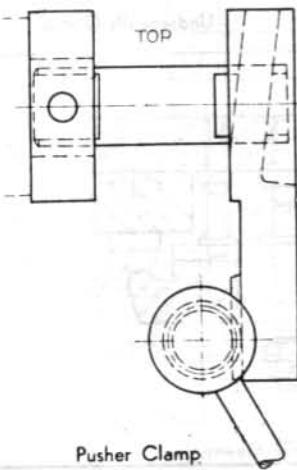
420



Pin B in C moves clamp A via the cam. The small cam angle locks the clamp.

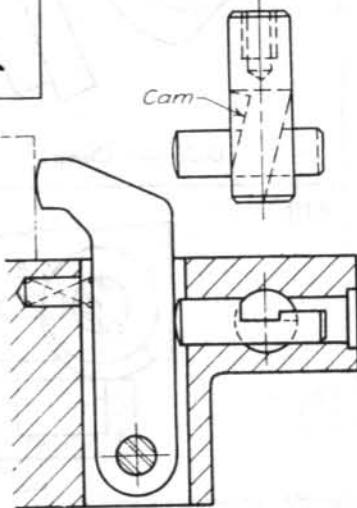
Pusher Clamp

421



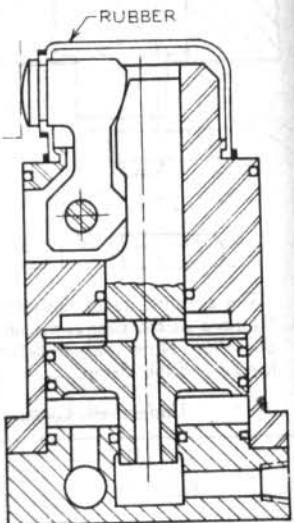
Pusher Clamp

422



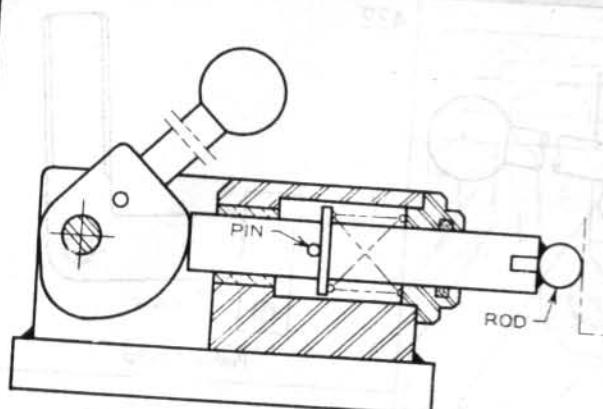
Pusher Clamp

423



Pusher Clamp

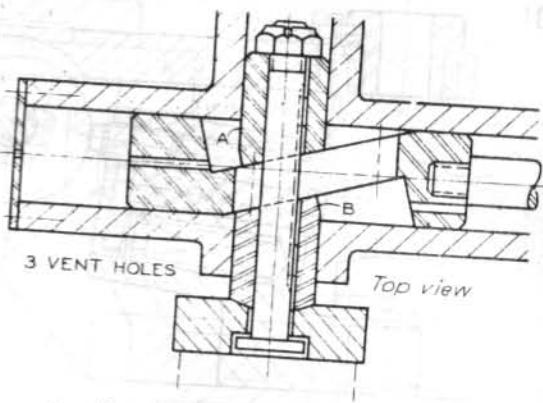
424



Pusher Clamp

424-430

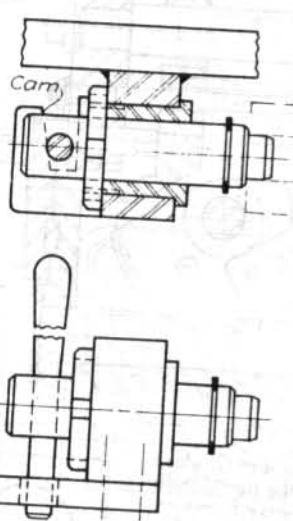
425



A and B are separate parts held by the bolt that also prevents the cam from rotating. Note the keys.

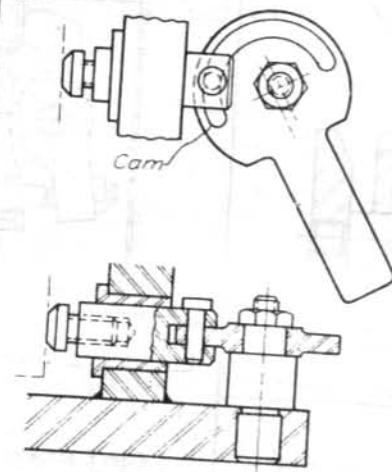
Pusher Clamp

426



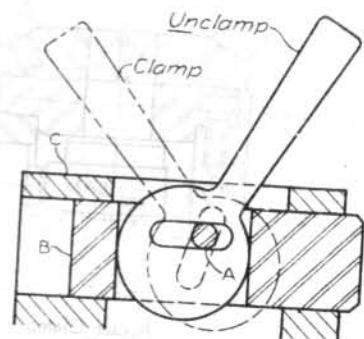
Pusher Clamp

427



Pusher Clamp

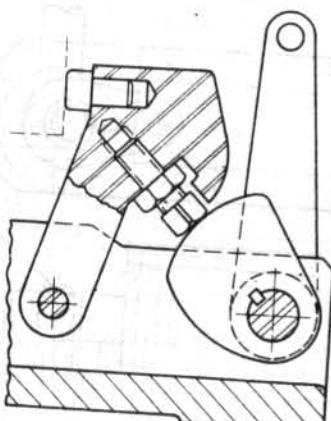
428



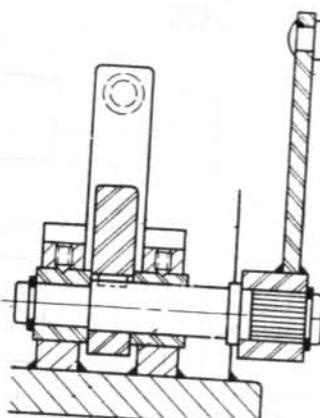
Pin A is in frame C: The cam and B have slots.

Pusher Clamp

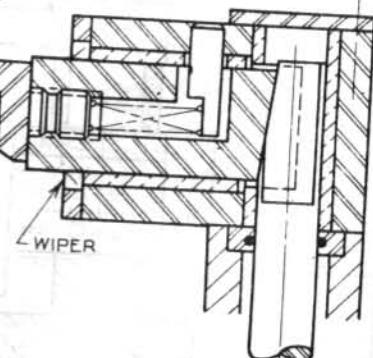
429



Pusher Clamp

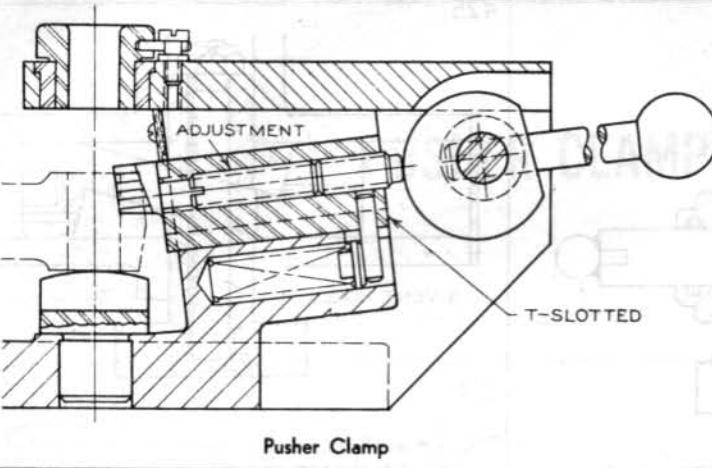


430

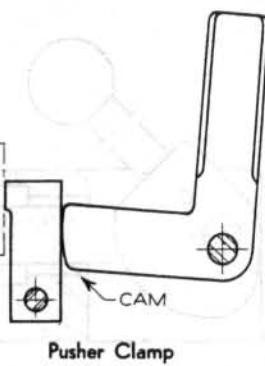


Pusher Clamp

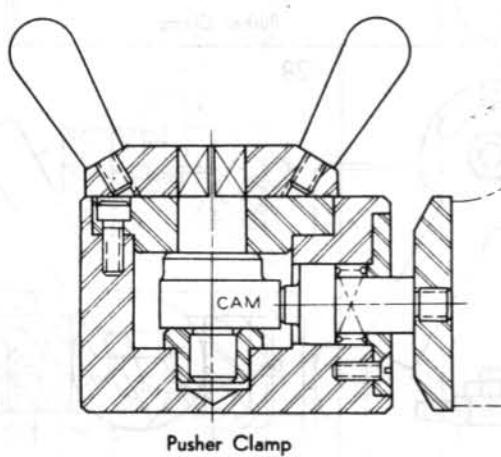
431



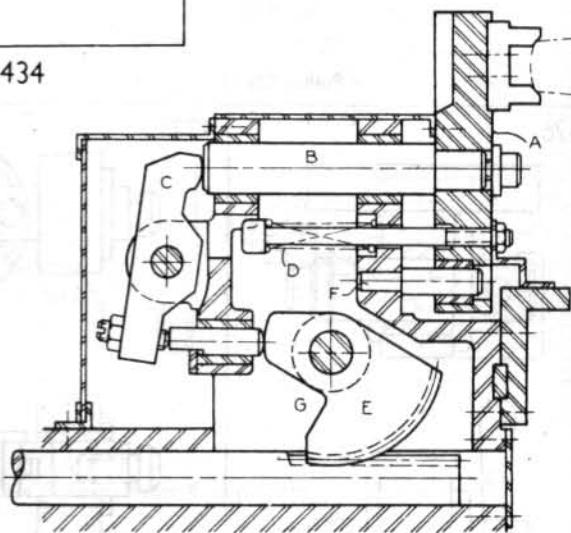
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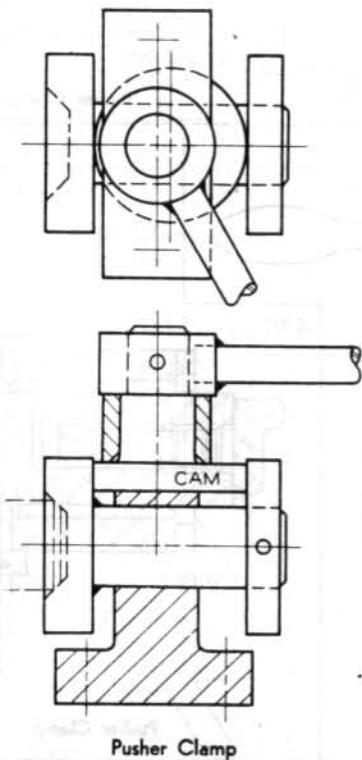
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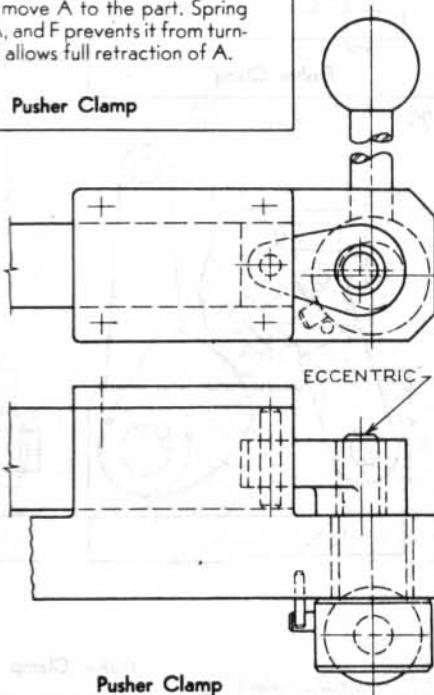
434



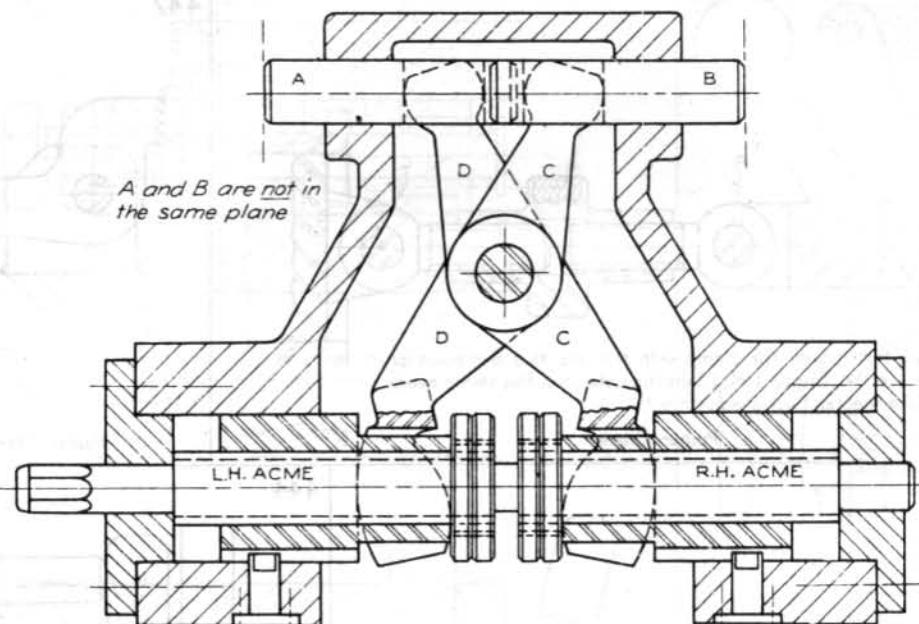
435



436

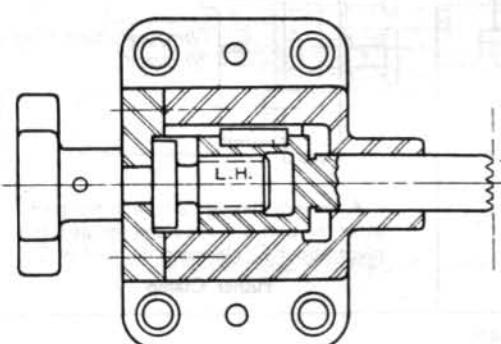


437



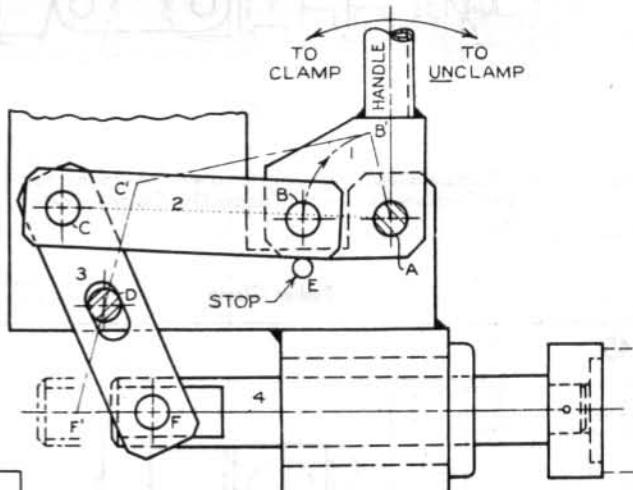
Pusher Clamp

438

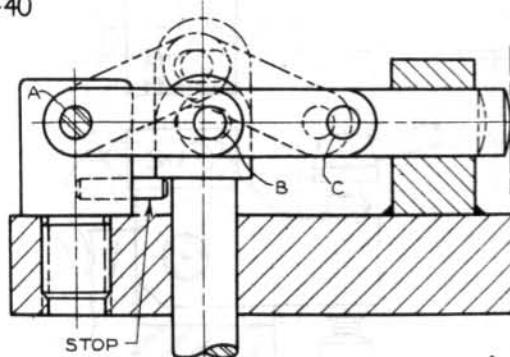


Pusher Clamp

439



440



Compare this toggle link clamp with the one that has been explained or see the Toggle Link Clamping category.

Pusher Clamp

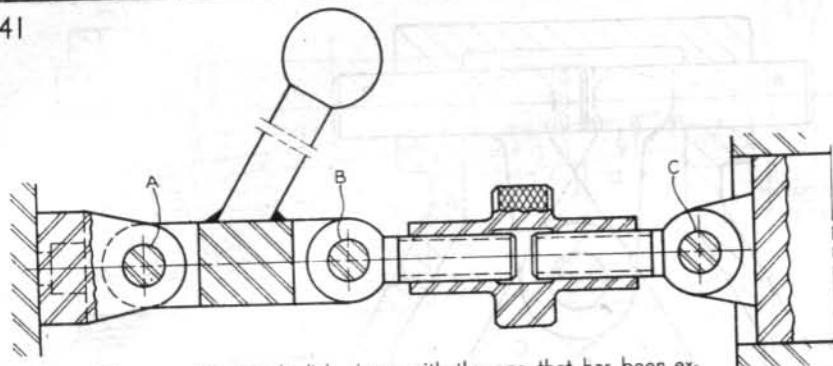
The basic principle used in the design of the toggle link clamp is also used in the design of vise grip pliers. When B is in line with A and C, the clamp exerts the greatest amount of pressure. Stopping B slightly beyond the straight line AC will prevent vibration from loosening the clamp. Note the unclamp prime-marked positions of the pins.

Pusher Clamp

"There is always something about your success that displeases even your best friends." OSCAR WILDE

441-446

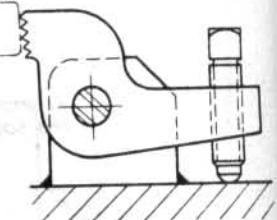
441



Compare this toggle link clamp with the one that has been explained or see the Toggle Link Clamping category. This clamp needs a stop. Note the turnbuckle adjustment.

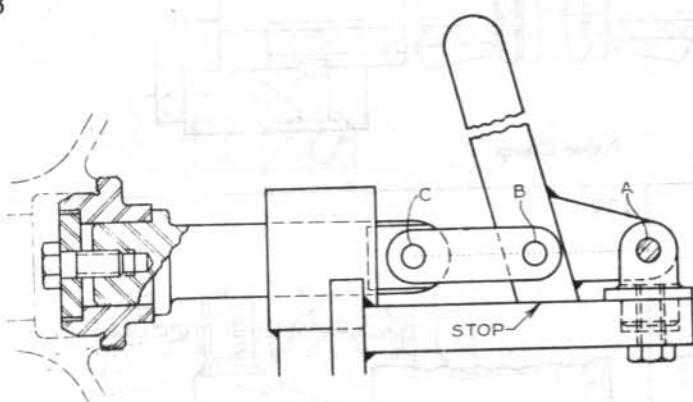
Pusher Clamp

442



Pusher Clamp

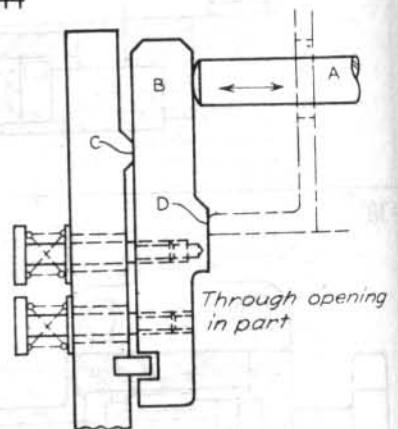
443



Compare this toggle link clamp with the one that has been explained or see the Toggle Link Clamping category.

Pusher Clamp

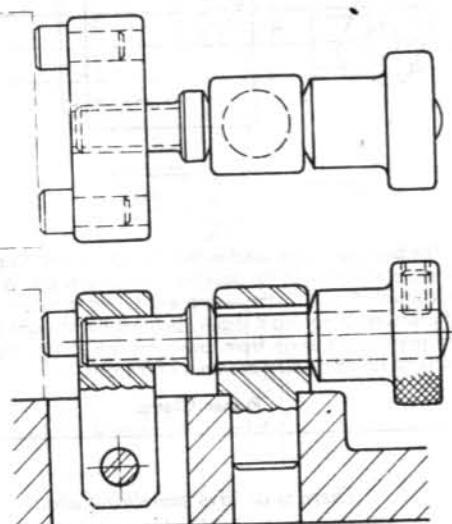
444



A extends through a hole in the part after the part is loaded and forces B to pivot about C, clamping the part at D.

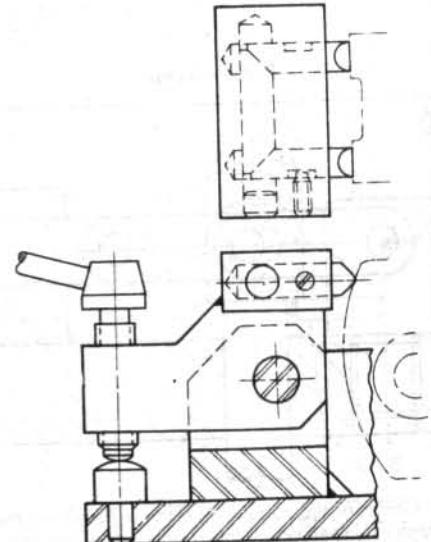
Pusher Clamp

445



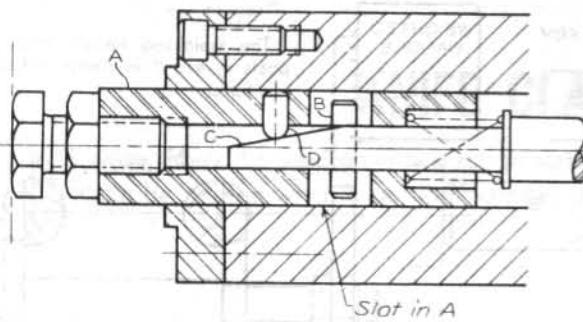
Pusher Clamp

446



Pusher Clamp

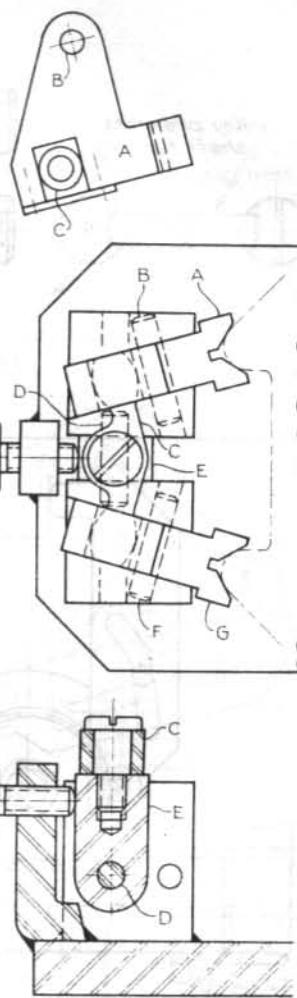
447



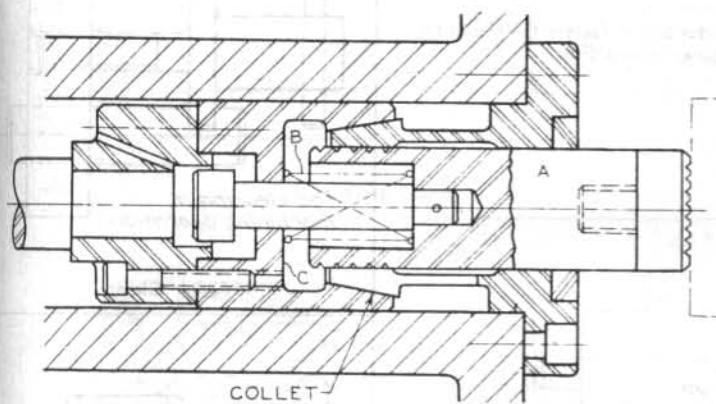
The spring forces clamp A to the part before cam C contacts locking pin D. B prevents cam C from turning and from retracting beyond D. B also retracts A.

Pusher Clamp

448



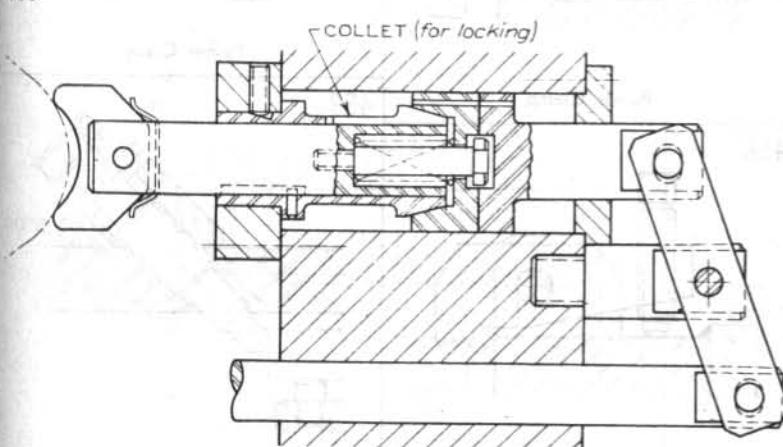
449



Spring B forces clamp A to the part before collet squeezer C locks the collet to clamp A.

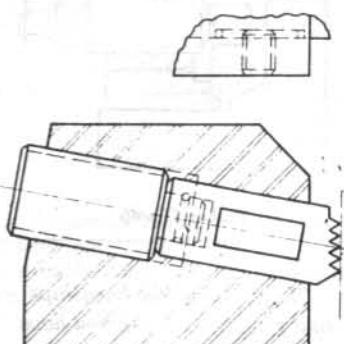
Pusher Clamp

450



Pusher Clamp

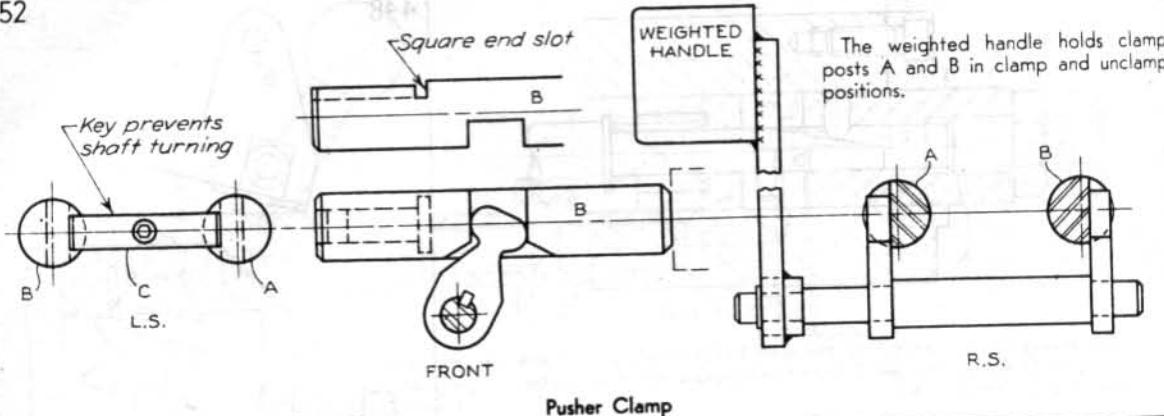
451



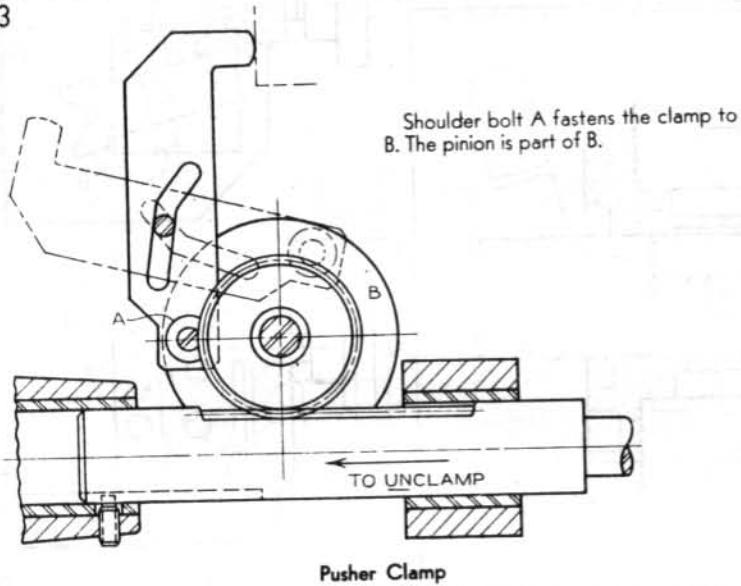
Pusher Clamp

452-459

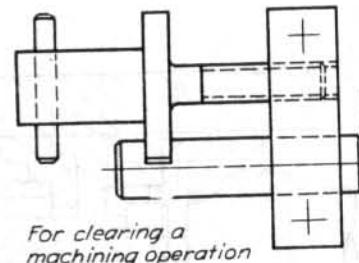
452



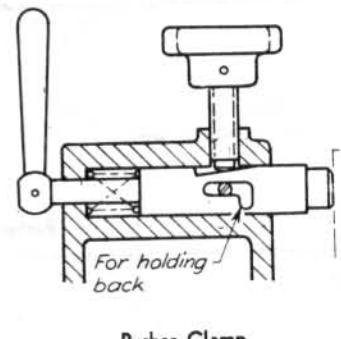
453



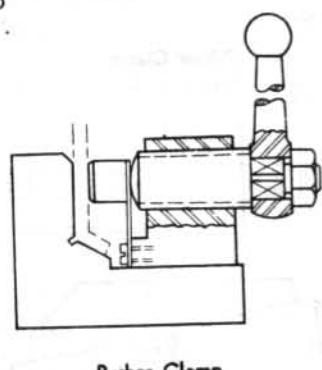
454



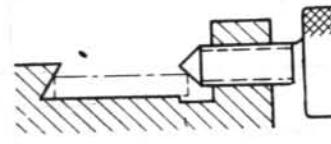
457



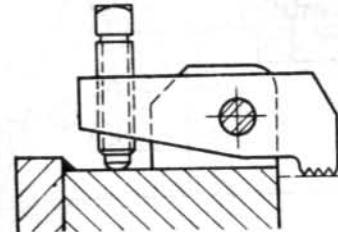
455



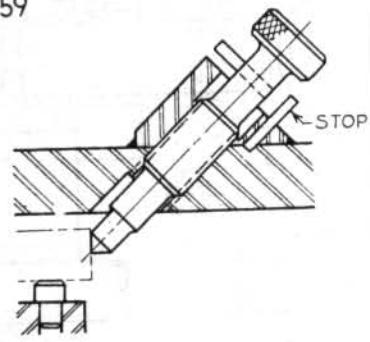
456



458



459

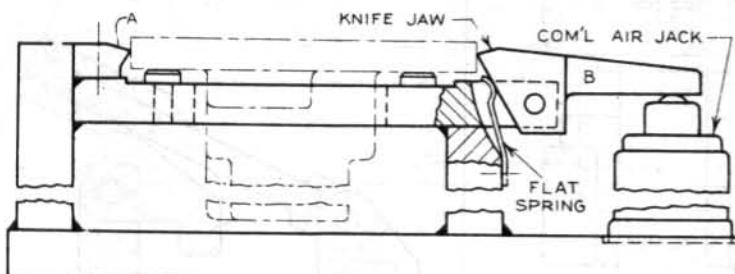


"Luck means the hardships and privations which you have not hesitated to endure; the long nights you have devoted to work." MAX O'RELL

KNIFE CLAMPS

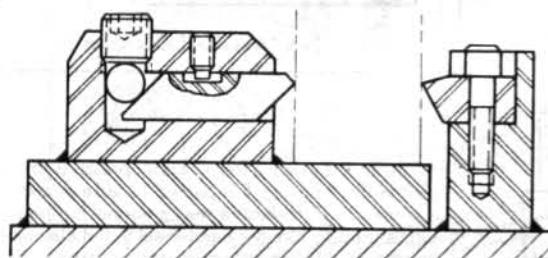
A knife edge should be used on only a rough surface. A round knife edge will last a long time because it can be rotated when a portion becomes dull.

460



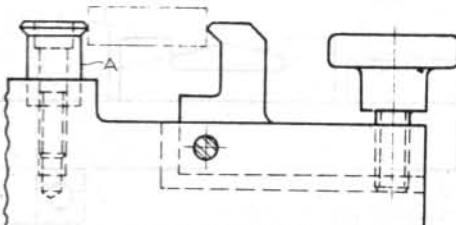
Knife Clamp

462



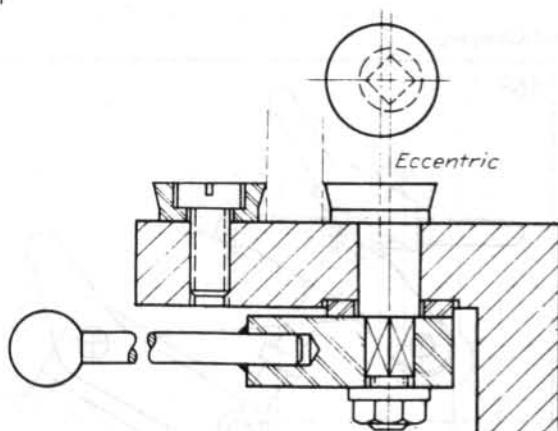
Knife Clamp

463



Knife Clamp

464



Knife Clamp

Setting A in a counterbore enables it to bear the thrust that the smaller diameter cap screw would have to absorb if A were to rest on the surface. A may be rotated when a portion of the edge becomes dull.

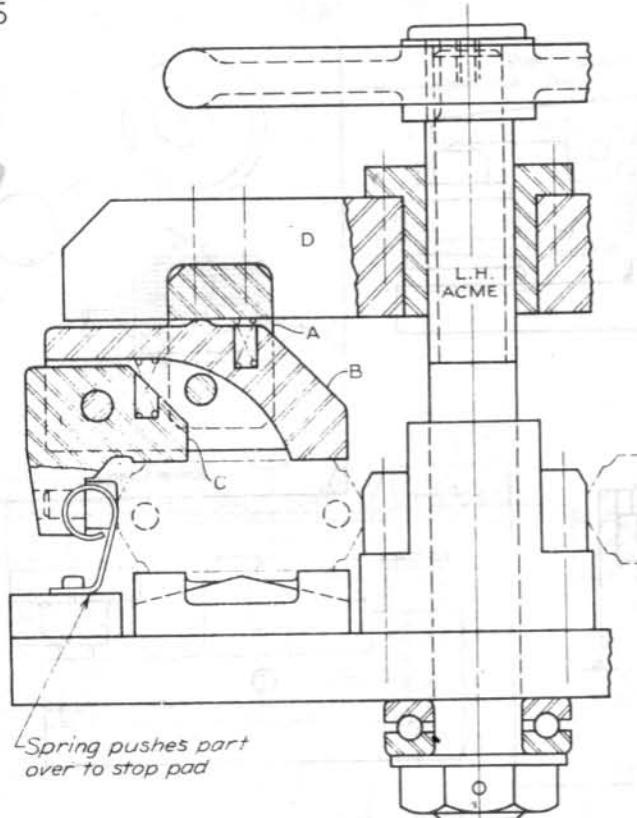
Knife Clamp

"Any man's success hinges about 5 percent on what others do for him and 95 percent on what he does, with the emphasis on the does." JAMES A. WORSHAM

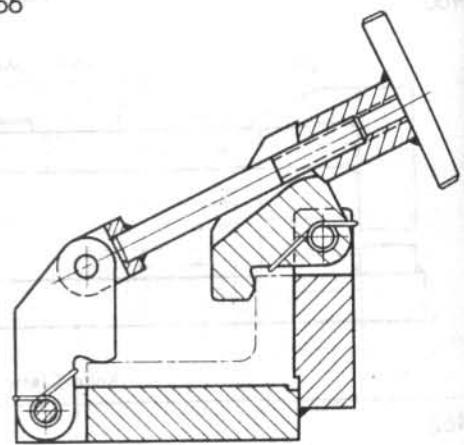
TWO DIRECTIONAL CLAMPING

In two-directional clamping an operator applies a single force to the part in two places. This is frequently achieved through the use of equalizers. The A, B, C pin designations used in the Toggle Link Clamping category are also used for toggle linkages in this category.

465

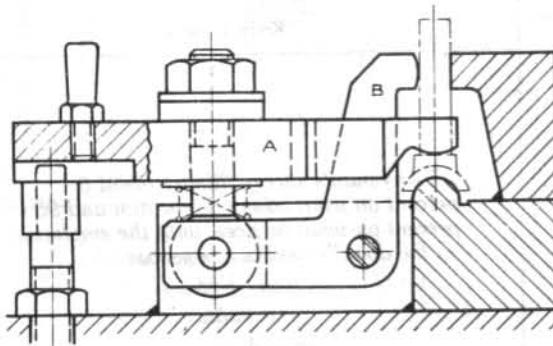


466

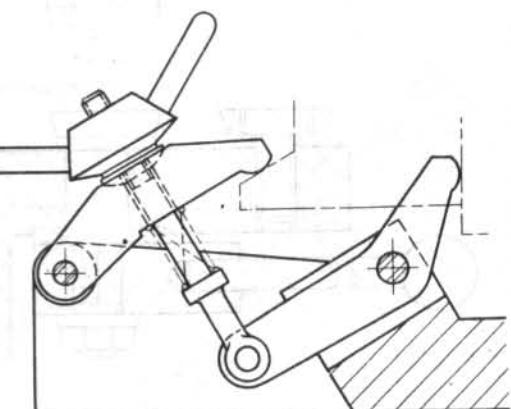


Clamp B and equalizer C apply pressure to the part in three places. B is pinned to yoke A and C is pinned to B. To ensure that a normal right-hand turn is used to turn the handwheel in the clamping operation, left-hand threads are necessary. This unit clamps two parts.

467

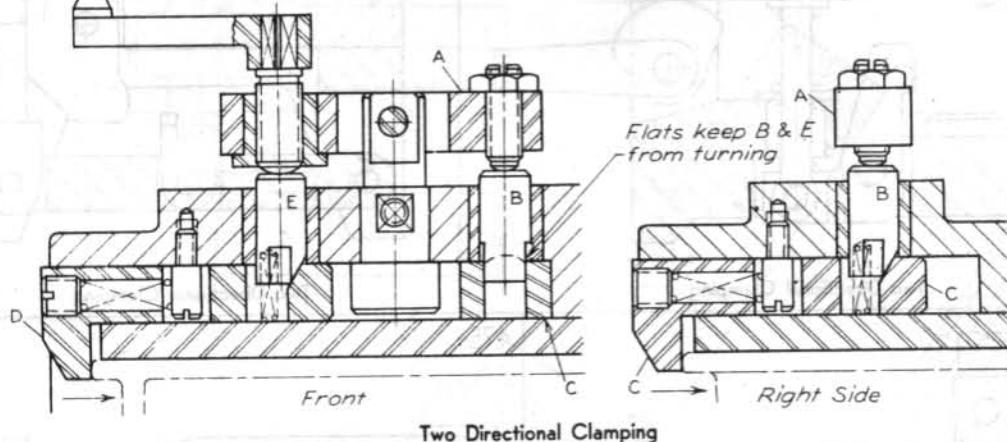


468



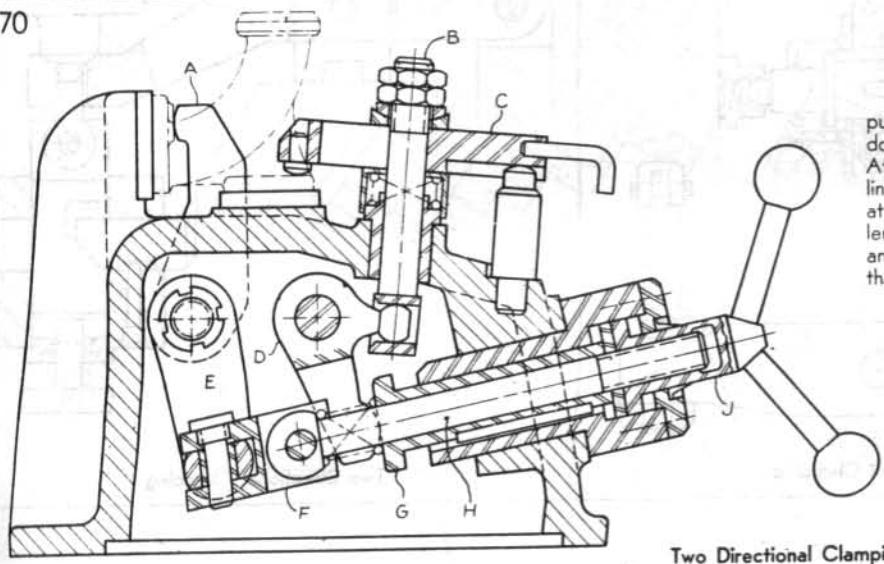
469

Clamp D moves the part to the right and clamp C moves it toward the rear. Rocker arm A applies pressure to cam E, which actuates D, and to cam B, which actuates C. E and B fit in slots in D and C to prevent them from turning. Note how the offset springs retract the clamps.



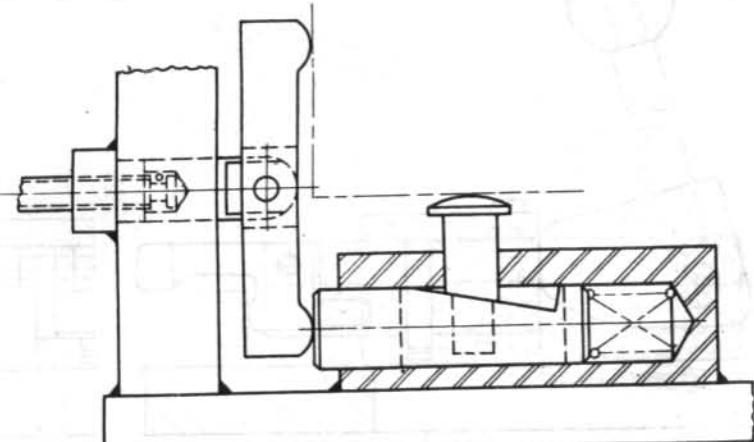
470

When the handle is turned, G pushes rocker arm D, which pulls down post B to actuate clamp C. At the same time, bolt H pulls on link F, which forces arm E to actuate clamp A. G and nut J slide lengthwise to equalize clamps A and C. In the unclamping operation the springs retract the clamps.



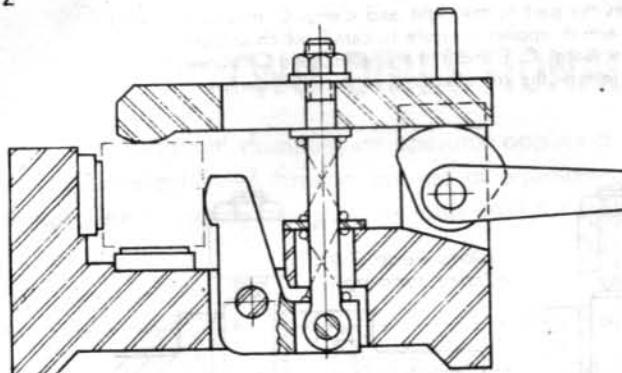
471

Two Directional Clamping

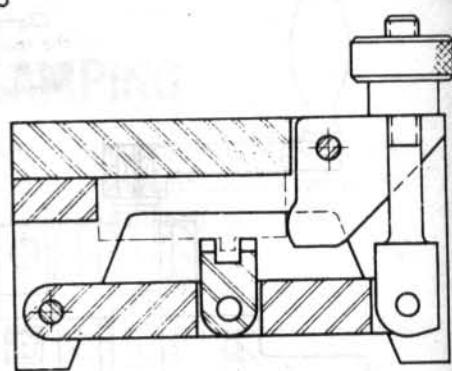


472 - 476

472

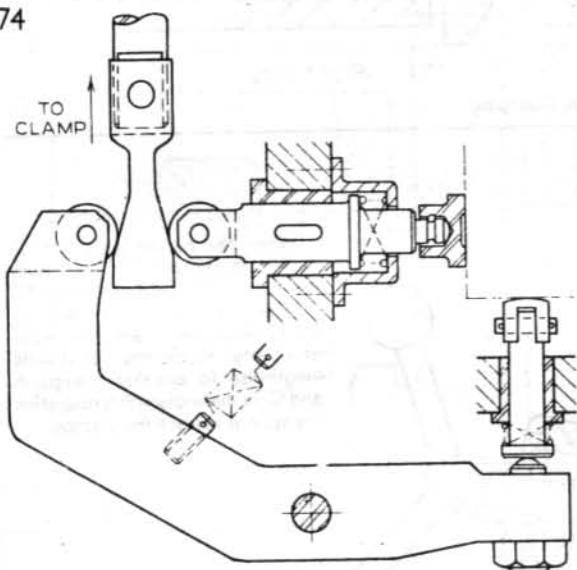


473



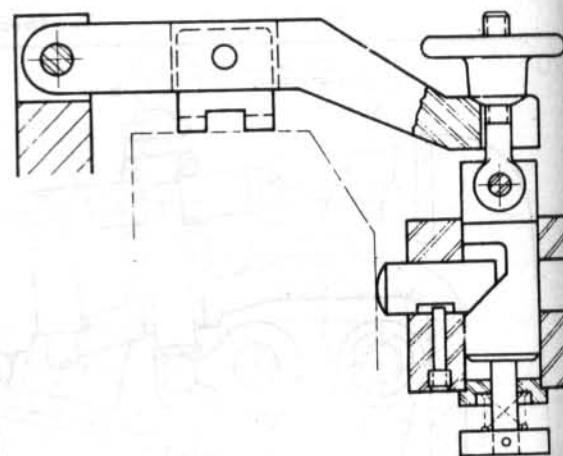
Two Directional Clamping

474



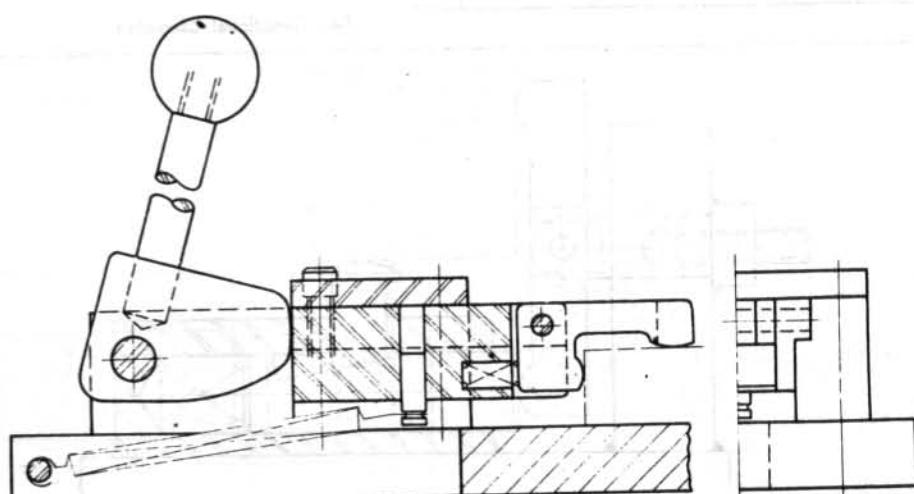
Two Directional Clamping

475



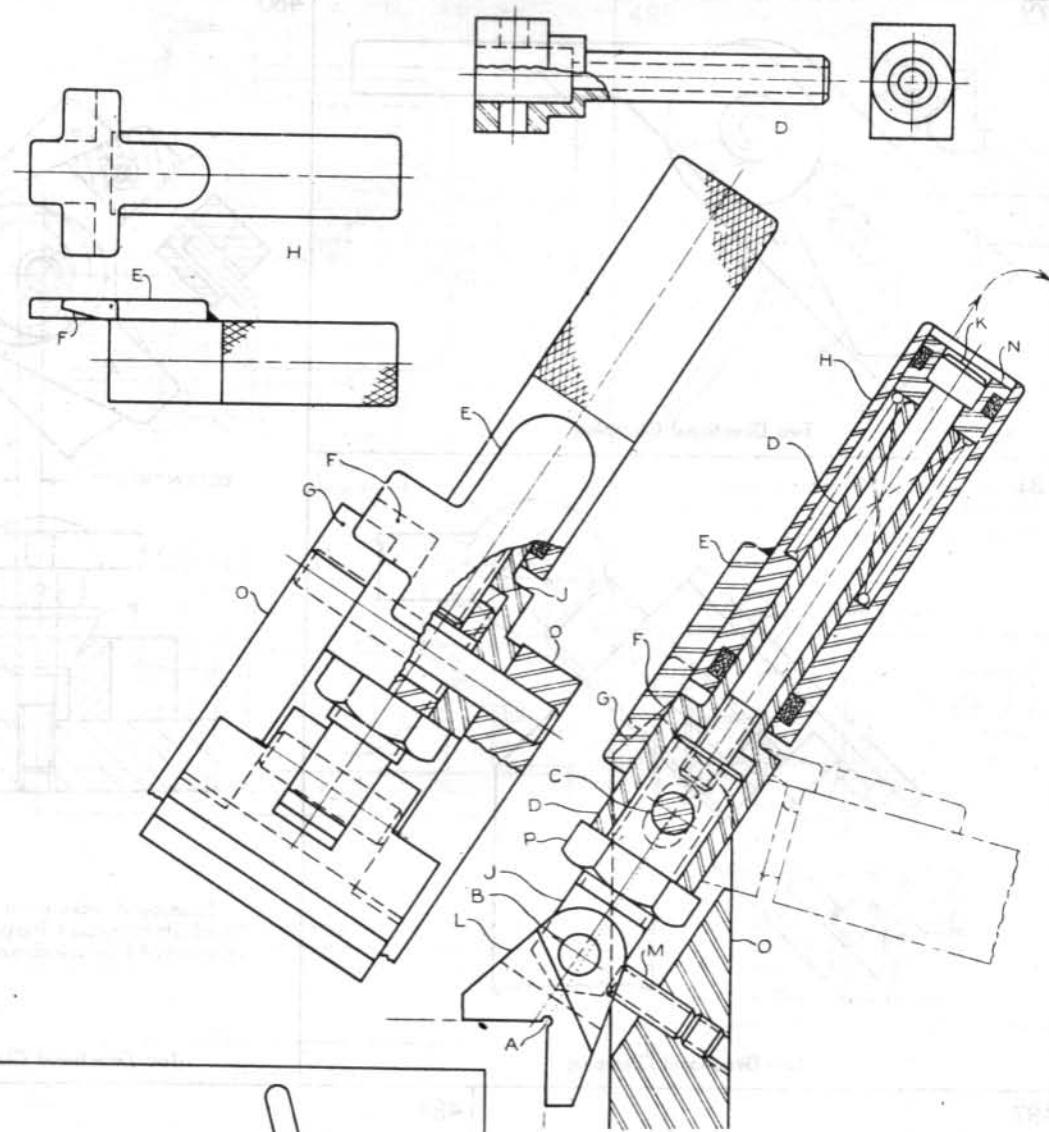
Two Directional Clamping

476

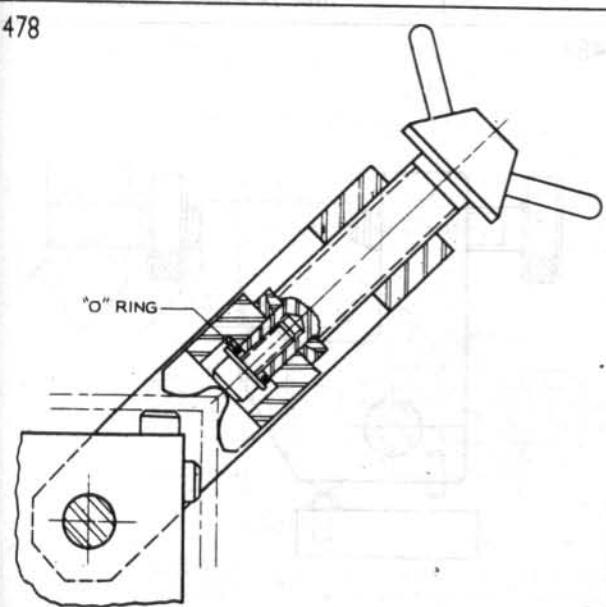


Two Directional Clamping

477



478



Two Directional Clamping

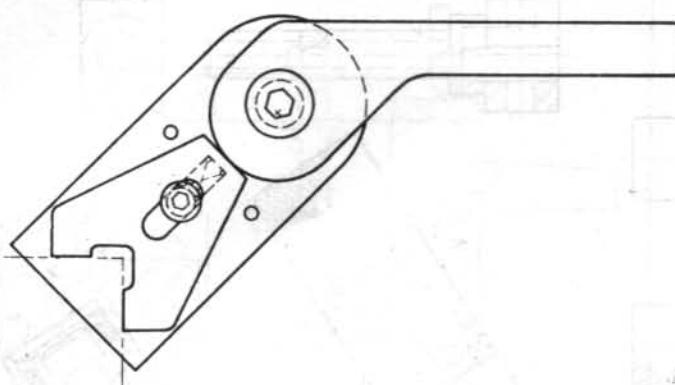
This is an application of a toggle linkage. A, B, C is the toggle linkage and M the adjustable stop. Since B does not extend slightly beyond a straight line connecting A and C, an extra stop is needed to prevent unclamping action. The extra stop is created by catch F hooking onto G. The spring holds E, of which F is a part, tightly against G. The operator pulls back on H to which E is welded, releasing F, and then the linkage may be bent at B and rotated about C.

Adjustment of the toggle linkage is provided by cap screw K and nut P. D is not threaded; it acts as a spacer between the cap screw head and nut P.

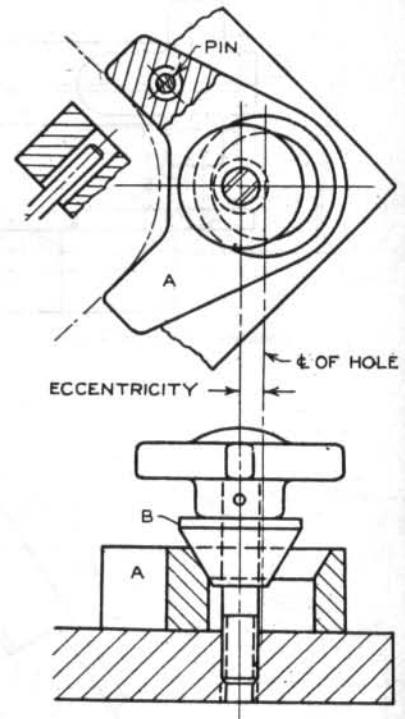
Two Directional Clamping

479-483

479

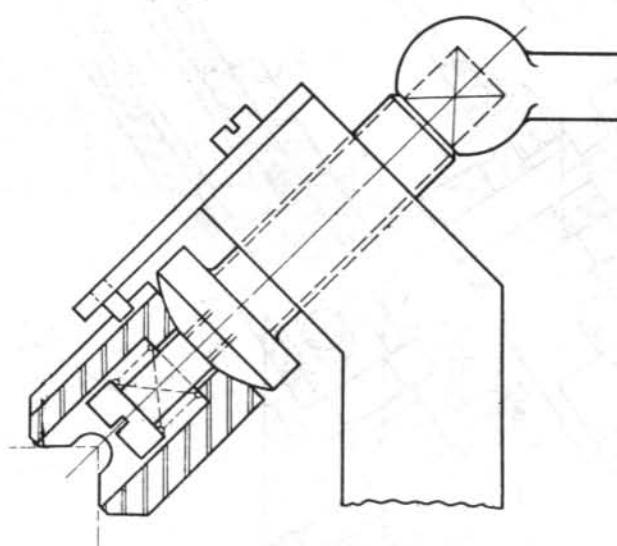


480



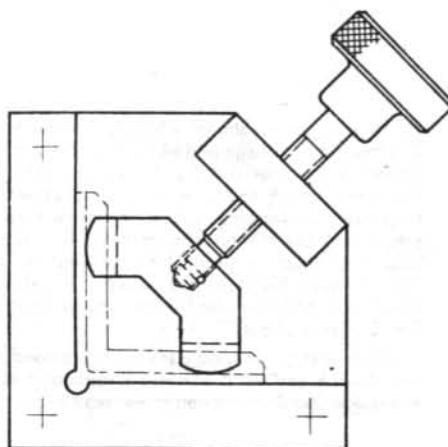
Equalizer A rocks about spreader B as it adjusts to the part. The pin in the frame prevents A from swinging out of position.

481

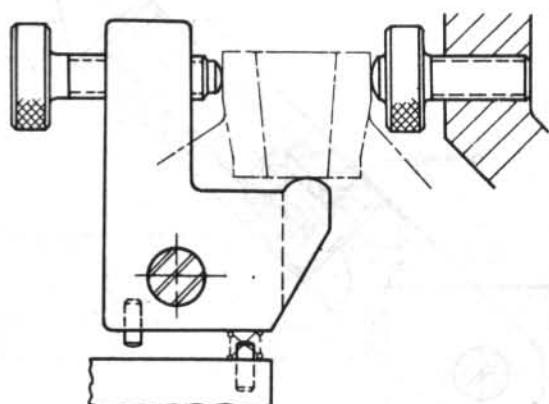


Two Directional Clamping

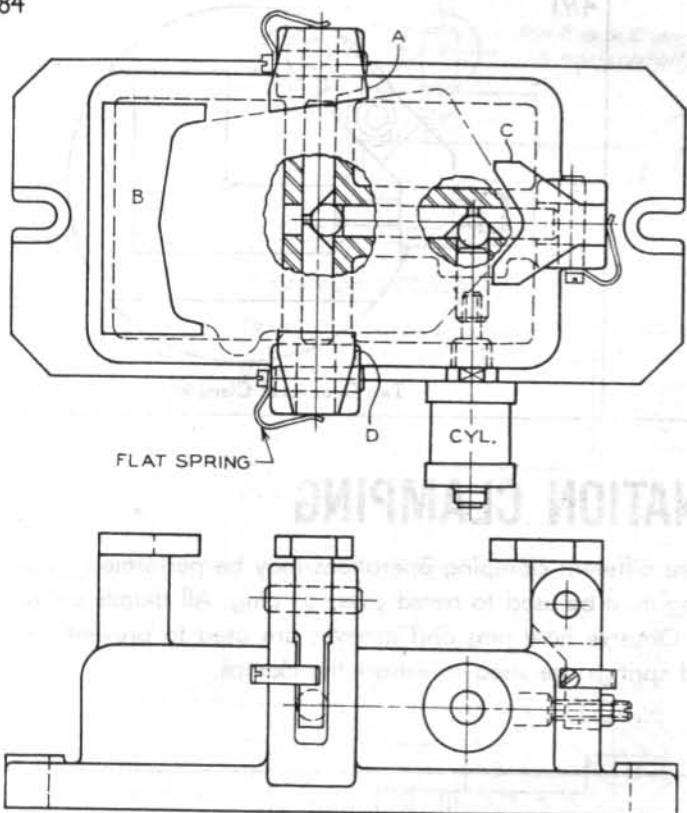
482



483



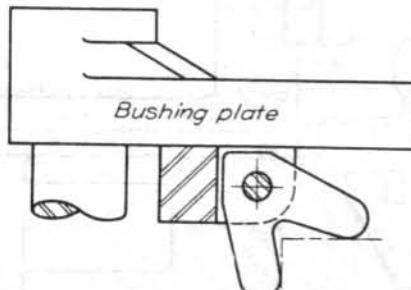
484



The cylinder causes two balls and four pins to actuate clamps A, C, and D. The part is forced against B as it is clamped.

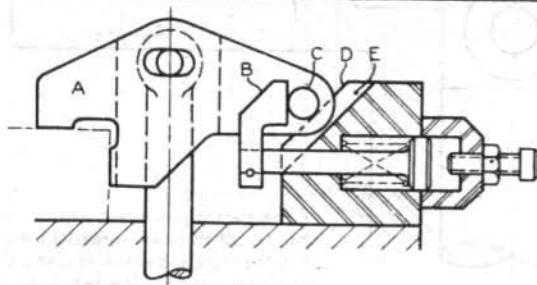
Two Directional Clamping

487



Two Directional Clamping

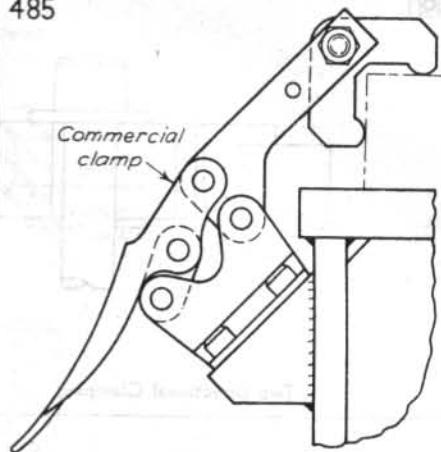
489



Clamp A with inserted pin C slides down cam D, groove E preventing it from turning. Spring-loaded B retracts the clamp.

Two Directional Clamping

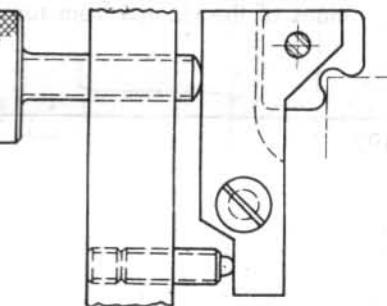
485



An equalizer has been added to this commercial toggle clamp. Commercial clamps are sometimes modified as an economy measure.

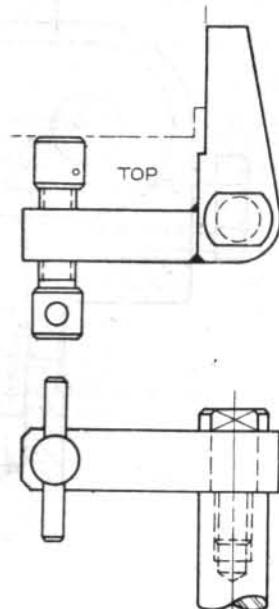
Two Directional Clamping

486



Two Directional Clamping

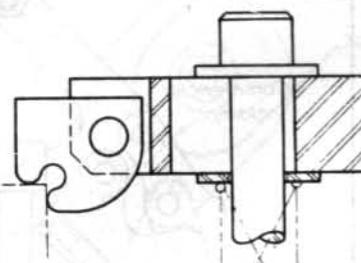
488



Two Directional Clamping

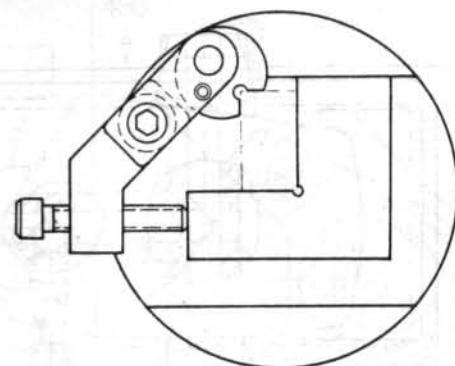
490-492

490



Two Directional Clamping

491

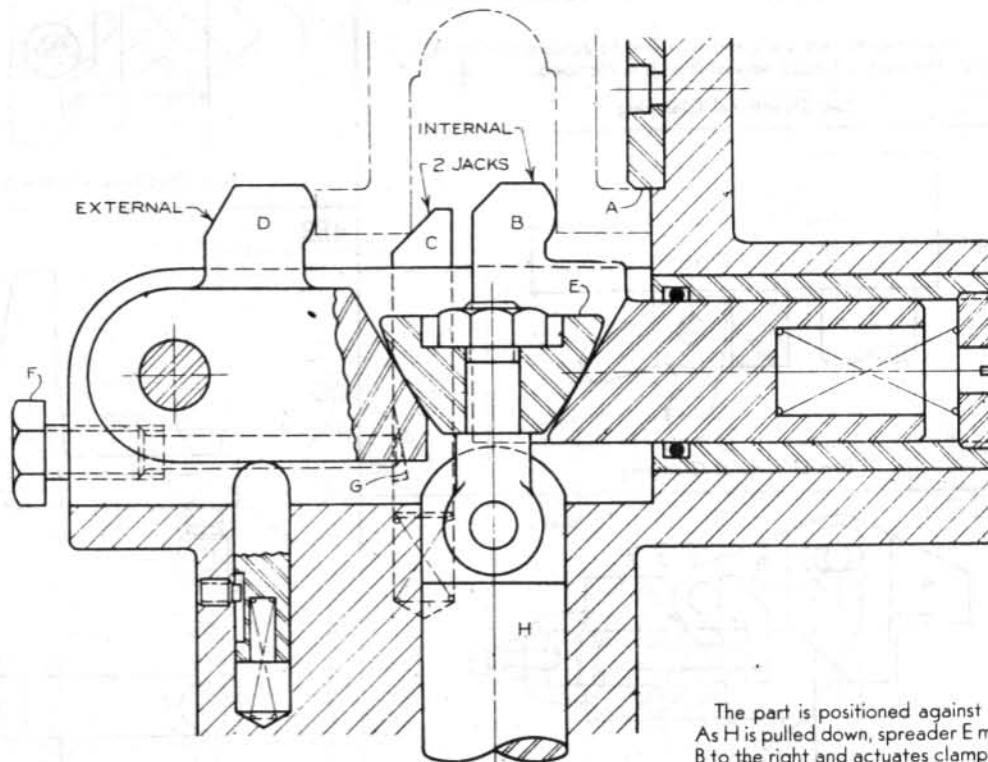


Two Directional Clamping

COMBINATION CLAMPING

To reduce loading time, two or more different clamping operations may be performed simultaneously. In some instances, equalizing must be used to avoid overclamping. All details should be studied, not just those mentioned. Observe how pins and grooves are used to prevent portions of the clamps from turning, and springs are used to retract the clamps.

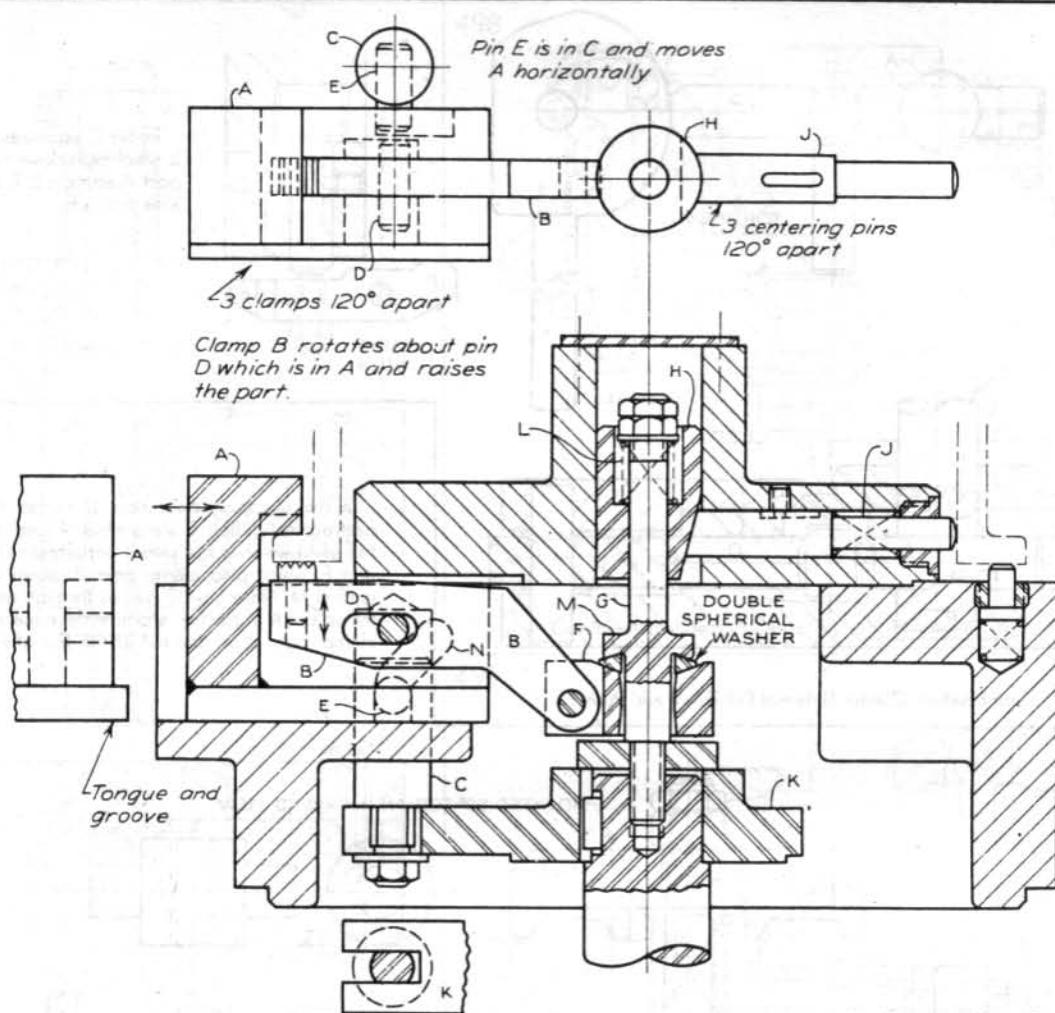
492



The part is positioned against shoulder A. As H is pulled down, spreader E moves clamp B to the right and actuates clamp D to rotate to clamp position. The two jacks are locked separately by F.

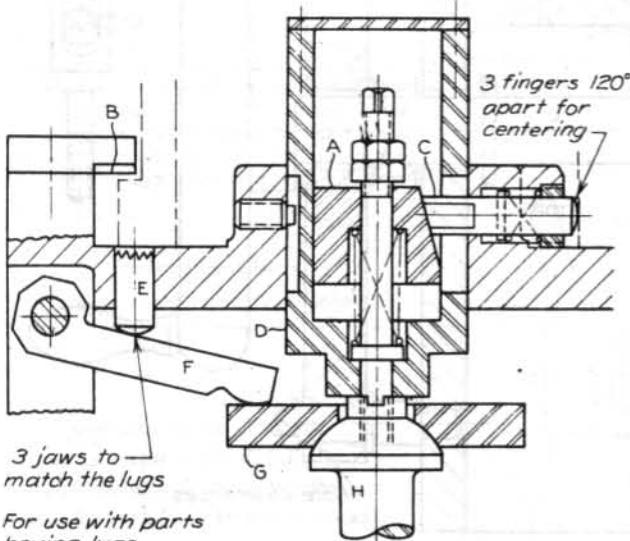
Combination Clamp (Internal, External, and Jack)

493



Combination Clamp (Centering and Raising the Part)

494



As soon as shoulder M is free of spring-loaded expander H, the three centering pins J center the part. Then clamp B pivots about pin D to raise the part and clamp it against A. Before the clamping stage is reached, post C pulls pin E down out of cam groove N, thereby drawing A into clamp position.

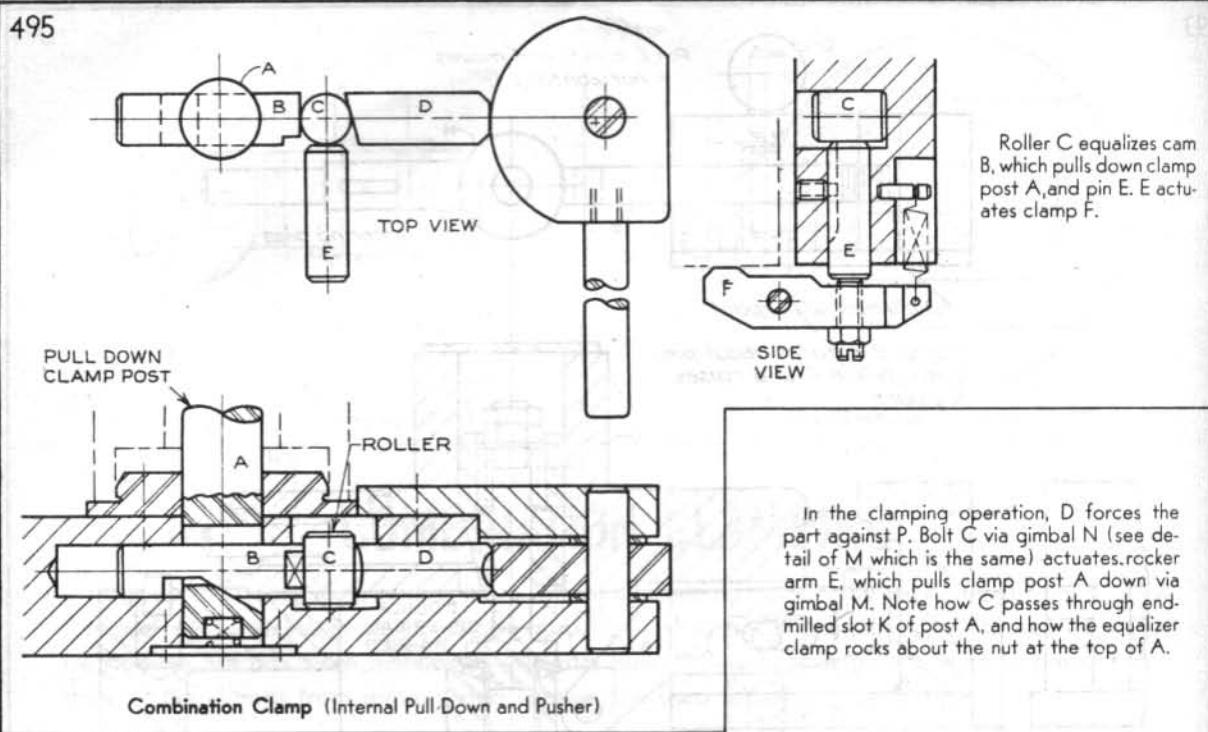
In the unclamping operation, M raises H, retracting pins J. Jaw B lowers, and pin E in post C follows cam N of A, moving outward horizontally to release the part.

When H is raised, it raises D and forces the spring to raise expander A, actuating the three pins C to center the part before plate G raises the three arms F, which, in turn, force E to raise the part to stop B.

Combination Clamp (Centering and Raising the Part)

495-496

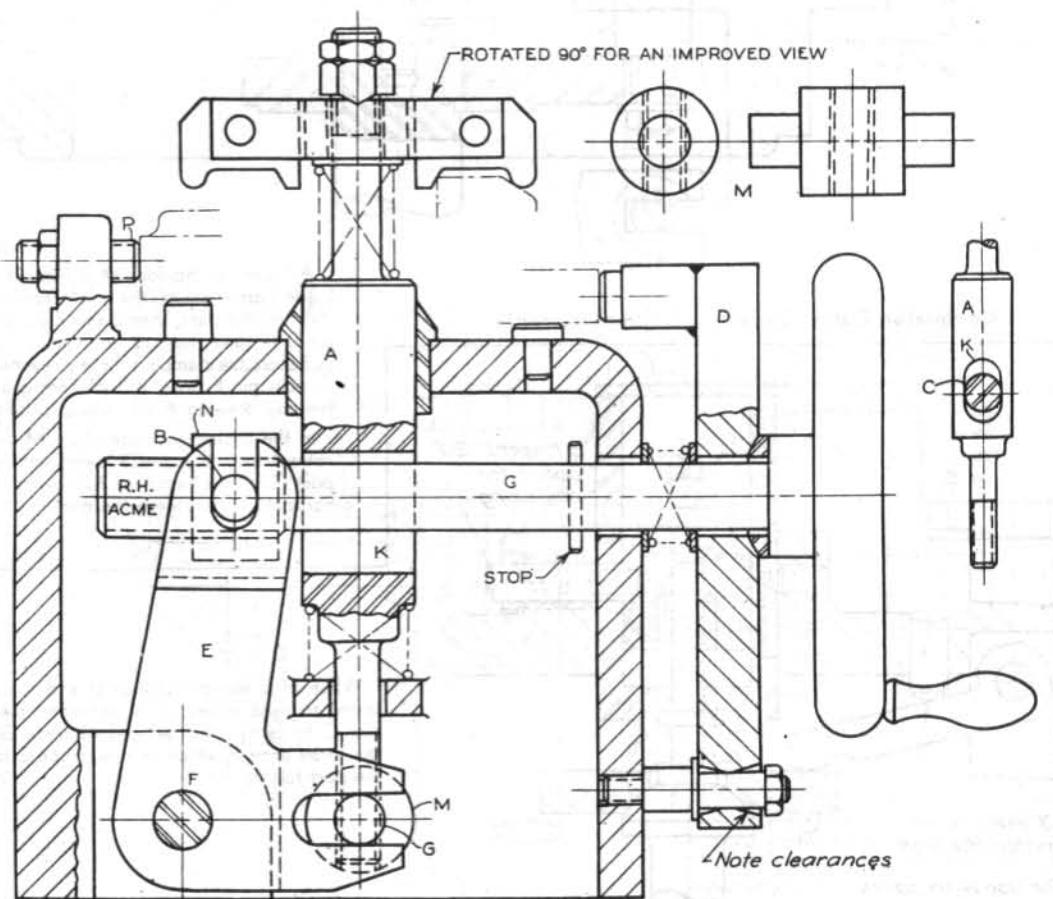
495



Roller C equalizes cam B, which pulls down clamp post A, and pin E. E actuates clamp F.

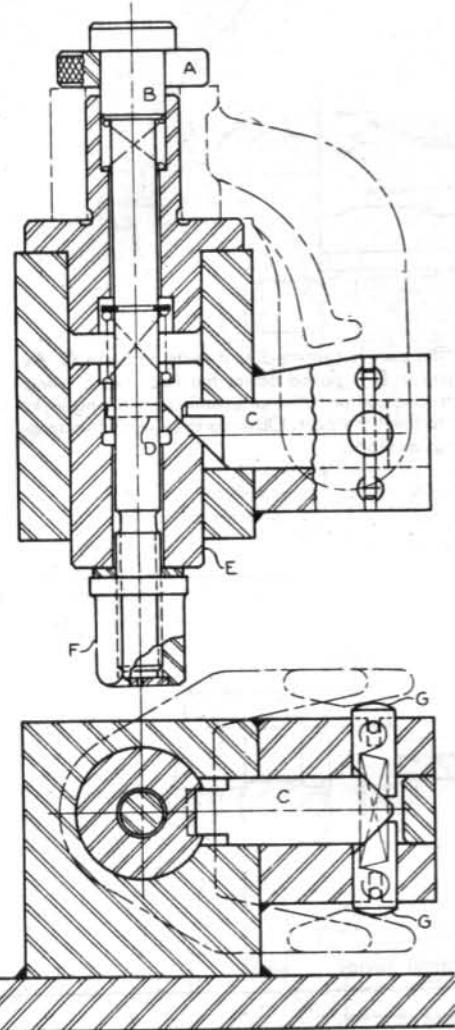
In the clamping operation, D forces the part against P. Bolt C via gimbal N (see detail of M which is the same) actuates rocker arm E, which pulls clamp post A down via gimbal M. Note how C passes through end-milled slot K of post A, and how the equalizer clamp rocks about the nut at the top of A.

496



Combination Clamp (Internal Pull Down and Pusher)

497

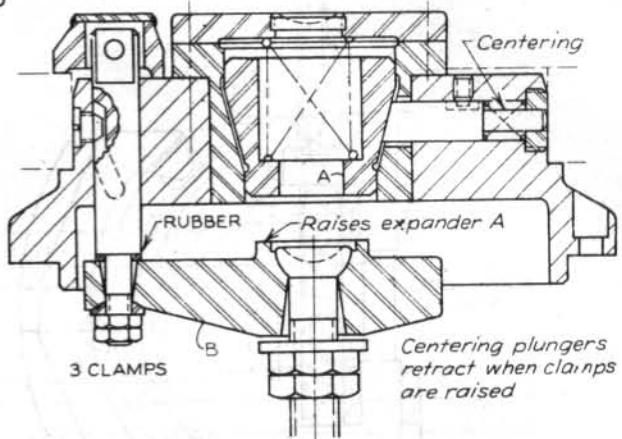


When nut F is turned, cam E forces spreader C outward to actuate the two jaws G that center the part, and bolt B is drawn down, clamping c-washer A against the part. Note how pin D keeps the bolt from turning and C fits in a groove in E to keep it from turning.

Combination Clamp
(Centering and Internal Pull Down)

"I never did anything worth doing by accident nor did any of my inventions come by accident; they came by work." THOMAS A. EDISON

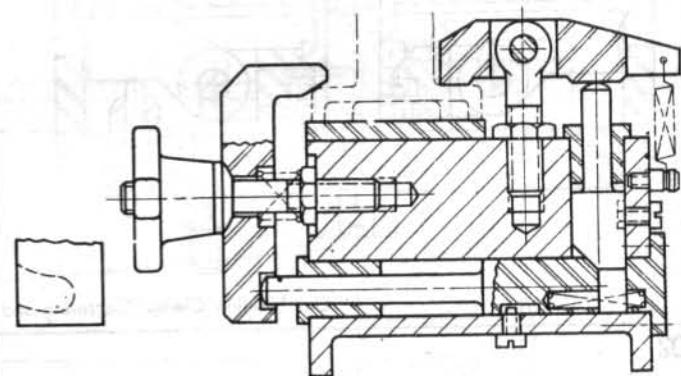
498



Raising trunnion B actuates the three clamping jaws to rotate inward and raises spring-loaded expander A, allowing the centering jaws to retract.

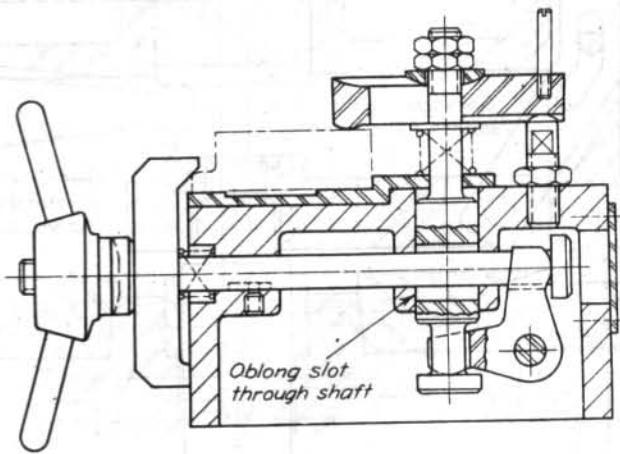
Combination Clamp (Centering and Internal Pull Down)

499



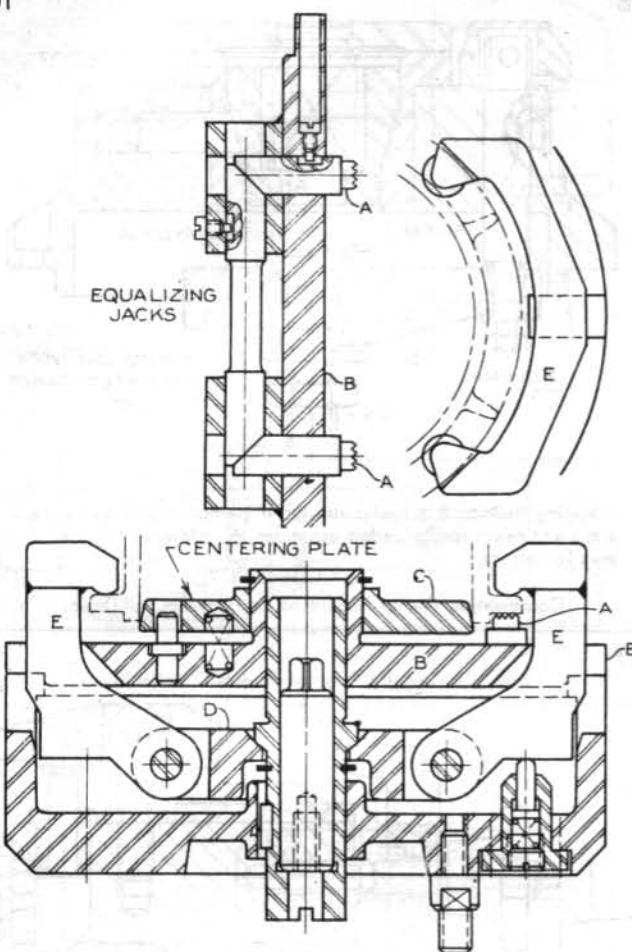
Combination Clamp (Toe and Clamping in the Rear)

500



Combination Clamp (Toe and Clamping in the Rear)

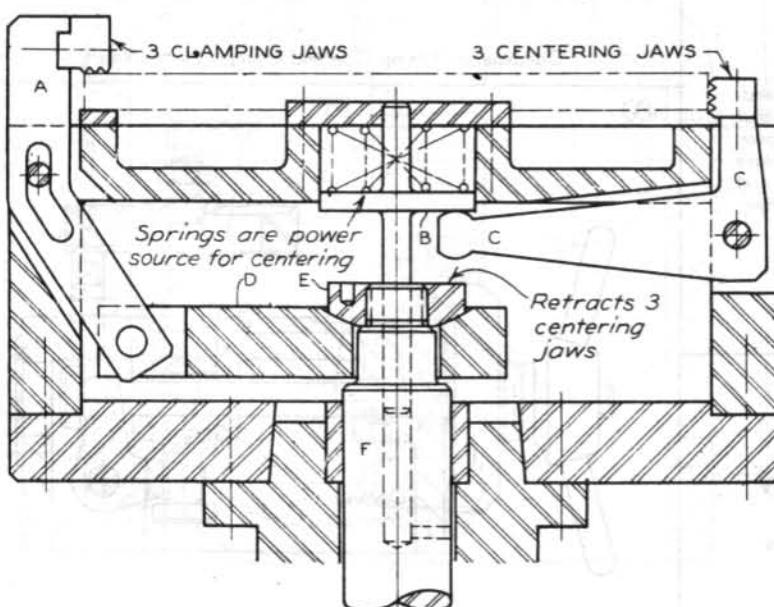
501



The part is centered as it rests on plate C. As trunnion D is pulled down, the two jaws E swing into position and clamp, enabling equalizing jacks A to level the part. Observe the use of two snap rings as stops.

Combination Clamp (Centering and External Swing)

502



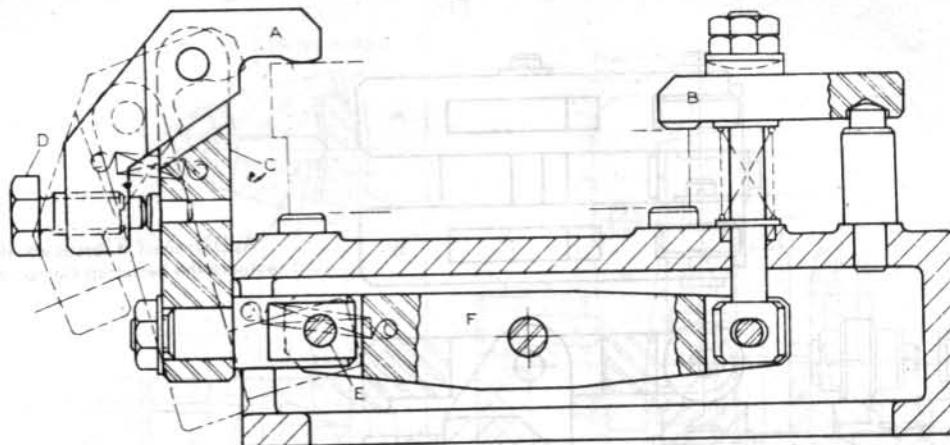
As F raises trunnion D, the three clamping jaws A swing outward, and nut E strikes the three centering jaws C, swinging them outward also. E raises B by means of C, compressing the springs. Before jaws A reach the clamping position, E is lowered, freeing the springs to actuate centering jaws C.

The space allotted the springs is not adequate to accommodate one spring of sufficient strength with the required amount of compression, therefore two springs with greater combined compressibility are used.

Note the airvent in F for the lower end of B.

Combination Clamp (Centering and External Swing)

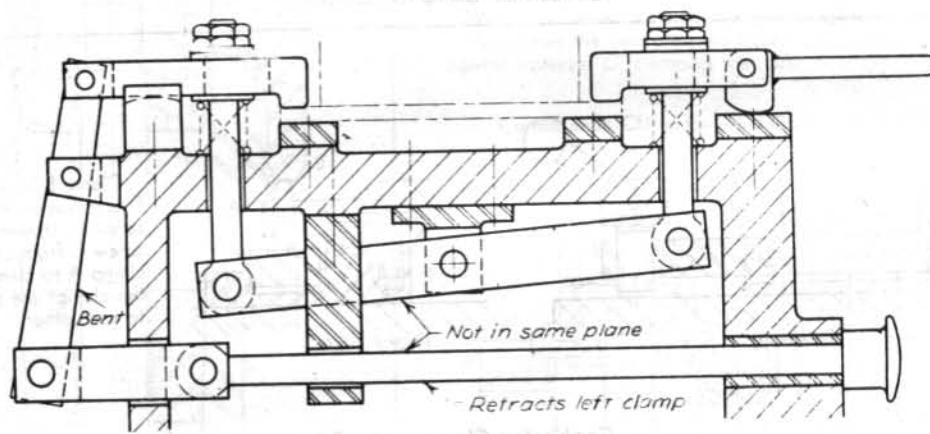
503



As D is tightened, A is forced to clamp and pulls C up, which raises F and pulls clamp B down. When unclamped, A, C, and D swing outward, revolving about E.

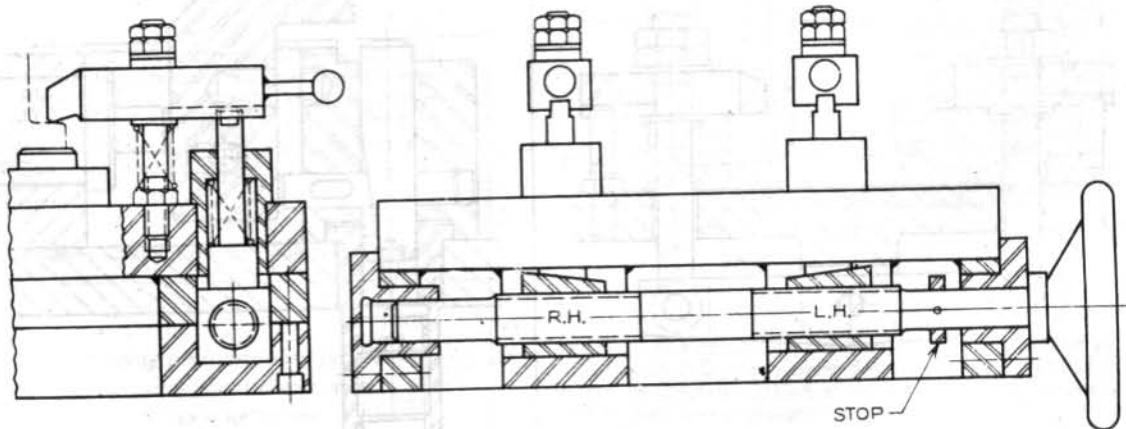
Combination Clamp (Double Toe)

504



Combination Clamp (Double Toe)

505



Combination Clamp (Double Toe)

ate C. As
s E swing
lizing jacks
f two snap

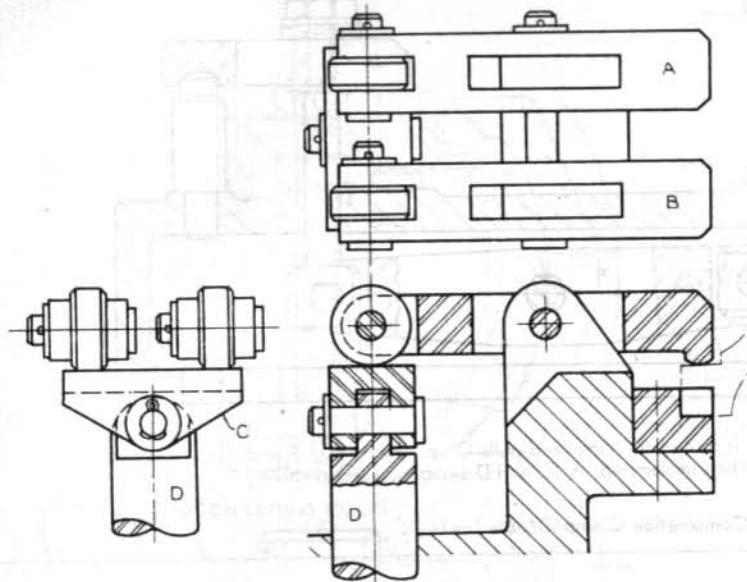
on D, the three
g outward, and
three centering
them outward
means of C, com-
Before jaws A
g position, E is
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in F for the low-

506-509

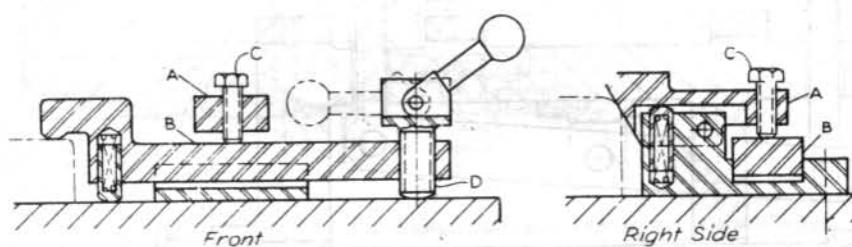
506



As D is raised, it forces equalizer C to actuate the two strap clamps, A and B.

Combination Clamp (Double Toe)

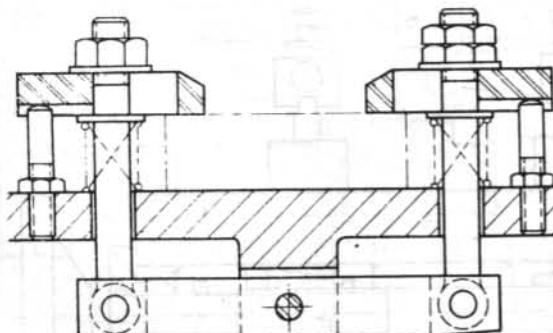
507



Clamp B is raised by screw D and forced to pivot about screw C. Upward pressure on screw C from clamp B forces clamp A to clamp. Note that the clamps are perpendicular to each other.

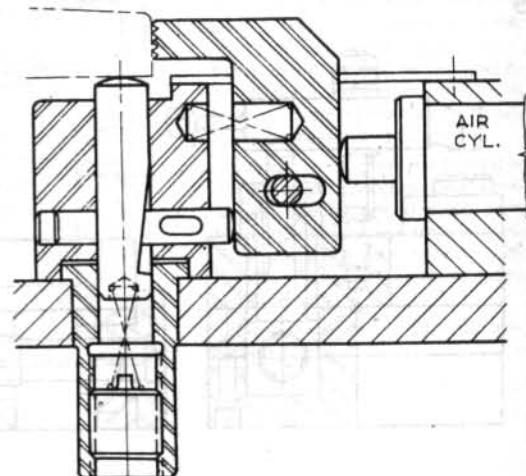
Combination Clamp (Double Toe)

508



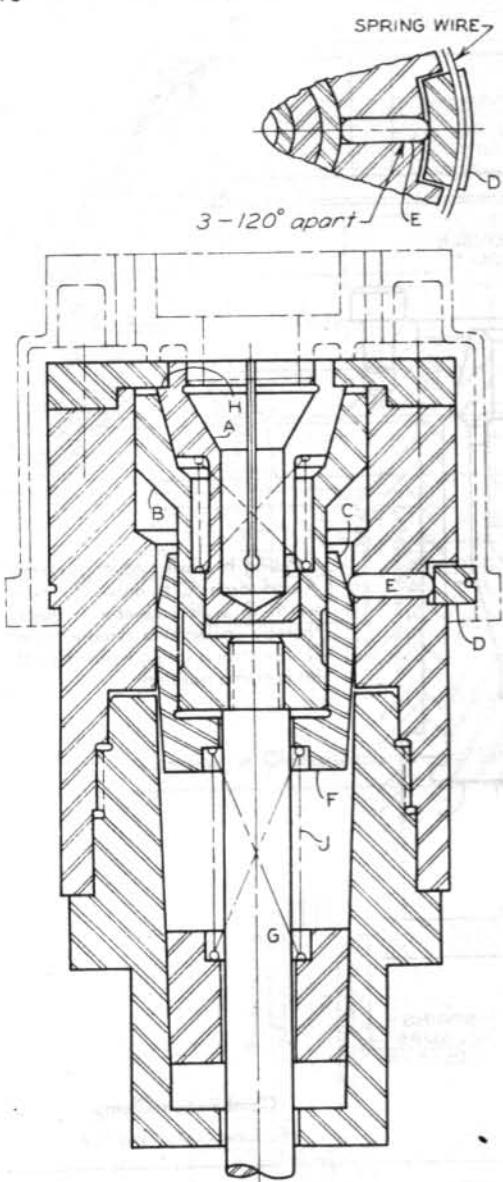
Combination Clamp (Double Toe)

509

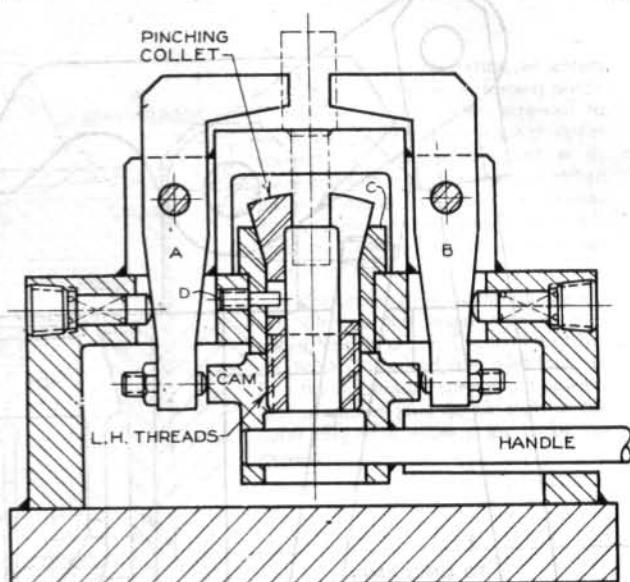


Combination Clamp (Pusher and Jack)

510



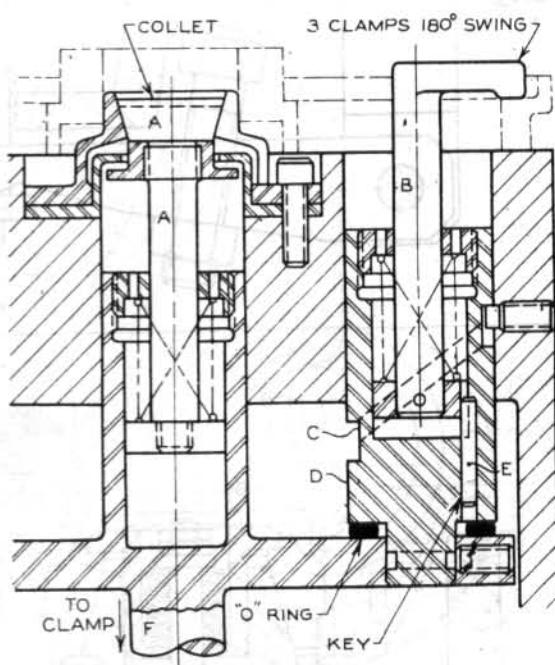
511



When the handle rotates the cam that actuates jaws A and B, it also screws the cam onto the collet, pulling the collet down against squeezer C, clamping the part.

Combination Clamp (External Collet and External)

512



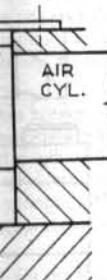
As F is pulled down in the clamping operation, expander A expands the collet; D rotates clamp B into position and then pulls it down. Cam C rotates D. Pin E allows B to move only vertically within D. Both springs prevent overclamping.

Combination Clamp (Internal Collet and Internal Pull Down)

"It's amazing what ordinary people can do if they set out without preconceived notions." CHARLES F. KETTERING

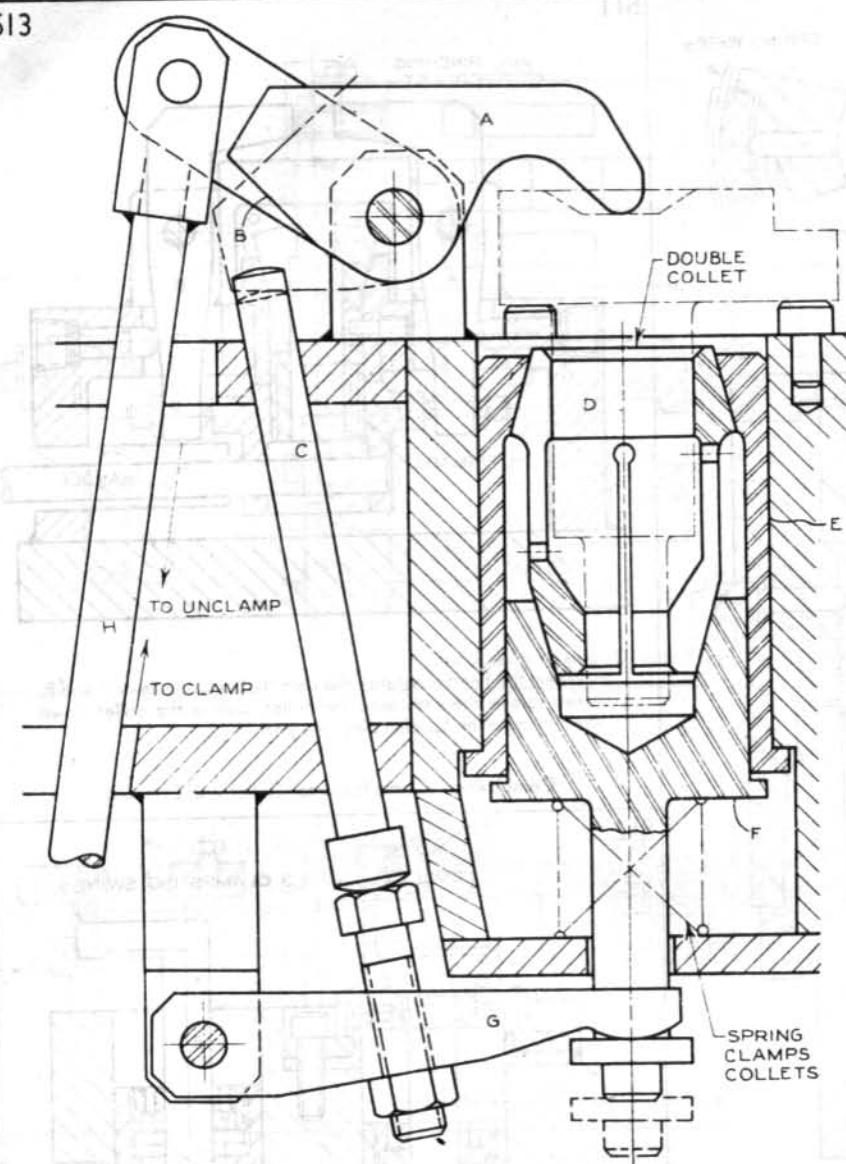
lizer C to
A and B.

ed by screw
pivot about
pressure on
amp B forces
p. Note that
perpendicular



Jack

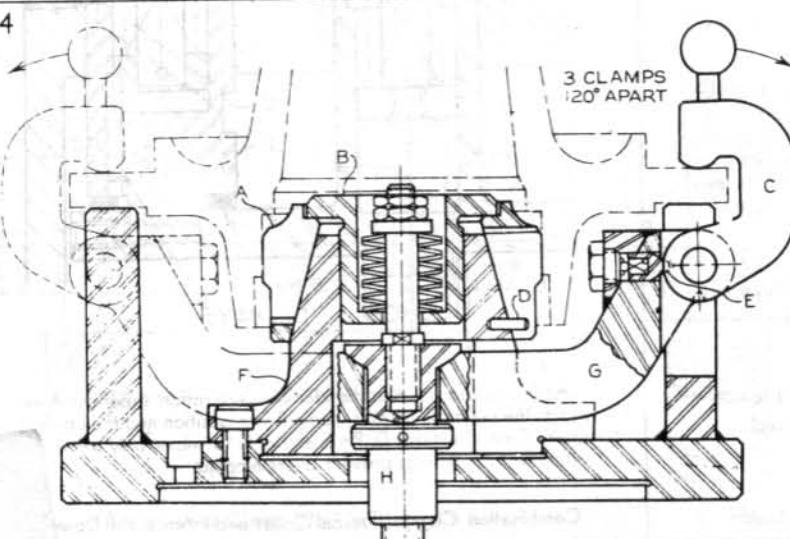
513



Pulling H down unclamps clamp A and forces C to move G downward. G pulls squeezer F down, thereby unclamping double collet D. The strong spring holds the collet in clamp position.

Combination Clamp
(External Collet and Toe)

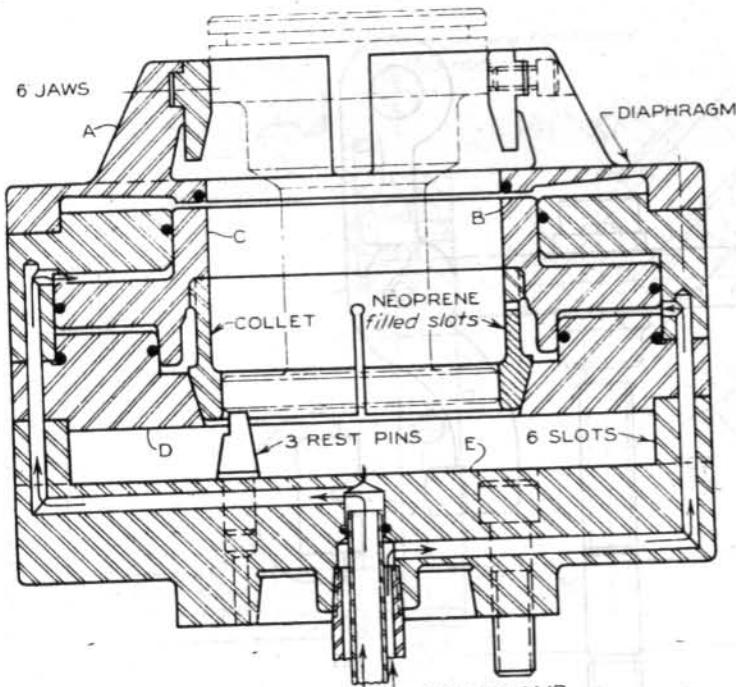
514



As H is pulled down, spring-loaded B forces collet A against spreader F, clamping the part internally. H also pulls down trunnion G, clamping the part externally. Detent E holds the clamp in either of two positions.

Combination Clamp
(External Swing and Internal Collet)

515

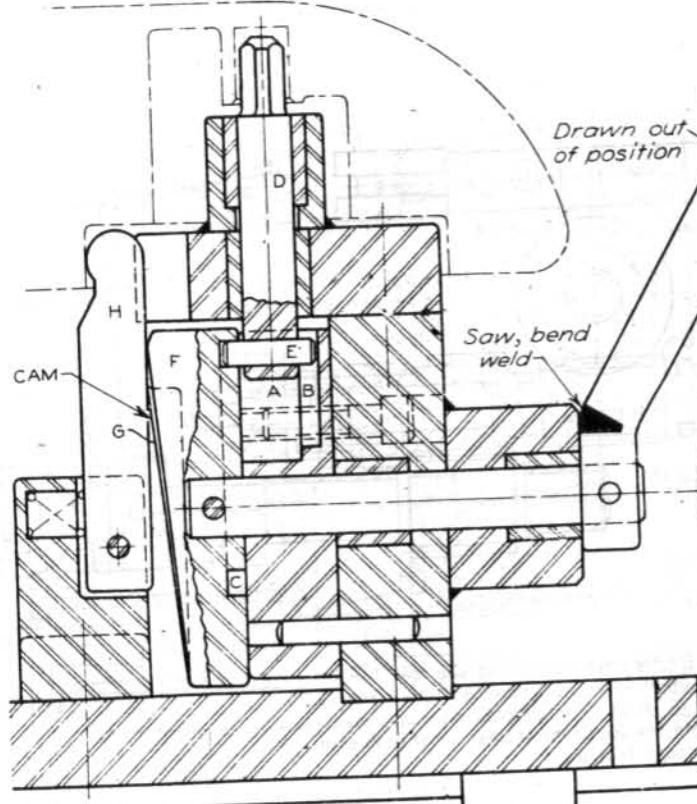


In the clamping operation, air enters through the smaller pipe, forcing piston C downward. The collet, screwed to C, is also forced down against collet squeezer D, clamping the part at its lower end as it rests on three pins. When piston C moves downward, it releases its pressure on the prestressed diaphragm, allowing it to clamp the upper portion of the part.

In the unclamping operation, air enters through the larger pipe as indicated; raising piston C and the collet. As piston C is raised, it applies force at B to the diaphragm, springing it upward and spreading jaws A. Six slots in the outer ring of E allow chips to be removed.

unclamps clamp move G down-
squeezes F down,
double collet
holds the col-
let.

516

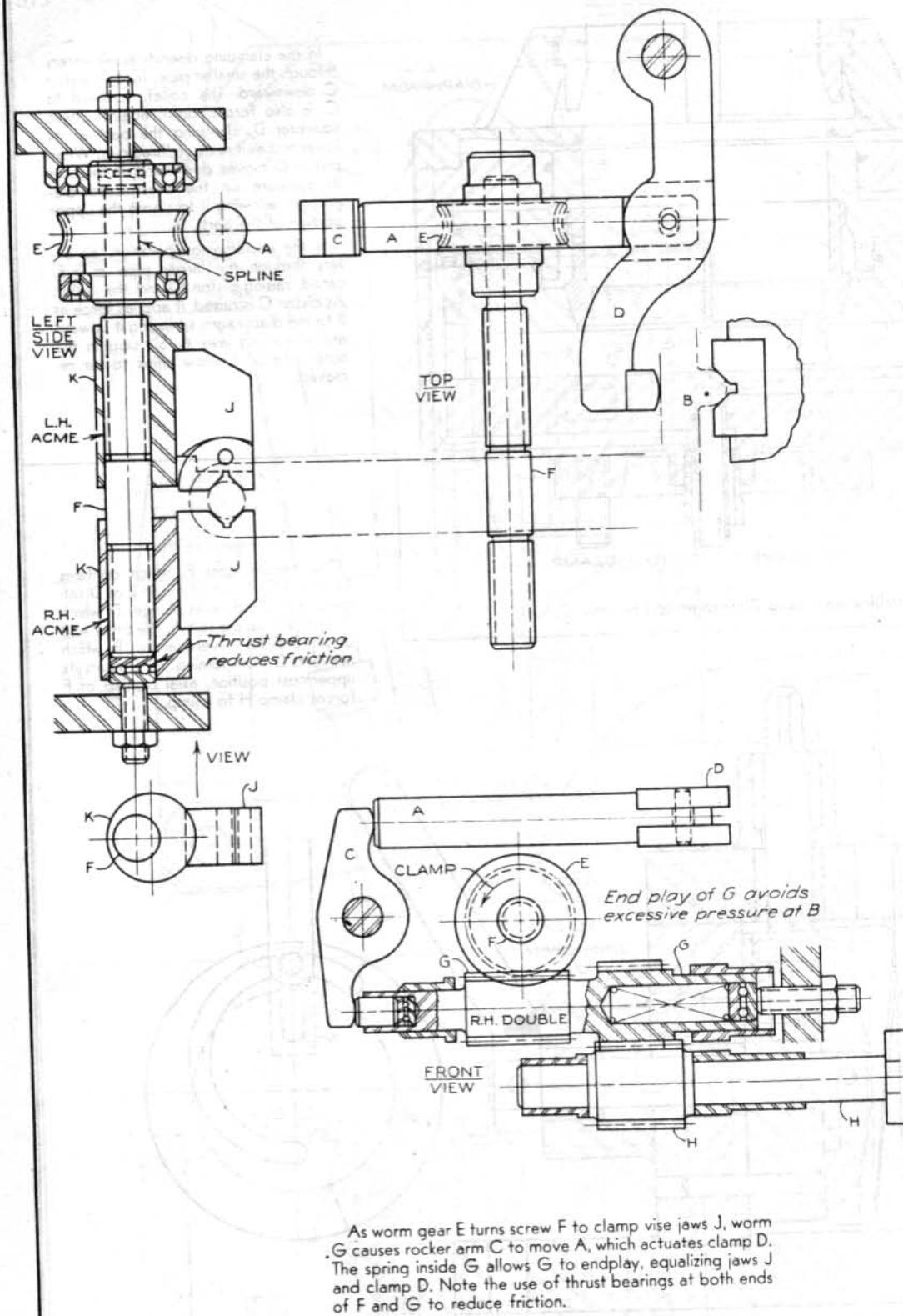


The handle turns F, which contains face cam C. One end of pin E of D follows cam C and raises plunger D, which functions in square slot A. The other end of pin E slides in vertical slot B, which prevents D from turning. As D nears its uppermost position, axial cam G of F forces clamp H to clamp.

on Clamp
(jet and Toe)

ed down, spring-
collet A against
mping the part in-
pulls down trunnion
e part externally.
he clamp in either

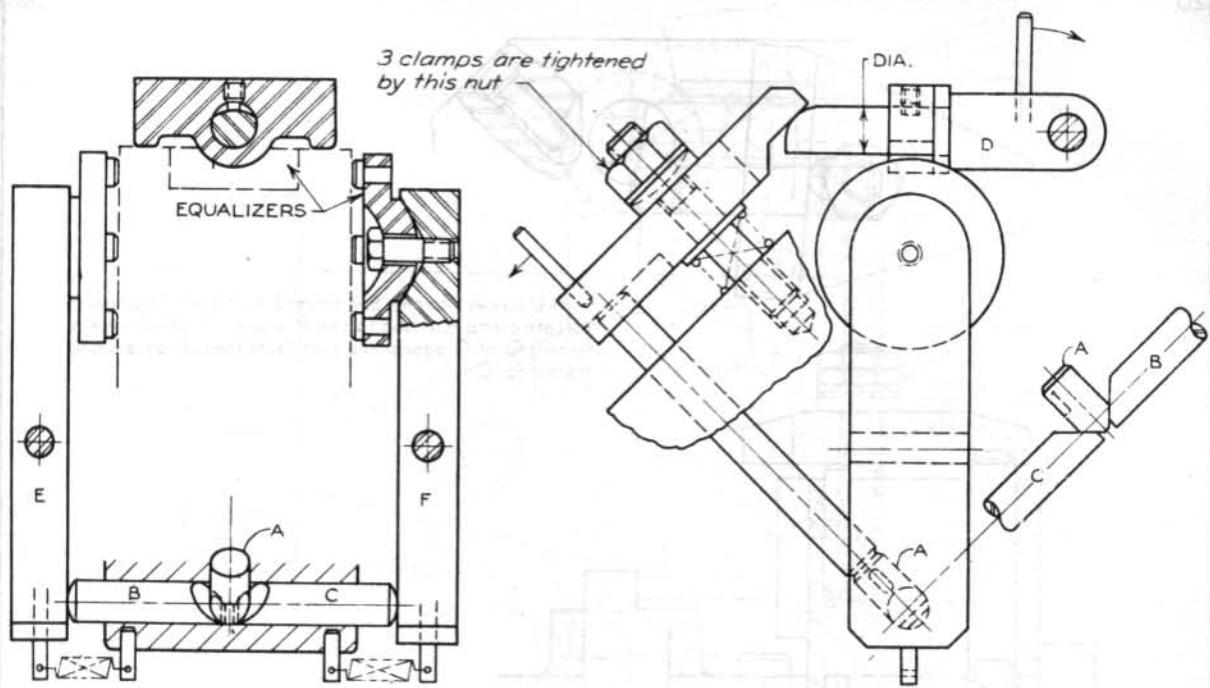
on Clamp
(Internal Collet)



As worm gear E turns screw F to clamp vise jaws J, worm G causes rocker arm C to move A, which actuates clamp D. The spring inside G allows G to endplay, equalizing jaws J and clamp D. Note the use of thrust bearings at both ends of F and G to reduce friction.

Combination Clamp (External and Pusher)

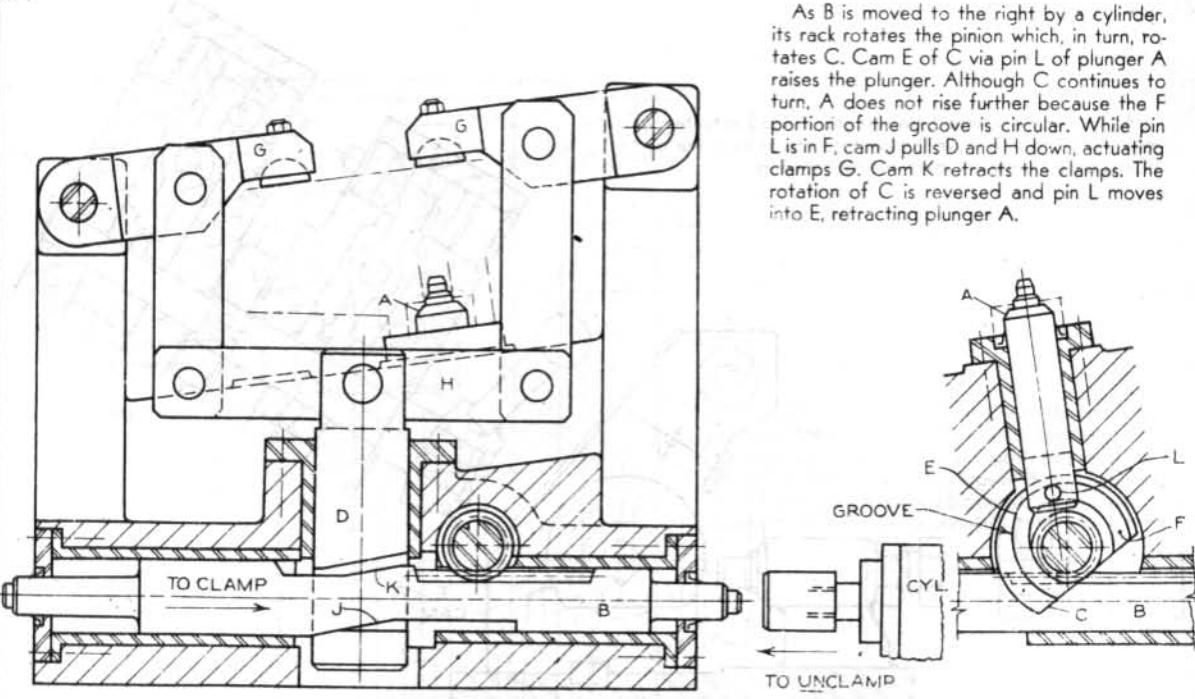
518



As the nut is turned, clamp D and its equalizer are forced down. Spreader A is forced to move B and C, which actuate the two clamps, E and F.

Combination Clamp (Three Directional)

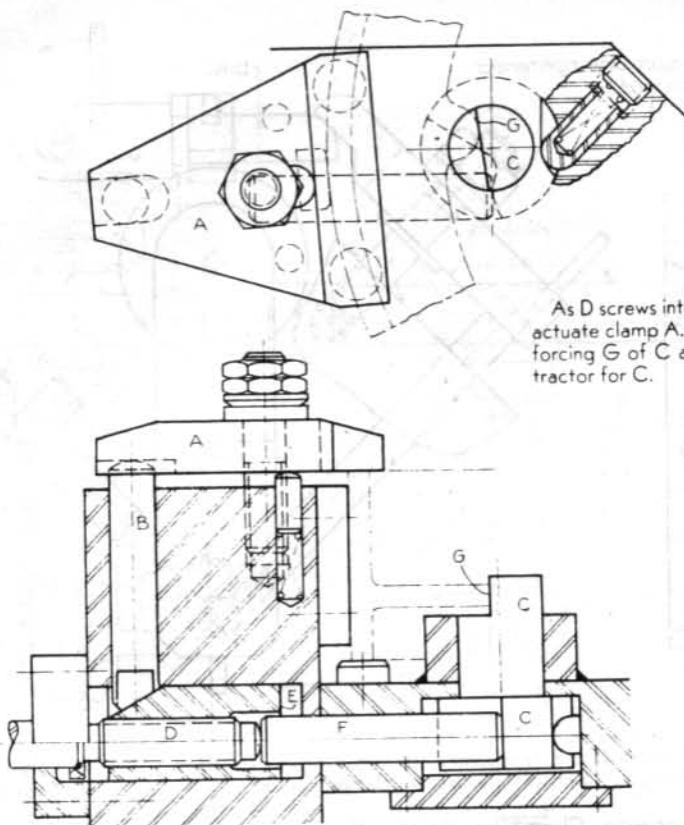
519



Combination Clamp (Double Toe and Plunger)

520-521

520

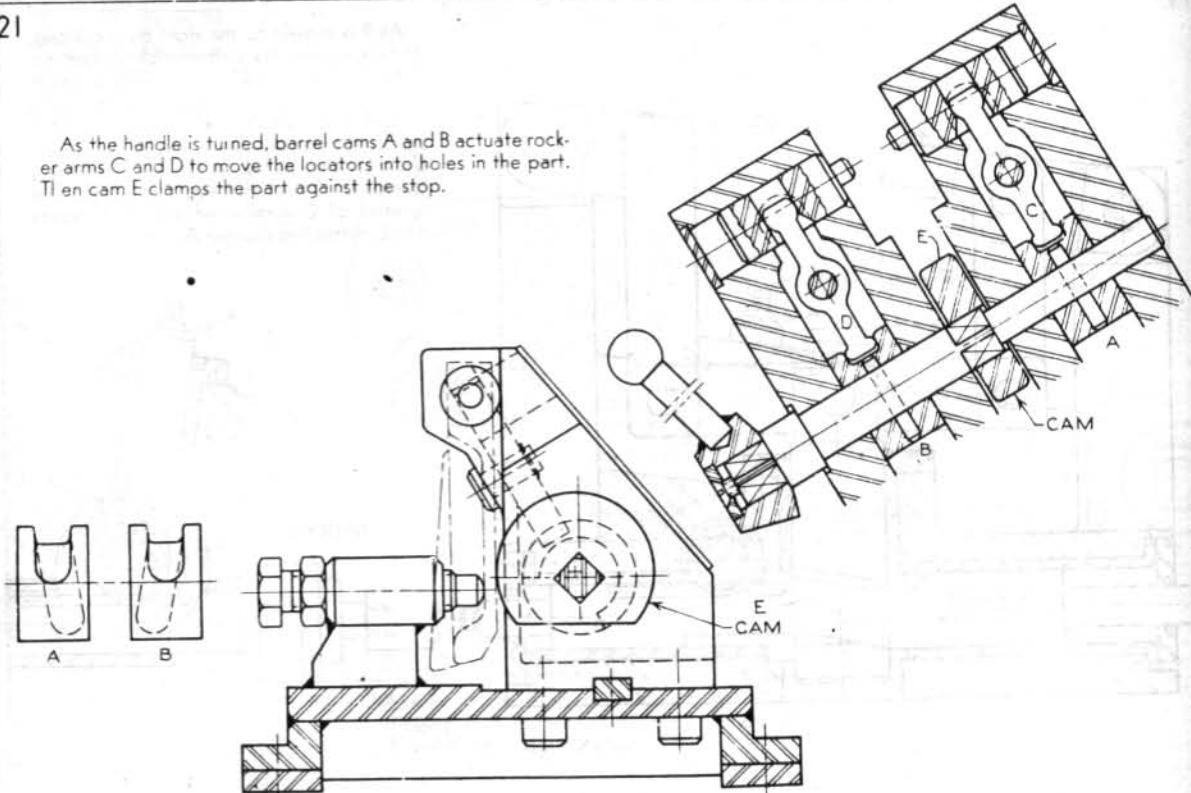


As D screws into cam E, it moves E to the left, forcing B to actuate clamp A. D also forces F against C, which rotates, forcing G of C against the part. Note the spring-loaded retractor for C.

Combination Clamp (Toe and Pusher)

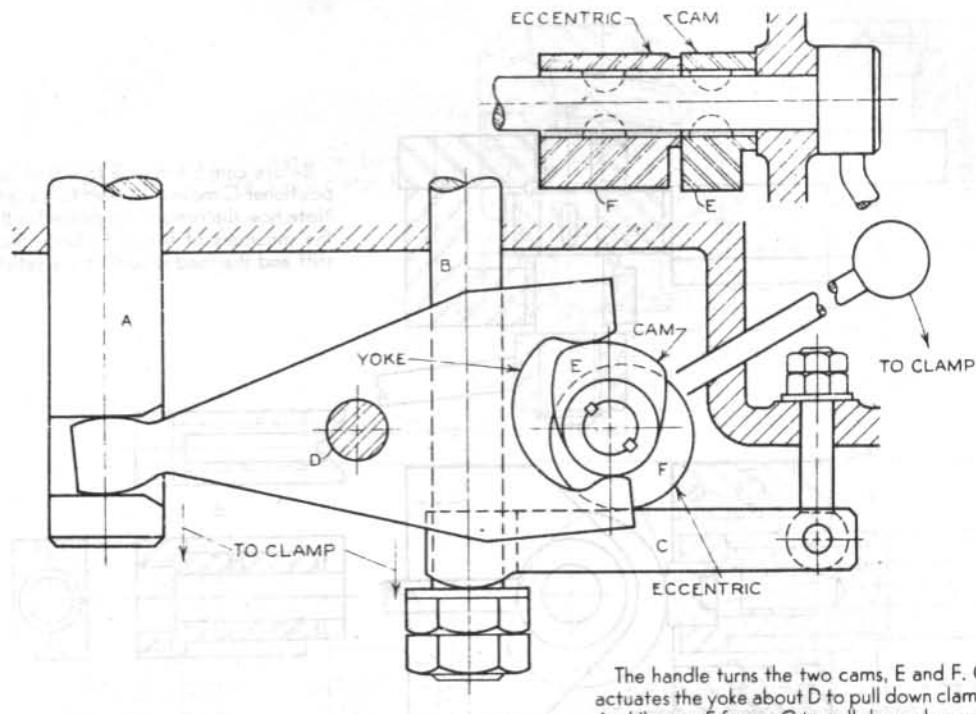
521

As the handle is turned, barrel cams A and B actuate rocker arms C and D to move the locators into holes in the part. Then cam E clamps the part against the stop.



Combination Clamp (Locators and Cam)

522

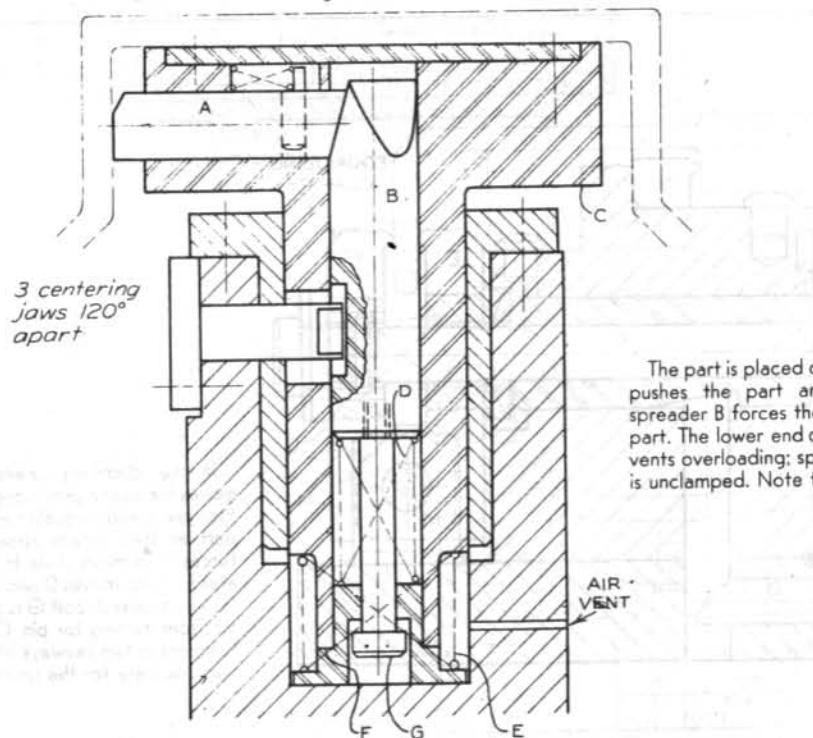


The handle turns the two cams, E and F. Cam E actuates the yoke about D to pull down clamp post A while cam F forces C to pull down clamp post B.

Combination Clamp (Double Pull Down)

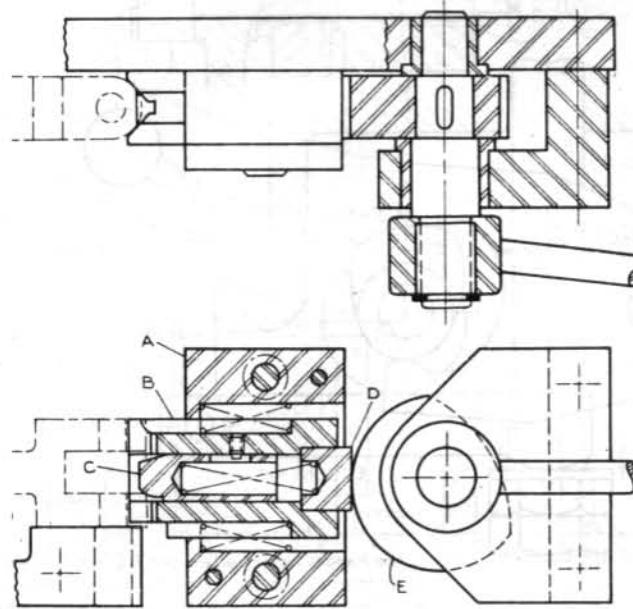
523

Part is held down by an overhead clamp



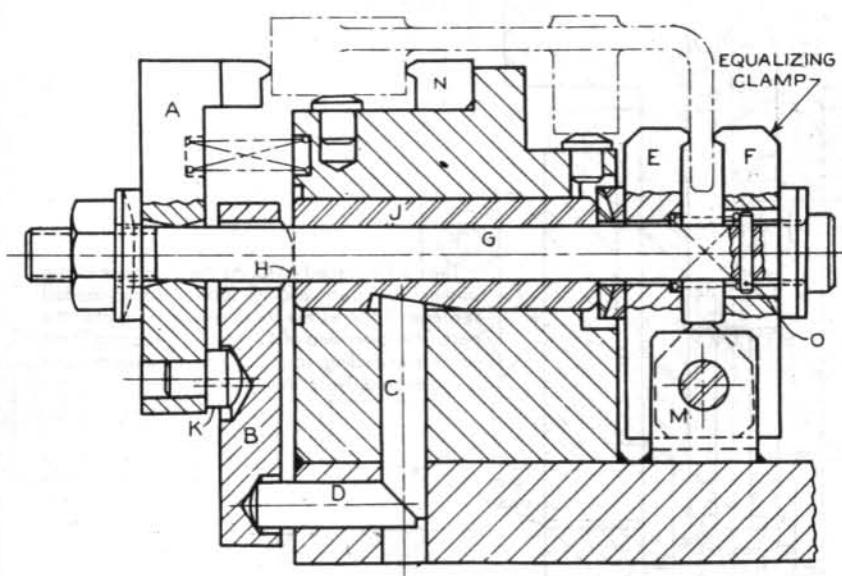
The part is placed on C. As the overhead clamp pushes the part and C down, spring-loaded spreader B forces the three jaws A to center the part. The lower end of C stops at F. Spring D prevents overloading; spring E raises C when the unit is unclamped. Note the airvent.

Combination Clamp (Overhead and Centering)



Before cam E forces B to clamp, spring-loaded positioner C moves the part to the left and down. Note how the retracting springs for B rest on only the shoulders of B and A. Since the springs are stiff and the load is light, this is satisfactory.

Combination Clamp (Pusher and Positioner)



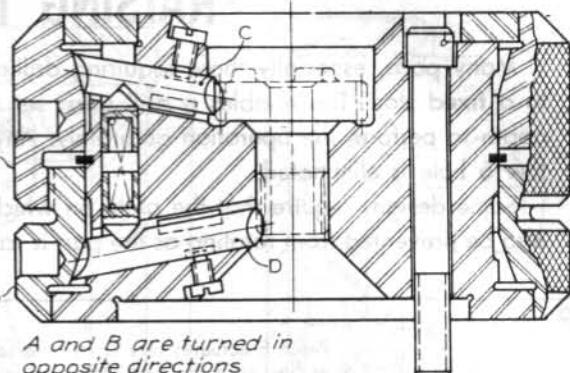
In the clamping operation, A moves the part against stop N, and then jaws E and F equalize about the part as they rotate about M. K forces B to move J via H. J actuates E. B also moves D and it moves C, which locks J. Bolt G is prevented from turning by pin O, which functions in two keyways of F. O is also one base for the spring.

Combination Clamp (External and Clamping in the Rear)

526

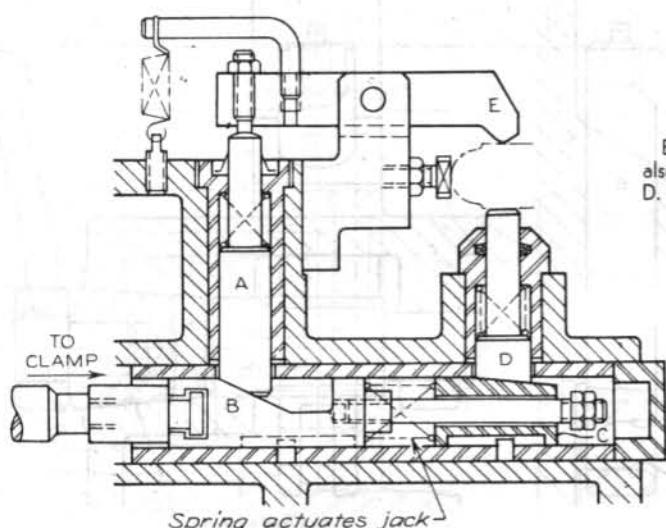
DESIGN THE PART

When A and B are turned in opposite directions by inserted rods, the three jaws C and the three jaws D clamp the part at two levels.



Combination Clamp (Double External)

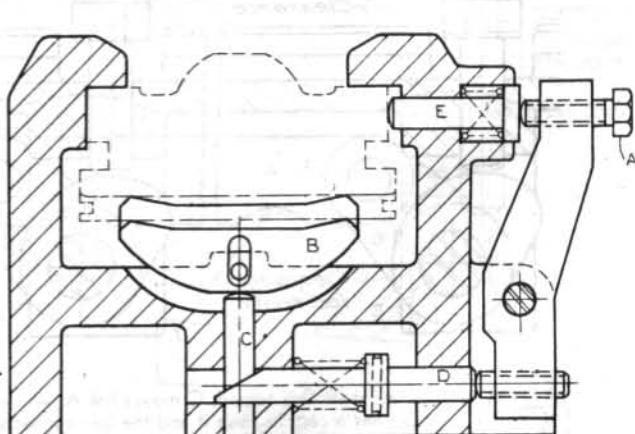
527



Combination Clamp (Toe and Jack)

528

Turning A forces D to raise C and, in turn, equalizer B, which raises the part to the stops. A also forces E to move the part to the left stop.



Combination Clamp (Pusher and Raising the Part)

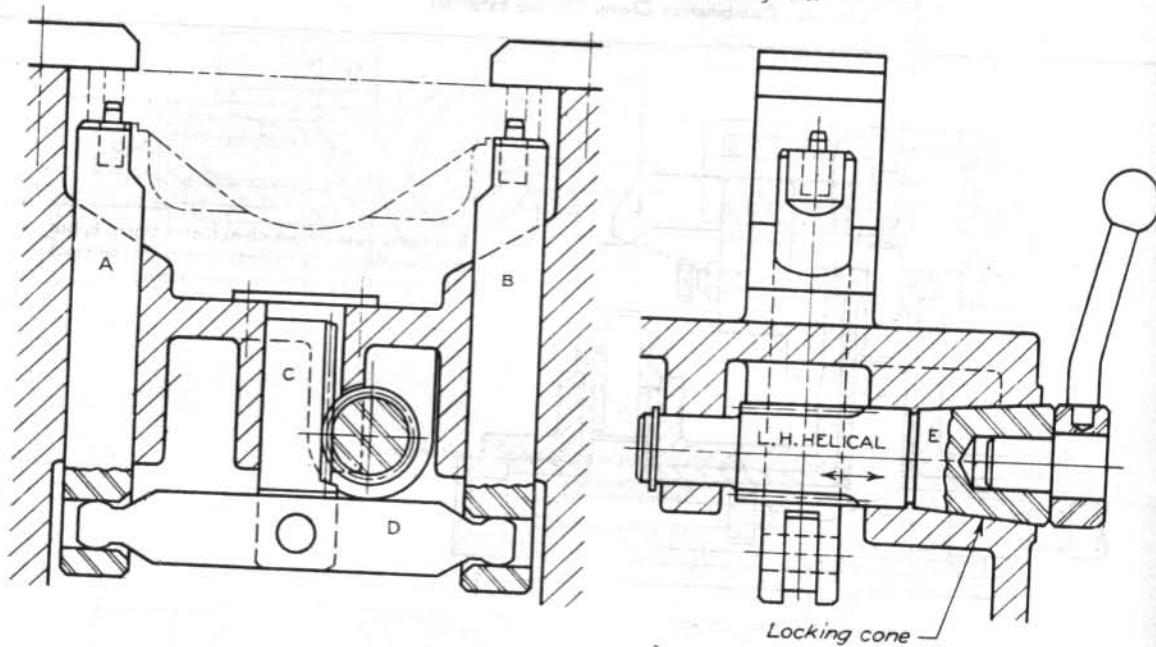
RAISING THE PARTS

Many parts, especially those requiring drilling or tapping operations, are raised on a plate to a fixed stop. This enables a drill press set to allow a drill to drill the part to a specified depth to perform the operation accurately. Any possibility of unintentionally drilling too shallow a hole is eliminated.

Some designs require that the plate on which the part is raised not only be an equalizer but also be prevented from rotating as the part is raised.

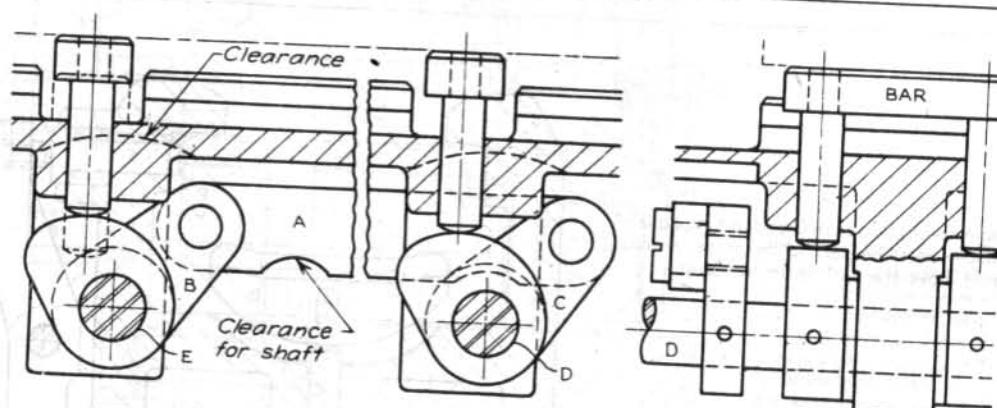
529

Pinion E actuates rack C to raise rocker arm D, which equalizes posts A and B as they raise the part. After the unit is clamped, the helical pinion slides to the left, pulling the cone into locking position in its mating hole.



Raising the Part

530

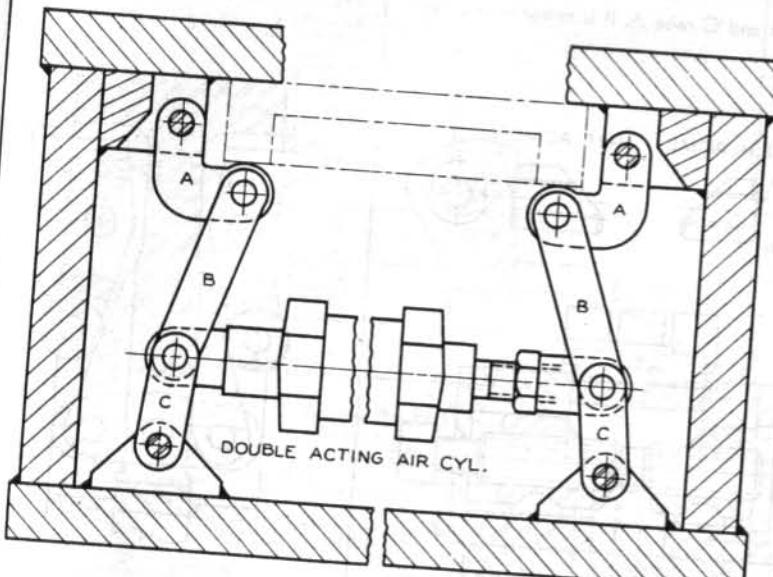


As shaft D is turned, C moves link A, which causes B to turn shaft E. Each pin has a cam to raise it and the bar connecting a pair of pins. Note the clearances necessary for the unclamping operation.

Raising the Part

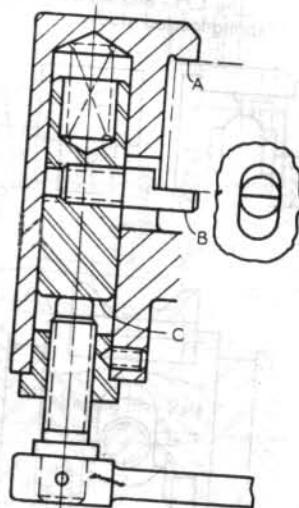
plate
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531

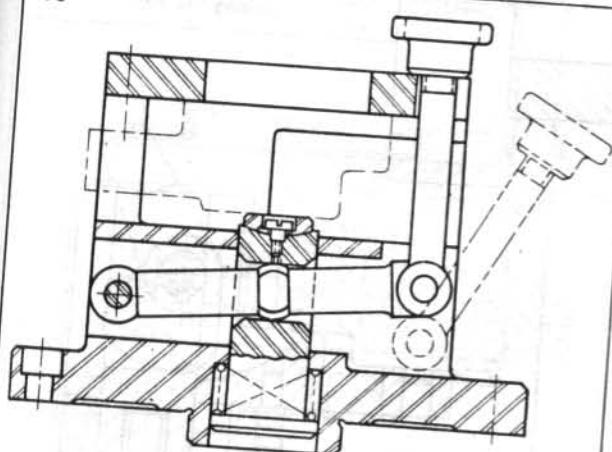


531-536

532

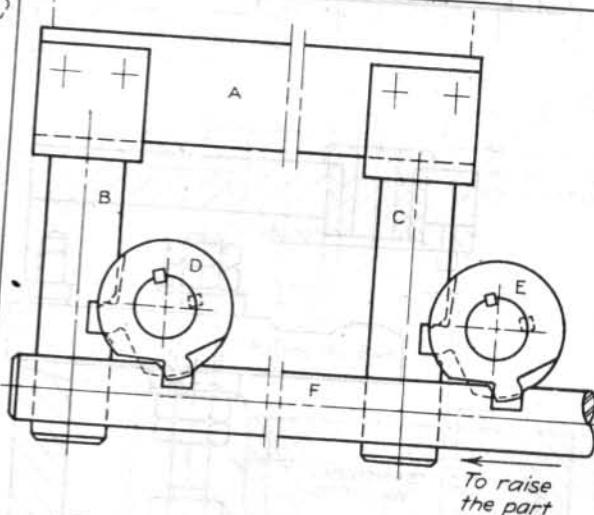


533



Raising the Part

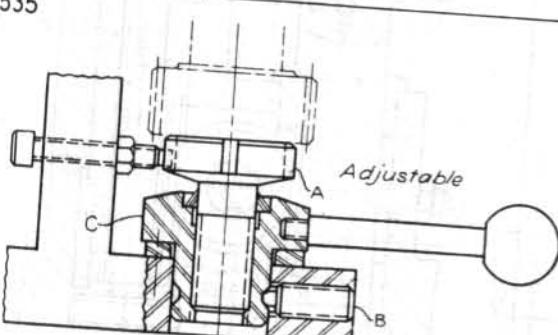
534



The handle in raising C raises B, which lifts the part to clamp against A. For which hand should the screw be threaded to allow the right hand to pull the handle forward (the normal way)?

Raising the Part

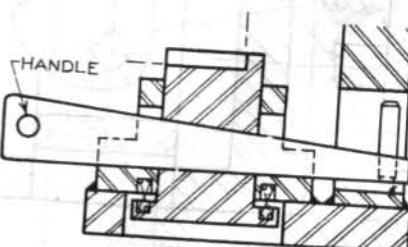
535



To ensure that the handle is always in a convenient position, A may be adjusted to another of the four vertical grooves. Spring plunger B keeps nut C from falling out when the fixture is not in use.

Raising the Part

536

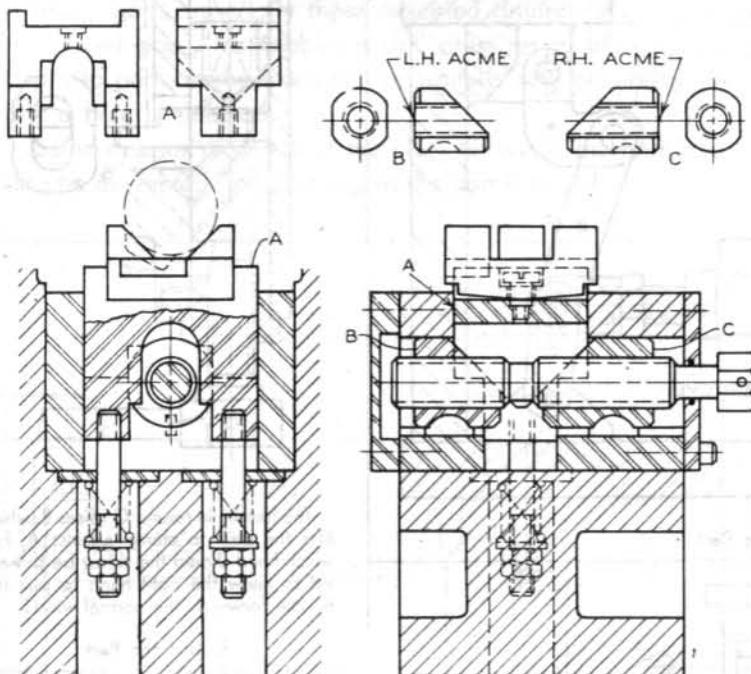


Raising the Part

537-540

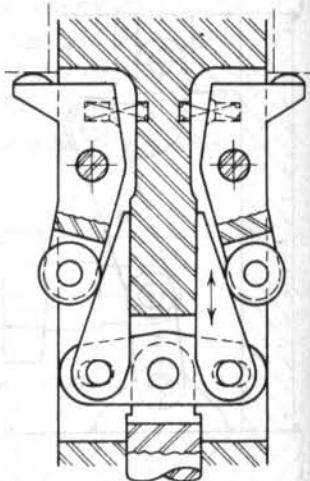
537

The L.H.- and R.H.-threaded cams B and C raise A. It is retracted by two spring-loaded studs.



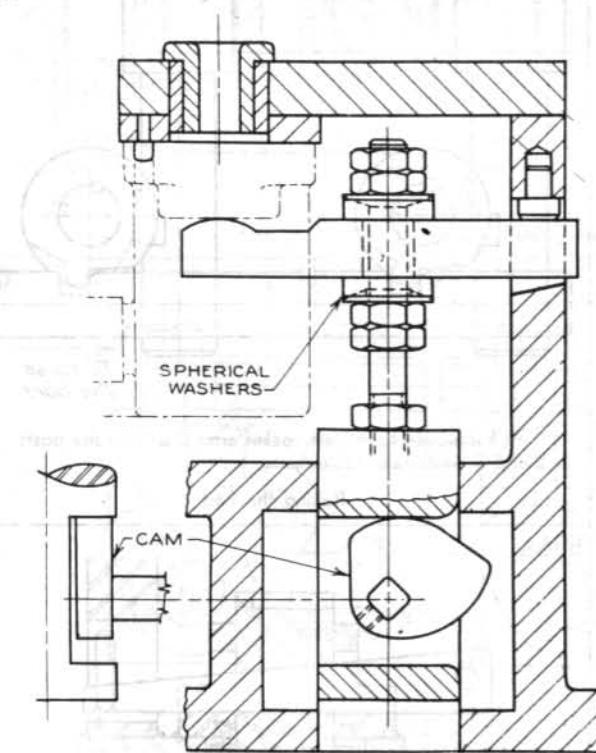
Raising the Part

538



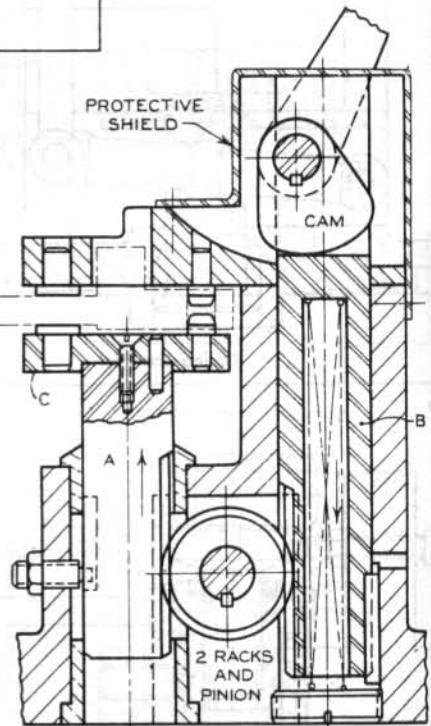
Raising the Part

539



Raising the Part

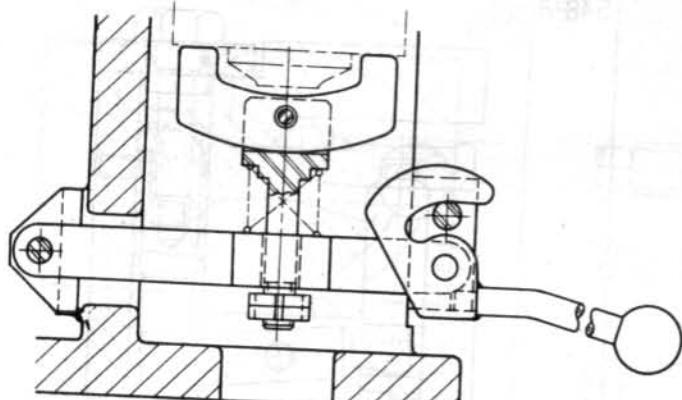
540



As the cam forces post B down, post A is raised via the racks on posts A and B and the connecting pinion. When the unit is unclamped, the strong spring reverses the movement.

Raising the Part

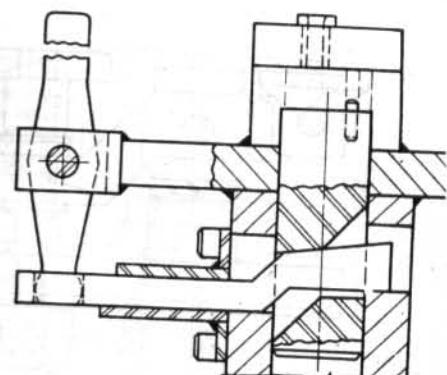
541



Raising the Part

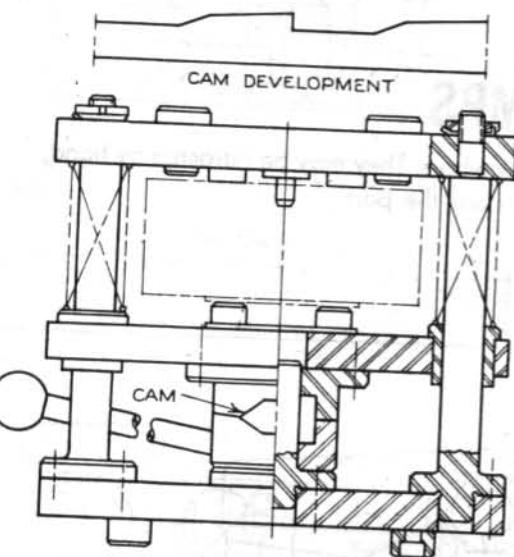
541-546

542



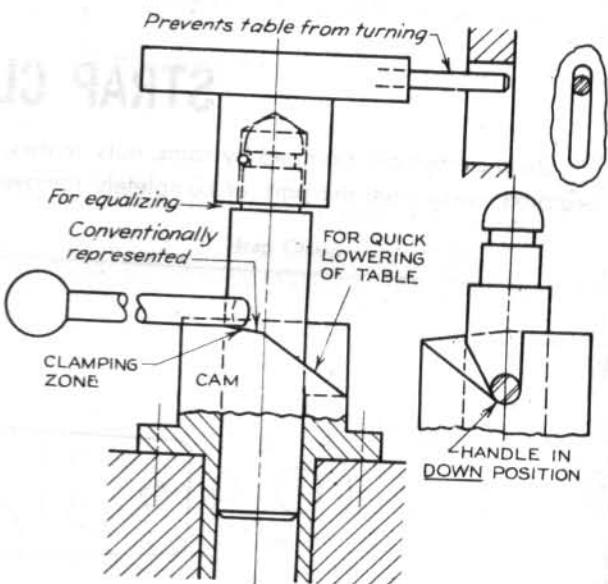
Raising the Part

543



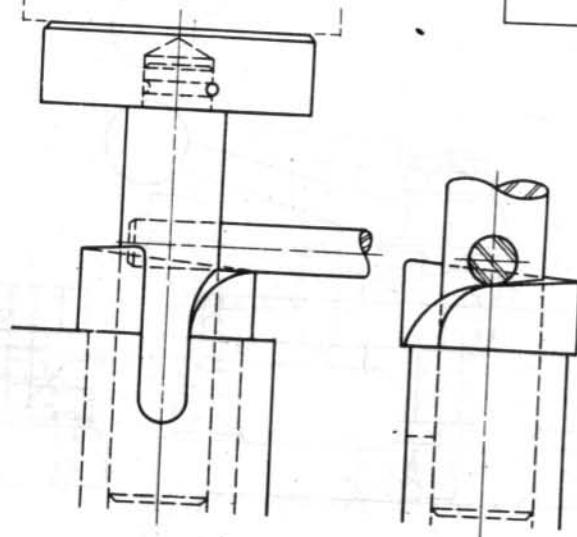
Raising the Part

544



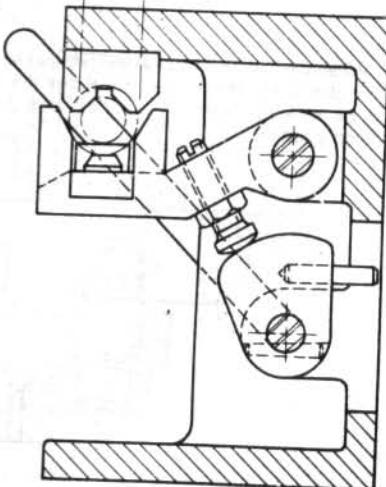
Raising the Part

545



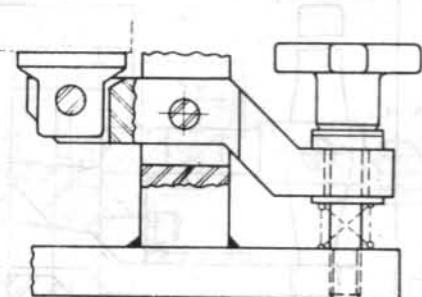
Raising the Part

546



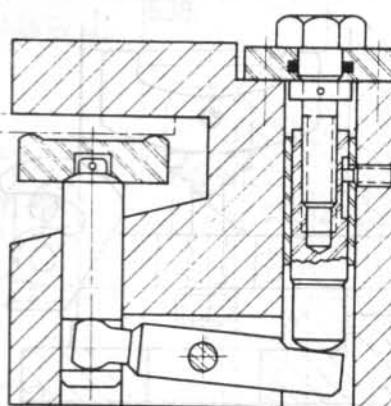
Raising the Part

547



Raising the Part

548

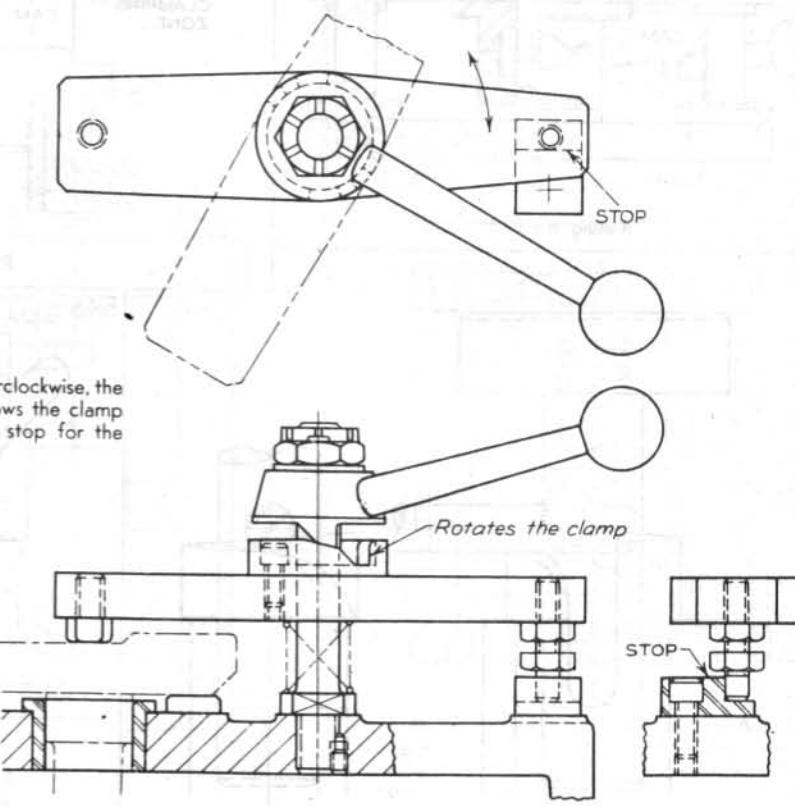


Raising the Part

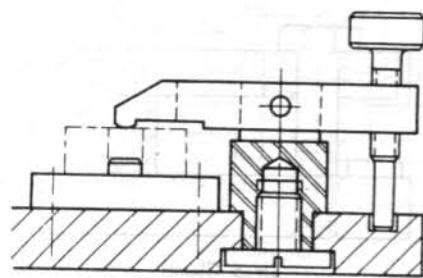
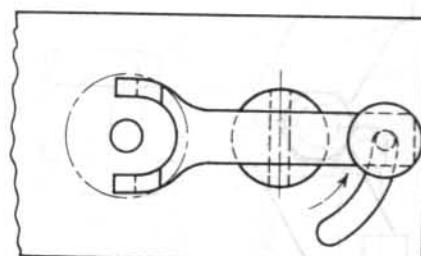
STRAP CLAMPS

Strap clamps are clamped by cams, nuts, screws, or drawbars. They may be retracted by hand, rotated away from the part, or completely removed to clear the part.

549



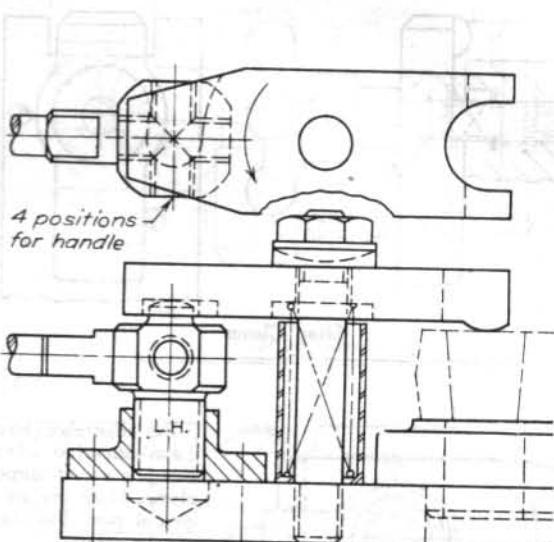
550



The groove acts as a stop for both ends of the rotation.

Strap Clamp

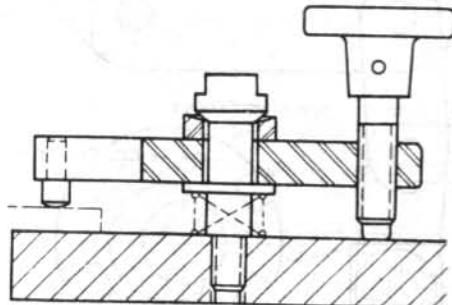
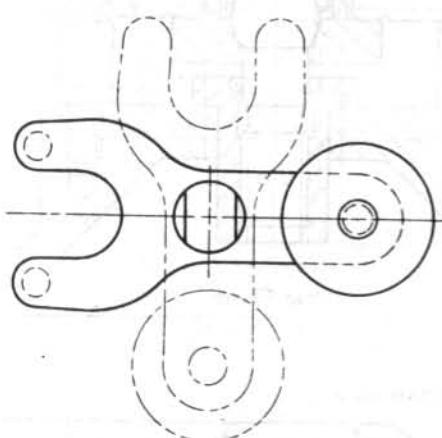
551



As wear occurs, the handle may be moved to another of the four threaded holes. Note the guard for the springs.

Strap Clamp

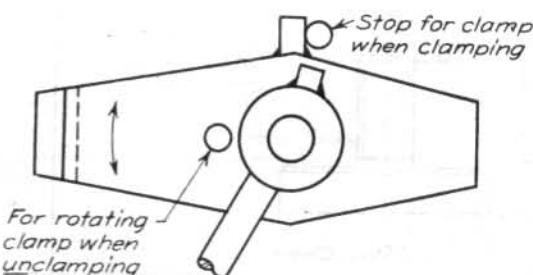
552



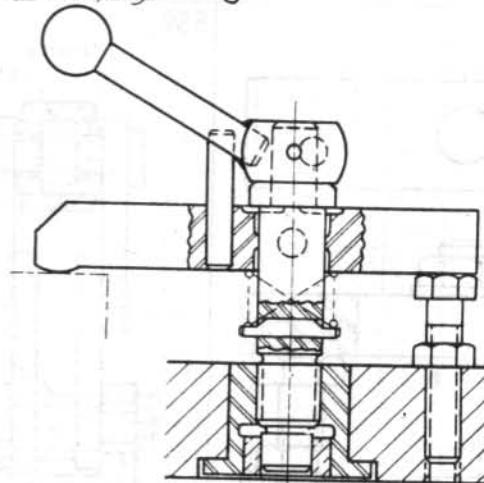
Rotating the clamp is sometimes preferable to retracting it.

Strap Clamp

553

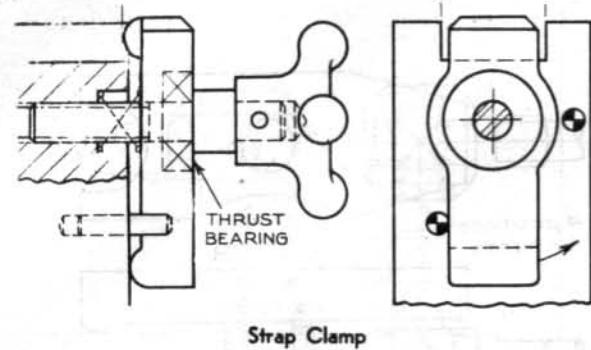


For rotating
clamp when
unclamping

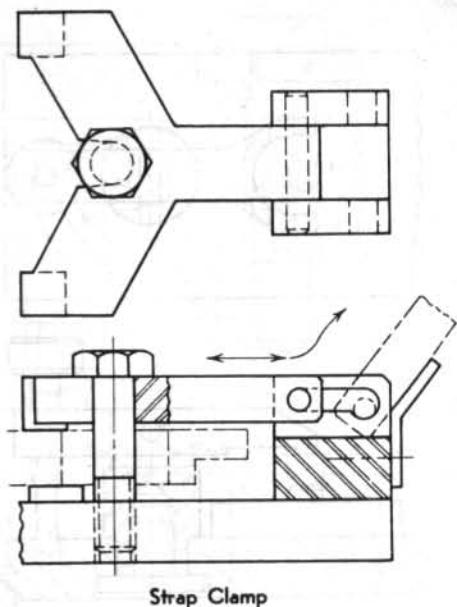


Strap Clamp

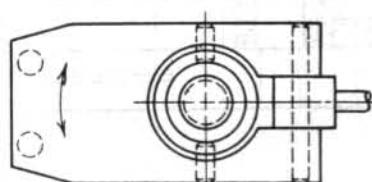
554



555

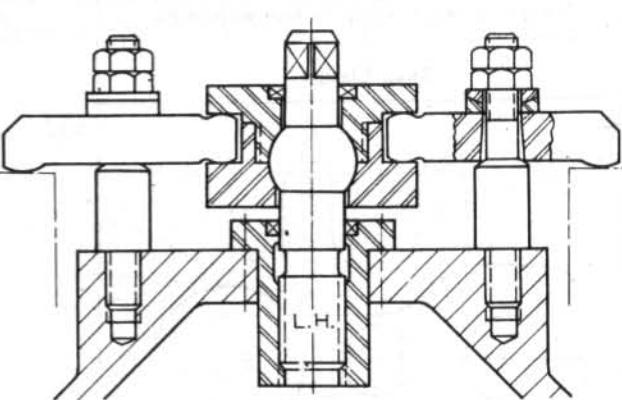
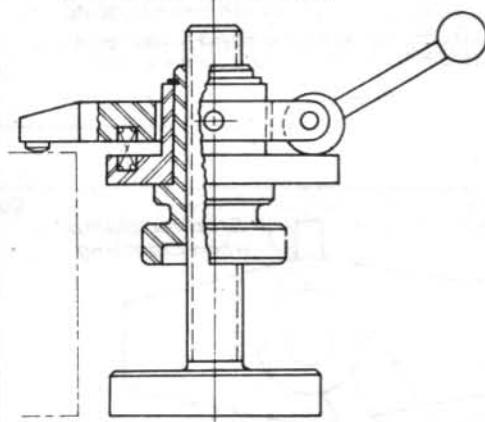


556



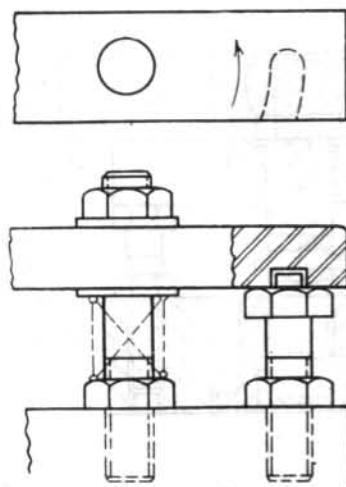
This adjustable-height cam-operated strap clamp is a multi-purpose clamp. Note the use of gimbal pins. The clamp may be rotated.

557



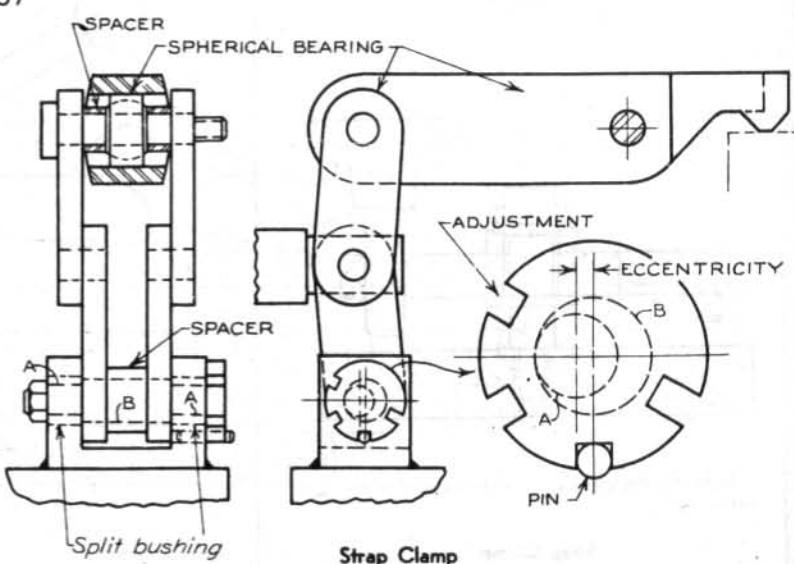
Strap Clamp

558



Strap Clamp

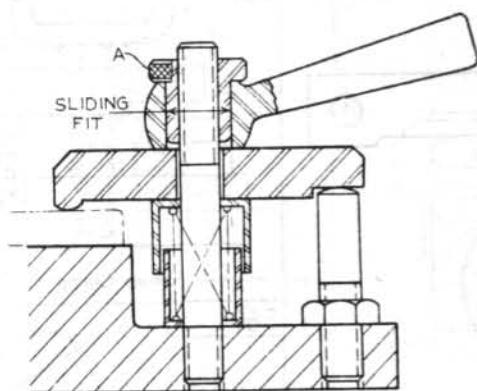
559



Strap Clamp

Split bushing

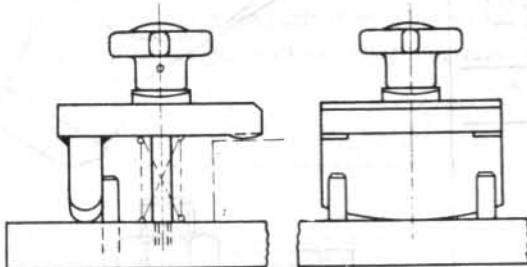
560



A slight vertical pull on the handle creates a very effective handle-clamping action to turn nut A with the added advantage that the handle may be kept in a convenient position. Note the guard for the springs.

Strap Clamp

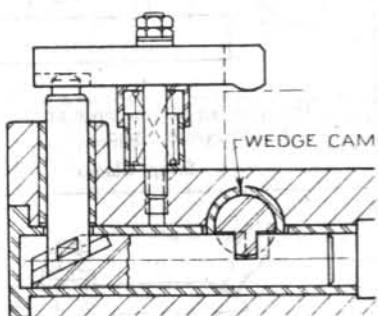
562



The two pins not only square the clamp with the part but also act as a stop. This is an equalizing clamp.

Strap Clamp

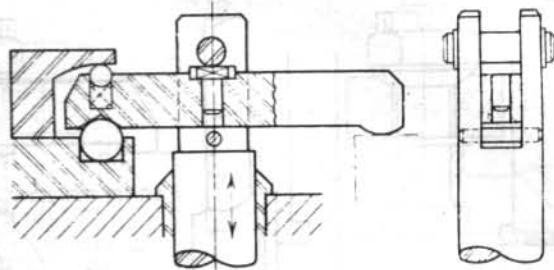
564



The wedge cam operated clamp is actuated by a T slot controlled clamp post.

Strap Clamp

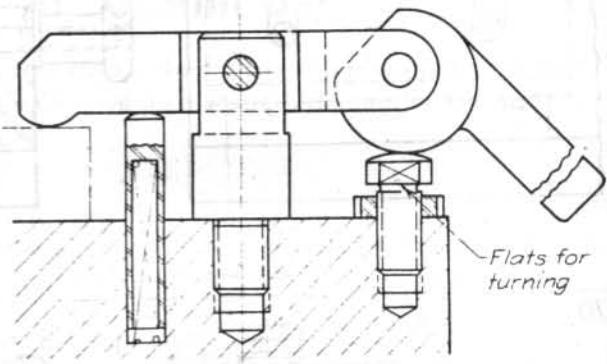
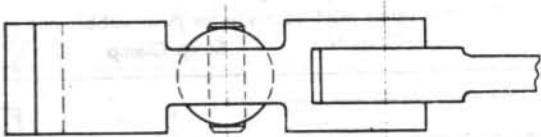
561



Note the unique pivot design at the left.

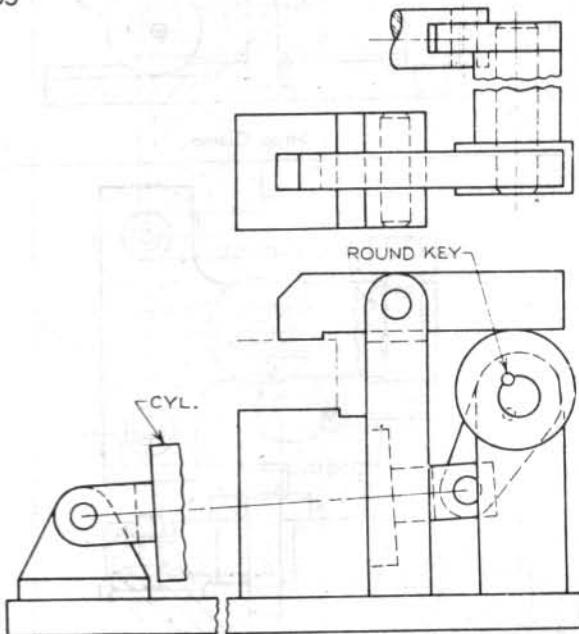
Strap Clamp

563



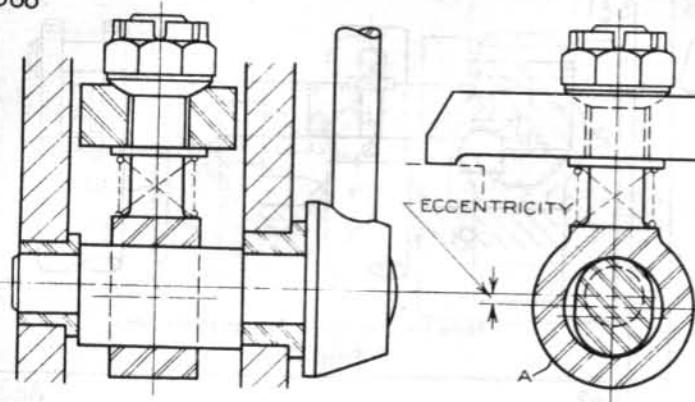
Strap Clamp

565



Strap Clamp

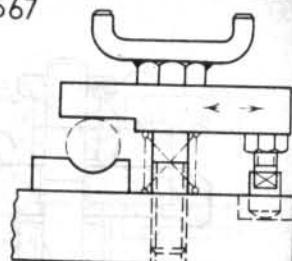
566



Allowance must be made for A to wobble due to the eccentric.

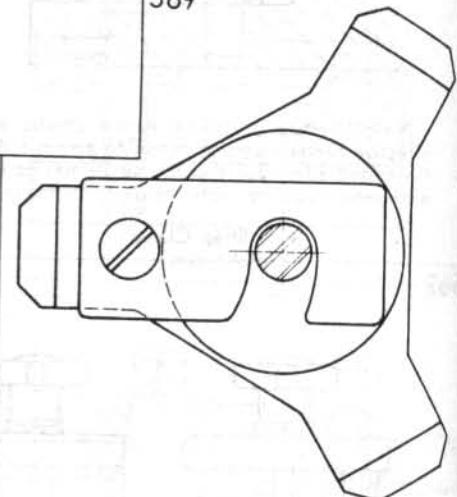
Strap Clamp

567

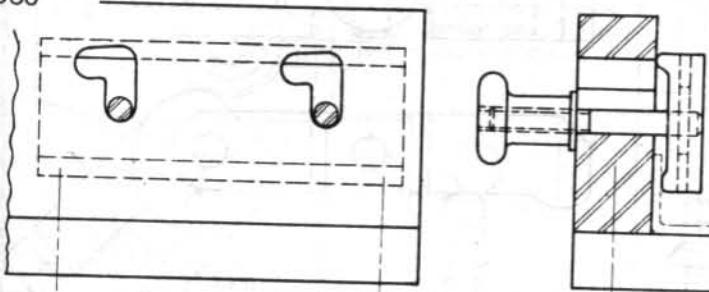


Strap Clamp

569



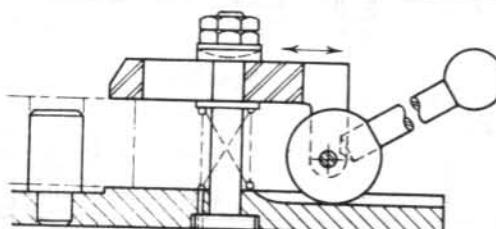
568



The clamp is raised and moved to the left to hold it above the part.

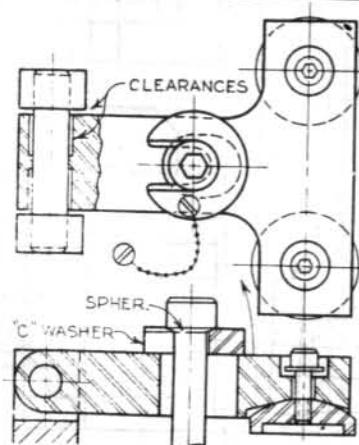
Strap Clamp

570



Strap Clamp

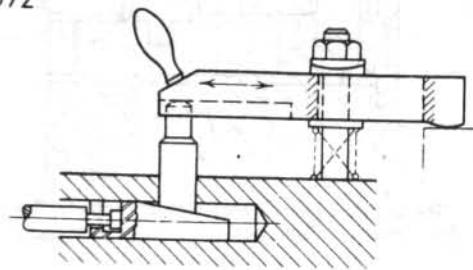
571



The clearances allow equalizing at the pivot pin. The chain prevents loss of the c-washer.

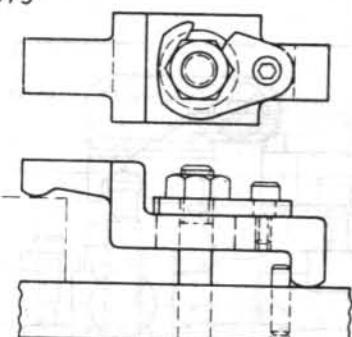
Strap Clamp

572



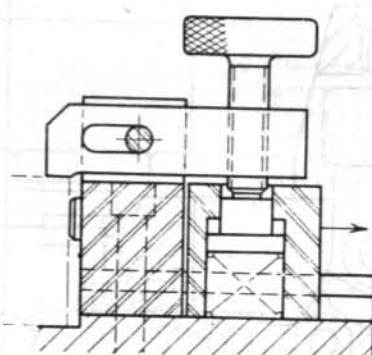
Strap Clamp

573



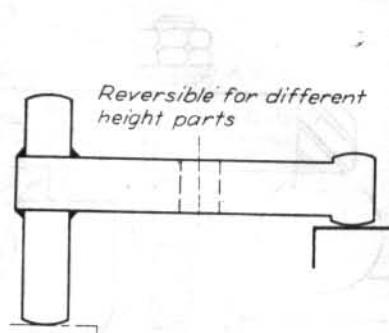
Strap Clamp

574



Strap Clamp

575

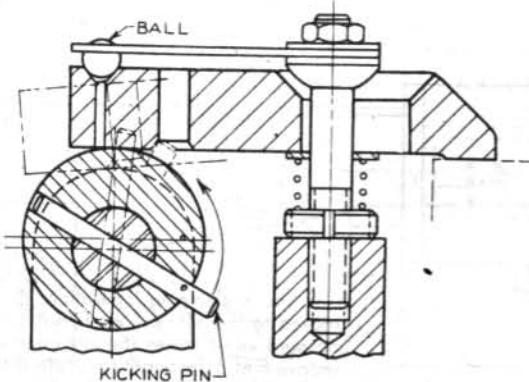


Strap Clamp

WALKING STRAP CLAMPS

The power source, either mechanical or hand, that clamps the strap clamp also moves it into position and later retracts it in a single operation. Observe the numerous designs for the walking feature of the walking strap clamps.

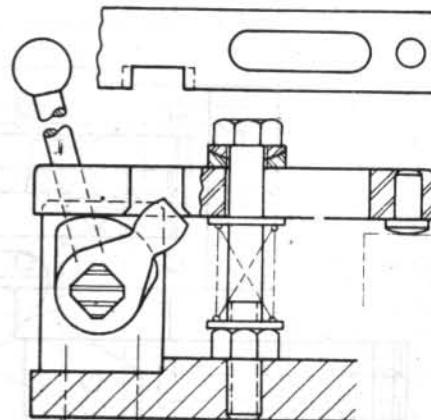
576



There are a number of variations in how the cam and kick-pin are used to clamp and walk the strap clamps. In this illustration the kickpin strikes the side of the retracting hole and moves the clamp back. During the clamping action the kick-pin moves the clamp forward and then the cam actuates the clamp.

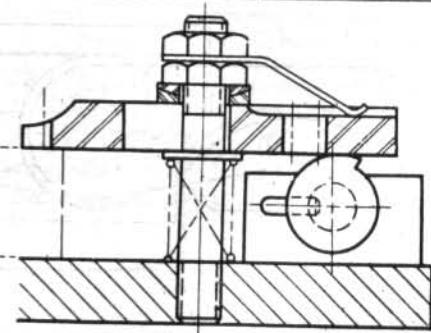
Walking Strap Clamp

577



Walking Strap Clamp

578

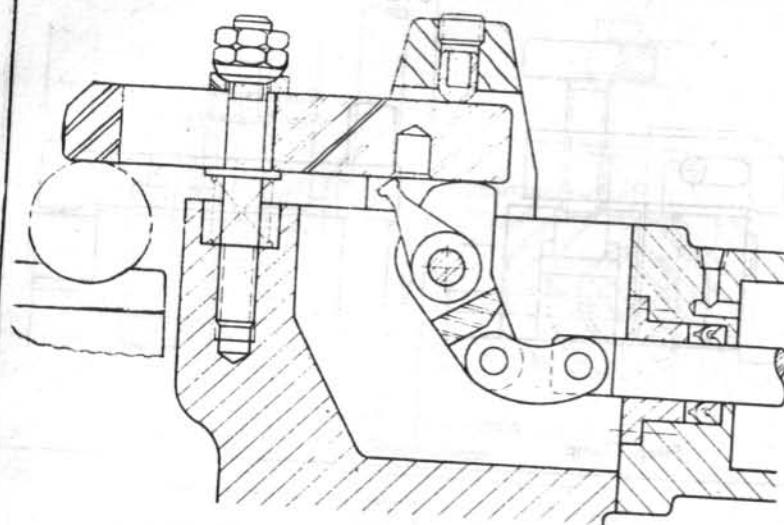


Walking Strap Clamp

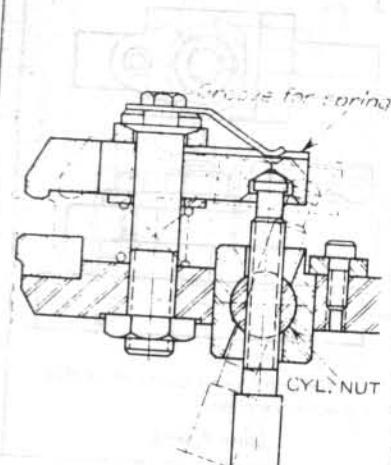
"No one ever attains very eminent success by simply doing what is required of him; it is the amount and excellence of what is over and above the required, that determines success"

CHARLES KENDALL ADAMS

579

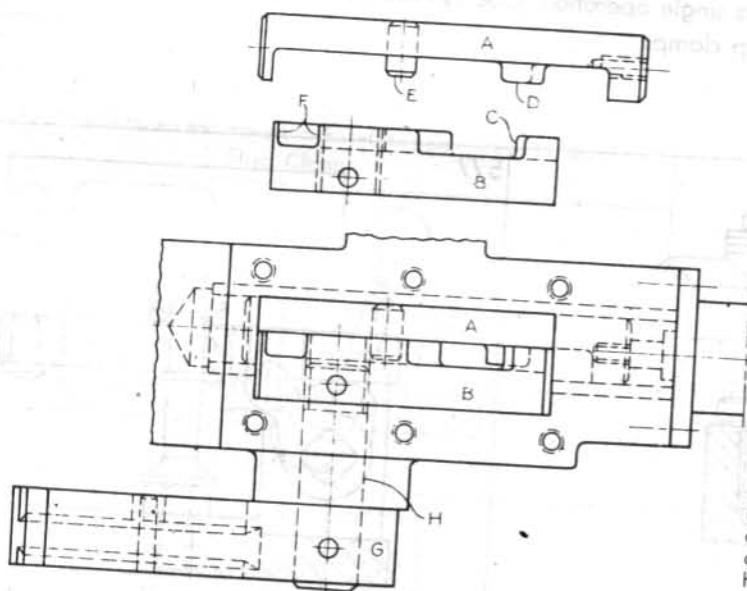


580



Walking Strap Clamp

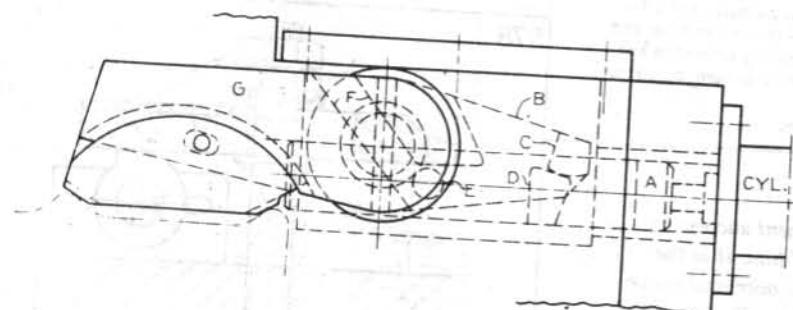
581



Walking Strap Clamp

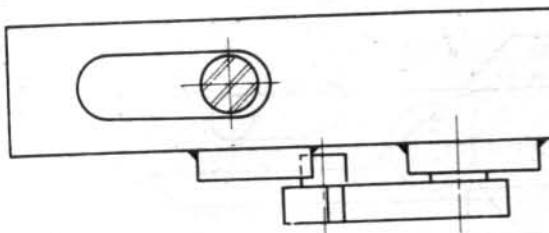
583

In the unclamping operation, A is moved to the left, and pin E in A (see detailed view) strikes the left edge of groove F of B, forcing B to rotate shaft H, which is fastened to B. H, in turn, rotates clamp G. In the clamping operation, A moves to the right. E leaves groove F, and D of A acts as a cam, raising C of B, which causes H to actuate clamp G.

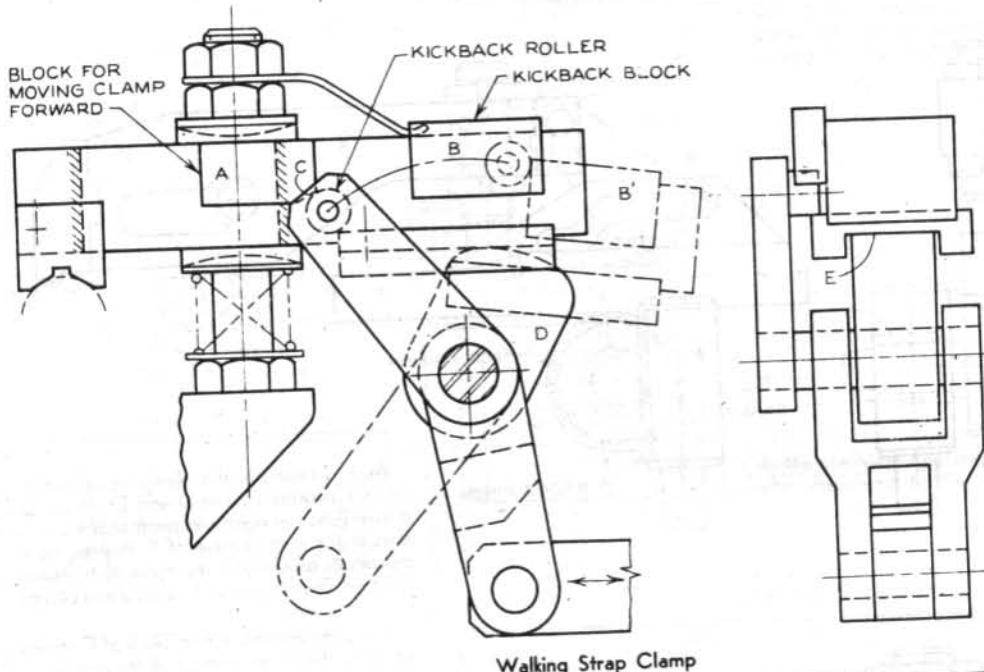


Walking Strap Clamp

582

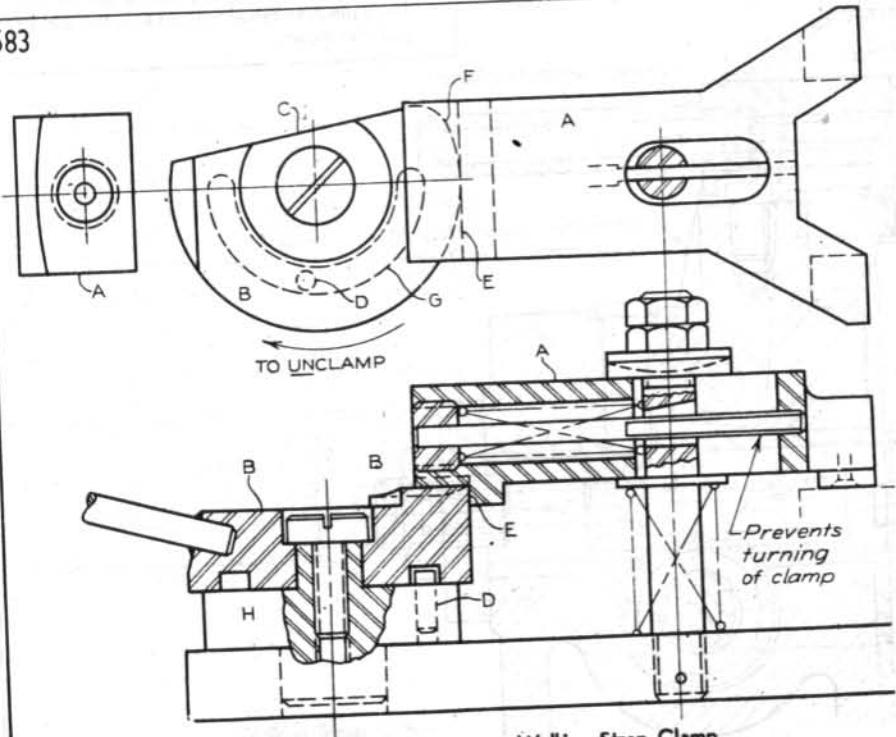


The kickback roller pushes against block A to move the clamp into clamping position. Upon reaching it, the roller slips past block A at C, and then cam D clamps in groove E, which prevents the clamp from turning. In the unclamping action the roller slips past C again, strikes block B, and retracts the clamp. The flat spring pushes down the farther end of the clamp.



Walking Strap Clamp

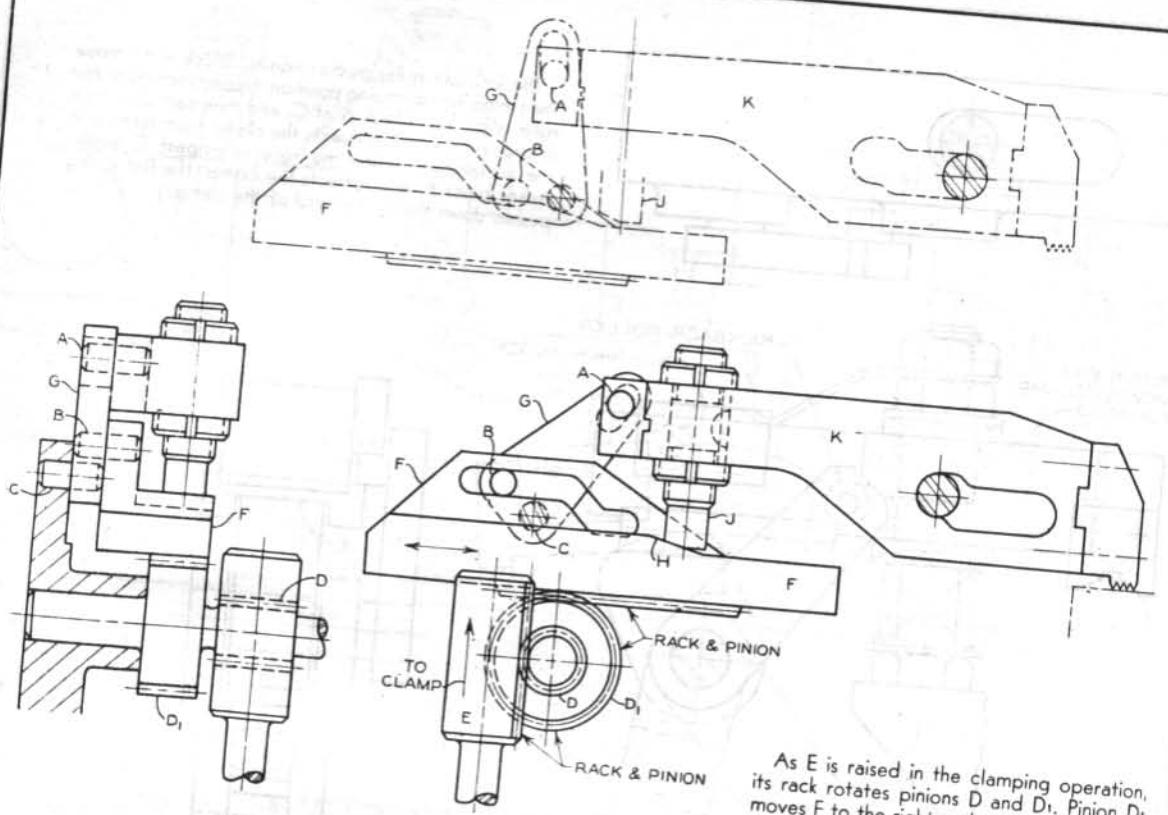
583



As unclamping takes place, F, having moved clamp A to the right during the clamping action, moves away from E, and the spring retracts clamp A to the new rotated position of C. Pin D stops the movement of cam B. The front view of D has been drawn out of position.

During the clamping operation, C leaves E and then F moves clamp A to the right. Clamping action by axial cam B follows.

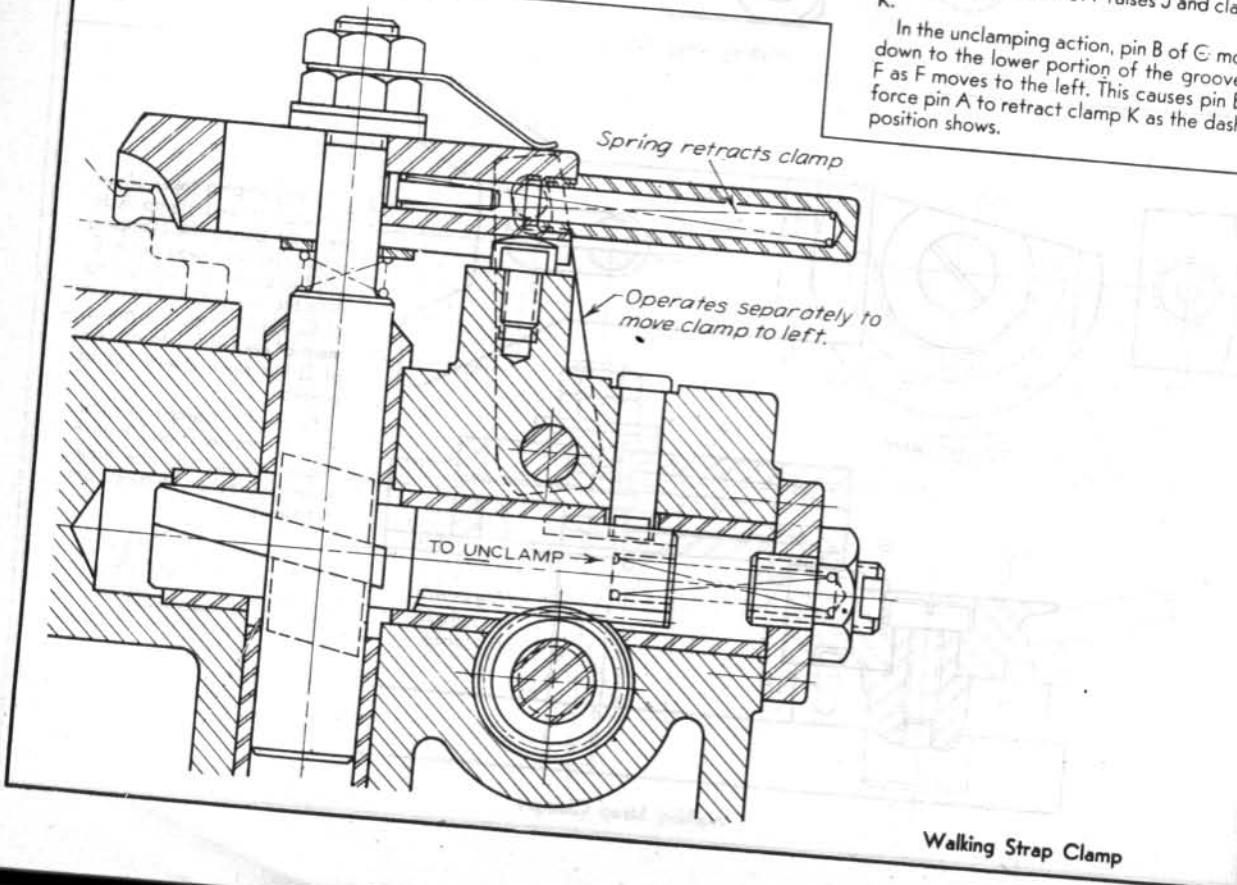
Walking Strap Clamp



Walking Strap Clamp

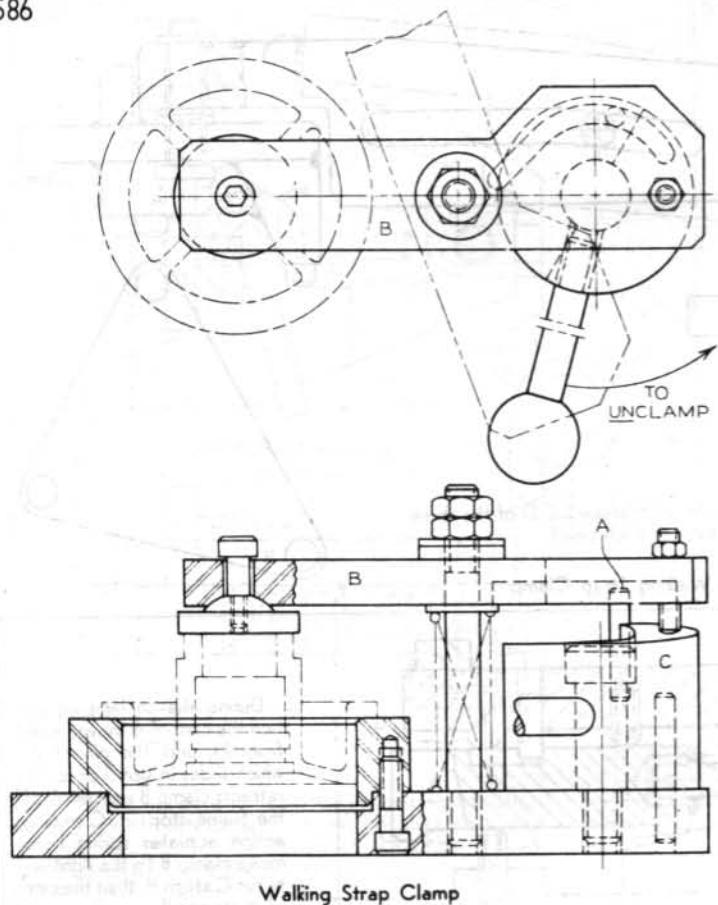
As E is raised in the clamping operation, its rack rotates pinions D and D₁. Pinion D₁ moves F to the right and pin B of link G follows in the cam groove of F, thereby causing pin A of clamp K to move K to clamp position. Then cam H of F raises J and clamps K.

In the unclamping action, pin B of G moves down to the lower portion of the groove of F as F moves to the left. This causes pin B to force pin A to retract clamp K as the dashed position shows.



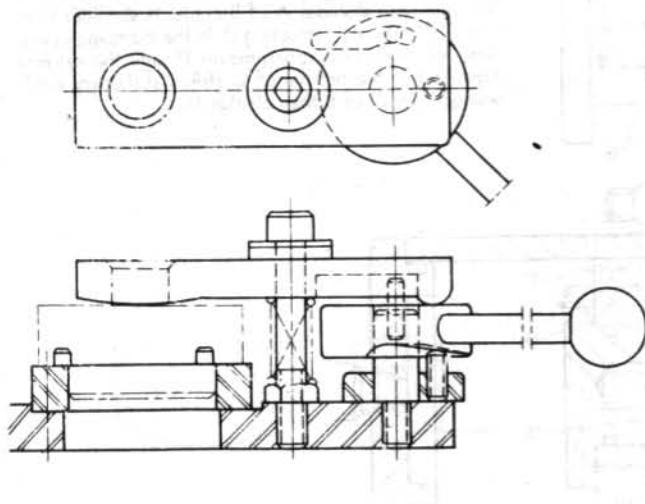
Walking Strap Clamp

586

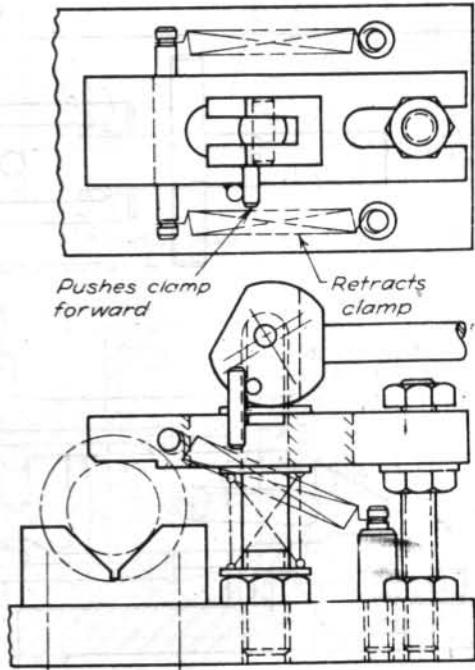


In the unclamping operation, pin A in cam C moves to the left in the groove of clamp B. When it reaches the straight portion of the groove, it swings the clamp as shown. During the clamping action, the pin moves along the circular portion of the groove, leaving the clamp stationary.

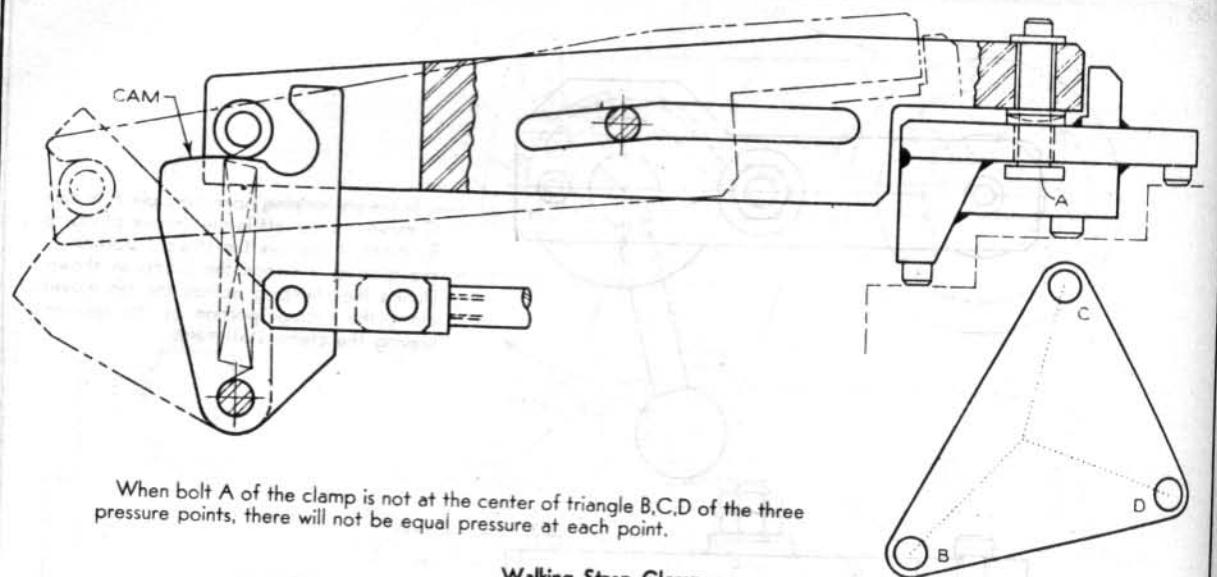
587



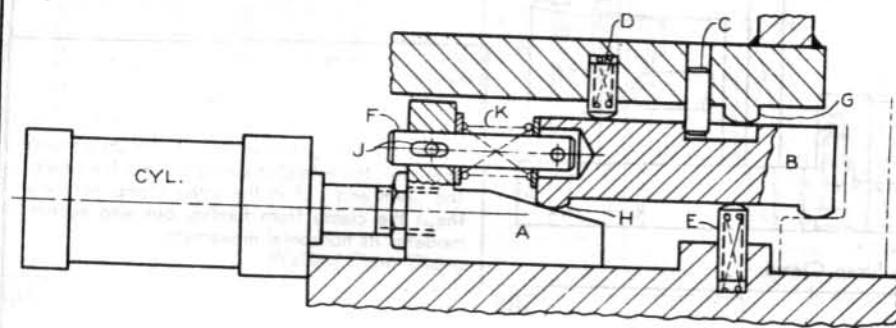
588



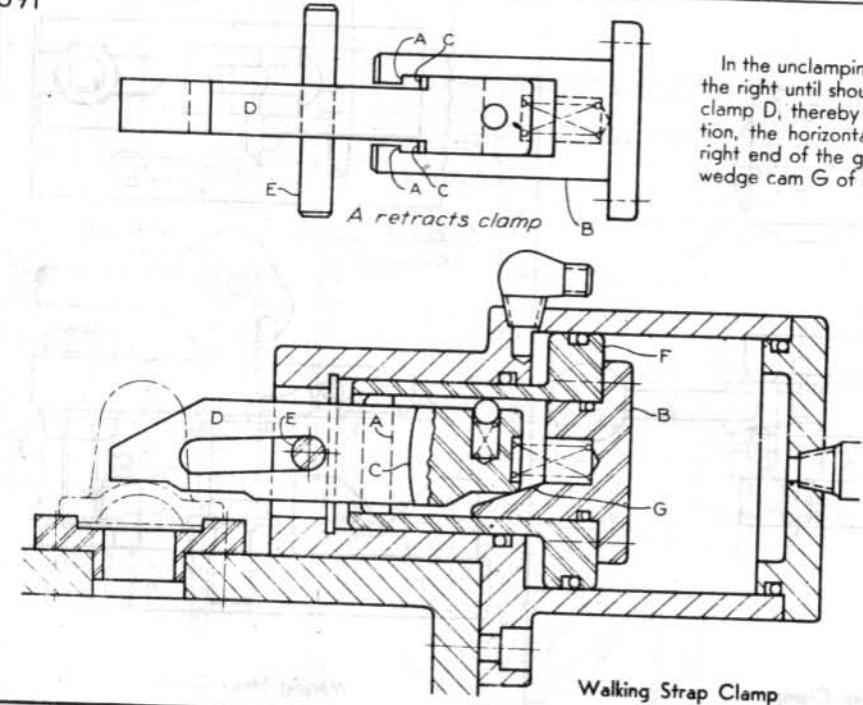
Pushes clamp forward
Retracts clamp



Walking Strap Clamp

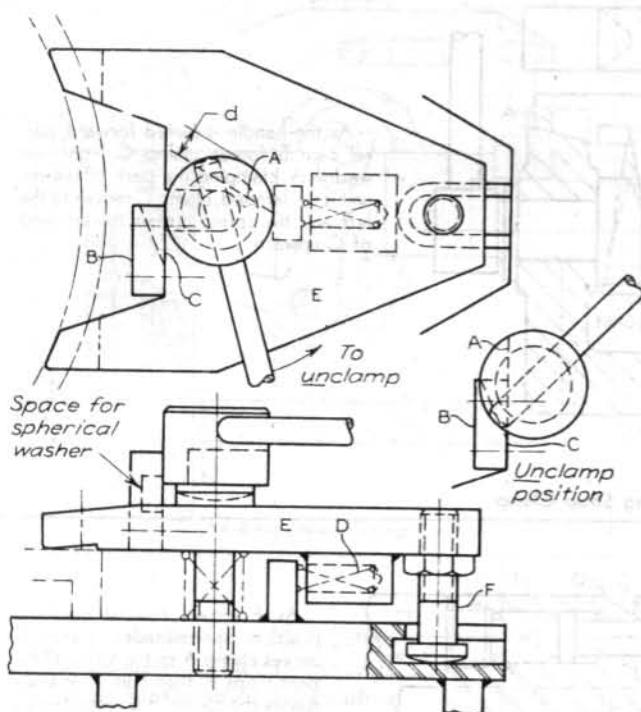


Walking Strap Clamp



Walking Strap Clamp

592



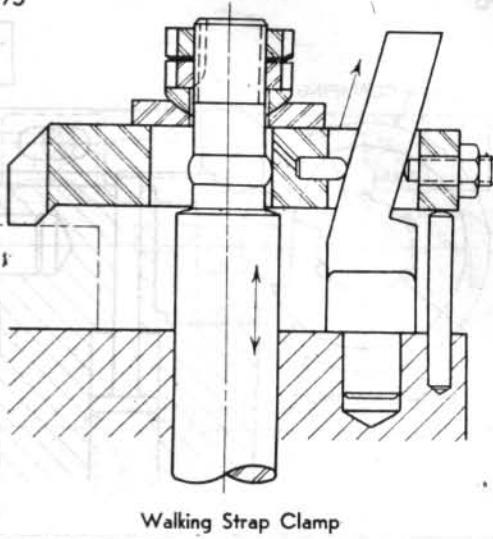
As the handle is turned in the unclamping operation, surface A meets surface C of block B, which is fastened to clamp E to limit the amount of retraction. E is retracted by spring D and prevented from turning by the T-slot in which F is placed. The amount of retraction is indicated by d.

Walking Strap Clamp

595

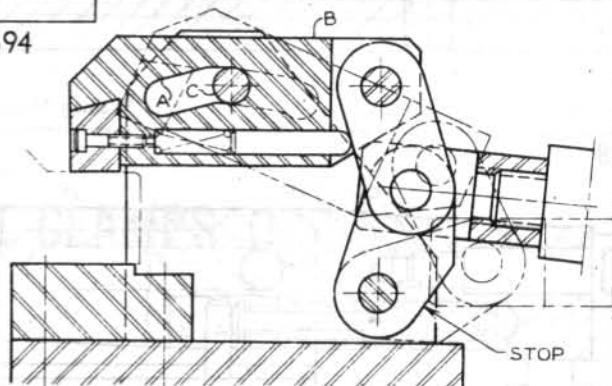
As E moves to the left, piston B moves away from D, allowing spring C to bring clamp A into clamping position. Then wedge cam F actuates the clamping action through the roller. During retraction, F moves away from the roller and B strikes D, retracting clamp A as the spring-loaded button pushes the right end of A down.

593

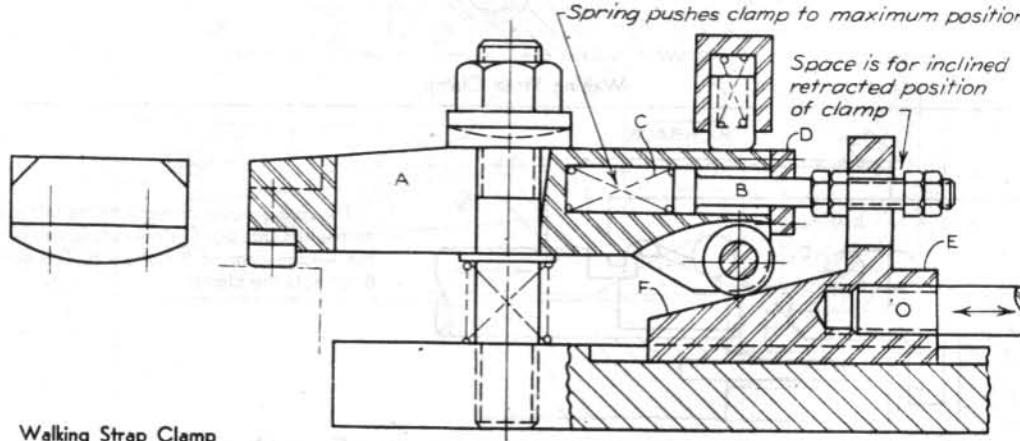


In the unclamping operation, the toggle linkage retracts clamp B until the left end of groove A strikes stationary pin C. Note the frequent use of a slot, one portion of which is inclined and the other horizontal.

594

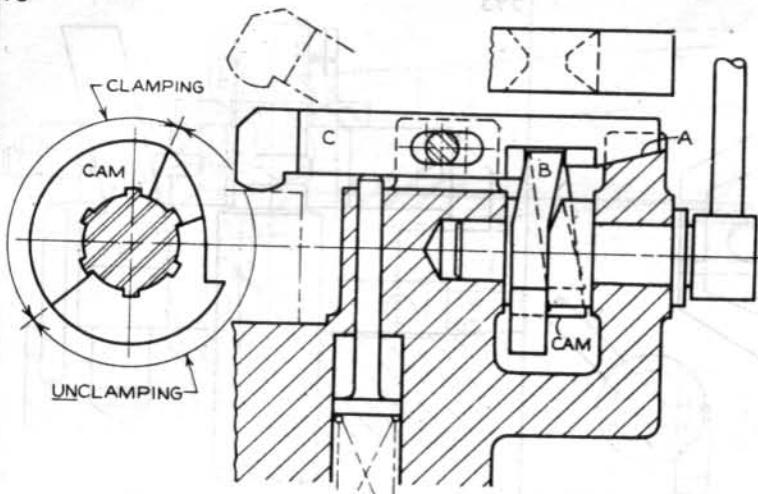


Walking Strap Clamp



Walking Strap Clamp

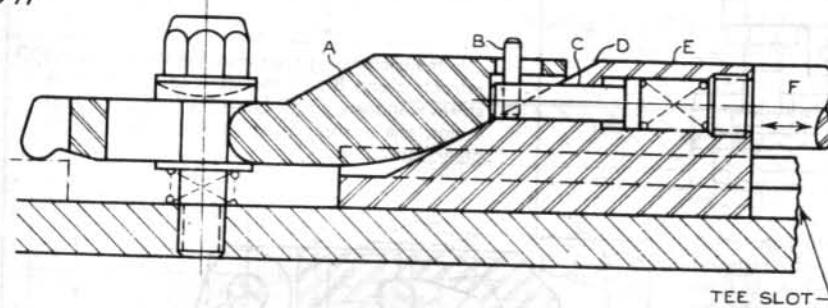
596



As the handle is pulled forward, barrel cam B forces clamp C higher on wedge A, clamping the part. When the unit is unclamped, clamp C moves to the left and the spring pushes the left end of C upward.

Walking Strap Clamp

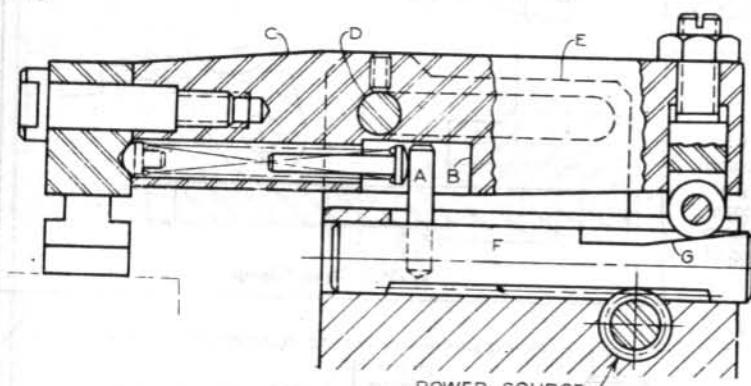
597



As F moves toward clamping position, spring-loaded piston C moves clamp A to the left until the post stops it, then cam D of E actuates the clamp. It is retracted by pin B in piston C.

Walking Strap Clamp

598

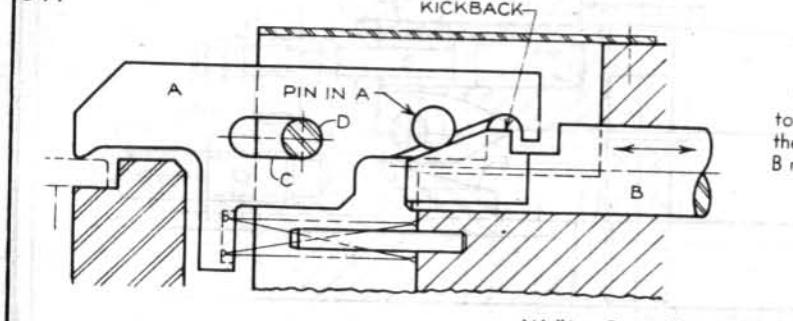


F moves to the right and cam G away from its clamping force during the unclamping action. Pin A in F then strikes the B end of the endmilled groove, compressing the spring and retracting clamp C.

As F moves to the left in the clamping operation, A moves away from B, and the spring pushes clamp C to the left until pin D in C strikes the left end of the slot in frame E. Then cam G clamps clamp C.

Walking Strap Clamp

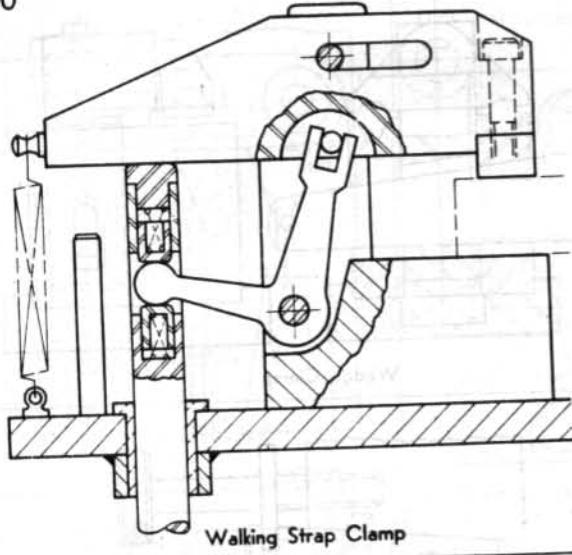
599



The spring moves clamp A to the left as B moves to the left until slot C strikes stationary pin D. Then the wedge cam of B clamps A. The kickback of B retracts the clamp.

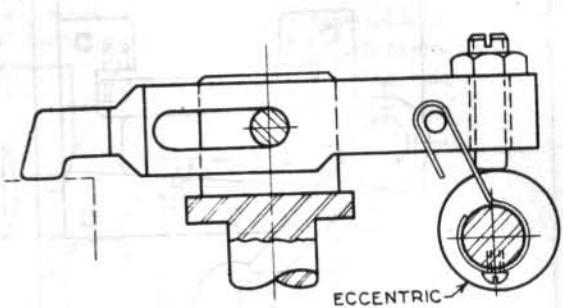
Walking Strap Clamp

600



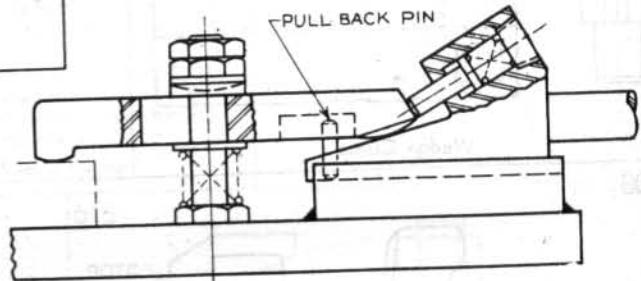
Walking Strap Clamp

601



Walking Strap Clamp

602

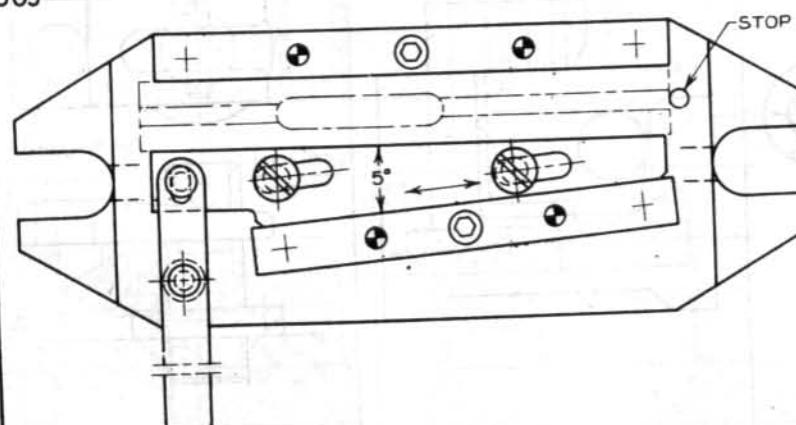


Walking Strap Clamp

"The ladder of life is full of splinters, but they always prick the hardest when we're sliding down." WILLIAM L. BROWNELL

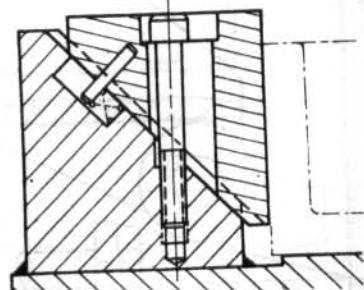
WEDGE CLAMPS

603



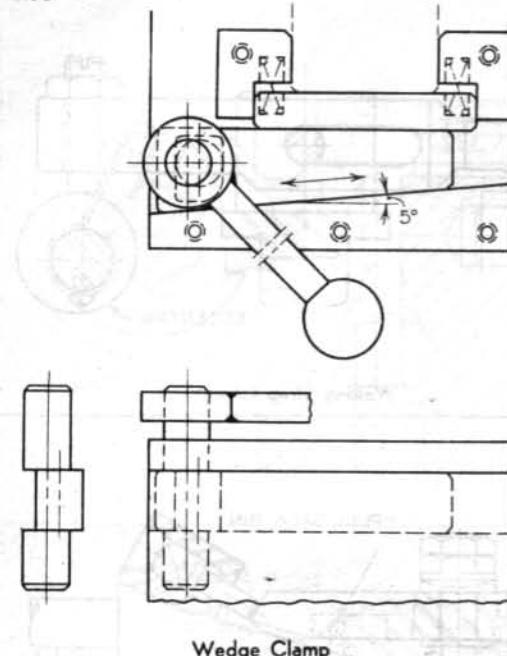
Wedge Clamp

604

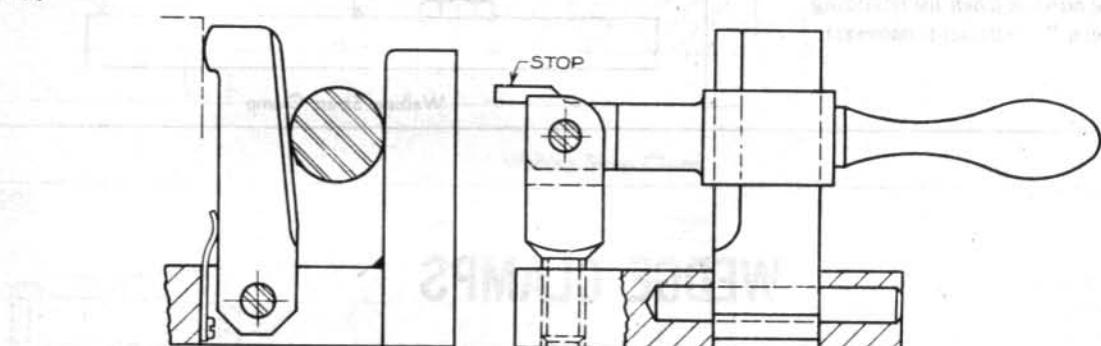


Wedge Clamp

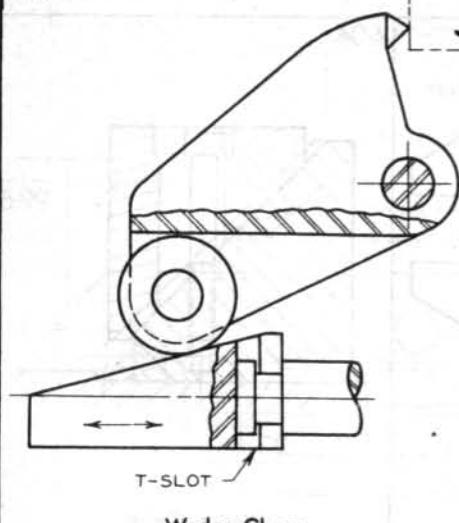
605



608

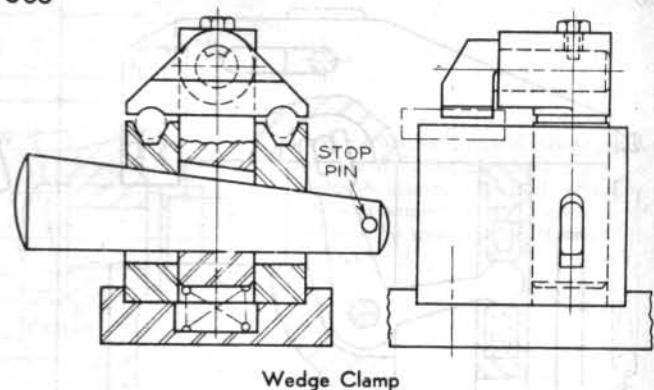


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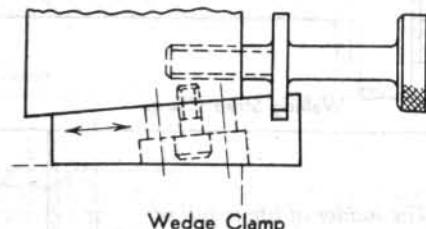


Wedge Clamp

606

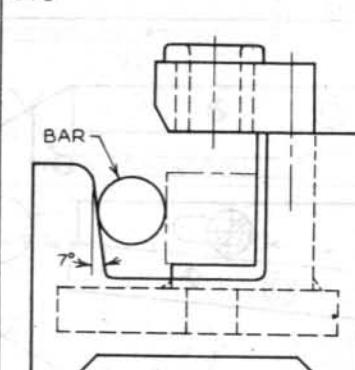


607



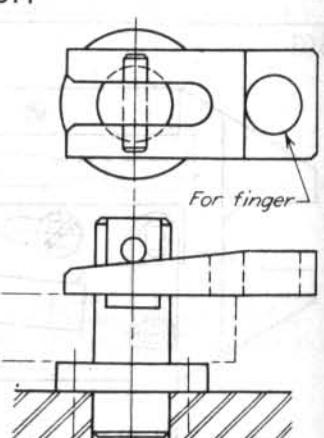
Wedge Clamp

610



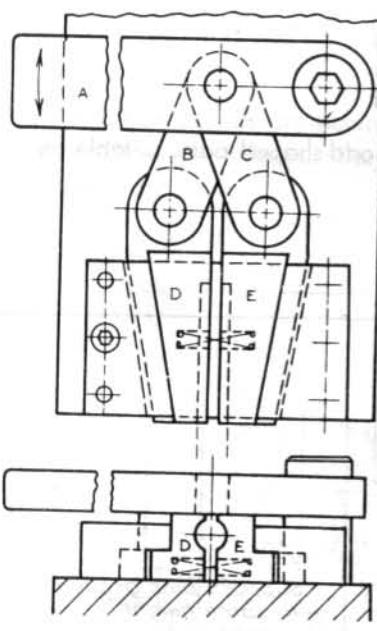
Wedge Clamp

611



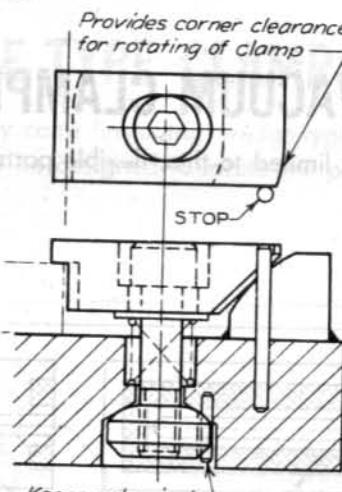
Wedge Clamp

612



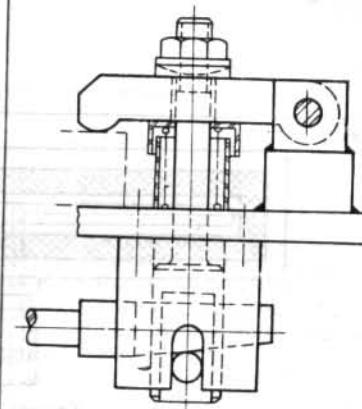
Wedge Clamp

613



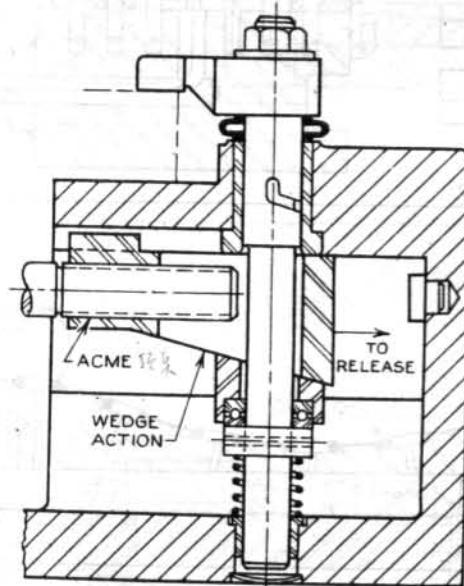
"Confidence without competence fails to produce results." ORVAL CRAIG

614



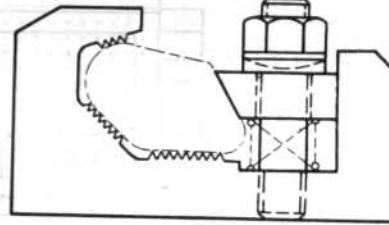
Wedge Clamp

615



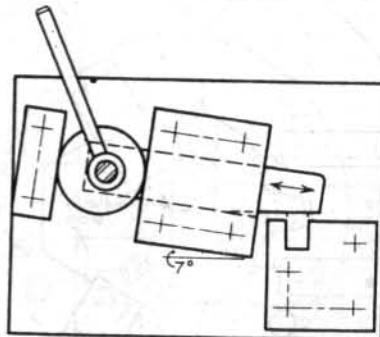
Wedge Clamp

616



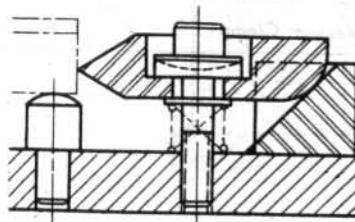
Wedge Clamp

617



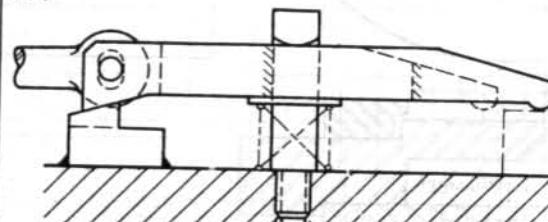
Wedge Clamp

618



Wedge Clamp

619

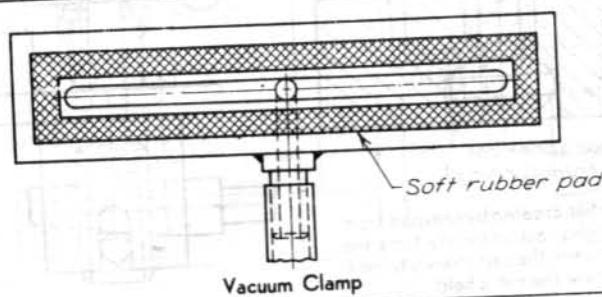


Wedge Clamp

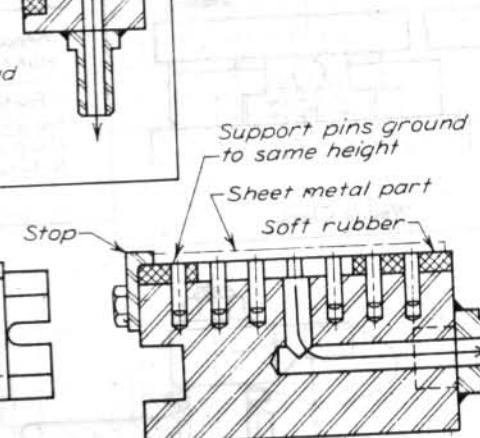
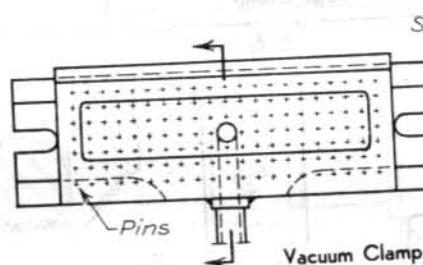
VACUUM CLAMPING

Vacuum clamping is usually limited to thin, flexible parts and odd-shaped parts suitable for light machining.

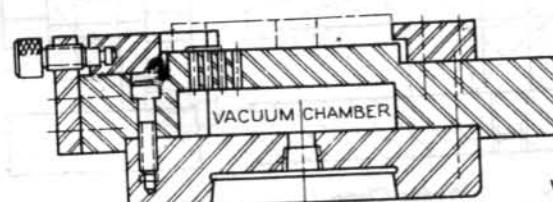
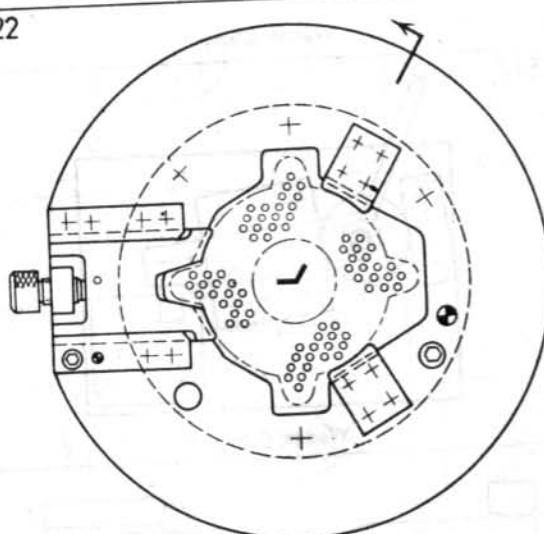
620



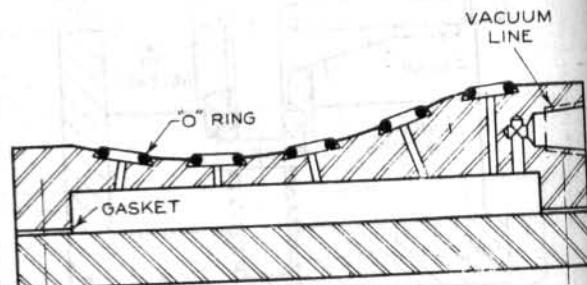
621



622



623



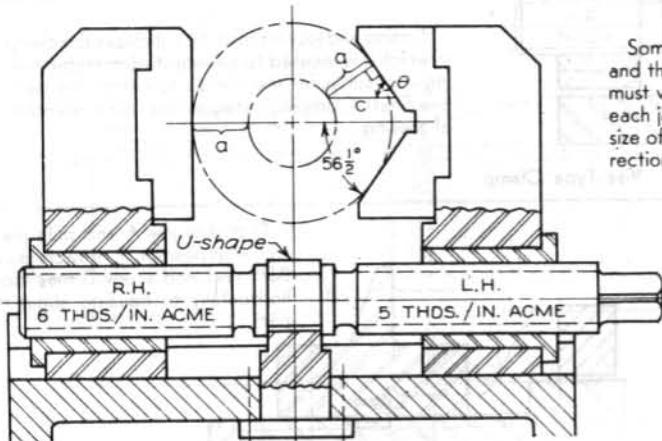
Vacuum Clamp

Vacuum Clamp

VICE TYPE CLAMPS

Vise-type clamps are actuated by cams (including wedge-type), racks, gears, thread, rocker arms, or toggle linkages. They may be designed to locate the part or to equalize it relative to other clamping.

624



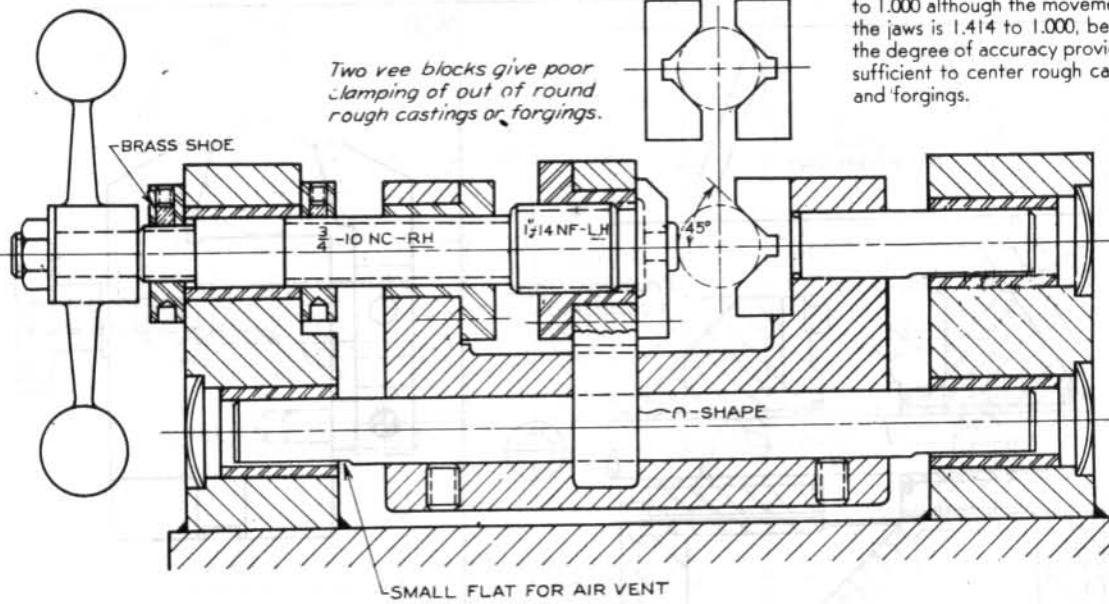
Some designers prefer that one clamping jaw be a plate and the other a v-block. The two threads in a centering vise must vary as to the number of threads per inch to permit each jaw to move in properly for centering regardless of the size of the diameter of the part. Observe the different directions of a , the difference between the radii.

$$\text{SIN } \theta = \text{SIN } \frac{a}{C} = \frac{1}{6} (\text{PITCH}) / \frac{1}{5} (\text{PITCH}) = .833$$

$$\theta = 56 \frac{1}{2}^\circ$$

Vise Type Clamp

625

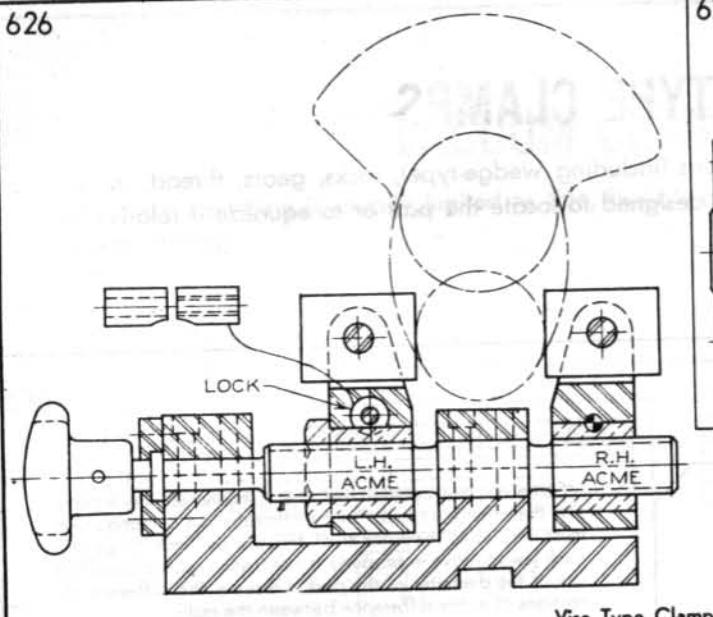


The ratio of the threads is 1.400 to 1.000 although the movement of the jaws is 1.414 to 1.000, because the degree of accuracy provided is sufficient to center rough castings and forgings.

Vise Type Clamp

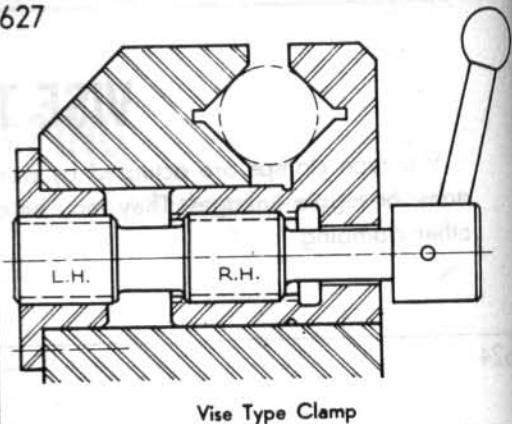
626-630

626



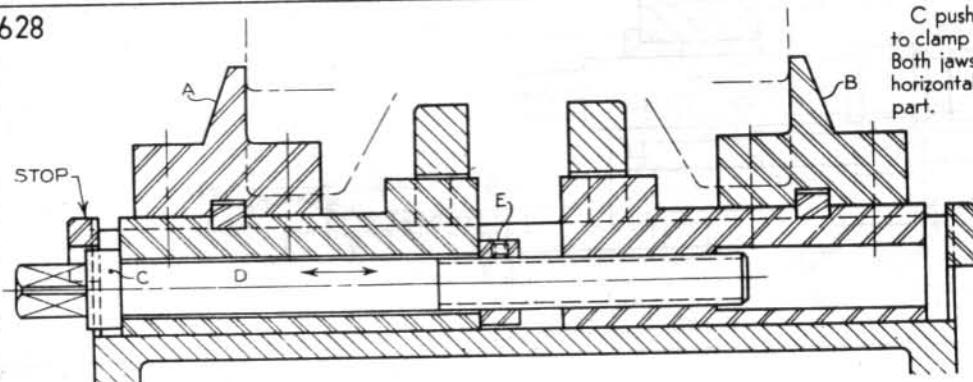
Vise Type Clamp

627



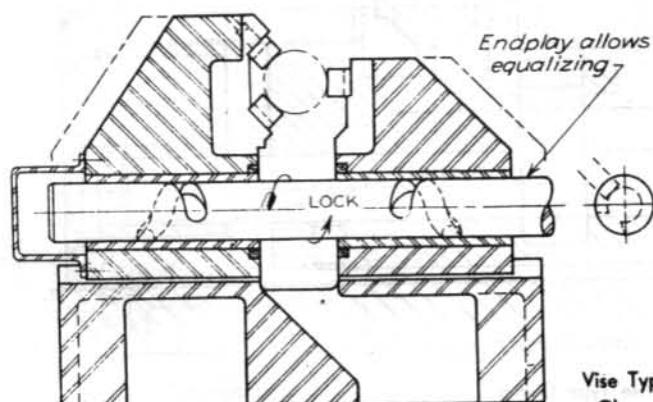
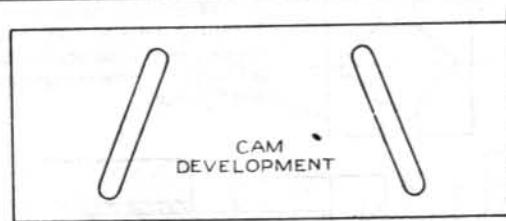
Turning and locking the L.H. nut allows the clamp in which it is located to be adjusted, thereby making it possible for the clamps to center the part. See Shaft Clamping category for more examples of locking.

628



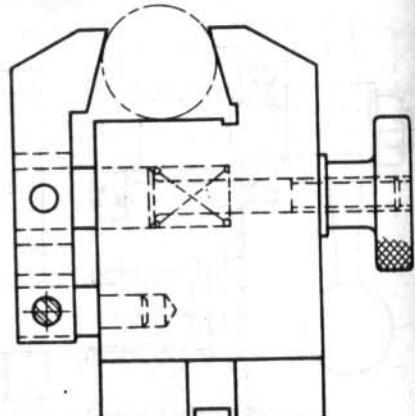
C pushes jaw A and pulls jaw B to clamp position. E retracts jaw A. Both jaws and screw D may move horizontally to equalize about the part.

629



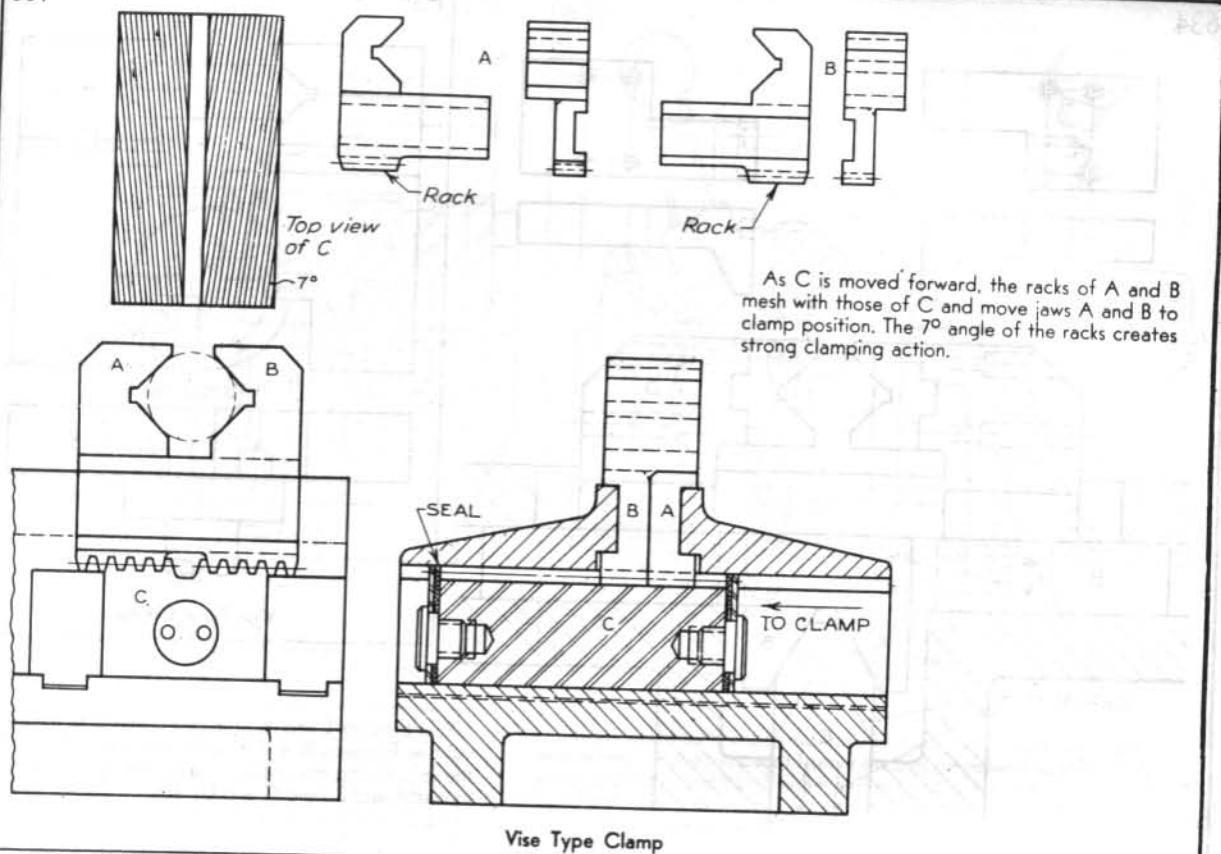
Vise Type Clamp

630



Vise Type Clamp

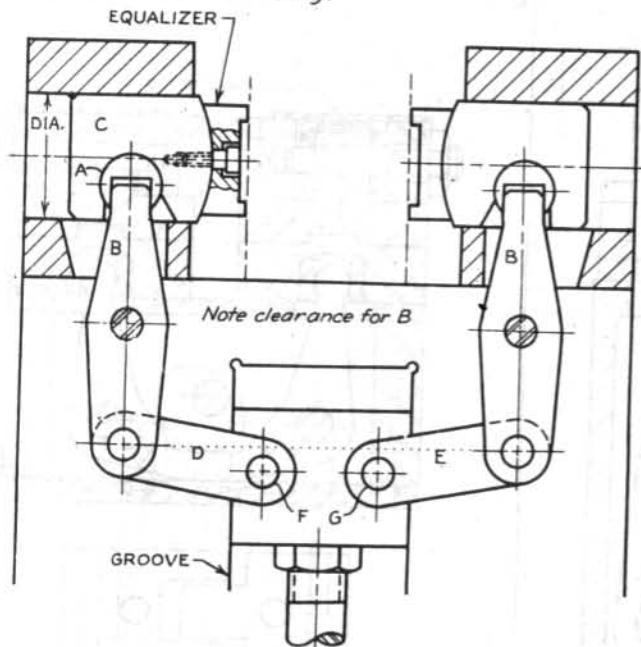
631



Vise Type Clamp

632

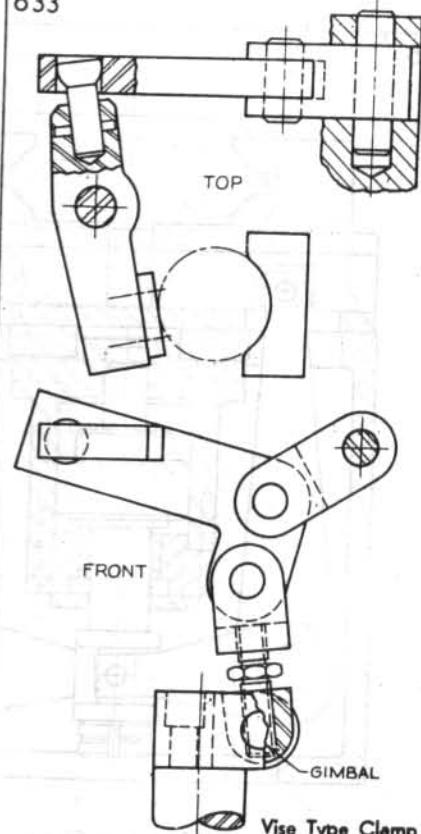
Cylindrical pin A fits in reamed slot in C. Slot in C is needed for assembling.



As links D and E approach the horizontal, the applied force is quite strong. When a part is a bit undersized, center pins F and G will move above the horizontal, relieving the clamping, unless there is a stop. This is a toggle link clamp.

Vise Type Clamp

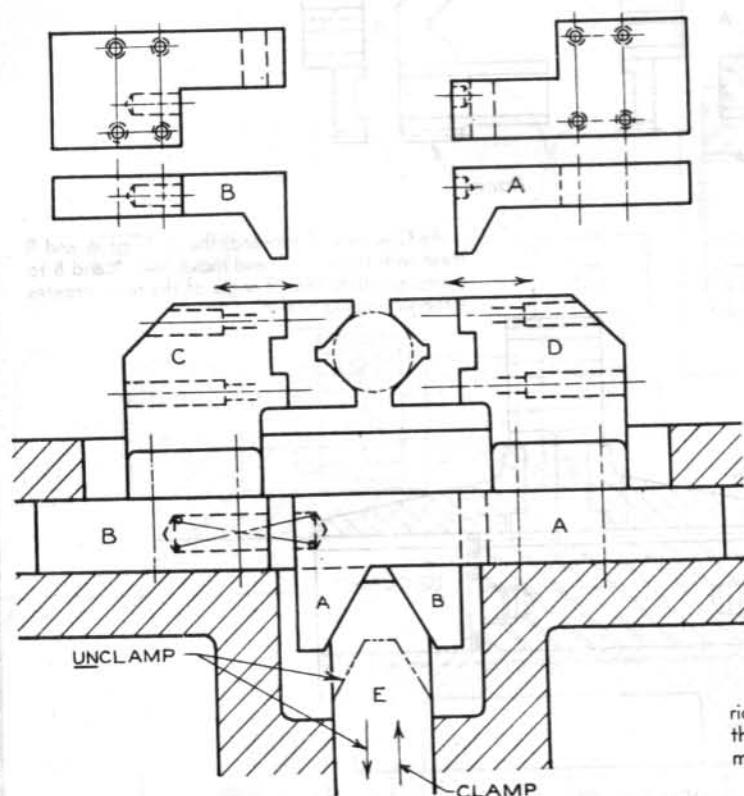
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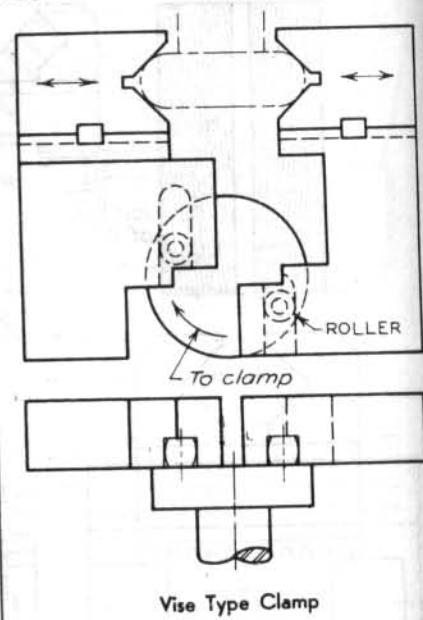
Vise Type Clamp

634-637

634

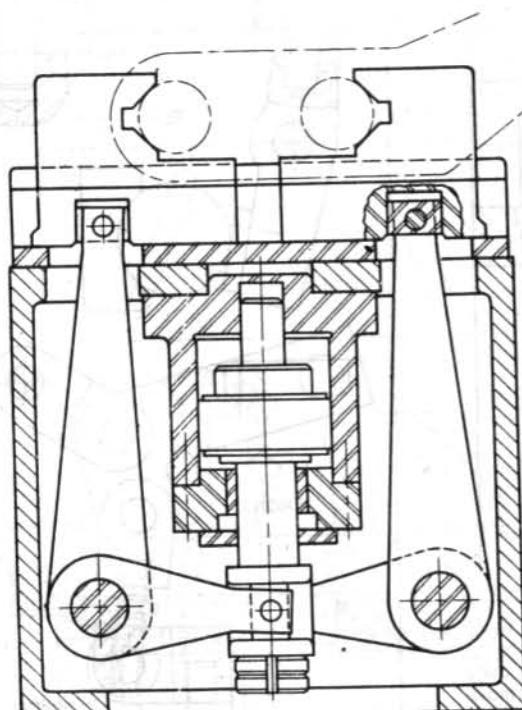


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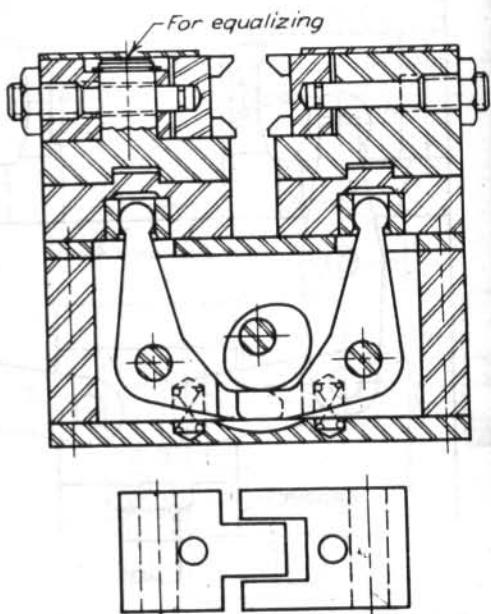
Vise Type Clamp

636



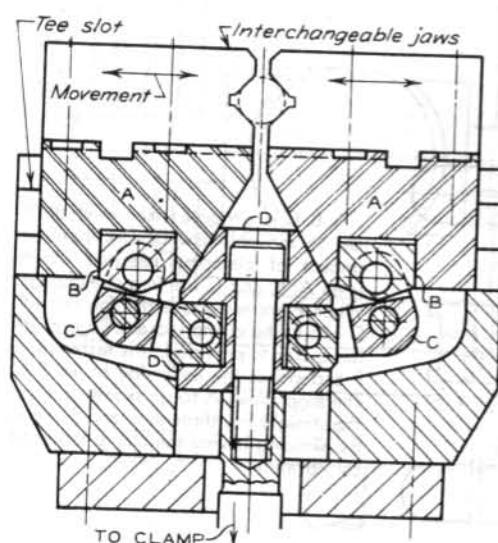
Vise Type Clamp

637



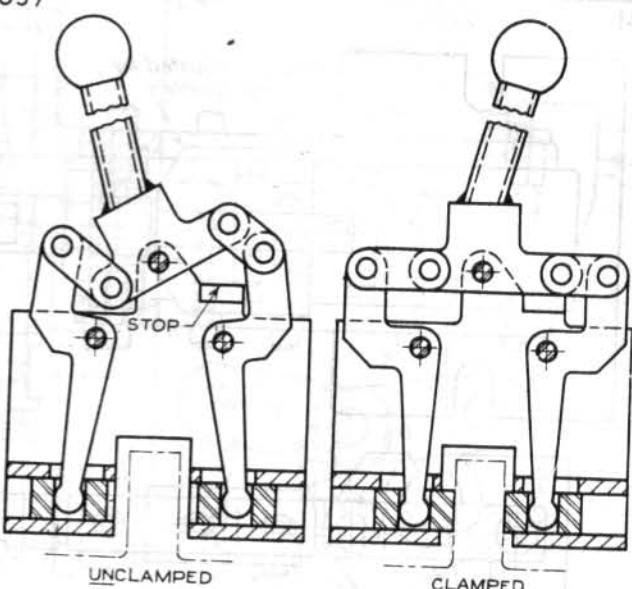
Vise Type Clamp

638

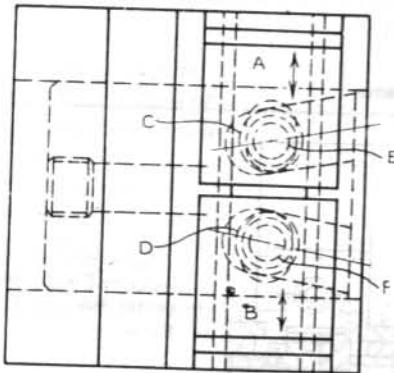


Vise Type Clamp

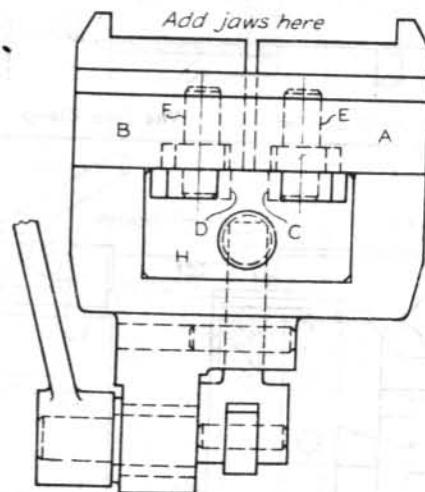
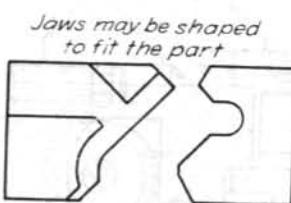
639

A Toggle Link Clamp.
Vise Type Clamp

640

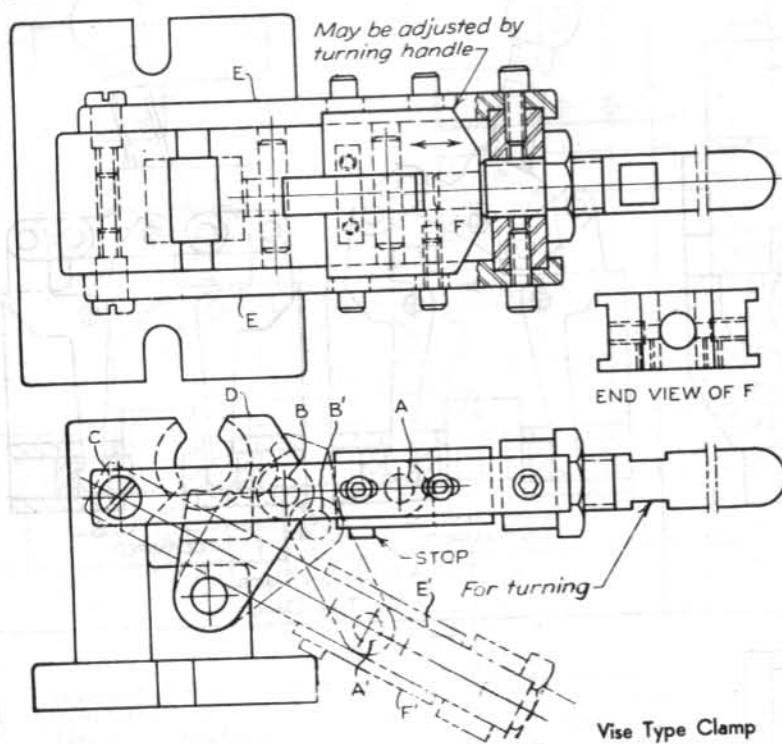


Jaws A and B slide in a horizontally formed T-slot. The angular open end milled grooves in cam H serve as cams for rollers C and D, which are pinned to A and B by E and F and move jaws A and B. Since pins E and F extend through frame G, slots are needed in G for their movement. J,K,L is a toggle linkage.



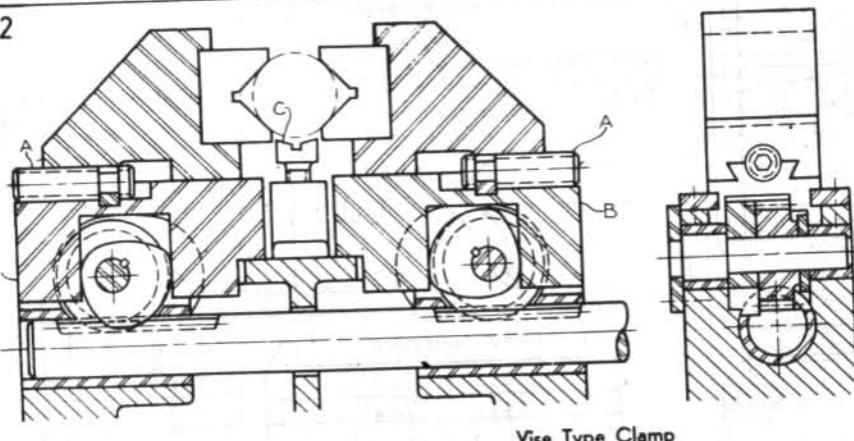
Vise Type Clamp

641

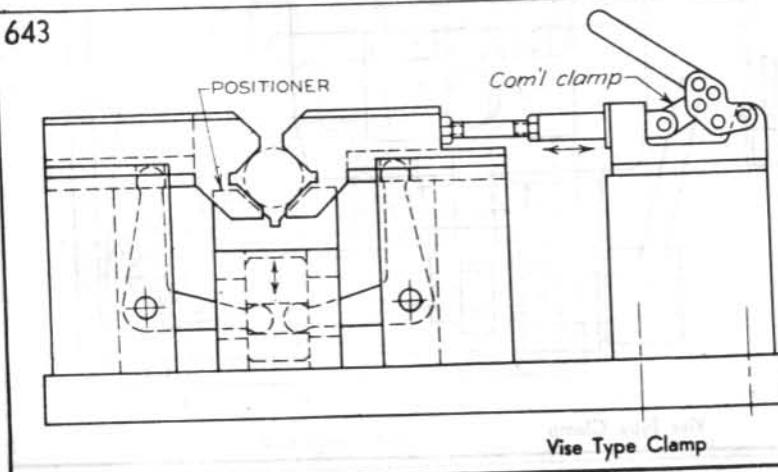


A, B, C is a toggle linkage with B pinned to movable jaw D. The maximum amount of clamping pressure occurs when A, B, and C are in a straight line. When A moves above the line through C and B, the clamp loosens. To prevent this stop is provided. It is fastened to F and strikes the underside of link B,A. The stop allows A to go slightly beyond the straight line through C and B, thereby avoiding having the clamp loosened by vibration.

642

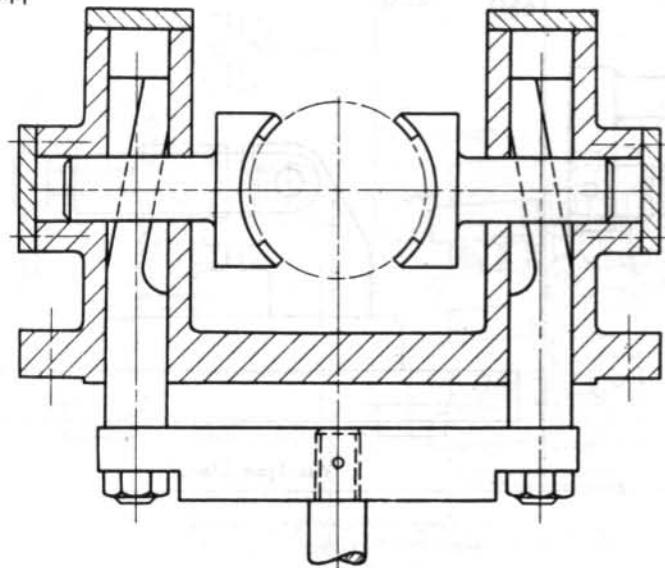


643



The positioner locates the part approximately and then the jaws raise it to clamp position. The power source is a commercial toggle clamp.

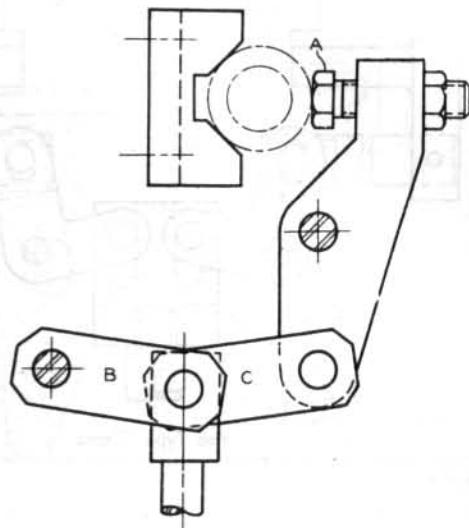
644



The wedge cams actuate the clamps. See Power Sources for Clamp Posts category for additional wedge cams.

Vise Type Clamp

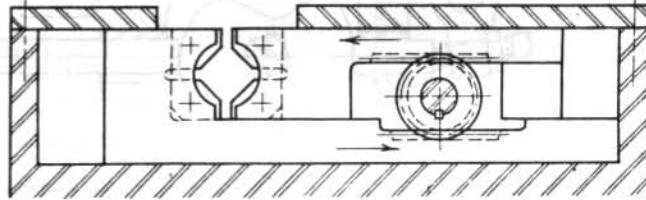
645



Properly adjusting A prevents B and C from aligning horizontally.

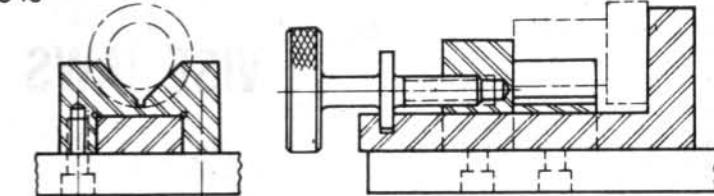
Vise Type Clamp

646



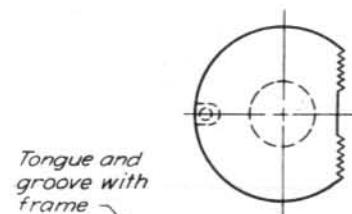
Vise Type Clamp

648

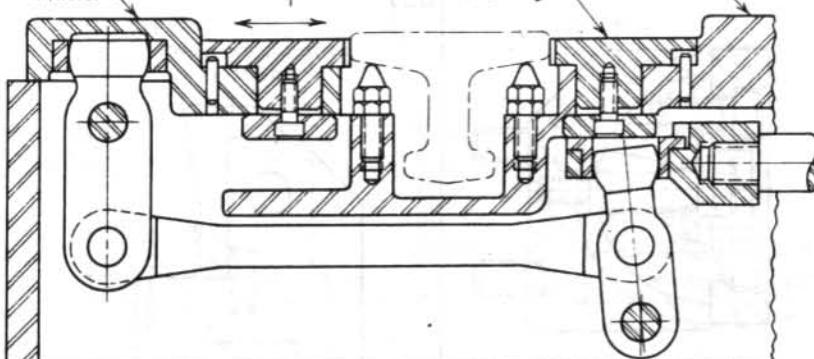


Vise Type Clamp

647



Tongue and groove with frame



Vise Type Clamp

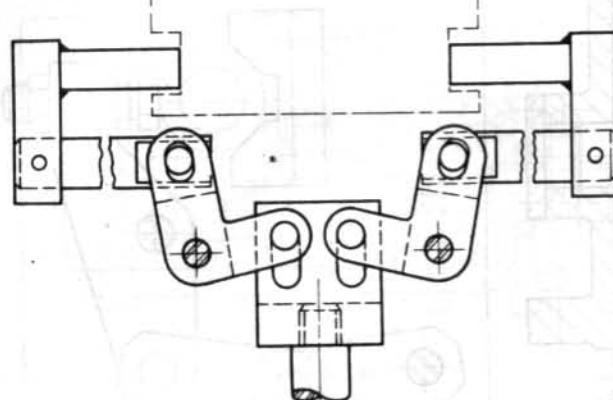
... with B pinned. The maximum pressure occurs along a straight line. A line through B. To prevent fastened to link B, A. Slightly beyond B, there- clamp loosened

... set screws in the jaws that C is a posi-

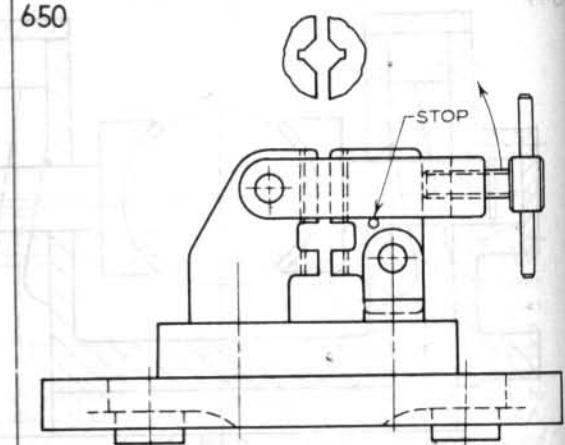
... a part ap-
raise it to
source is a

649-653

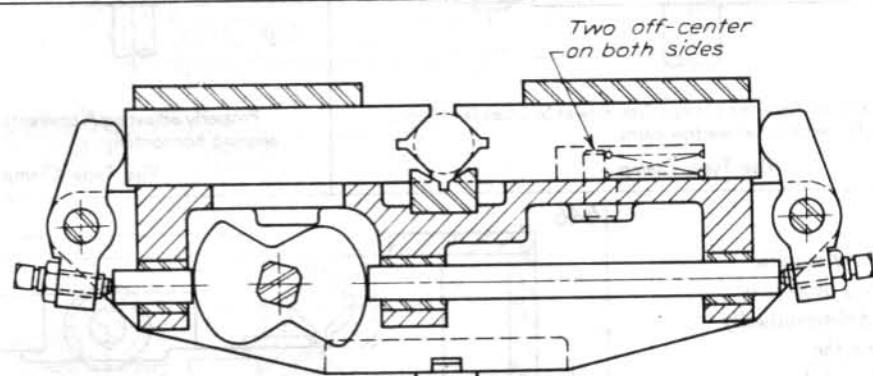
649



650

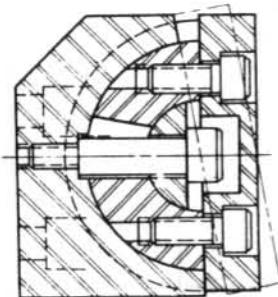


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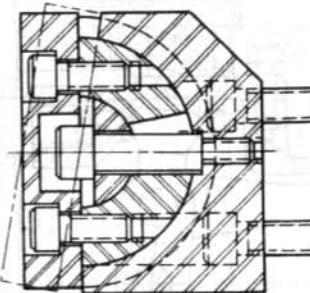
VICE JAWS

652

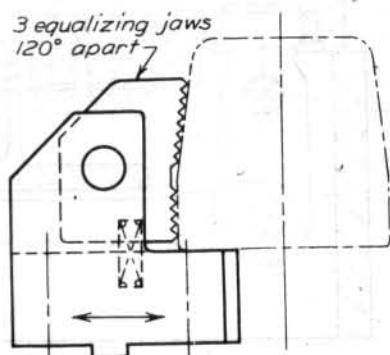


Vise Jaws

653

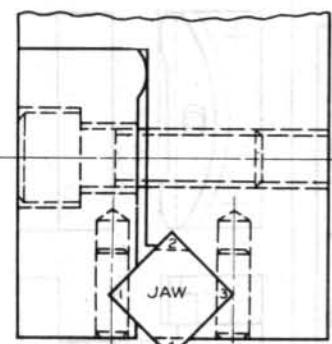


3 equalizing jaws
120° apart

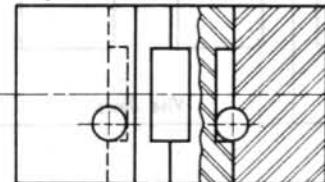


Vise Jaws

654

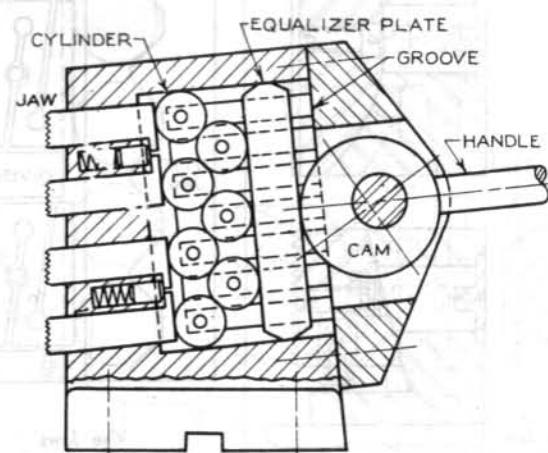


4 jaw tooth positions



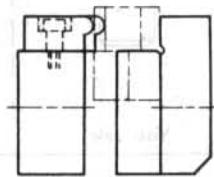
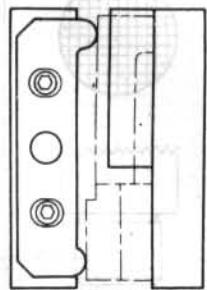
Vise Jaw

655



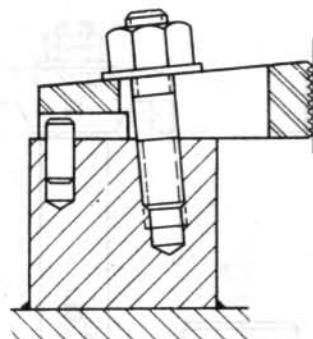
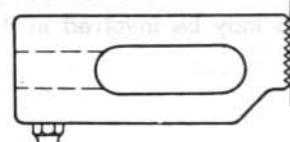
Vise Jaws

656



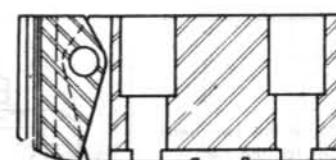
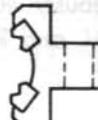
Vise Jaws

657



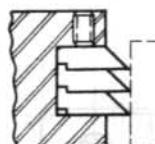
Vise Jaw

658



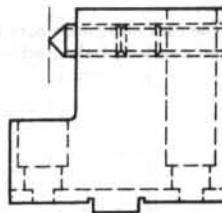
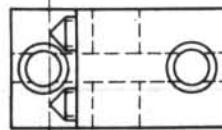
Vise Jaw

660



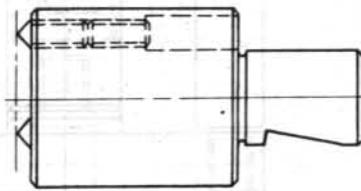
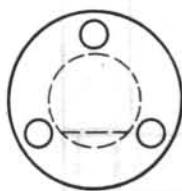
Vise Jaw

659



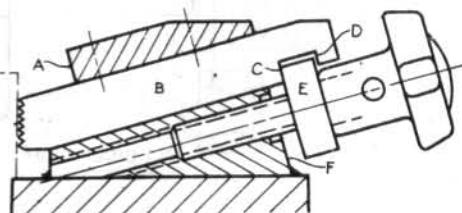
Vise Jaw

661



Vise Jaw

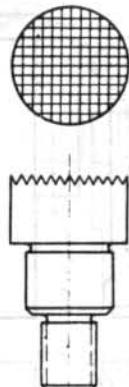
662



Vise Jaw

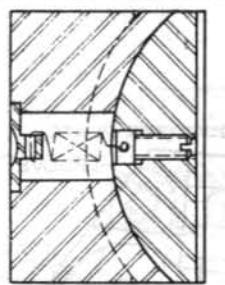
663-667

663



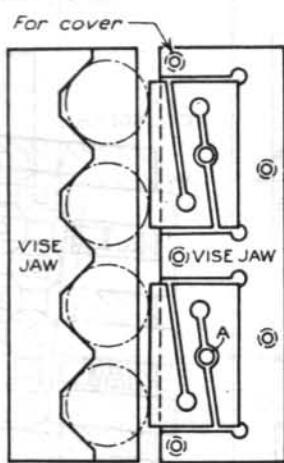
Vise Jaw

664



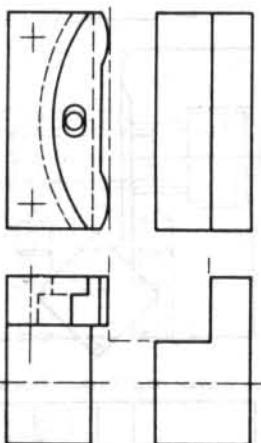
Vise Jaw

665



Vise Jaws

666



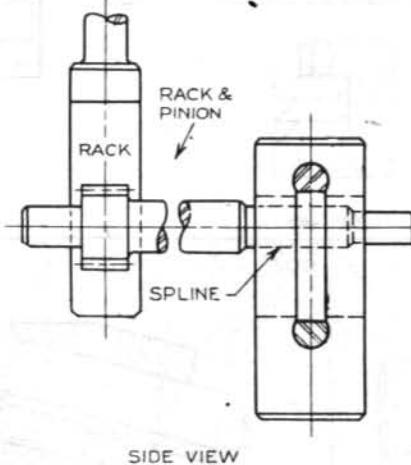
Vise Jaws

MULTIPLE LOADING

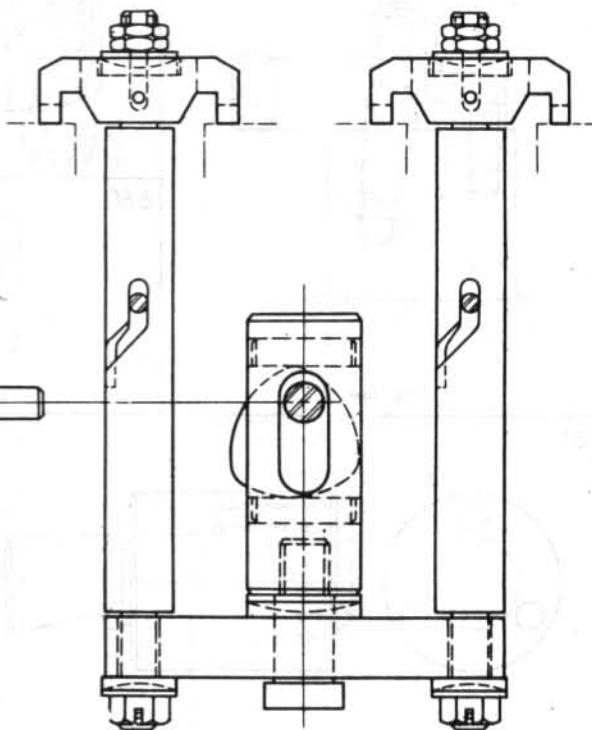
When two or more parts are clamped simultaneously, equalizers are invariably used. Springs or cams of various types, balls, collets, oil, or L.H. and R.H. threads may be involved in the clamping.

667

The rack and pinion rotate the cam. Note the two hardened pins with flats used as wear surfaces for the cam.



SIDE VIEW



Multiple Loading

668

Opposite sides of two parts can be machined simultaneously with this unit.

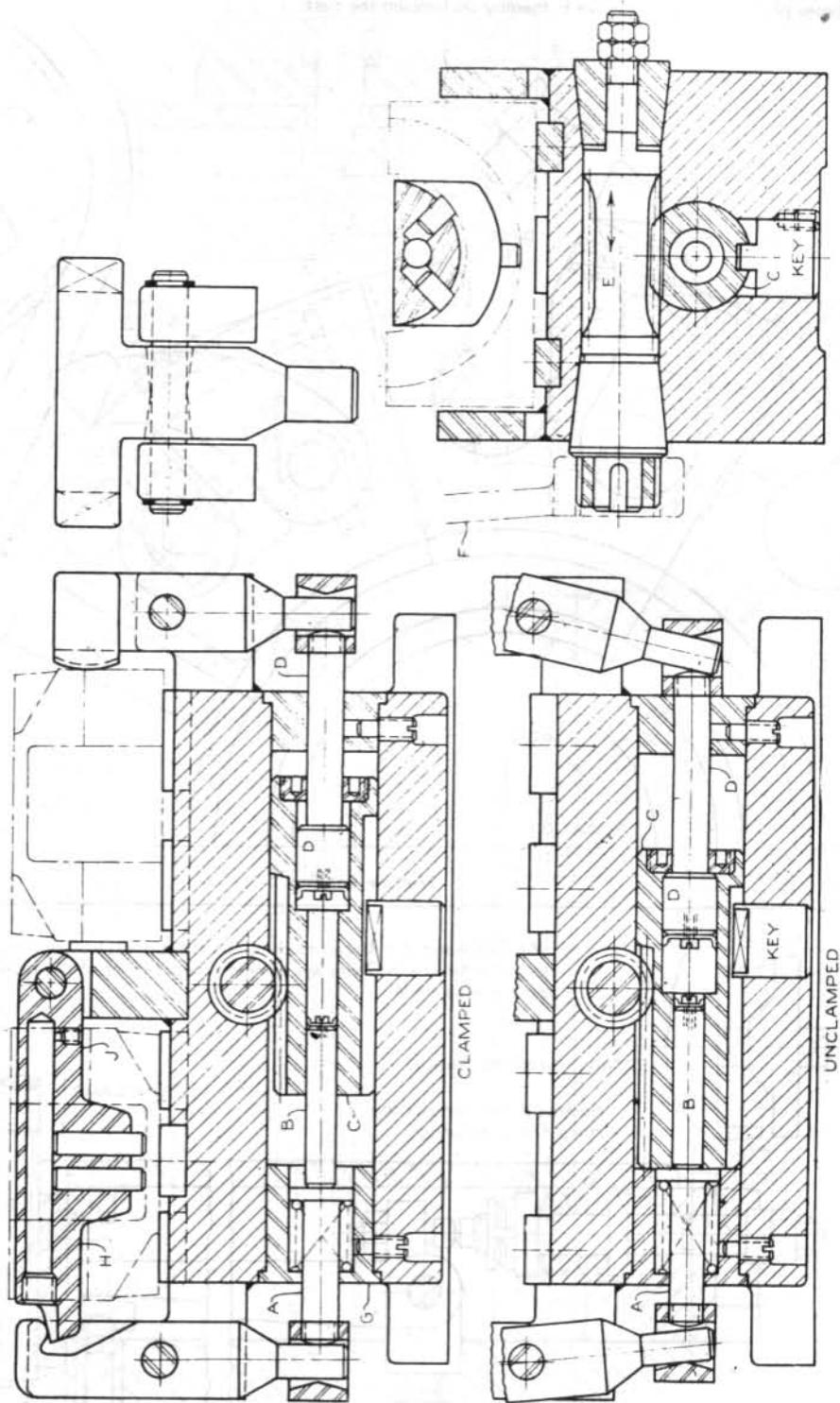
Piston B actuates the left clamp while D actuates the right one. The oil chamber volume must be slightly larger in the unclamp position than in the clamp position to release the pressure on the oil during the clamping operation. The oil chamber located in C is actuated by the rack of C and pinion E through handle F.

Note how the spring and rod A retract the left clamp and D the right clamp. The spring would push G out if it were not keyed by the set screw. Observe the cylindrical key which

prevents C from rotating.

Lid H is an oil-based equalizer. Note the use of six pistons which the oil equalizes; they cannot drop out. A small set screw closes the needed air vent after the chamber is filled with oil.

Pinion E is helical and has endplay to allow slippage between the pinion and rack when the unit is in clamp position until the cone tightens, locking the whole device.

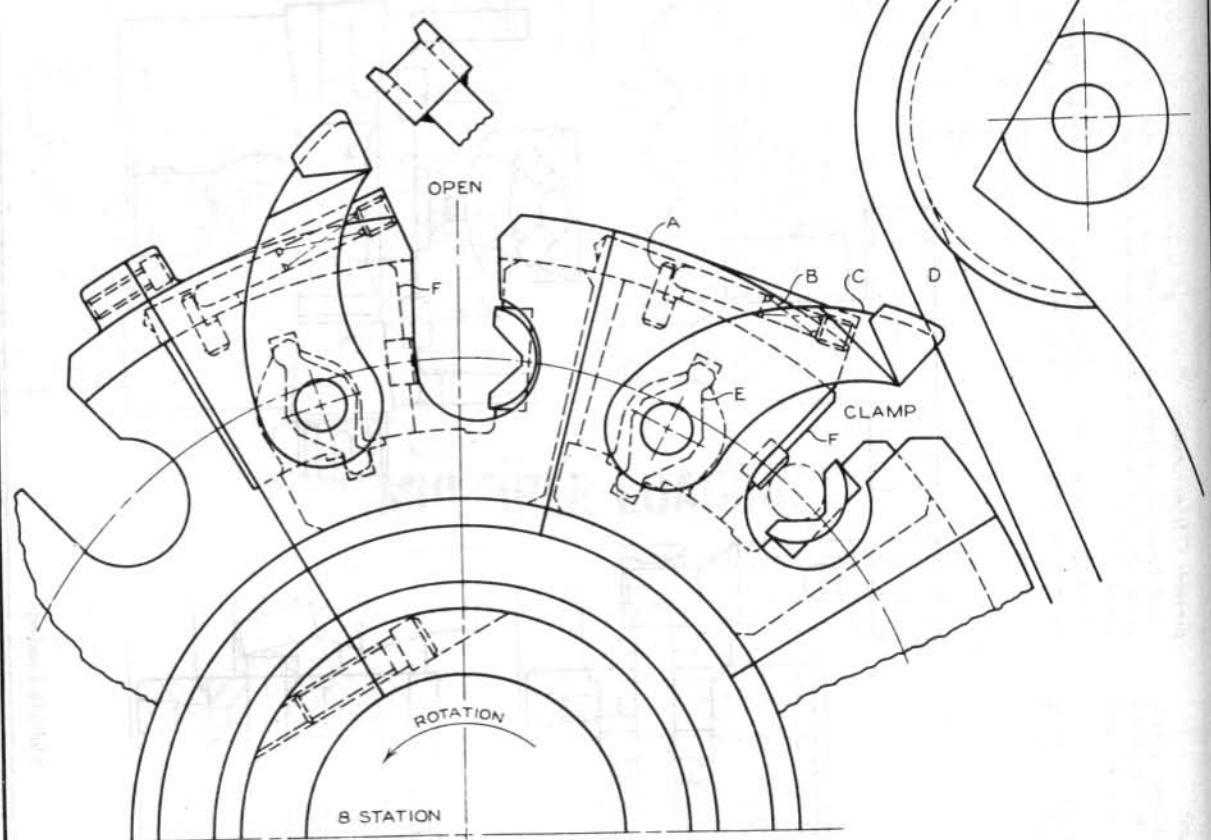


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669-670

669

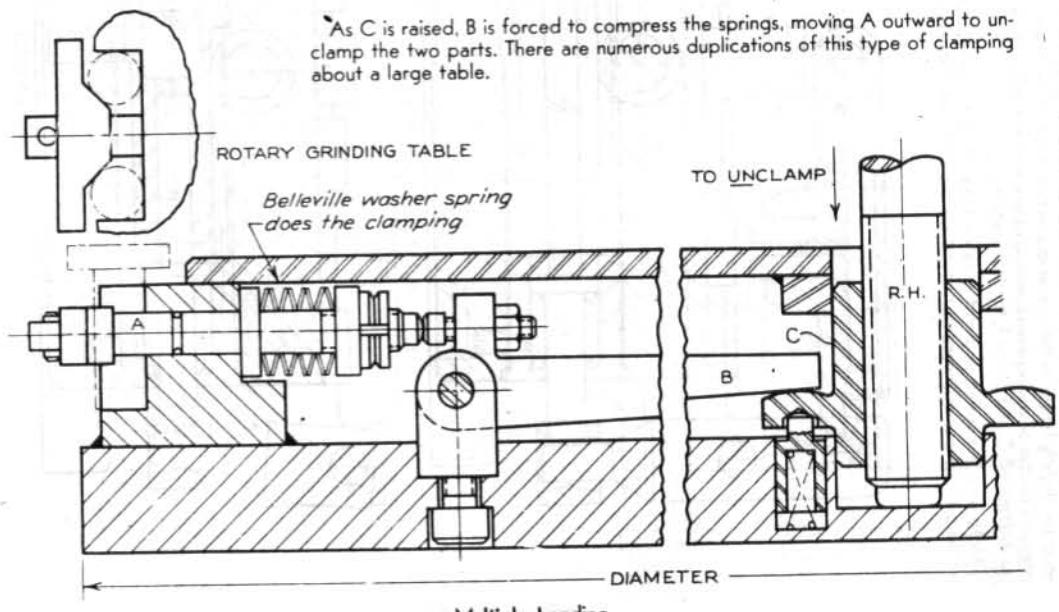
As the table rotates counterclockwise, tripping arm C strikes belt D and rotates rocker arm E, which moves clamp F to clamp position. The table then stops rotating and the machining operation is performed. As the table rotates again, C moves beyond D, and spring B forces pin A in clamp F to move F, thereby unclamping the part.



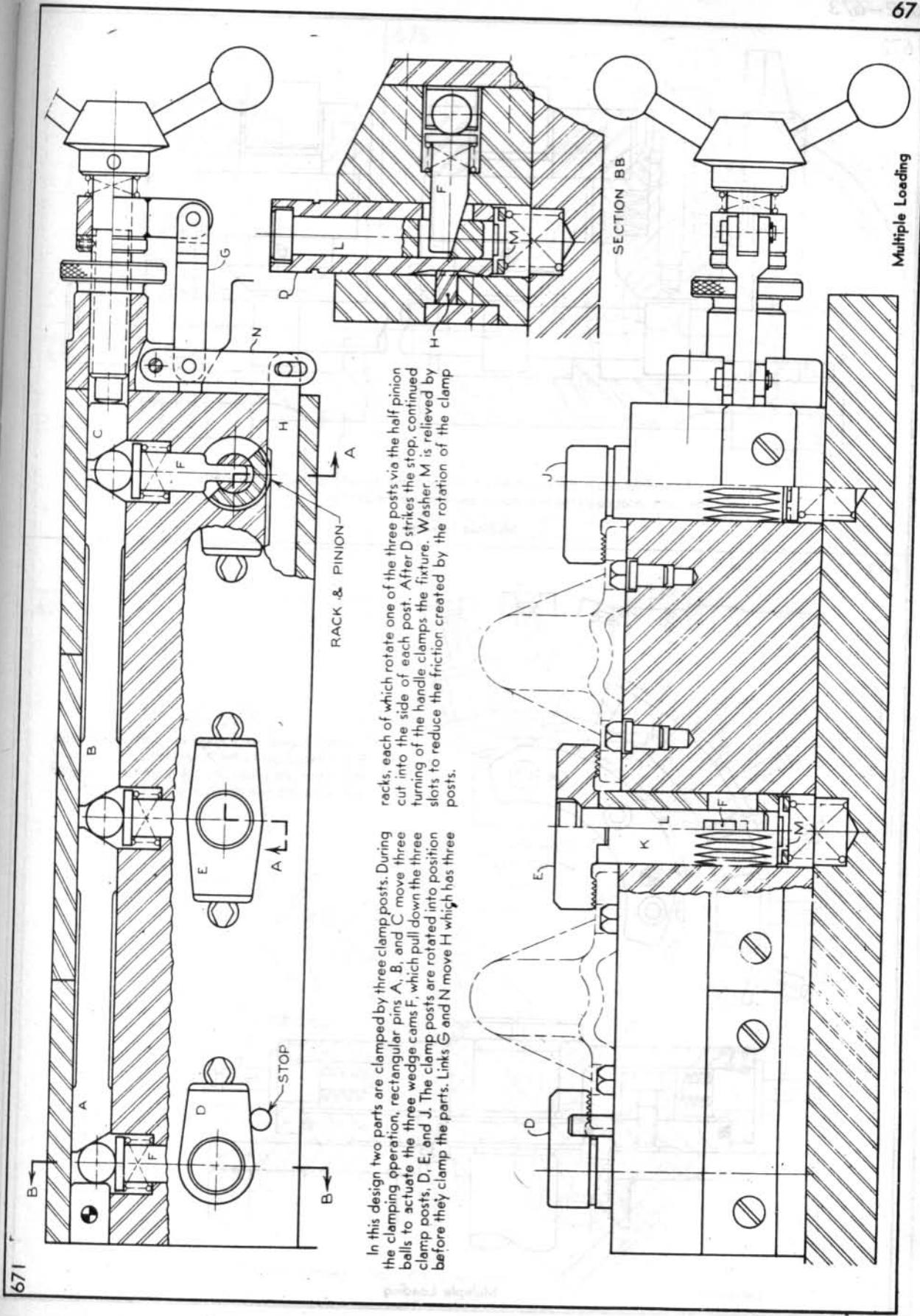
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670

As C is raised, B is forced to compress the springs, moving A outward to unclamp the two parts. There are numerous duplications of this type of clamping about a large table.

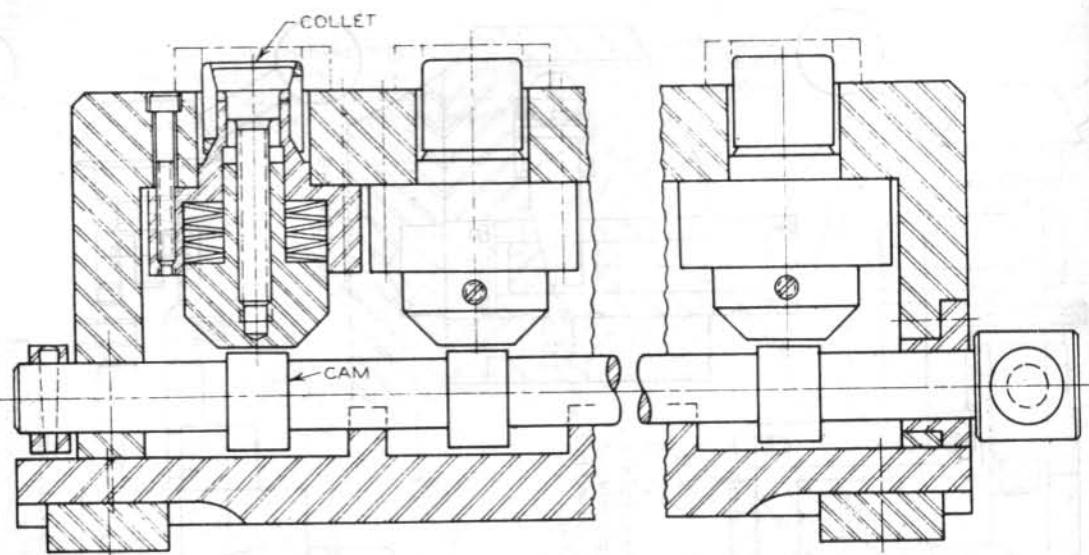


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672-673

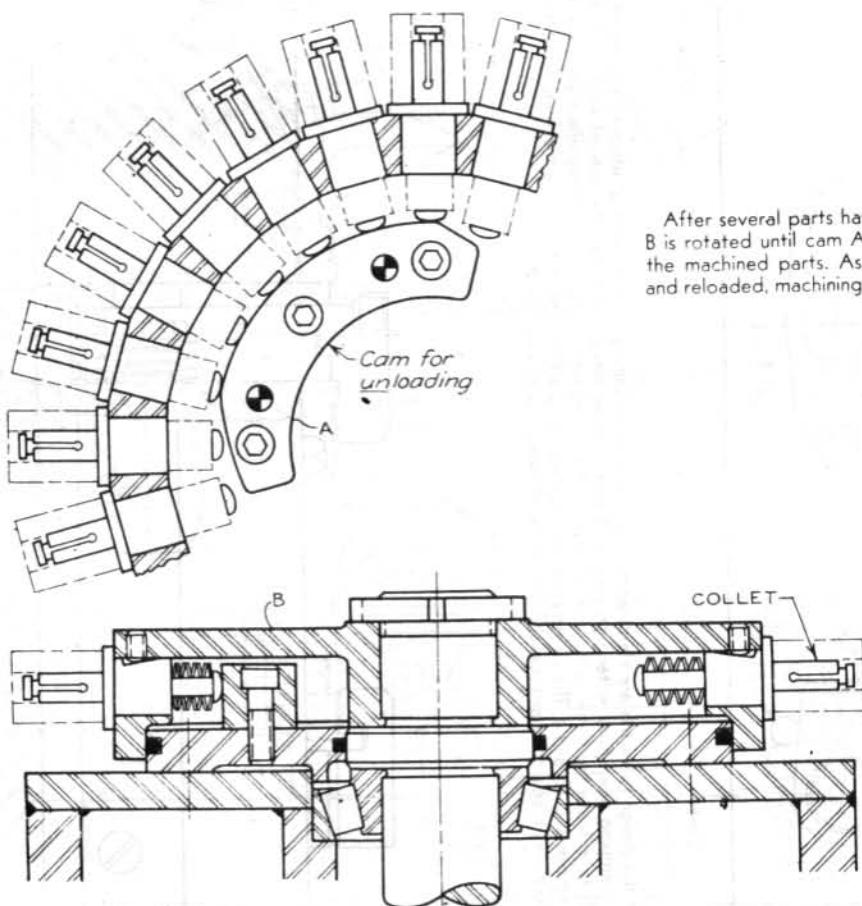
672



The springs cause the expanders to expand the collets, clamping the parts.
The cams later raise the expanders, unclamping the parts.

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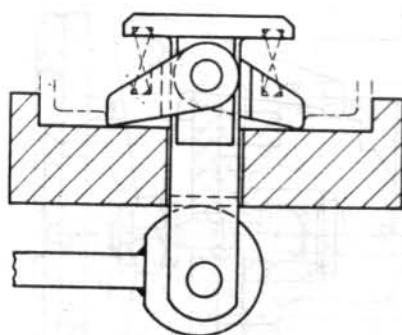
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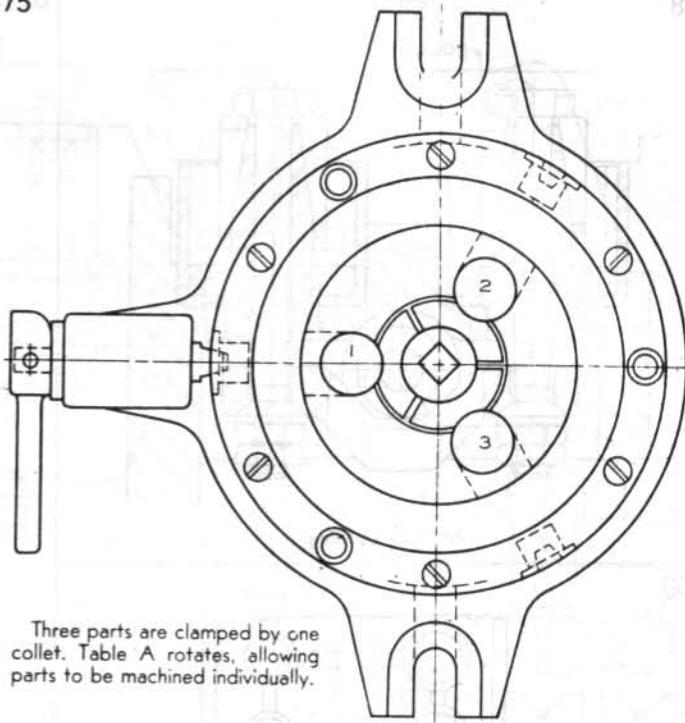
After several parts have been machined, table B is rotated until cam A unclamps the collets of the machined parts. As the parts are unloaded and reloaded, machining of other parts continues.

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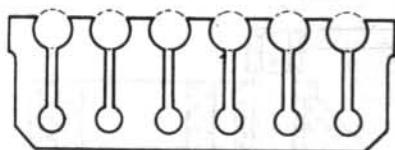
674



675

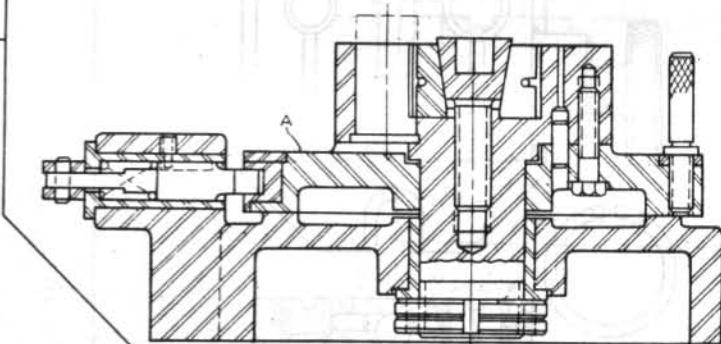
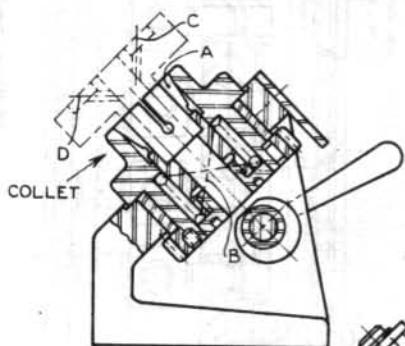


676



This is a clamping device for use in a vise.
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677

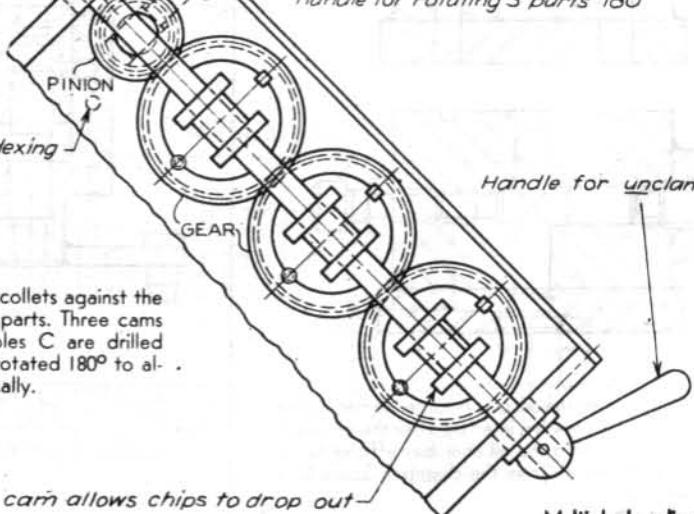


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Stop for 180° indexing



Handle for unclamping of 3 collets

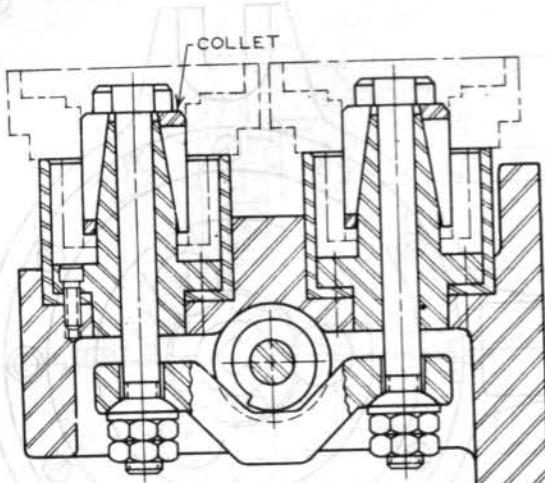


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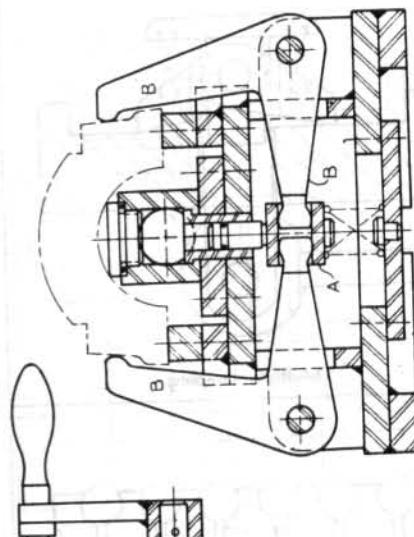
The strong springs B pull the collets against the squeezers, clamping the three parts. Three cams unclamp the collets. After holes C are drilled vertically, the three parts are rotated 180° to allow holes D to be drilled vertically.

678-680

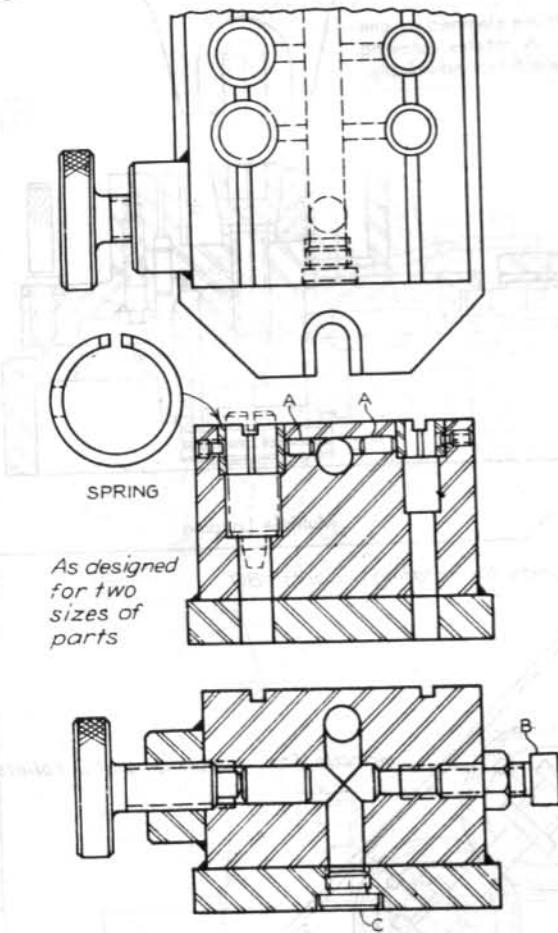
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679

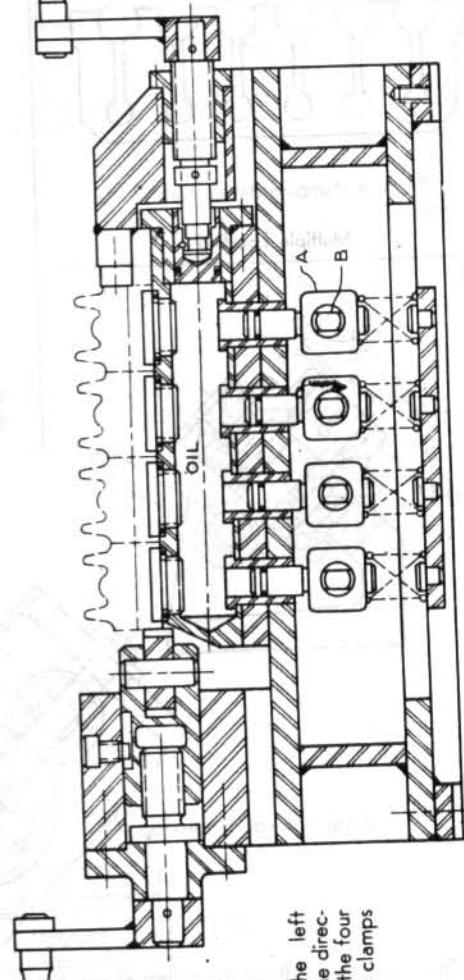


680



When pressure is applied to the oil, pins A force the flat, rolled springs to clamp the parts. Screw B is inserted after the oil chamber is filled. This method of filling the oil chamber efficiently removes the highly compressible air from the chamber. Screw C is a plug for the drilled hole.

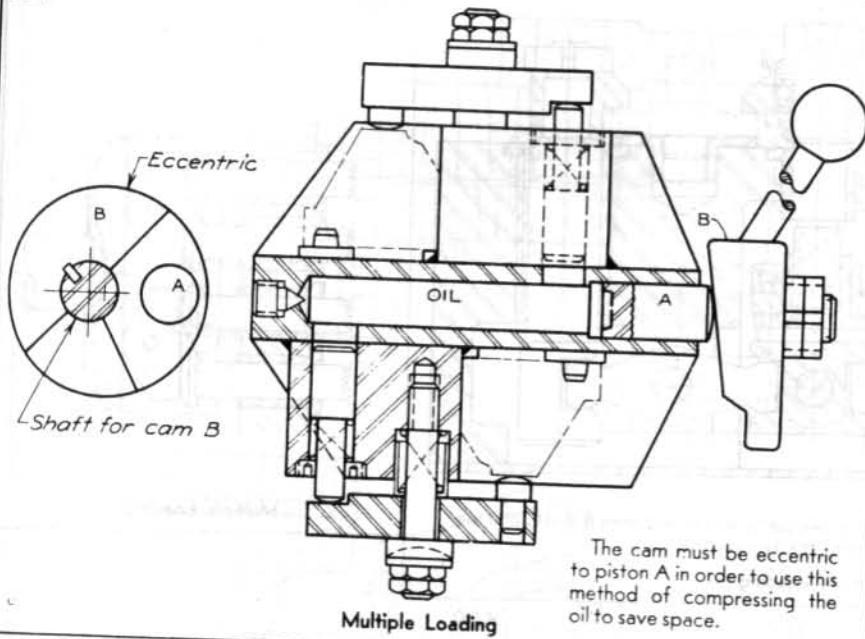
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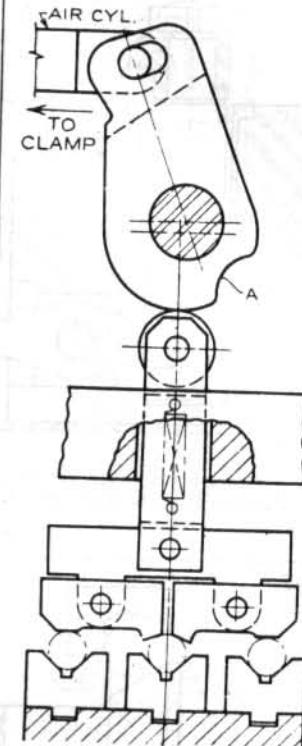
The handle on the left clamps the parts in one direction. The oil actuates the four pistons A that force clamps B to clamp.

681

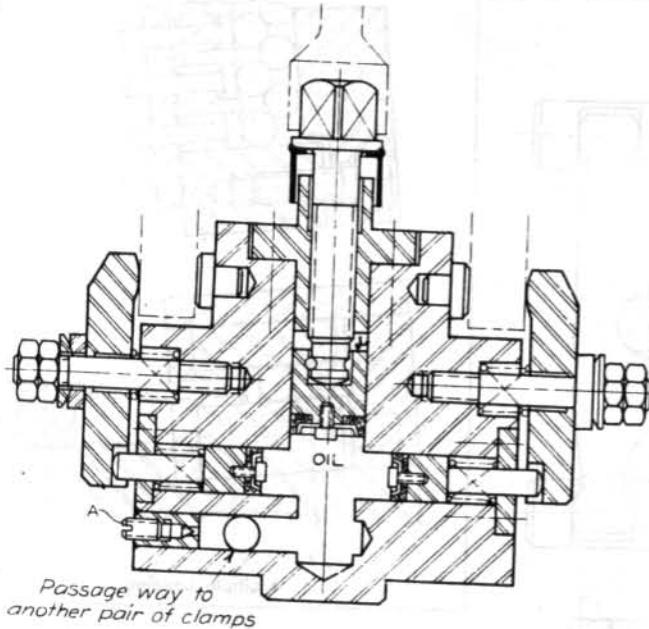


681-684

682



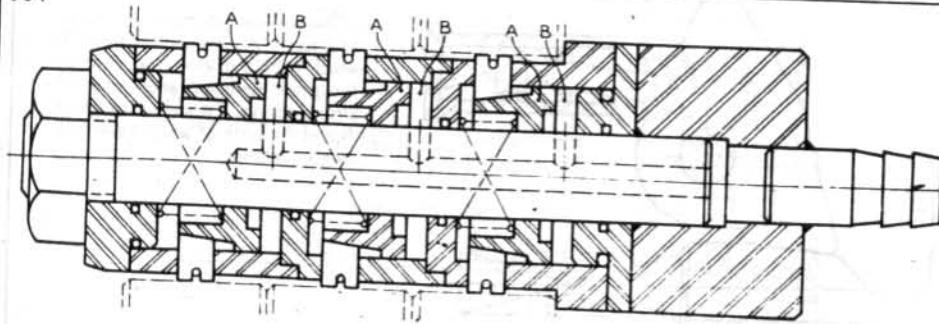
683



The simple addition of a passageway allows one oil chamber to serve as the pressure source for several clamps. A is inserted after the oil chamber is filled.

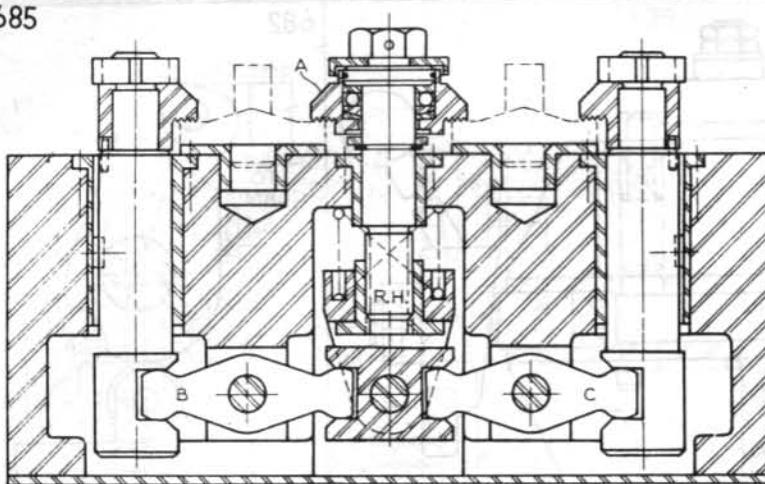
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684

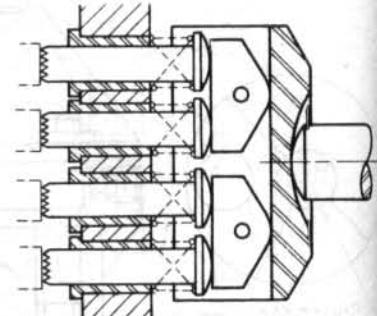


Air is forced into the three chambers B, actuating expanders A to spread the three sets of three jaws. The jaws are retracted by springs.

685

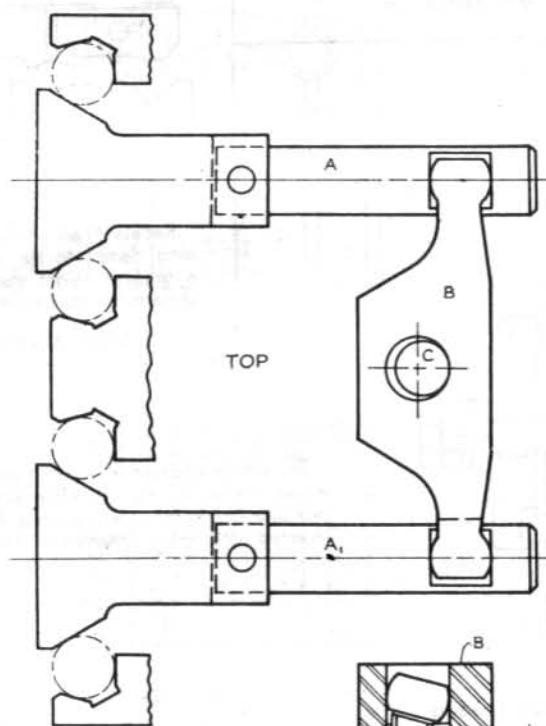


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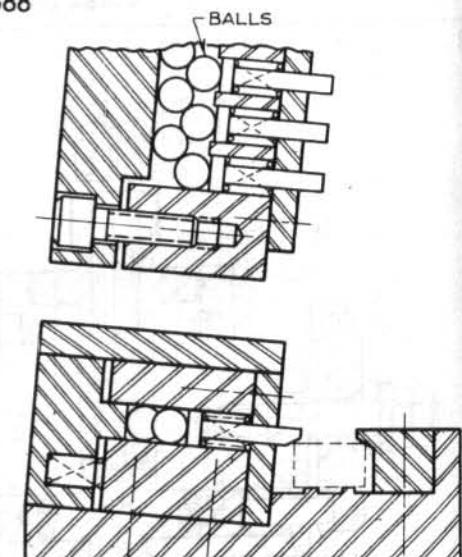


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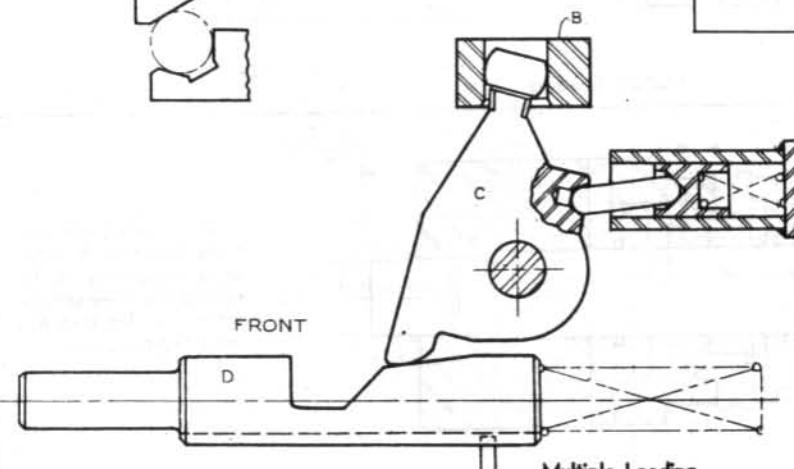
687



688



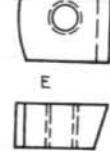
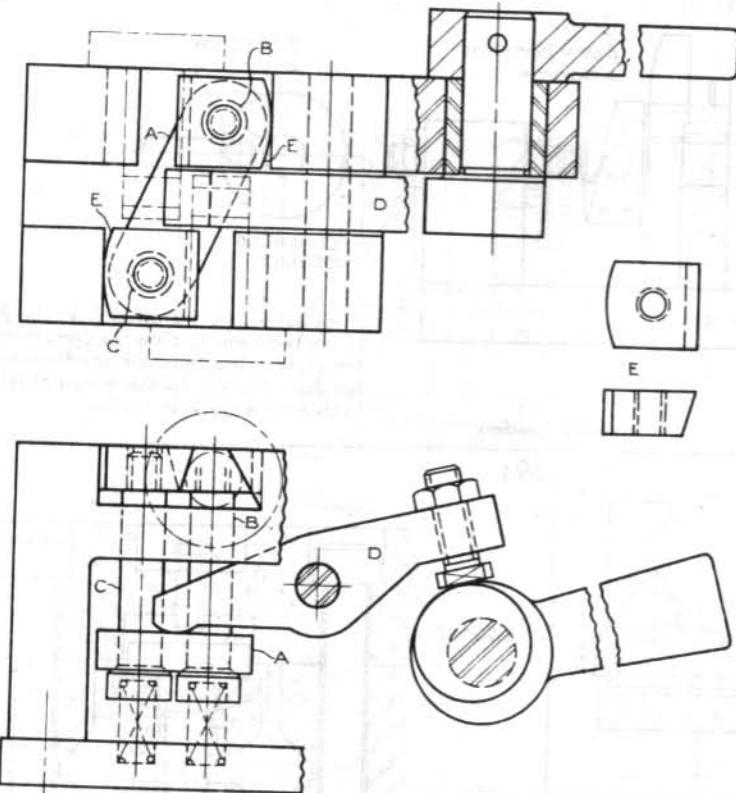
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This device automatically clamps four parts. A cam unclamps cam D which is held in clamp position by the small clamping angle and the strong spring. B equalizes between A and A₁, both of which have their own equalizers.

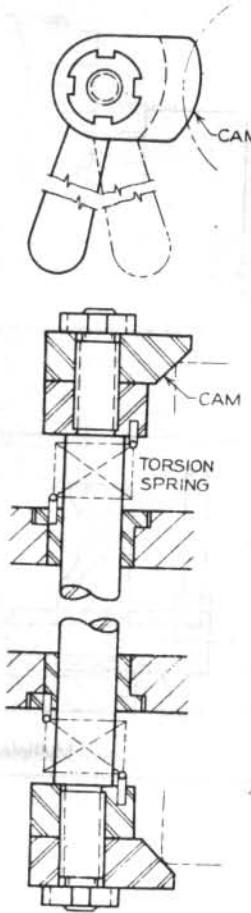
689



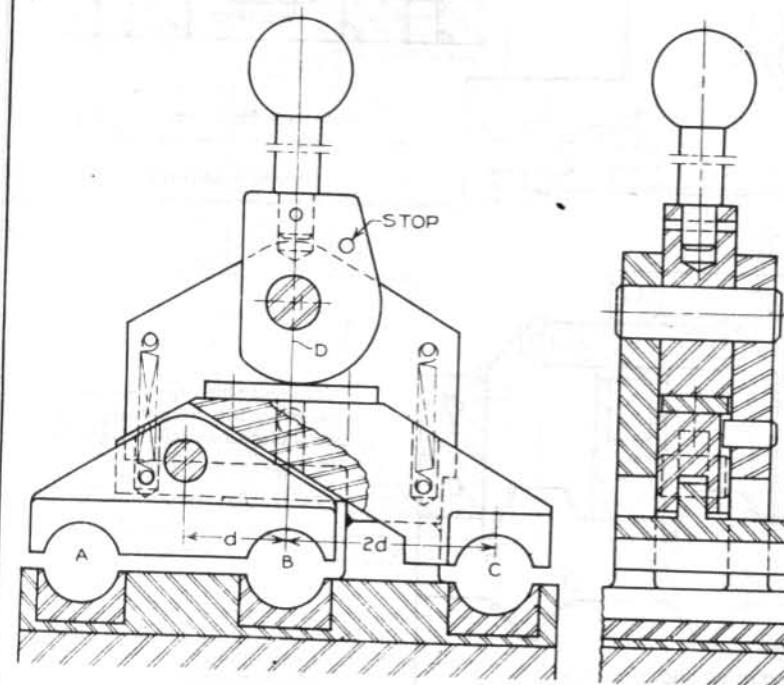
Rocker arm D forces down link A, which pulls down bolts B and C to clamp jaws E.

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690



691



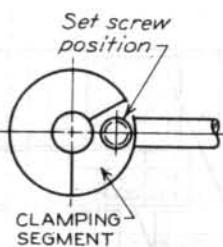
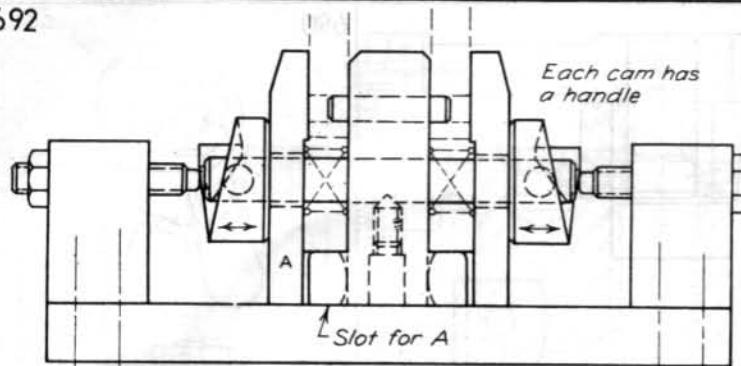
The two cams clamp two parts. The torsion springs hold the cams in clamp position during the clamping operation.

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When the pin for A and B is distance d from centerline D and C is distance $2d$ from D, the clamping action is equally distributed between the three parts.

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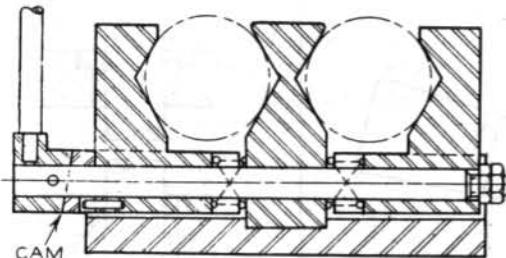
692



The set screws are offset from the shaft of the two cams to allow the cams to move the clamps. The cams are not fastened to the shaft. The slot for the tongue of A prevents the clamps from turning.

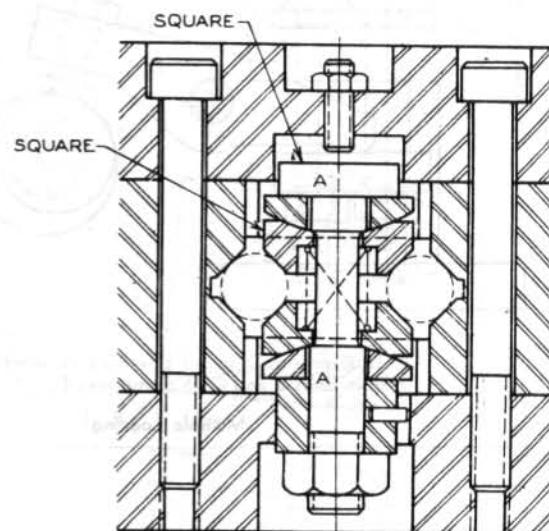
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693



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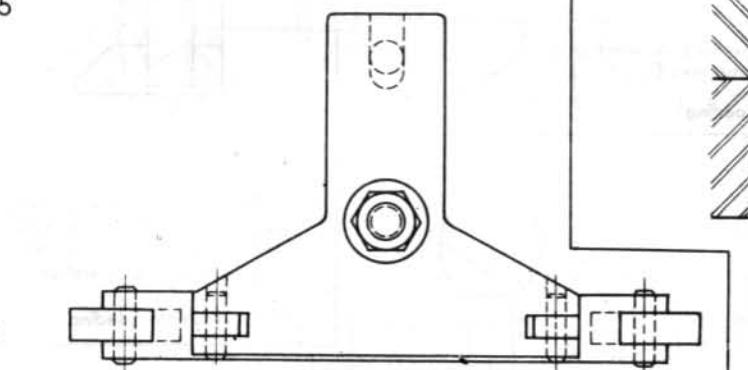
694



Square-headed bolt A fits in a square hole to prevent A from turning.

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695

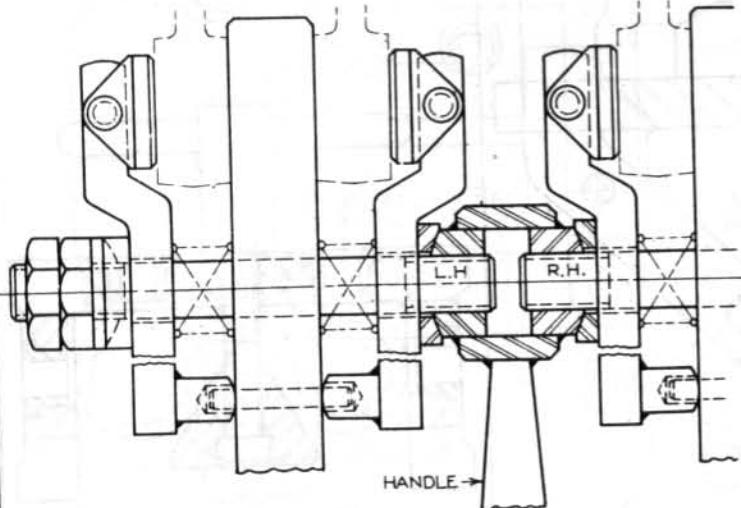


Pins and other items are used to prevent parts from being incorrectly placed in position for clamping.

Pin prevents part being inserted in wrong direction

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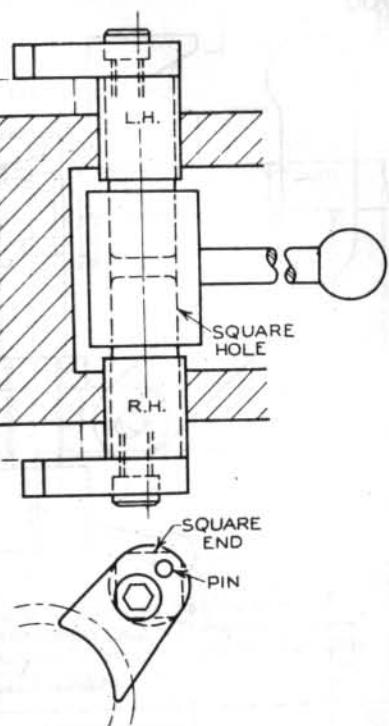
696



One handle clamps four parts through the use of L.H. and R.H. threads. Note how the clamps are prevented from turning.

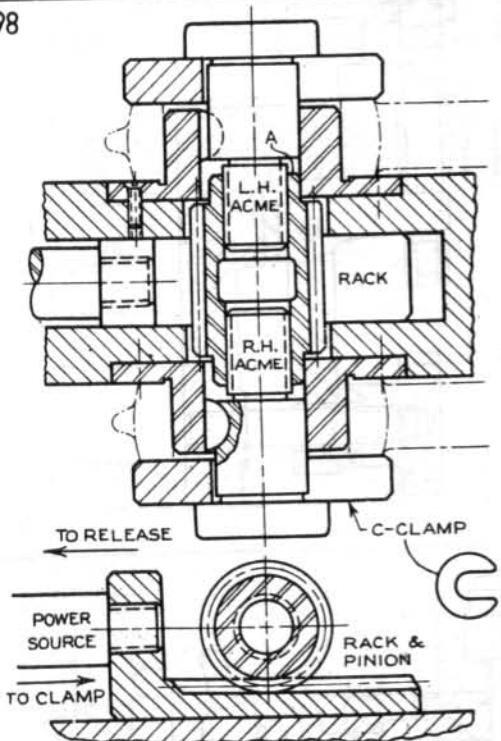
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697



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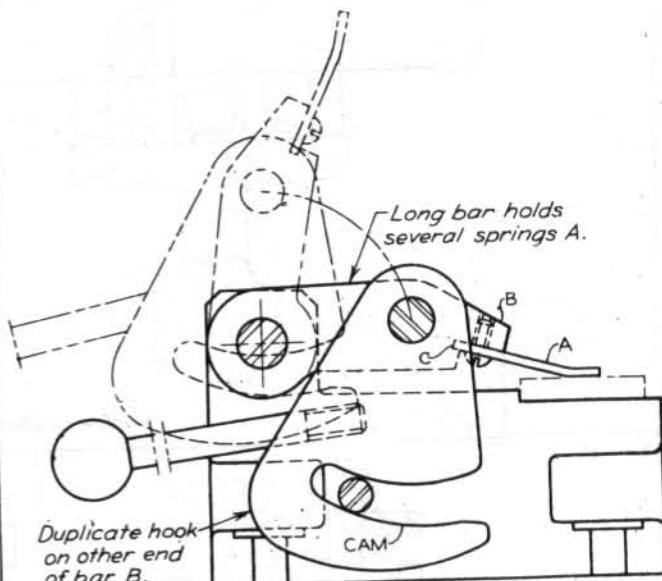
698



L.H. and R.H. nut A is turned by a rack that rotates the pinion on the outside of the nut. The acme bolts are keyed to prevent them from turning but do move longitudinally.

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699

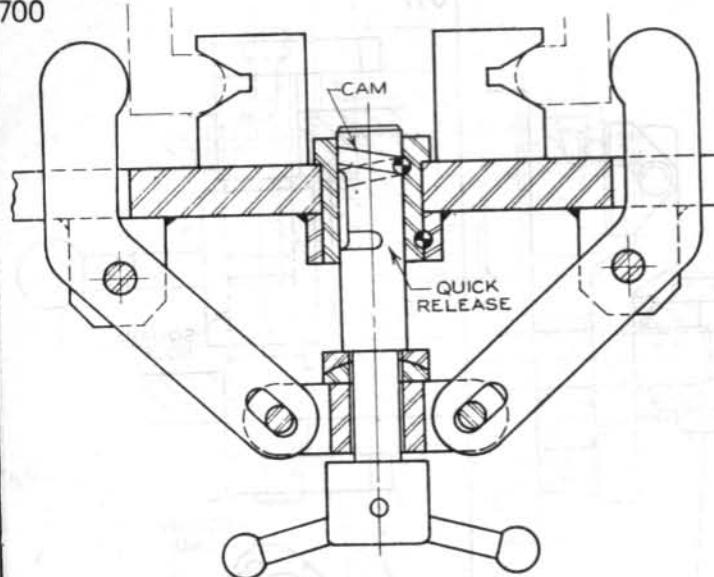


This design may include several flat springs, each holding a part. Note A is held in slot C of B.

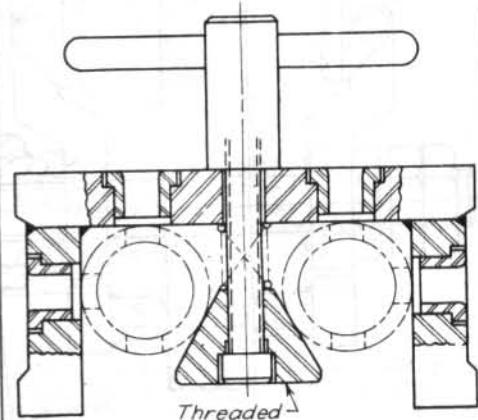
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700-703

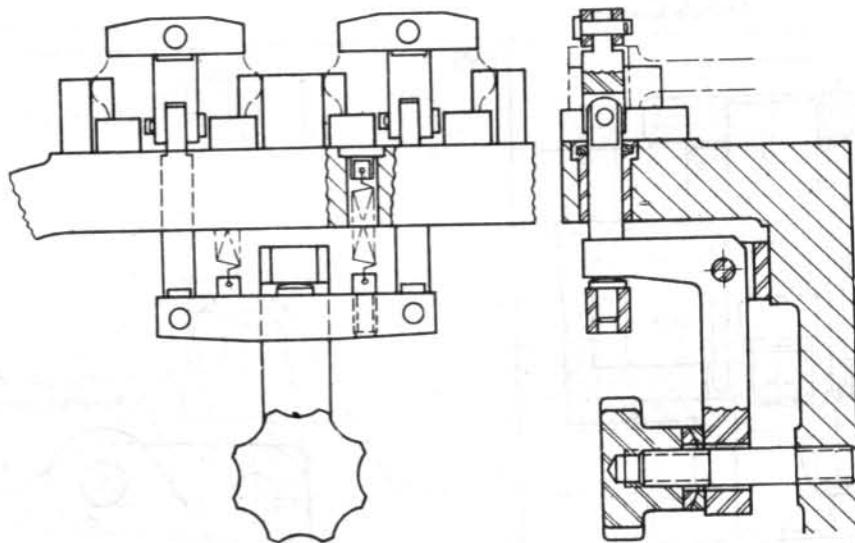
700



701

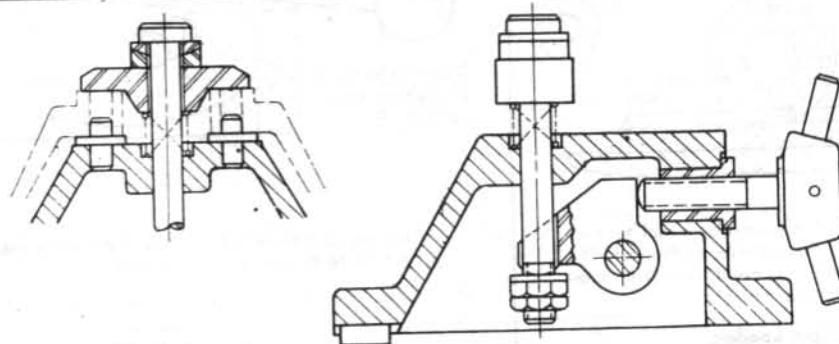


702



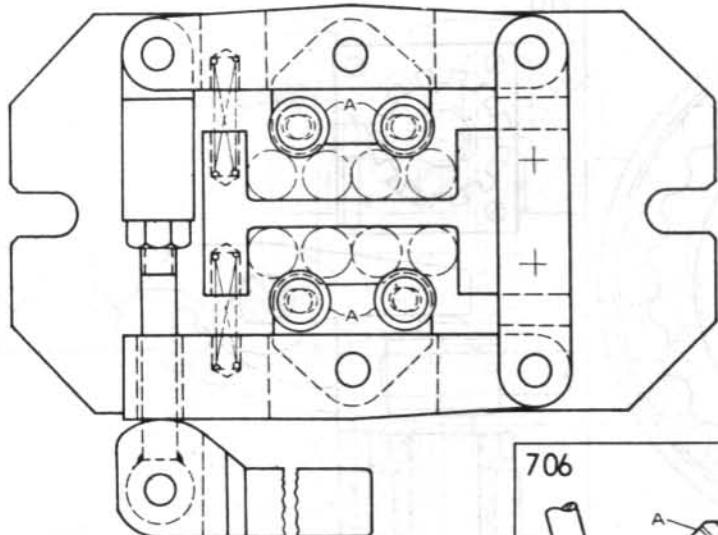
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703



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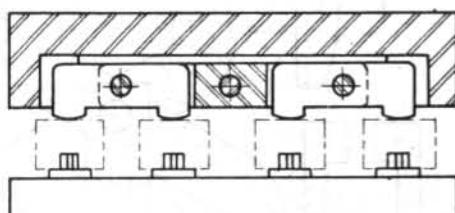
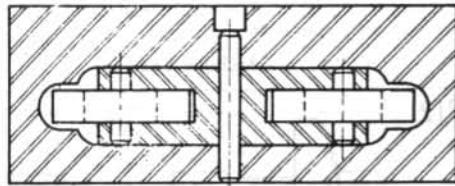
704



The four rollers A equalize eight parts.

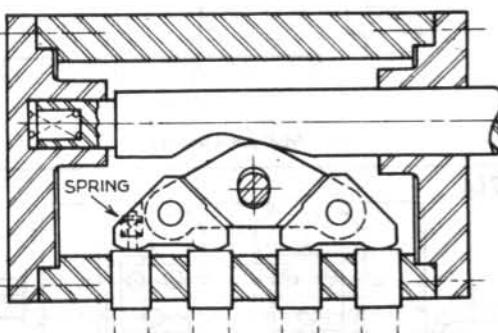
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705



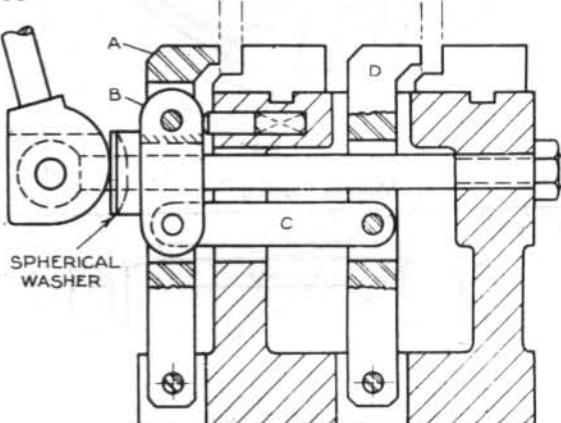
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707



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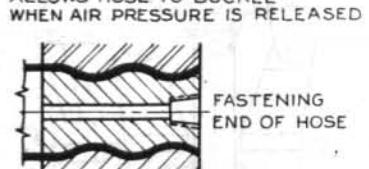
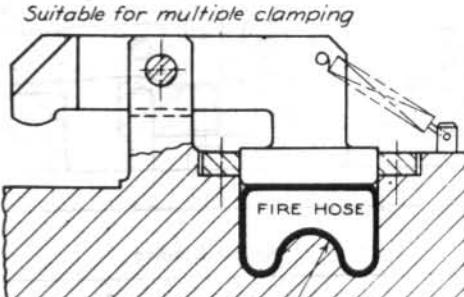
706



During the clamping action, B, which is pinned to A, actuates A to clamp position and, through link C, also actuates clamp D.

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708

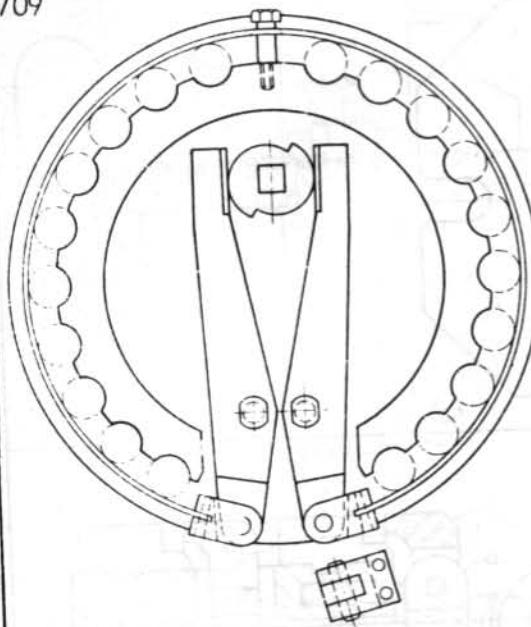


The fire hose can accommodate a number of clamps in line that may be used to clamp several parts or one part in several places. The hose automatically equalizes the clamps.

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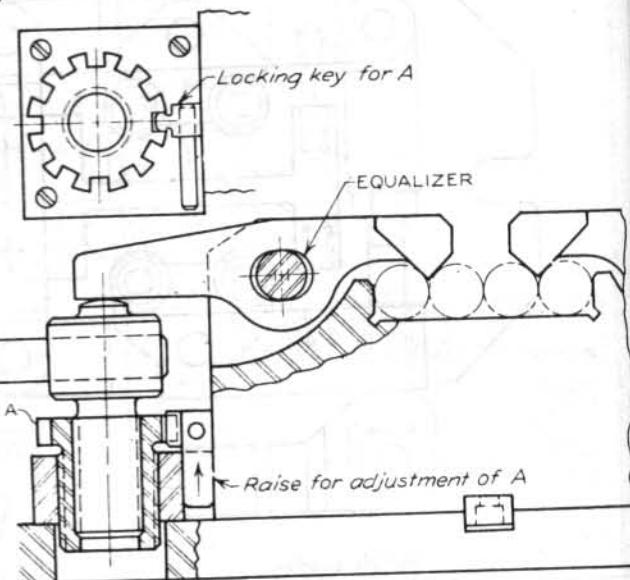
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709



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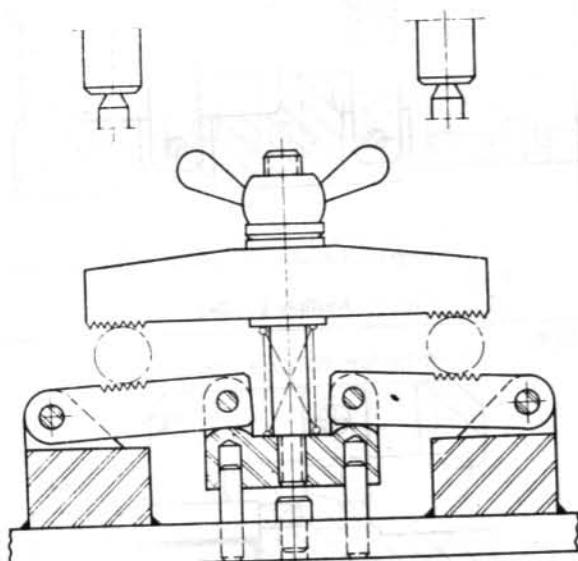
710



Raising by turning nut A allows the handle to be placed in the most advantageous position during the clamping operation.

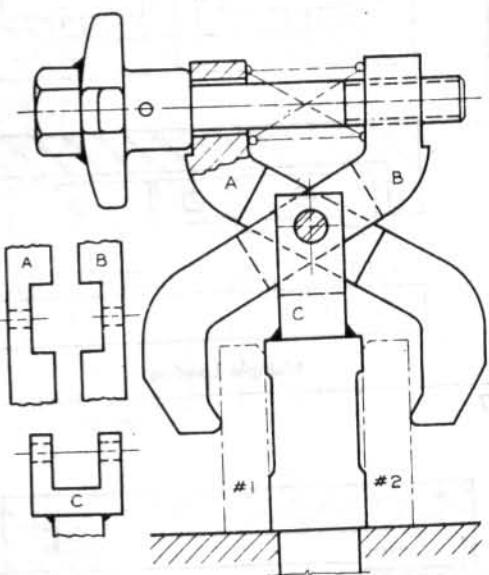
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711



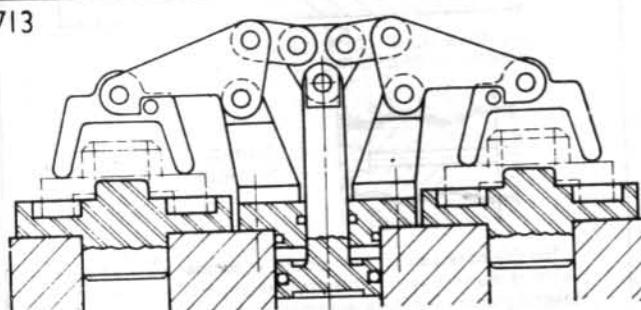
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712



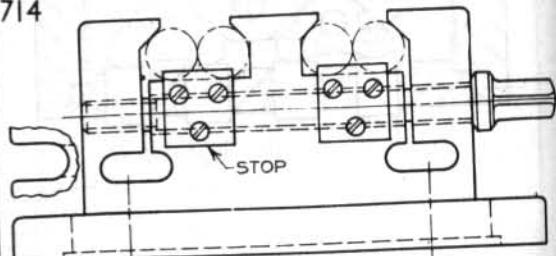
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713



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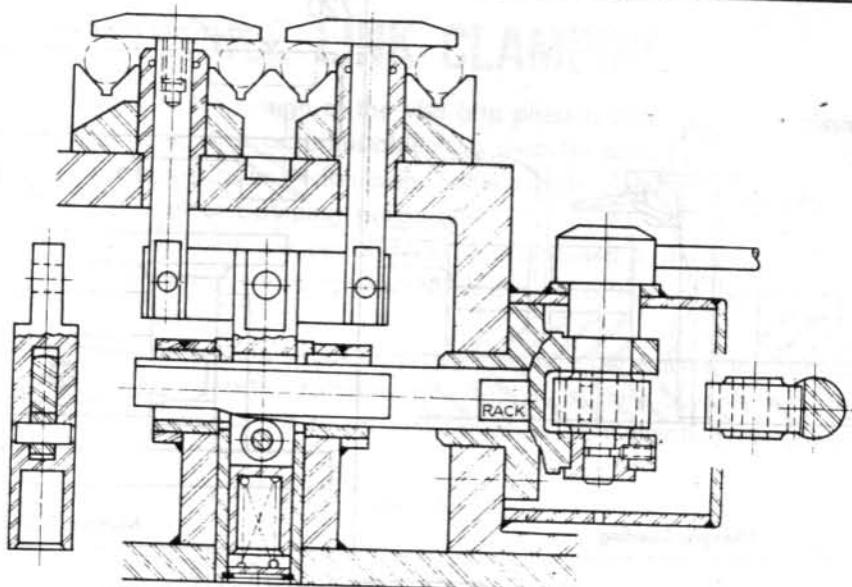
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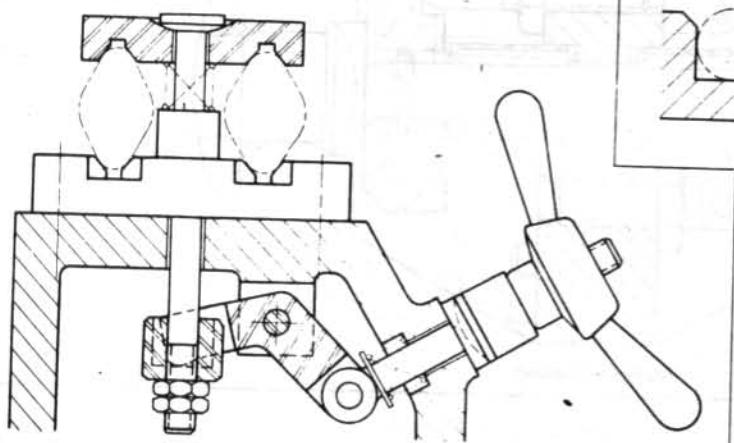
715-718

715



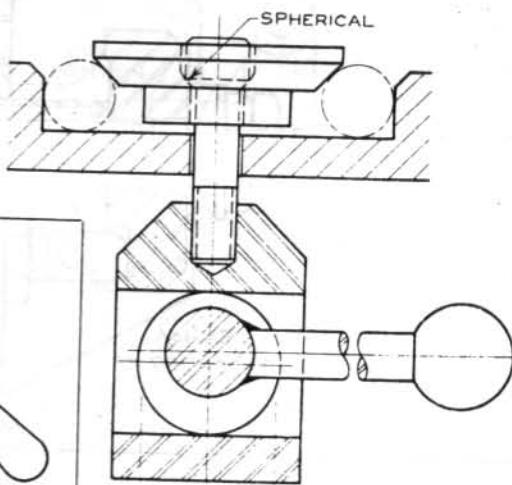
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716



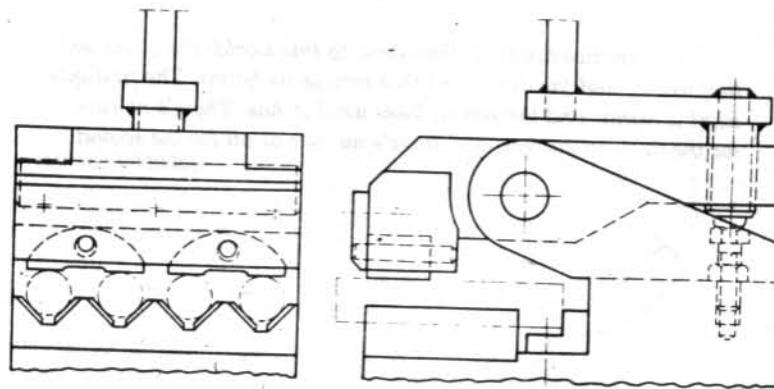
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717



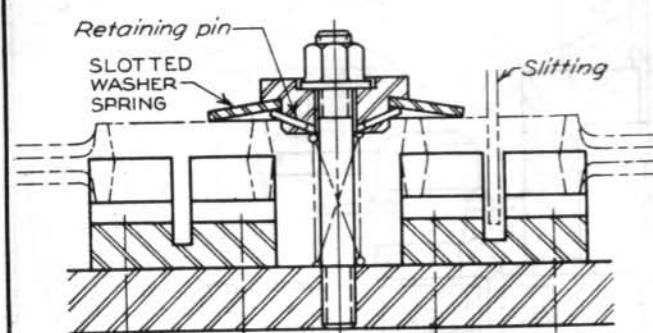
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718



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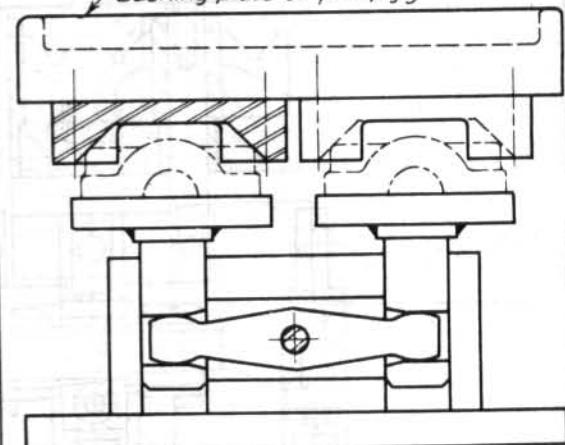
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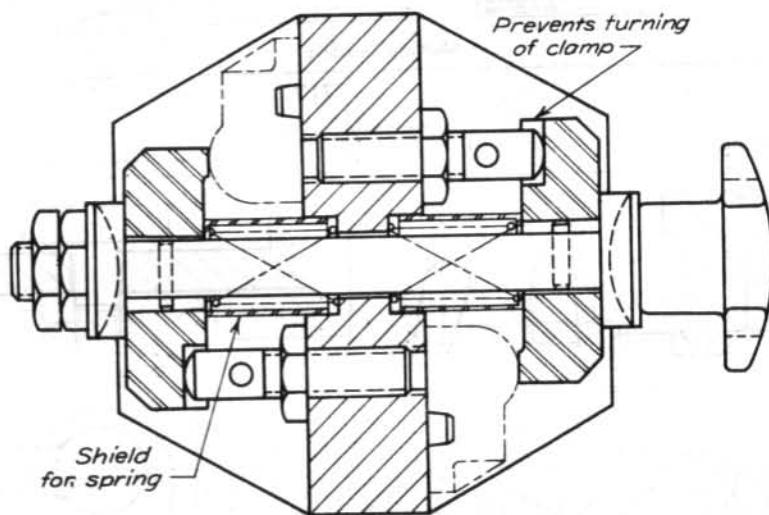
720

Bushing plate of pump jig



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721



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"There are two kinds of discontent in this world: the discontent that works, and the discontent that wrings its hands. The first gets what it wants, and the second loses what it has. There's no cure for the first but success; and there's no cure at all for the second."

GORDON GRAHAM

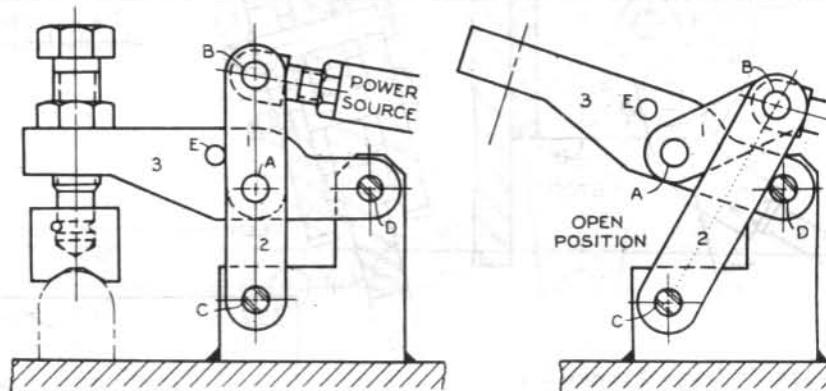
TOGGLE LINK CLAMPING

The basic principle used in the design of the vise grip pliers is also used in the design of the toggle link clamp. Either a rigid or an adjustable stop must be provided in the design of the toggle link clamp to prevent it from unclamping. Some toggle clamps have a built-in spring to avoid an excessive amount of clamping pressure.

Throughout this group, the clamp link pin of the clamp is labeled A, the hinge or elbow pin is labeled B (the one to which the power is applied either directly or through additional linkages), and the stationary pin is labeled C.

The maximum amount of clamping pressure is created when pin B is on the line connecting pins A and C. It is a common practice to allow pin B to go slightly beyond the straight line connecting A and C before stopping it to prevent vibration from creating an unwanted unclamping action.

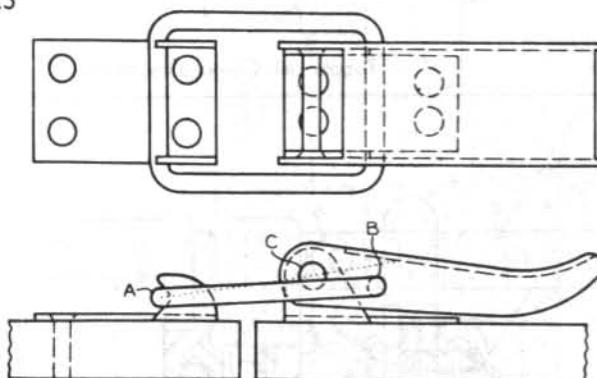
722



Force applied to pin B brings pin A of clamp 3 in line with B and C to create the maximum amount of clamping pressure. Note that B is beyond A and not between A and C as it is in some of the other toggle link designs. Movement of B beyond a line connecting A and C initiates an unclamping action that stop E prevents from taking place. Usually B is allowed to pass slightly beyond line AC to avoid having vibration loosen the clamp. Two links 1 and two links 2 provide symmetry about clamp 3.

Toggle Link Clamp (B beyond A, C)

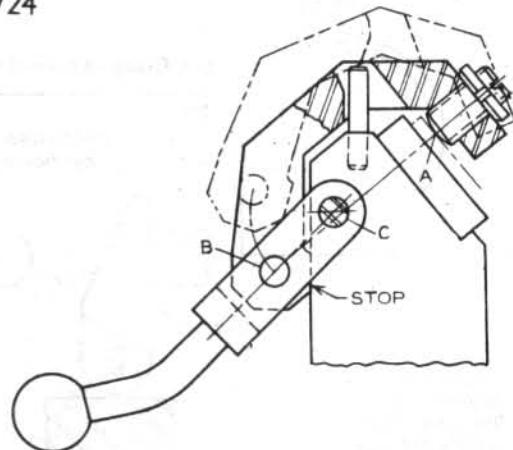
723



This clamp is similar to the toggle link clamp used on suitcases.

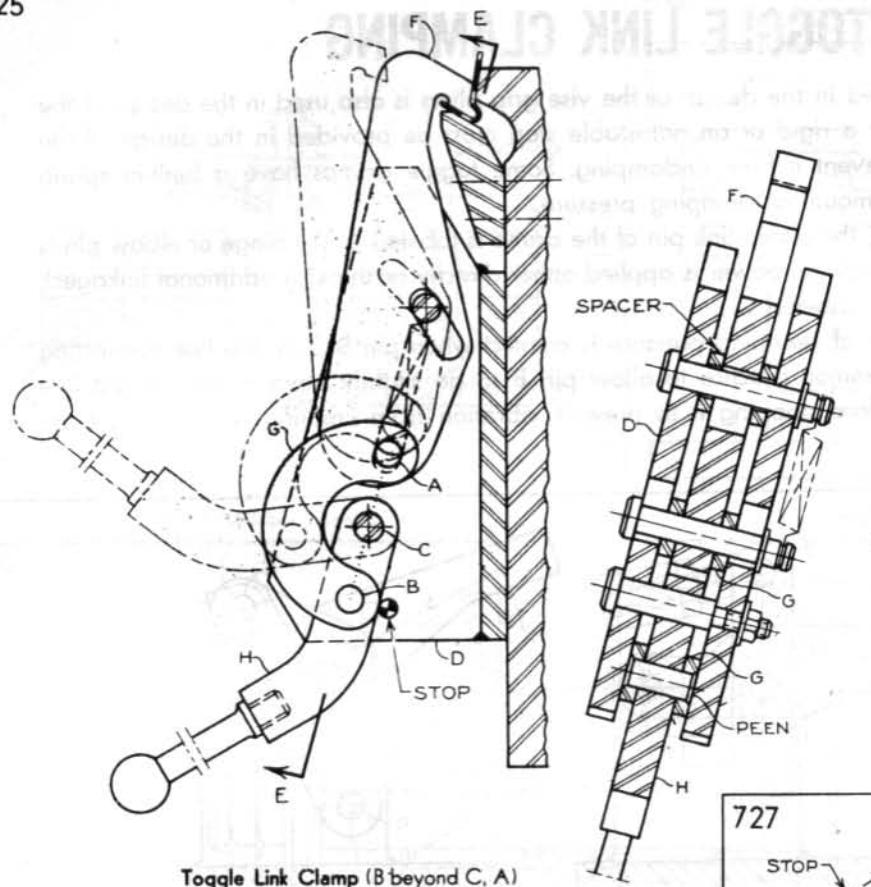
Toggle Link Clamp (B beyond C, A)

724



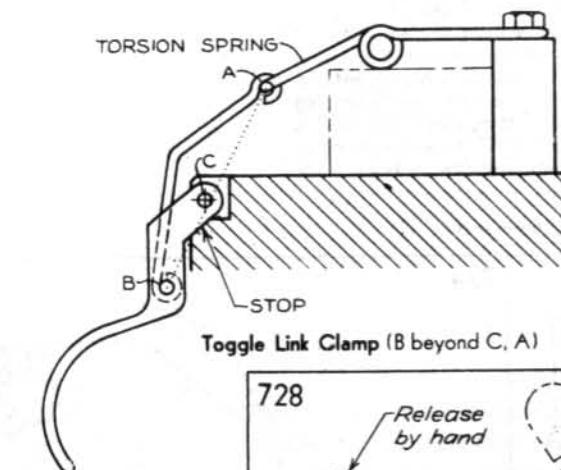
Toggle Link Clamp (B beyond C, A)

725



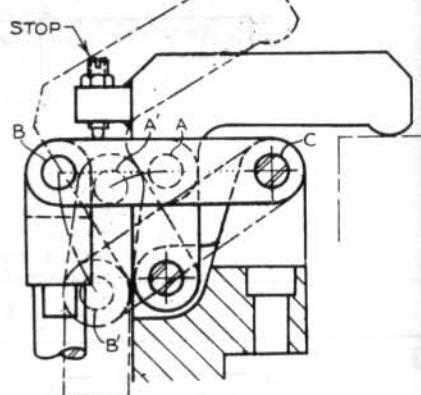
Toggle Link Clamp (B beyond C, A)

726



Toggle Link Clamp (B beyond C, A)

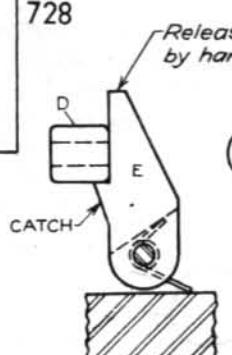
727



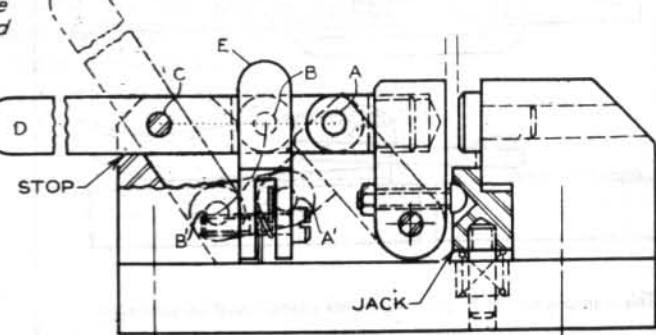
Toggle Link Clamp (B beyond A, C)

728

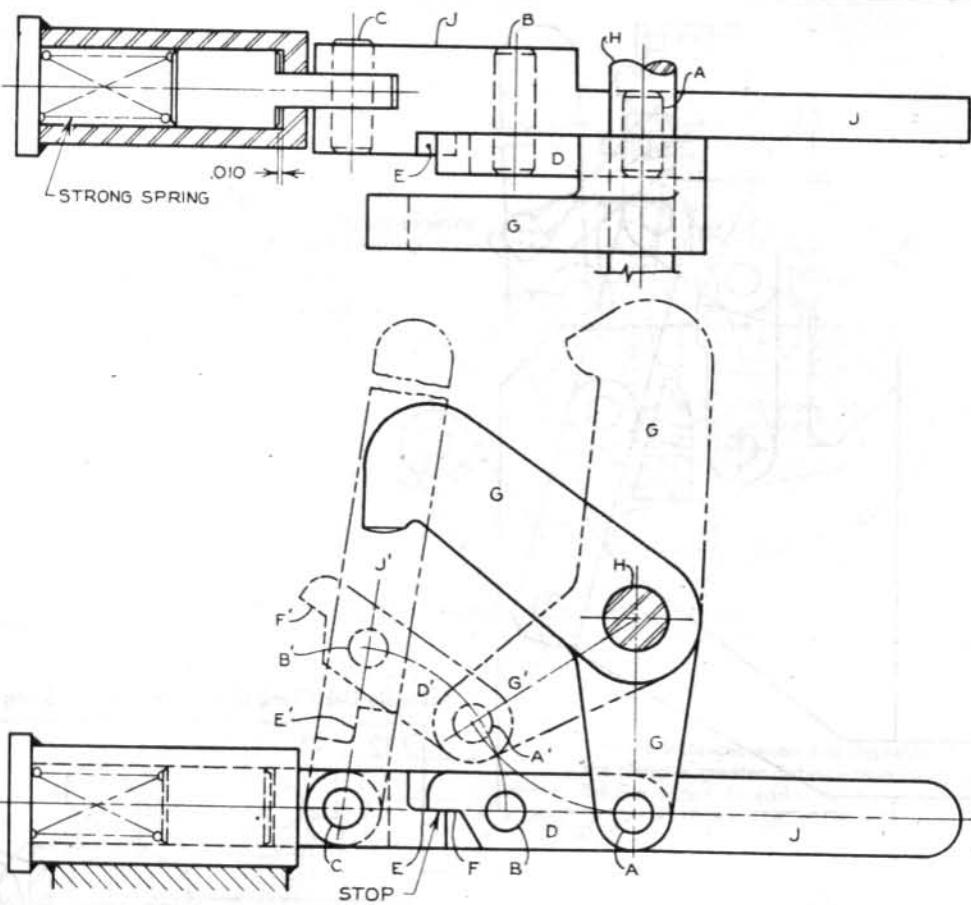
Catch E prevents vibration from loosening the clamp. Note that it is a different type of stop.



Toggle Link Clamp (B between A and C)

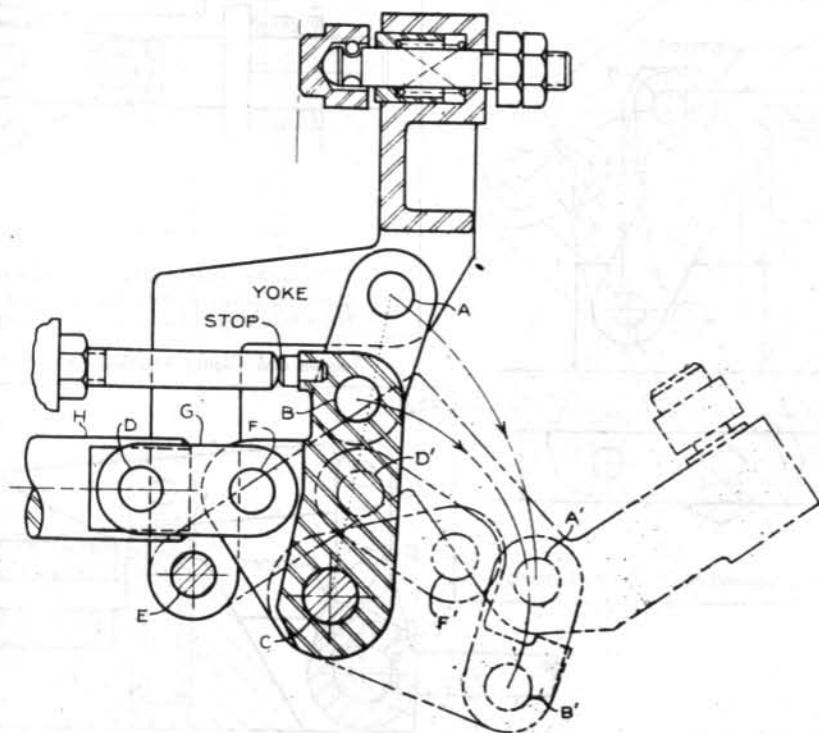


729



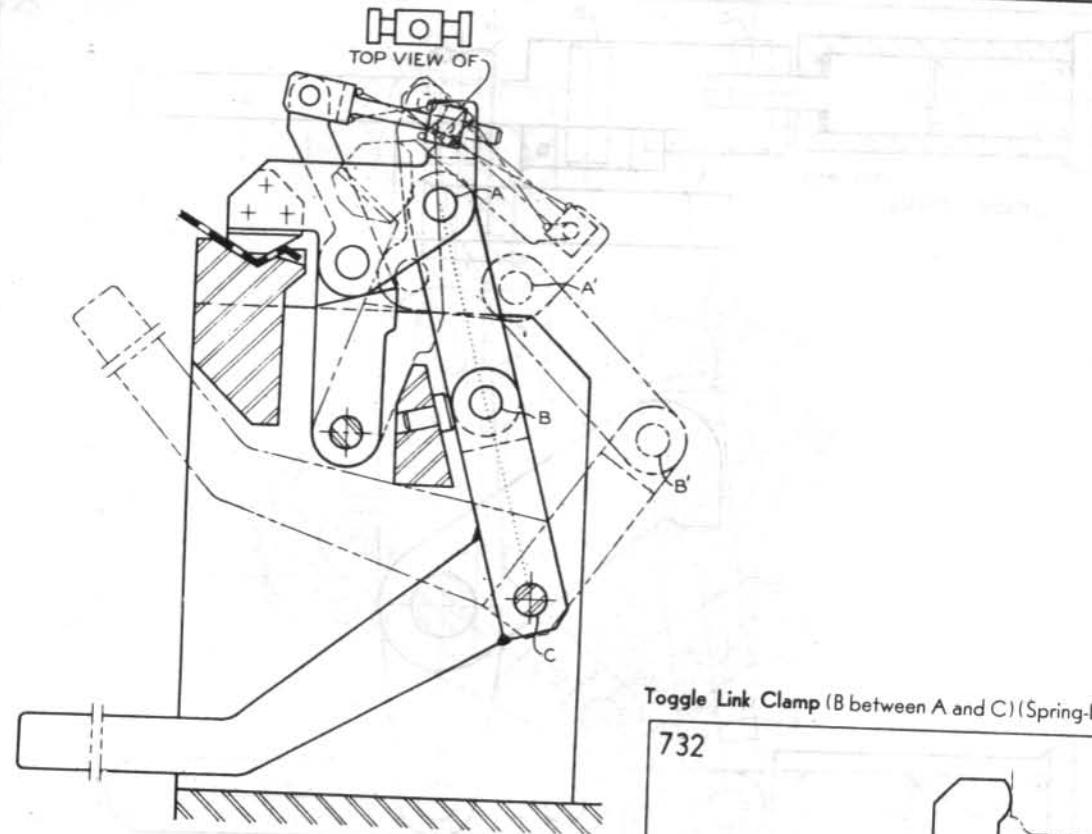
Toggle Link Clamp (B between A and C) (Spring-Loaded)

730



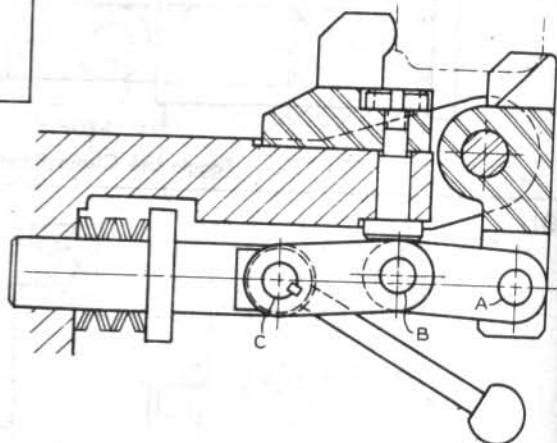
Toggle Link Clamp (B between A and C) (Spring-Loaded)

731



Toggle Link Clamp (B between A and C) (Spring-Loaded)

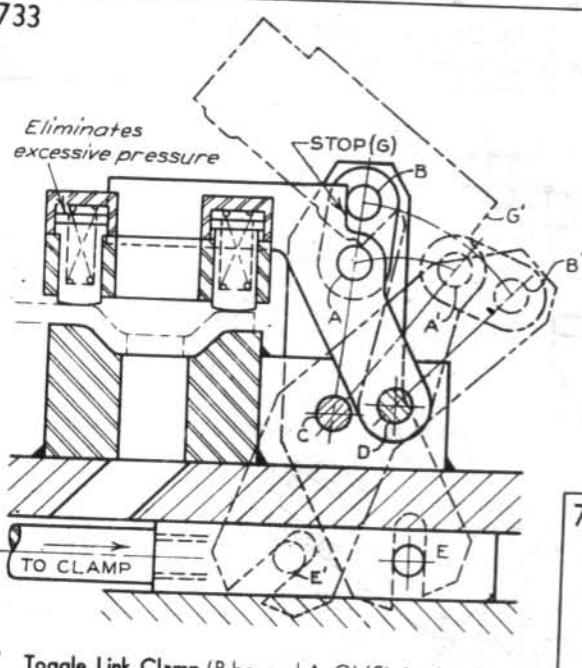
732



The washer springs prevent an excessive amount of clamping pressure when the part is a bit oversized. Note how other clamps are spring-loaded.

Toggle Link Clamp (B between A and C) (Spring-Loaded)

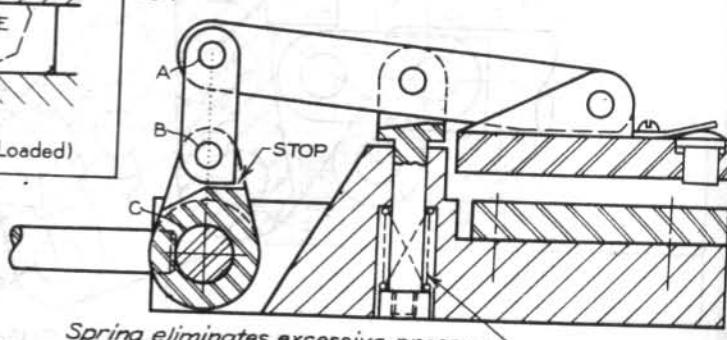
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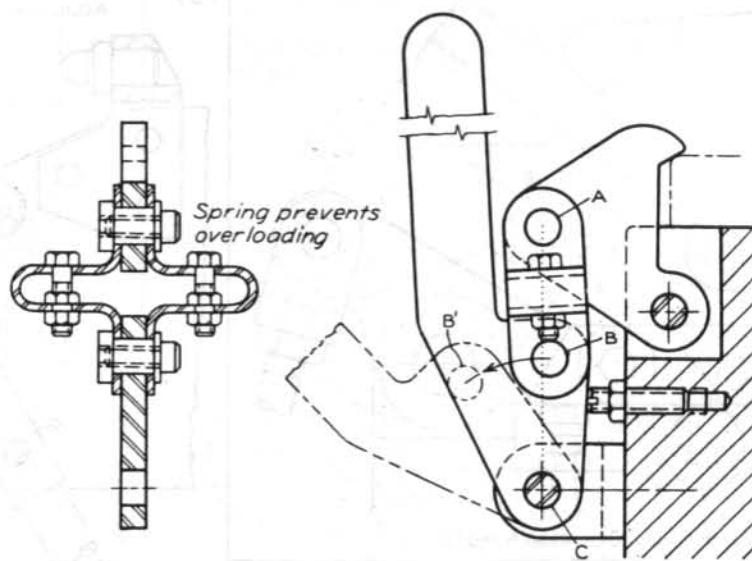
Toggle Link Clamp (B beyond A, C) (Spring-Loaded)

Toggle Link Clamp
(B between A and C) (Spring-Loaded)

734

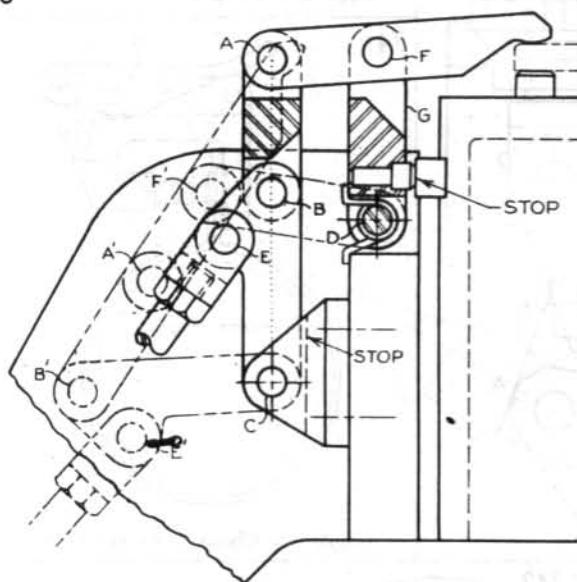


735



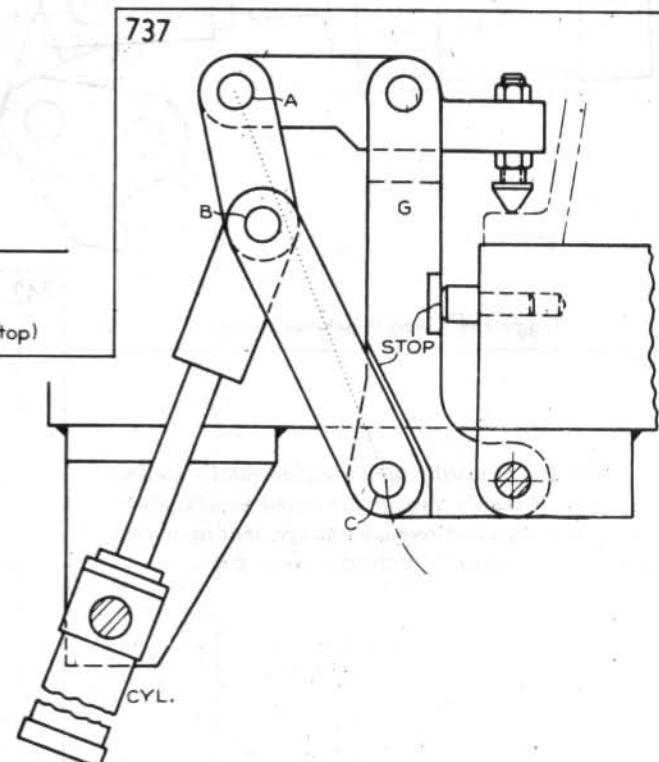
Toggle Link Clamp (B between A and C) (Spring-Loaded)

736



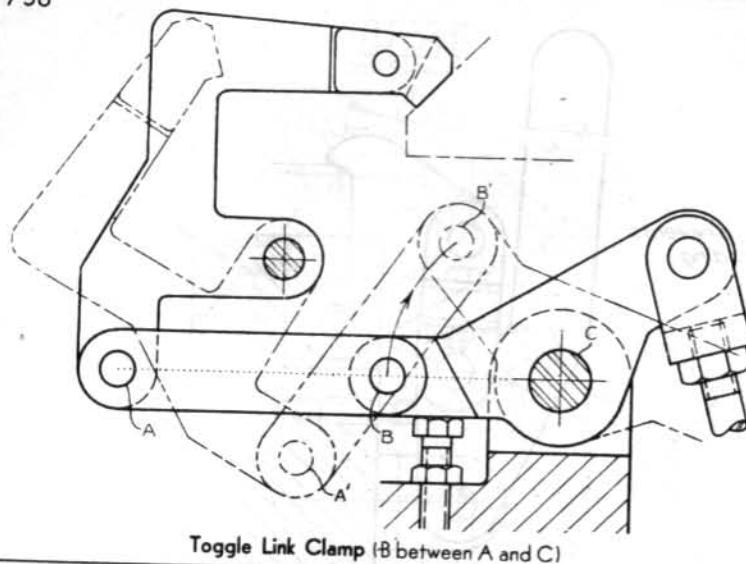
Toggle Link Clamp (B between A and C) (Double Stop)

"The man who will use his skill and constructive imagination to see how much he can give for a dollar, instead of how little he can give for a dollar, is bound to succeed." HENRY FORD

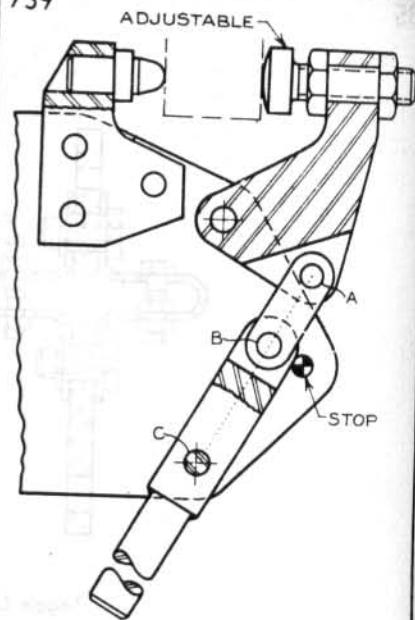


Toggle Link Clamp (B between A and C) (Double Stop)

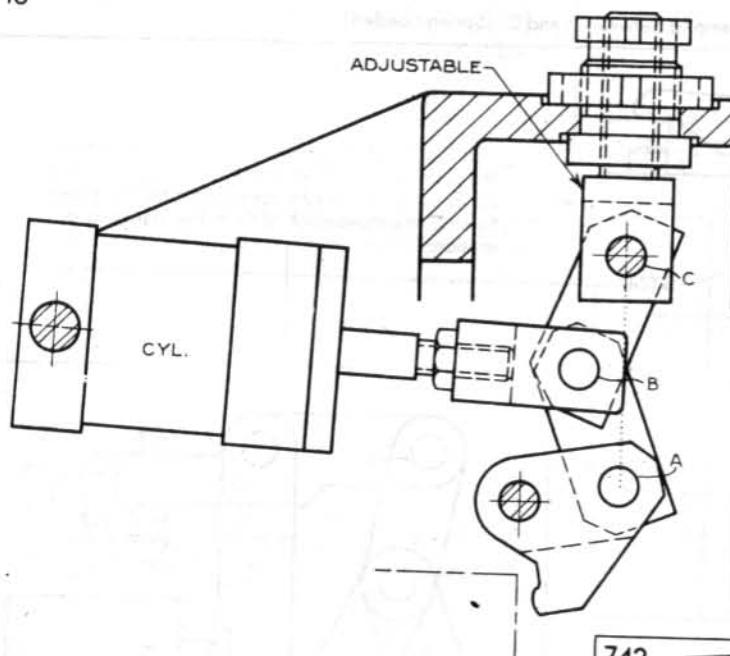
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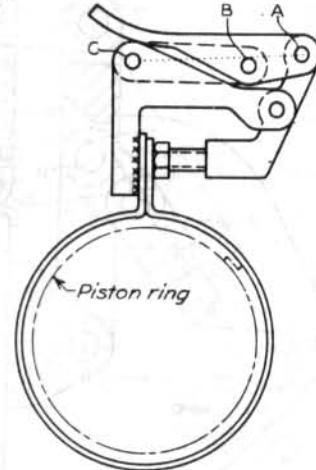
739



740

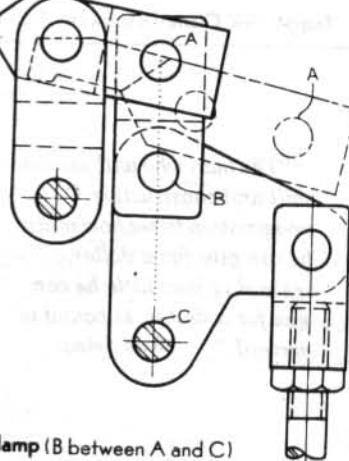


741



Toggle Link Clamp (B between A and C)

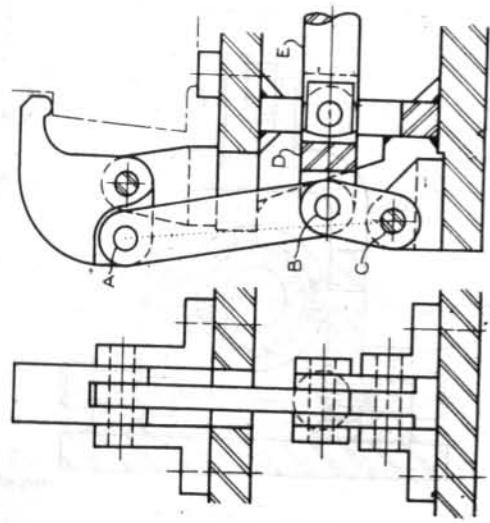
742



Toggle Link Clamp (B between A and C)

"The law of worthy life is fundamentally the law of strife. It is only through labor and painful effort, by grim energy and resolute courage, that we move on to better things." THEODORE ROOSEVELT

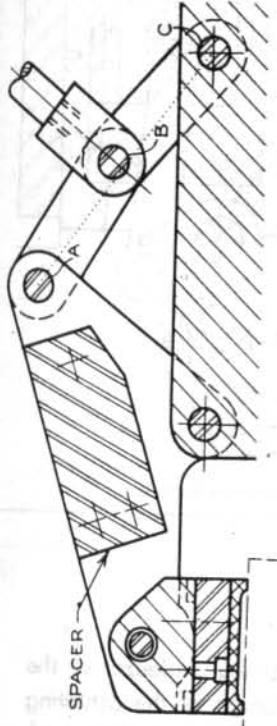
743



Whenever power shaft E remains fixed in direction, an extra link D is needed.

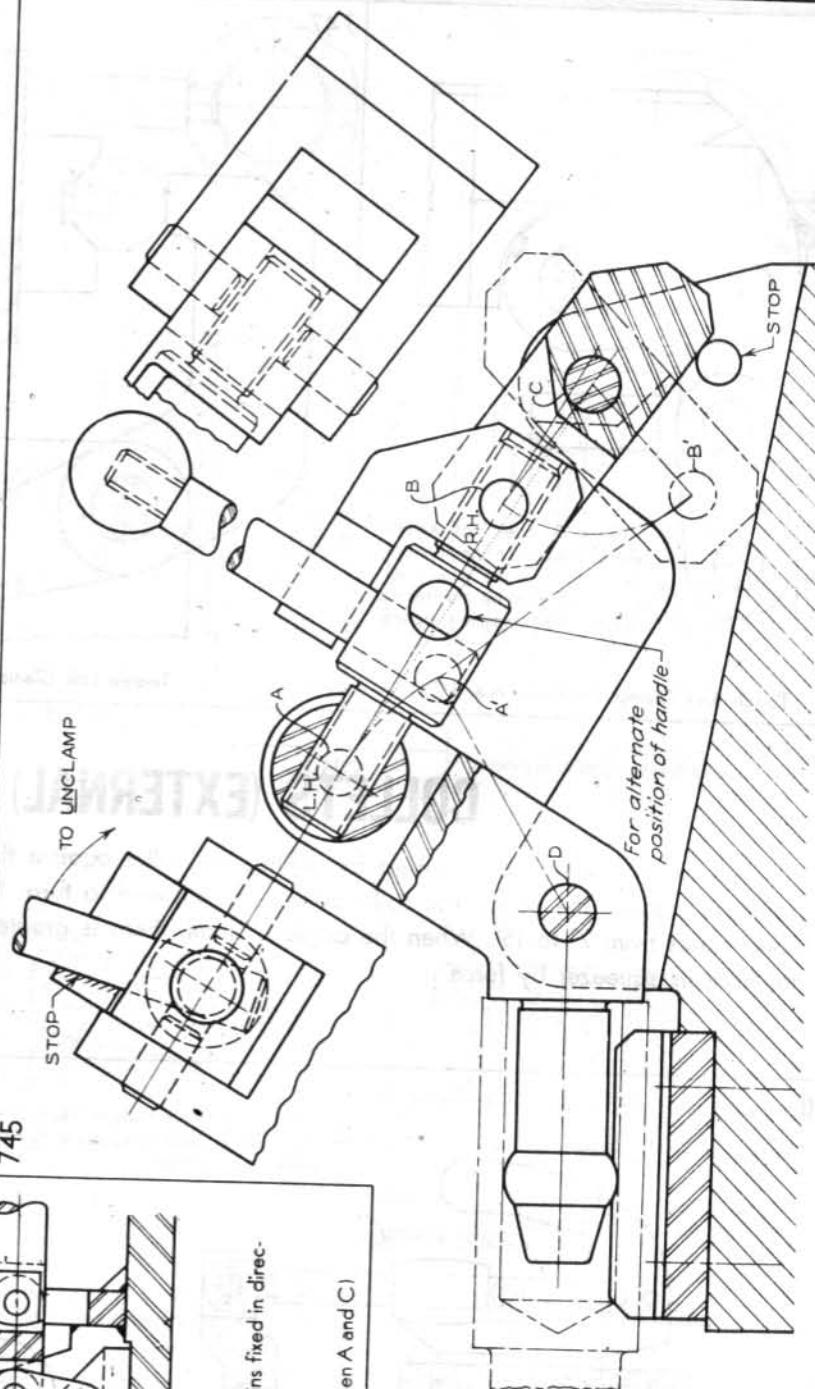
Toggle Link Clamp (B between A and C)

744



Toggle Link Clamp (B between A and C)

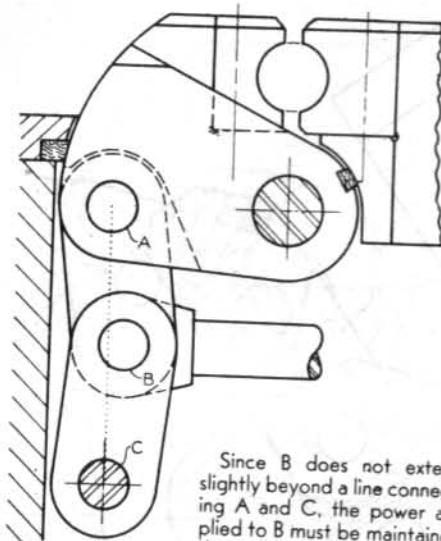
745



Toggle Link Clamp (B between A and C)

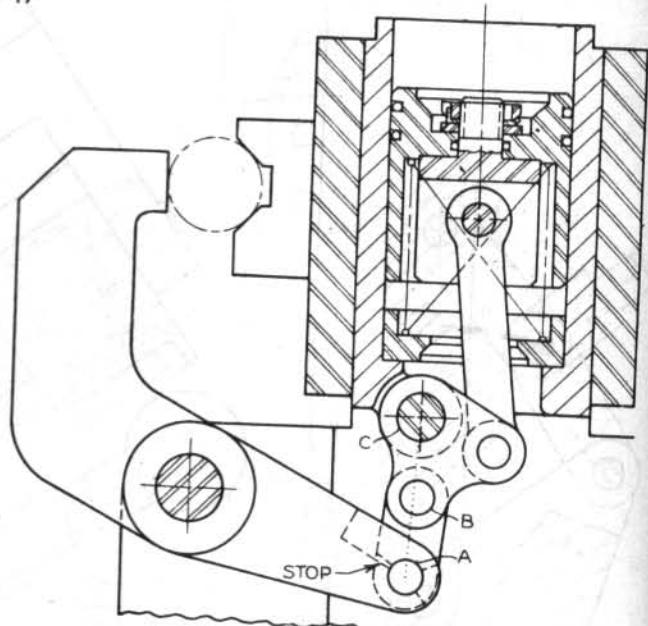
Turning the handle adjusts the amount of pressure created by this clamp.

746



Toggle Link Clamp (B between A and C)

747



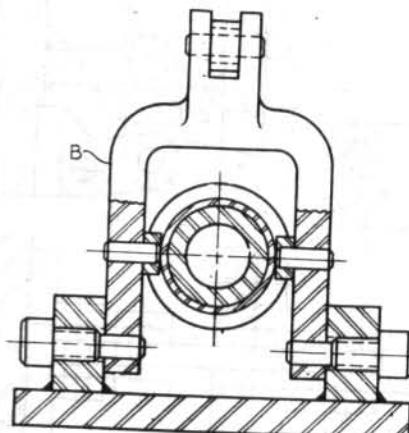
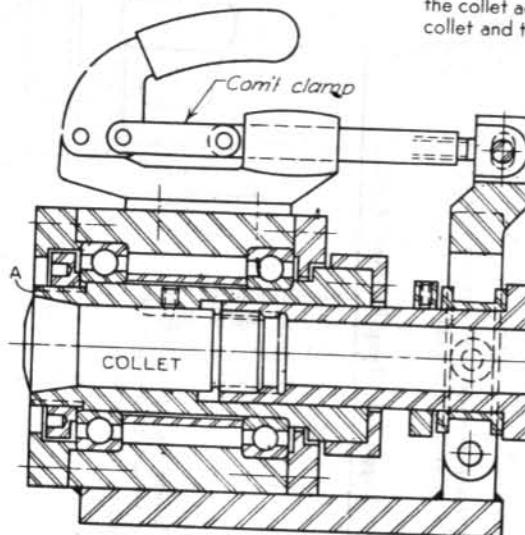
Toggle Link Clamp (B between A and C)

COLLETS (EXTERNAL)

Clamping action may be created by pulling the collet against the conical squeezer or the squeezer against the collet. The collet cannot be allowed to turn. The angle of the actuating cone varies from 7° to 15° . When the angle is small, there is greater need to uncinch the collet from its squeezer by force.

748

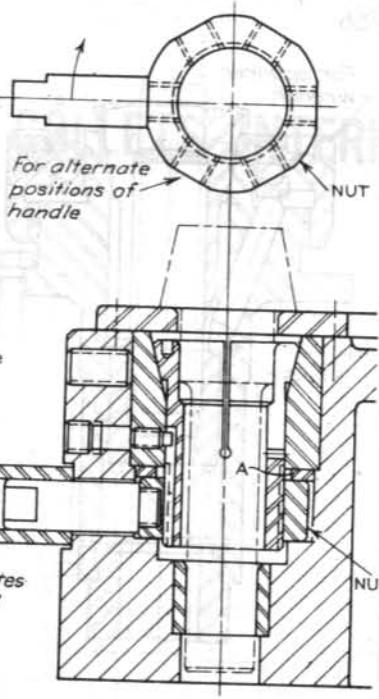
The commercial toggle linkage clamp actuates yoke B, which draws the collet against its squeezer A. Another power source rotates the collet and the part.



Collet (External)



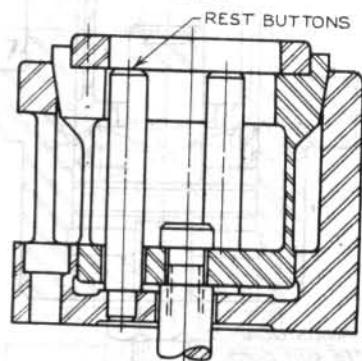
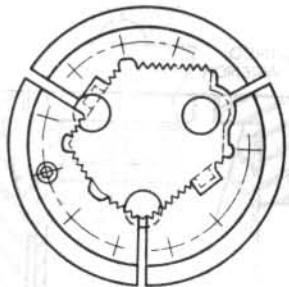
749



The nut actuates the collet. Note the hardened wear pad A above the nut.

Collet (External)

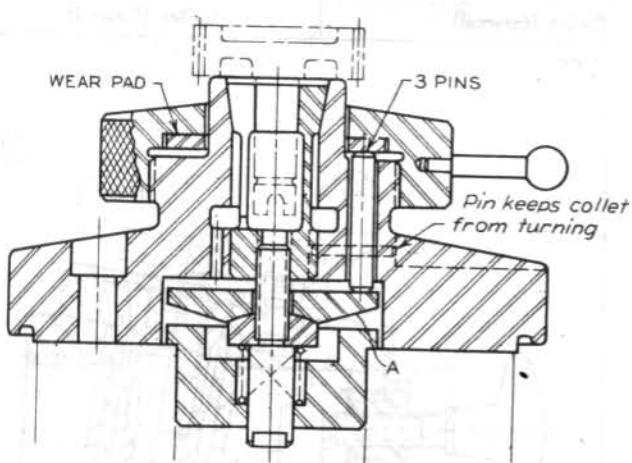
750



This collet, which is actuated by a drawbar, clamps an odd-shaped part.

Collet (External)

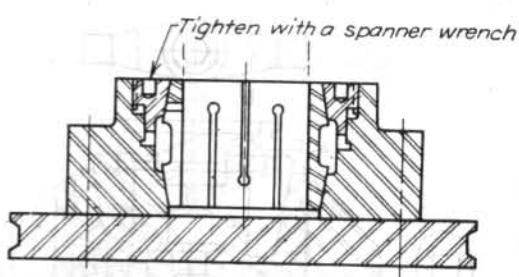
751



The three pins force trunnion A and the collet down. Pressure from the spring uncinches the collet in the unclamping operation.

Collet (External)

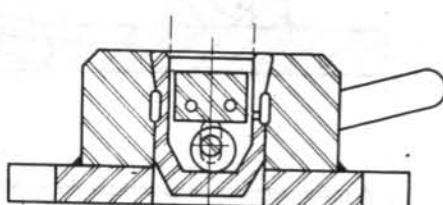
752



Slots are cut alternately from opposite ends of the double collet illustrated. A double collet requires two squeezers.

Collet (External)

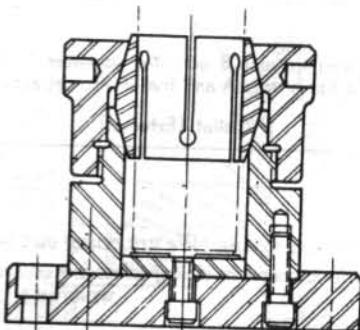
753



The cam draws the collet down. Note the rest in the center for the part.

Collet (External)

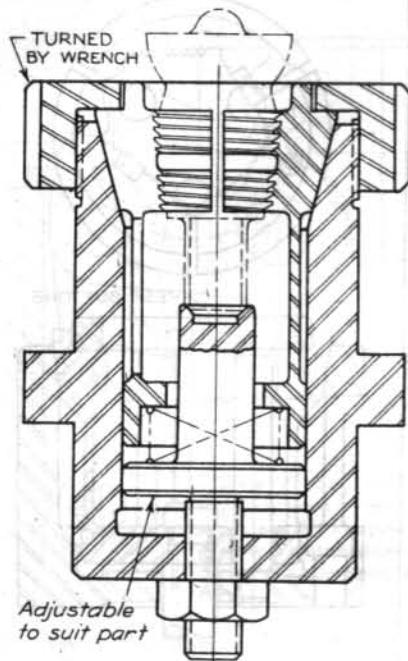
754



Collet (External)

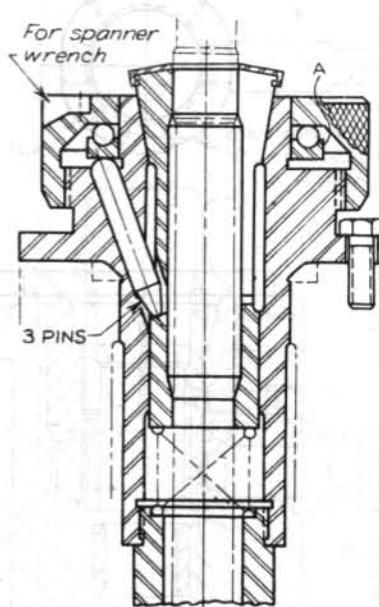
755-759

755



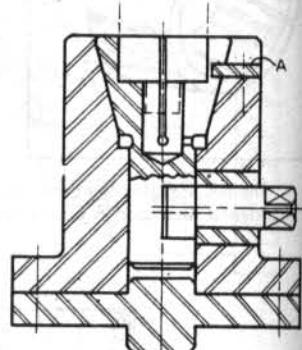
Collet (External)

756



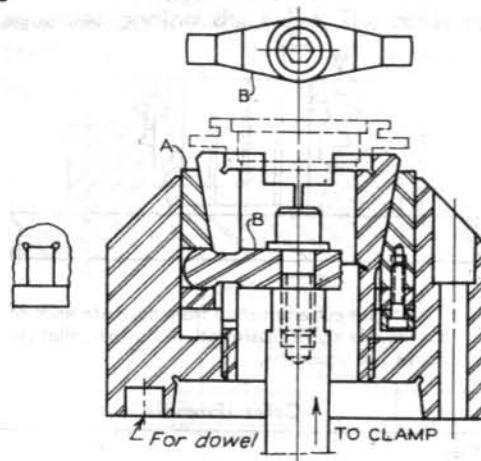
Thrust bearing A reduces friction.
Note the chip protector on the collet.

757



Actuated by an eccentric,
the collet is prevented from
turning by key A.

758

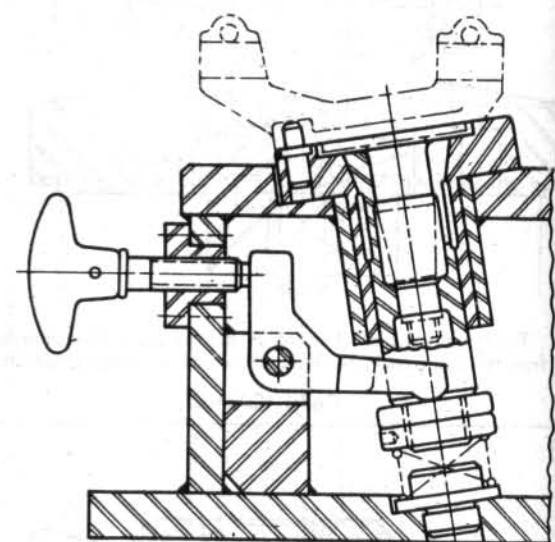


Raising trunnion B actuates squeezer A. Note
that B fits in slots A and that it also retracts A.

Collet (External)

*"It is no use saying 'We are doing our best.' You
have got to succeed in doing what is necessary."*
WINSTON S. CHURCHILL

759

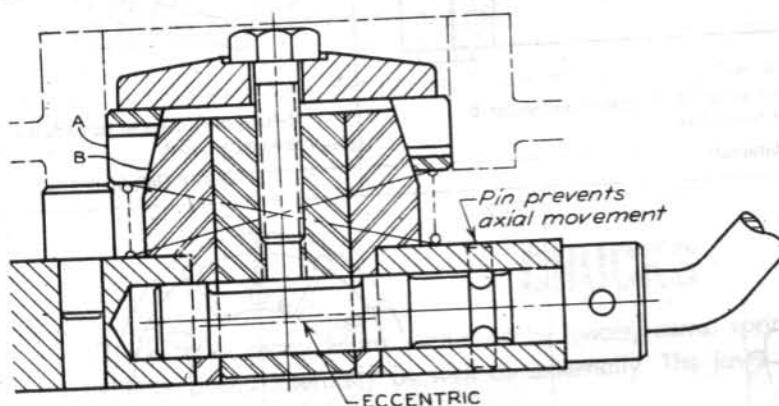


A rocker arm is used to actuate the collet.

Collet (External)

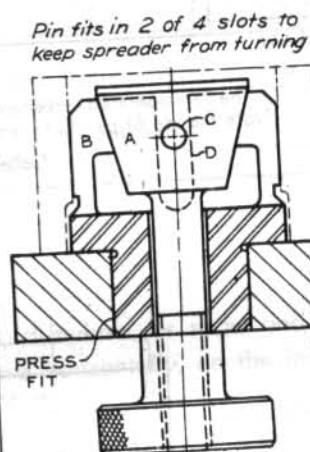
COLLETS (INTERNAL)

760

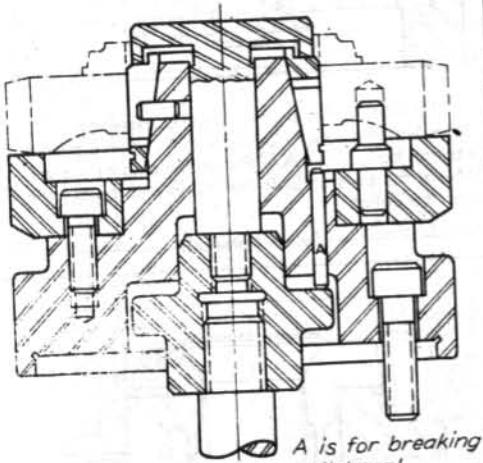


The eccentric draws collet A against expander B, clamping the part.
The cap screw also serves as an adjustor.

761



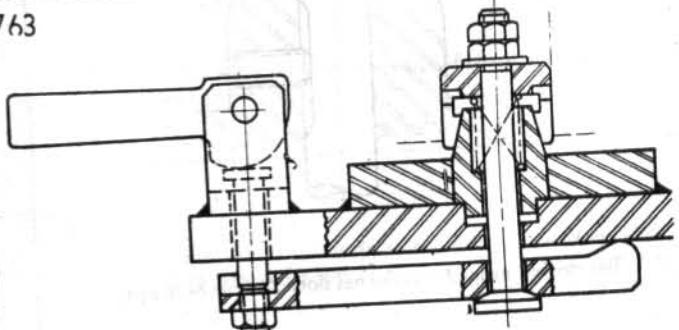
762



This collet is slotted alternately from opposite ends. It and the collet in the pictorial to the right are similar in this respect.

Collet (Internal)

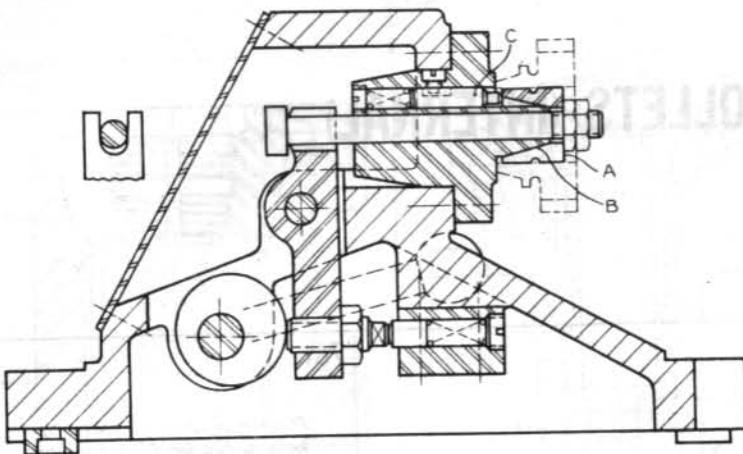
763



Collet (Internal)

764-768

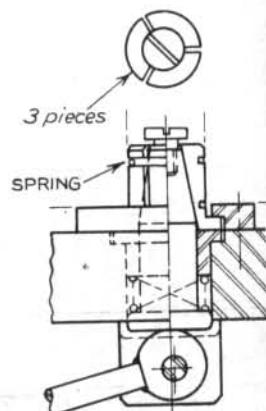
764



The cam-operated rocker arm forces collet A against expander B. Note the use of pins C to retract the collet.

Collet (Internal)

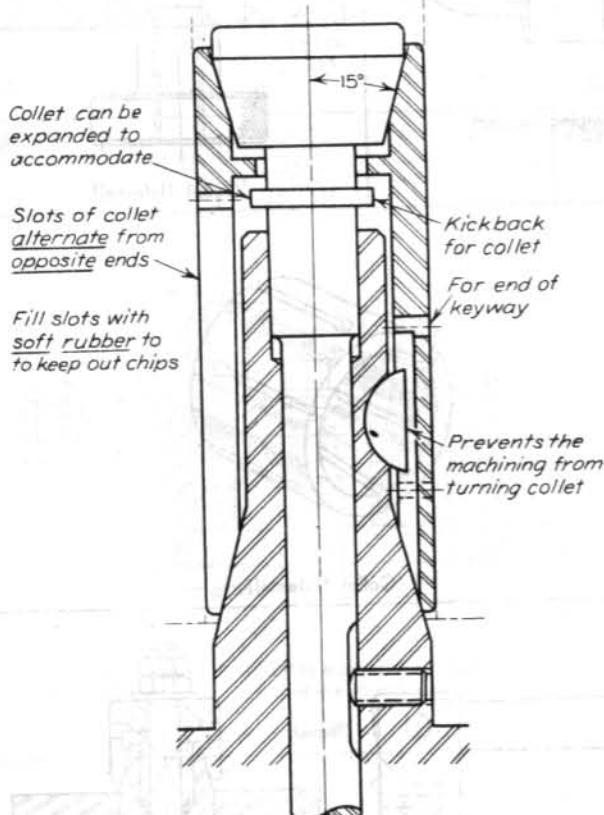
765



Raising the expander spreads the three-piece collet.

Collet (Internal)

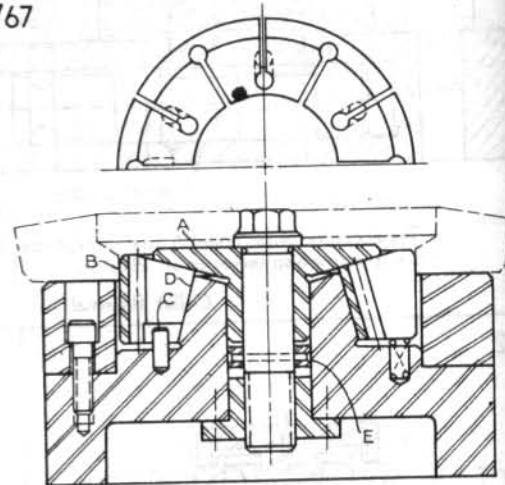
766



This double expander collet has slots cut from both ends.

Collet (Internal)

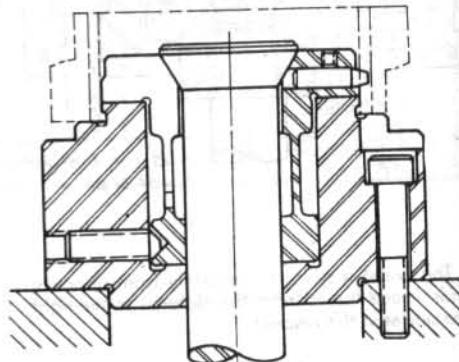
767



A forces collet B down against expander D. C prevents the collet from turning. E, which is pinned to the bolt, raises A in the unclamping operation. Note the slots on both the inside and the outside of the collet.

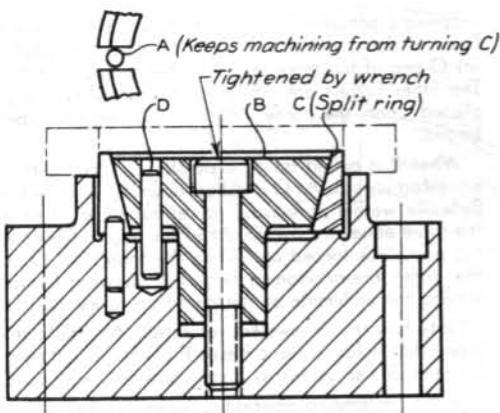
Collet (Internal)

768



Collet (Internal)

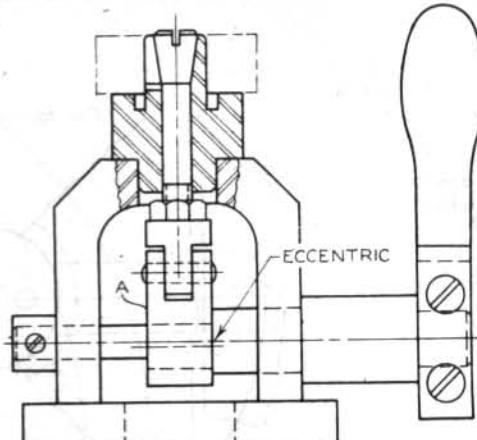
769



This is a simplified collet in that split ring C acts as a collet.

Collet (Internal)

770



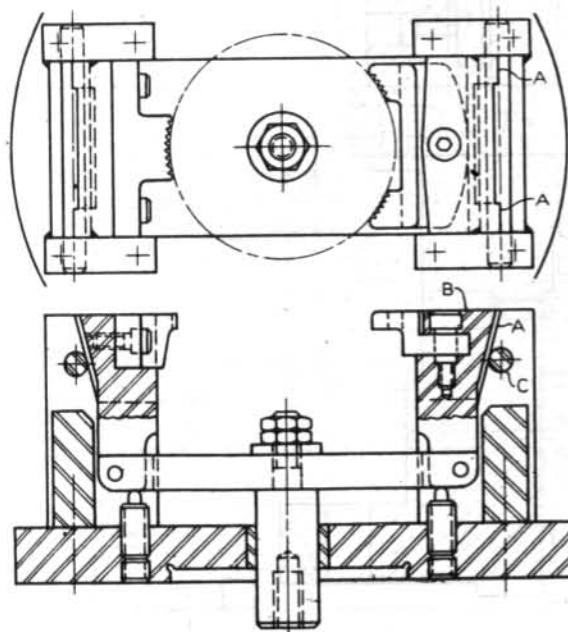
Link A enables the eccentric not only to clamp the collet but also to unclamp it.

Collet (Internal)

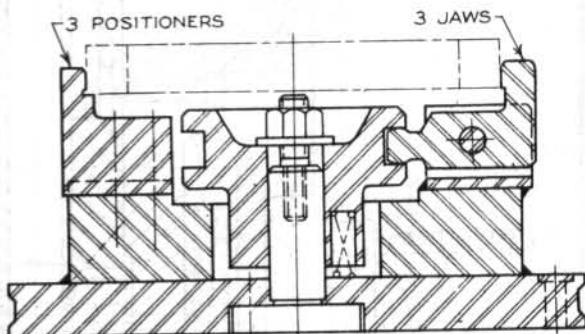
CHUCKS

Chucks take many forms. Actuated by gears, cams, springs, drawbars, or racks and pinions, they clamp internally as well as externally. The jaws move horizontally, on the incline, or may swing out of the way.

771



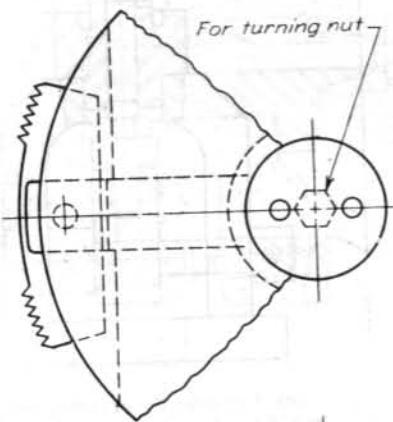
772



The three positioners are out of phase with the three jaws by 60°

Chuck

The two narrow surfaces A of jaw B move along pin C to reduce friction.

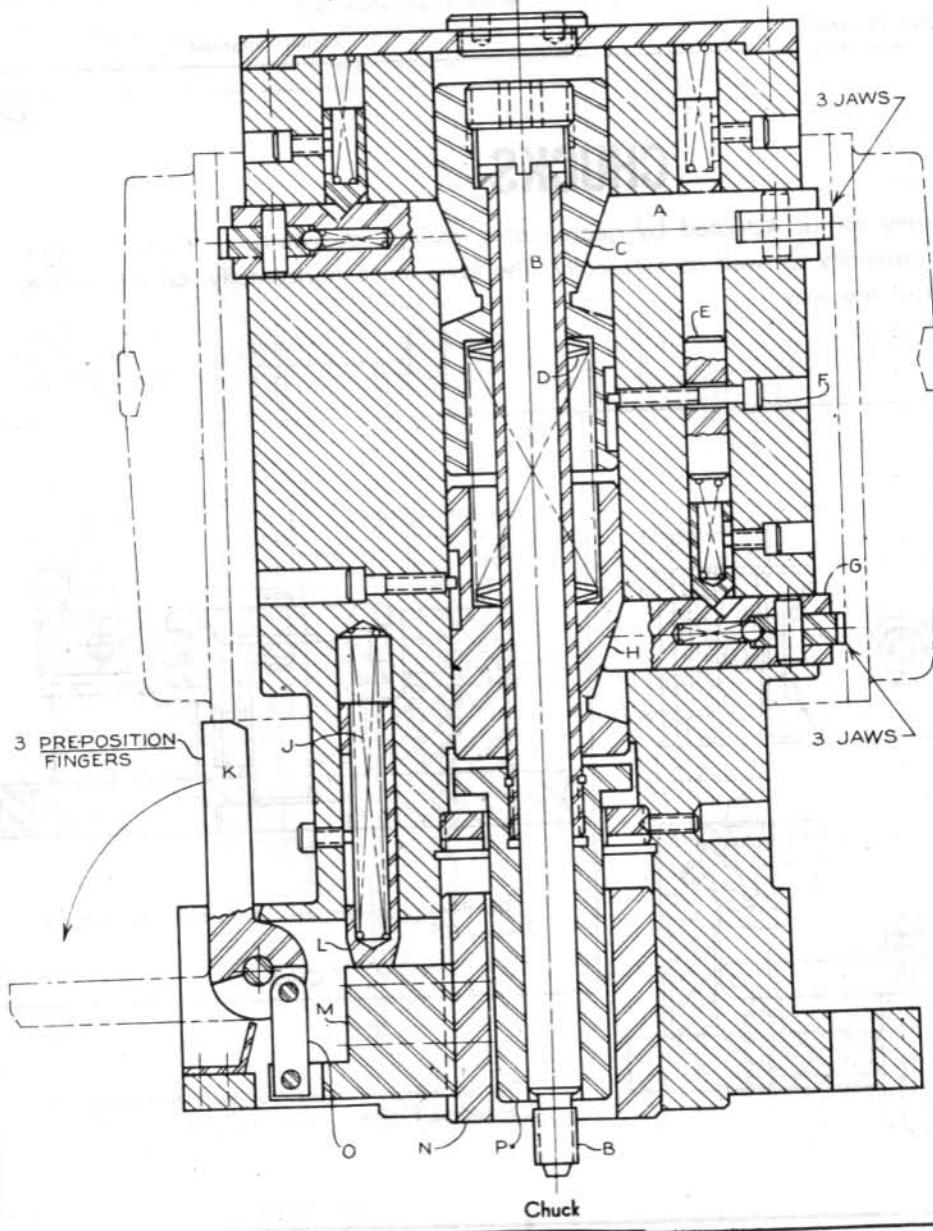


Spring J actuates M, which is fastened to sleeve N, to force N down, thereby rotating to a vertical position via link O one of the three fingers K that pre-position the part. The other fingers are similarly rotated. After the part is placed upon the three fingers, the clamping operation begins.

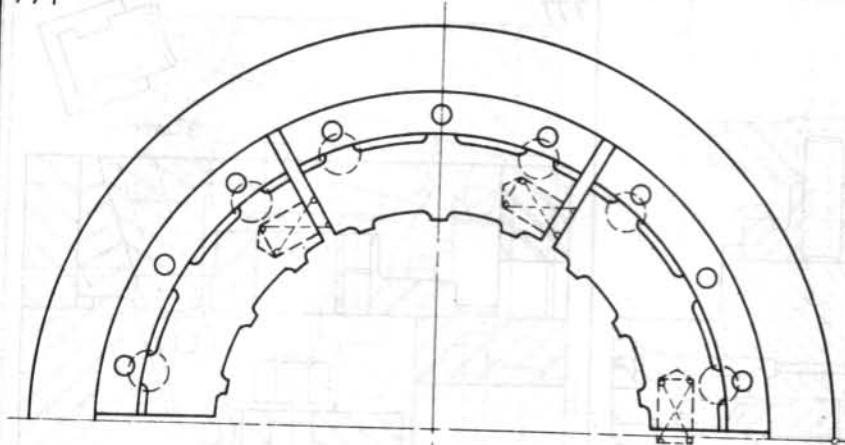
When B is pulled down, expander C spreads the three equalized jaws A. As C is pulled down by B, it, in turn, via Belleville washer springs D, forces expander H to spread the three equalized jaws G. After the six jaws have clamped the part, N is forced up. N, via the three links O, rotates the three pre-positioning fingers K outward horizontally, leaving the underside of the part free to be machined.

Note how the six jaws are retracted. Also note that the screw that holds in place bases E of the retracting springs for jaws G also serves as a set screw for expander C.

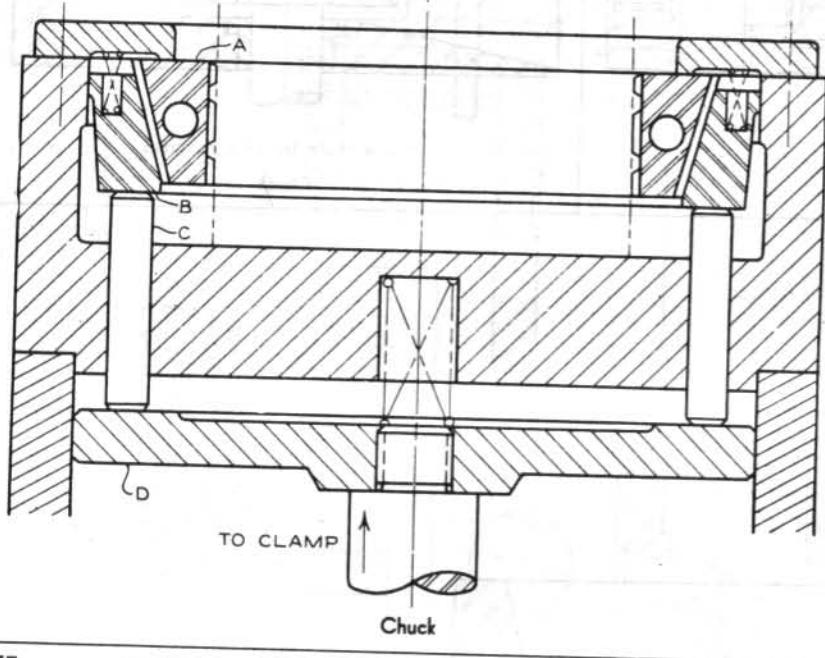
In the unclamping operation, sleeve P strikes expander H, raises it, and, via spring D, raises C, allowing the six jaws to retract.



774

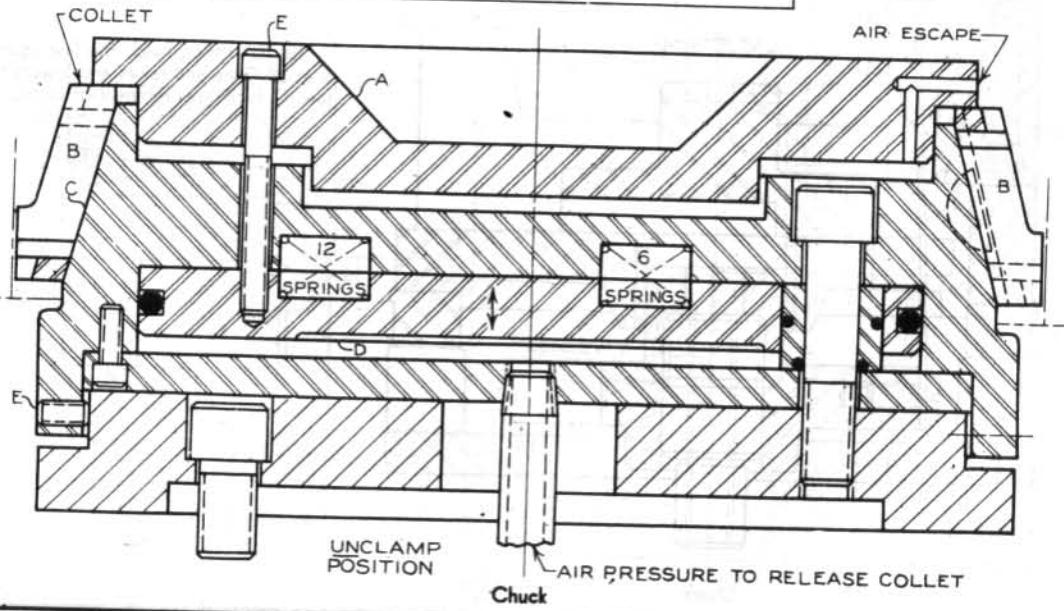


When D is raised, the twelve pins C raise squeezer B, which causes the six jaws A to clamp the part. Six springs retract the jaws.



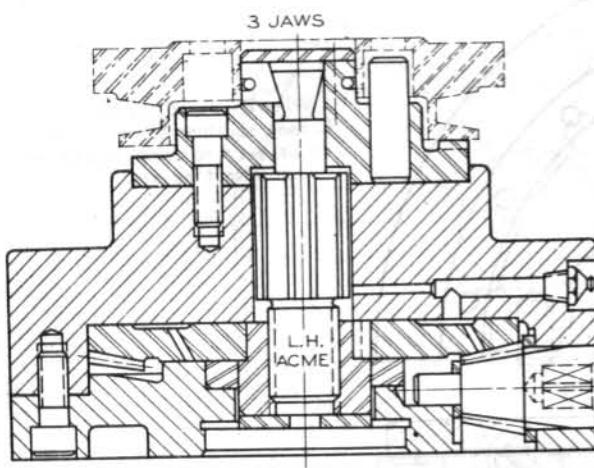
The six springs on the smaller of the two circles are offset relative to the twelve springs on the larger circle. The eighteen springs force piston D down, and it, via cap screws E, pulls down A, which forces expander C to expand the collet. Air pressure provides the power to unclamp the unit. Adjustment of the three set screws E ensures that the chuck and the machine are concentric.

775

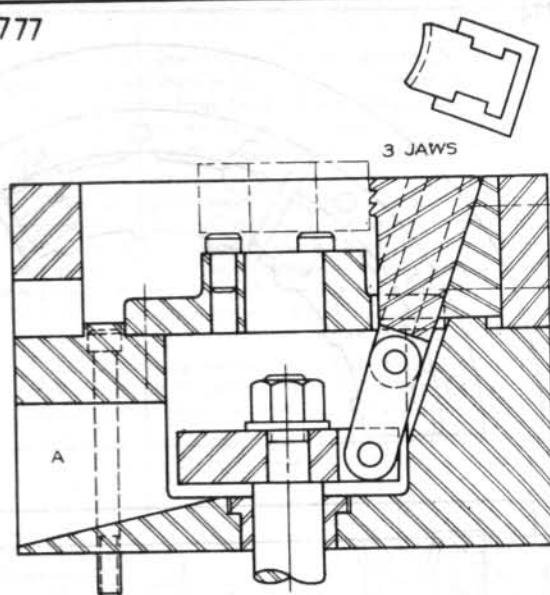


776-778

776



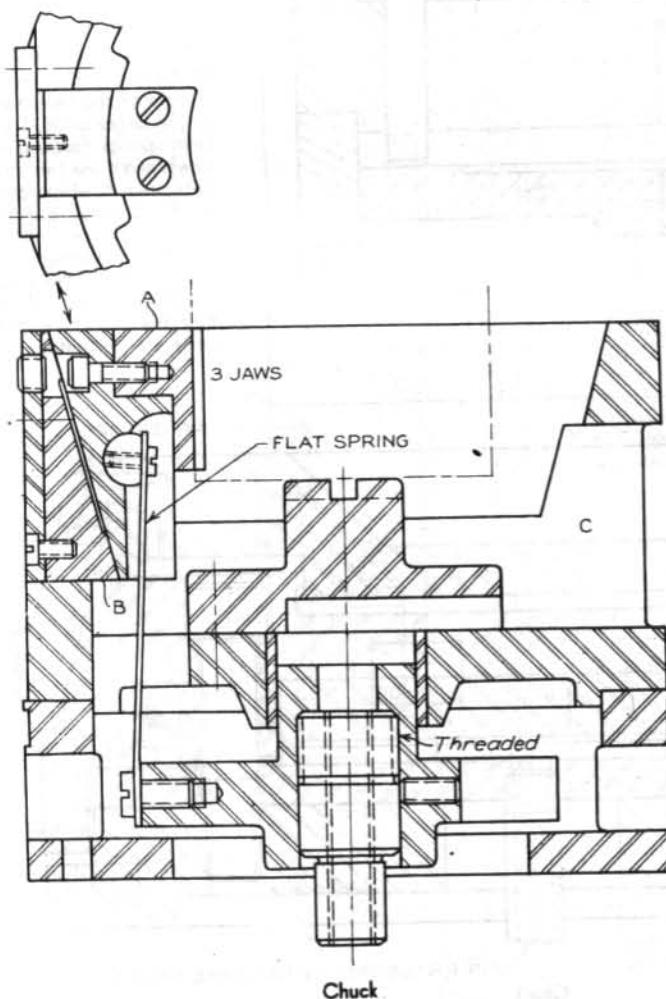
777



A is a chute for chip removal.

Chuck

778



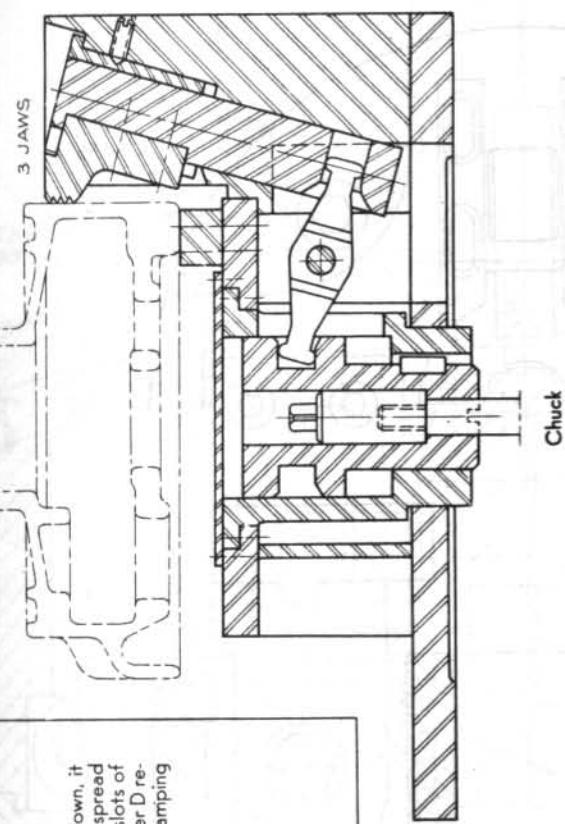
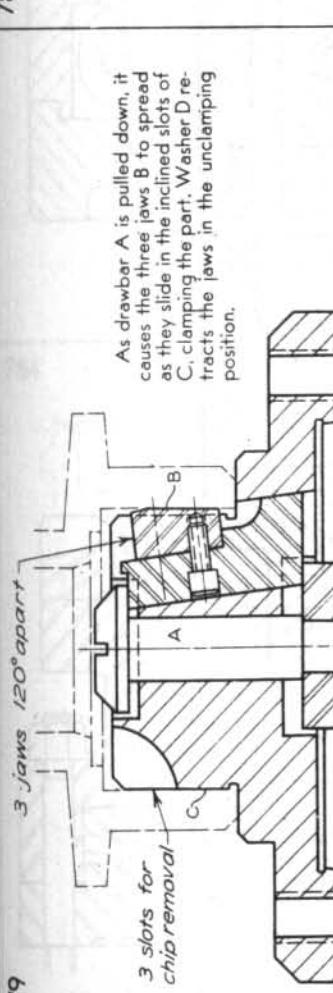
The flat spring holds the jaw against B at all times and raises and lowers the jaw. C facilitates removal of chips.

780

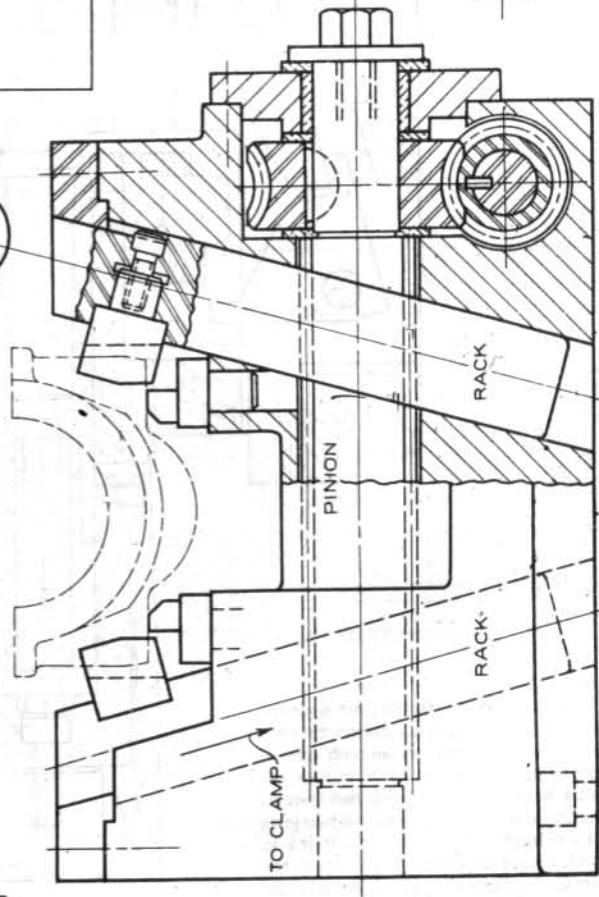
3 jaws 120° apart

779

779

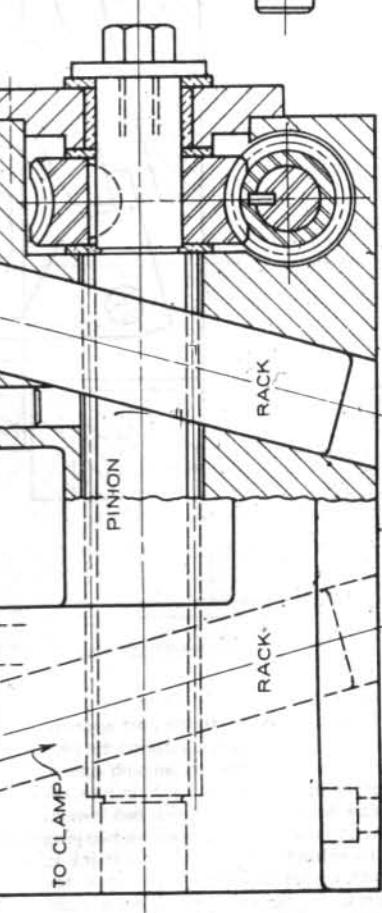
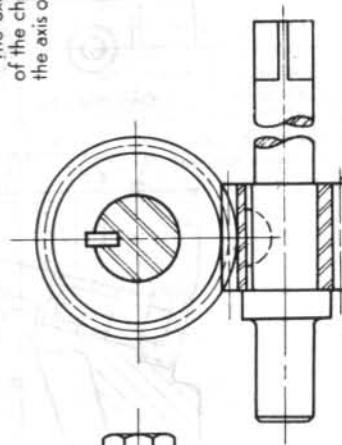


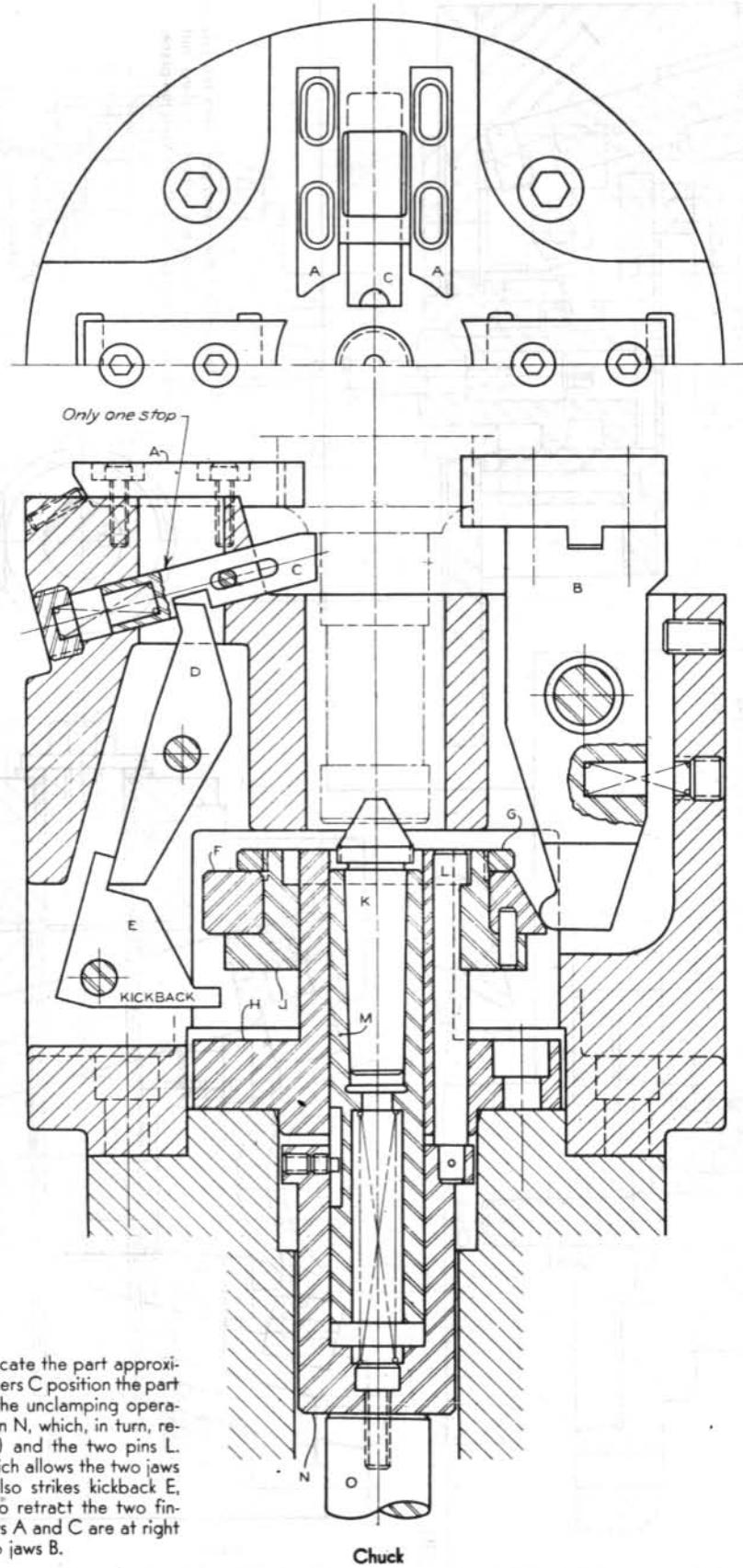
780



781

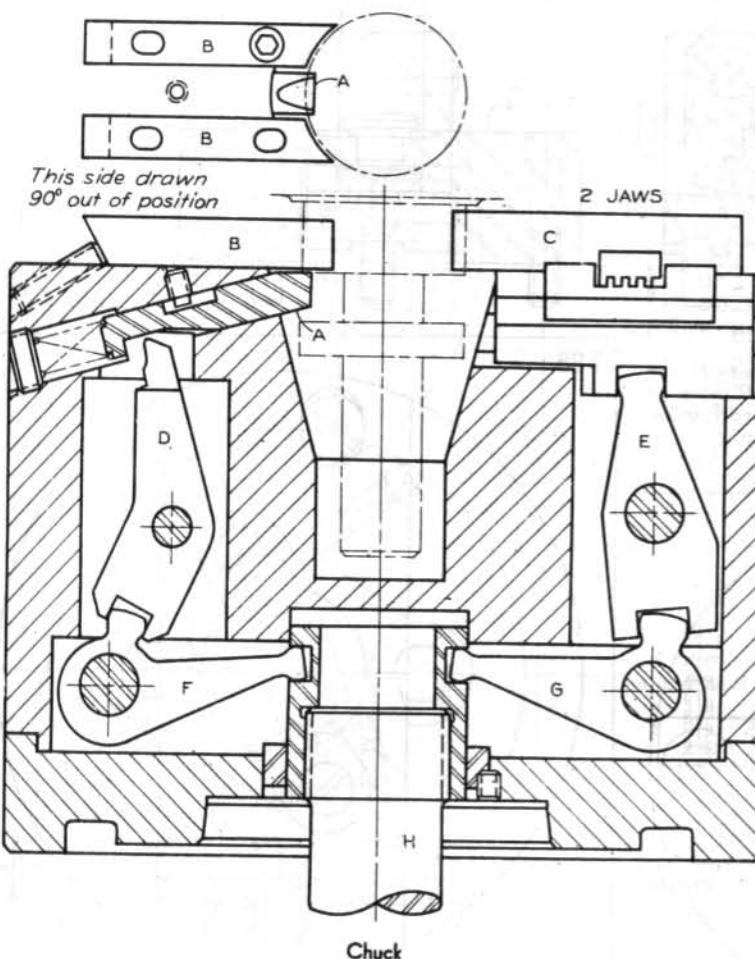
The axes of the clamp posts and the axis of the chuck body are in the same plane, but the axis of the pinion is offset from the plane.





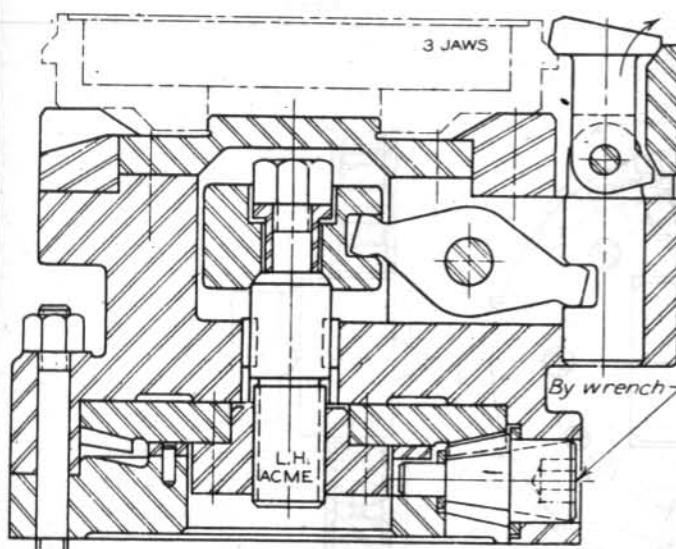
Positioners A locate the part approximately. K and fingers C position the part for clamping. In the unclamping operation, O pulls down N, which, in turn, retracts M (and K) and the two pins L. Pins L move F, which allows the two jaws B to retract. F also strikes kickback E, which causes D to retract the two fingers C. Positioners A and C are at right angles to the two jaws B.

783

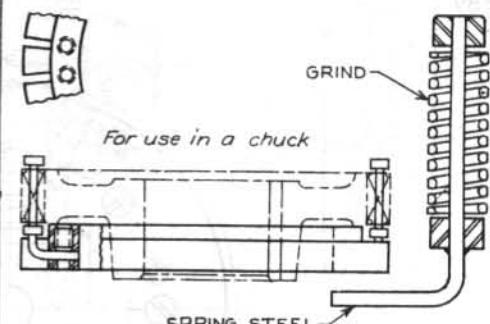


Positioners B locate the part approximately before it is clamped. Two pre-position fingers, one of which is shown, position the part vertically. In the unclamping operation, F causes D to retract pre-position fingers A as G causes E to move jaws C outward. The two jaws face each other as do positioners B and A. The jaws and the positioners are at right angles to each other.

784

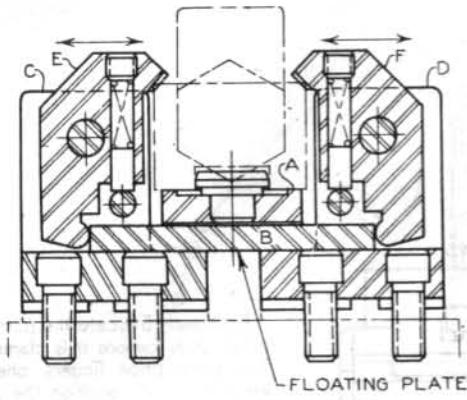


785



786-789

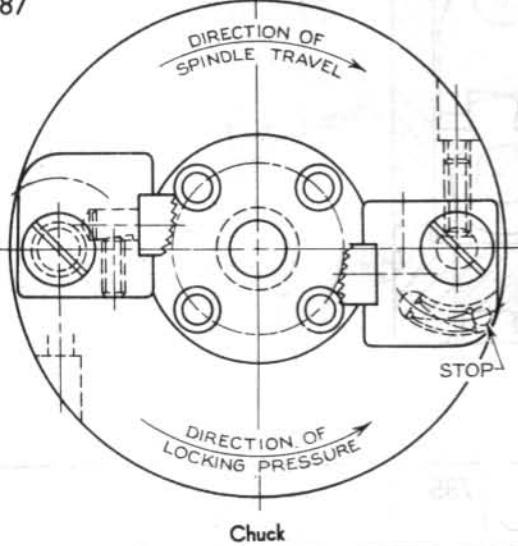
786



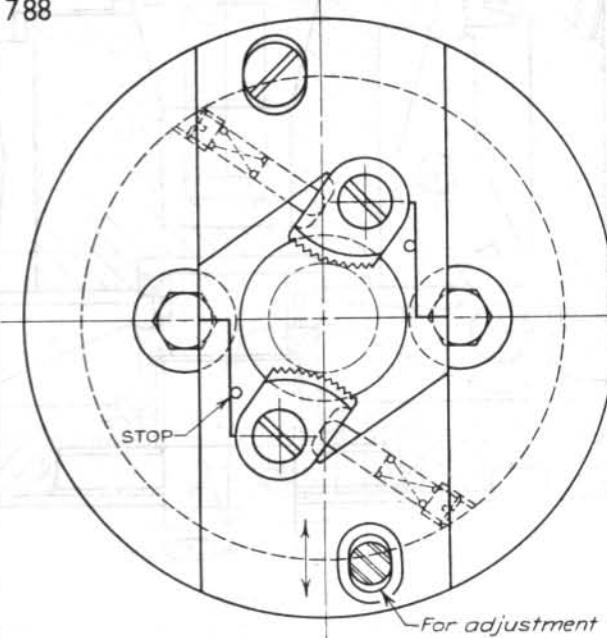
This unit is attached to a commercial two-jaw chuck. Stirrup A remains stationary, but C and D move in and out. When the lower ends of jaws E and F strike floating plate B, it forces the jaws to clamp.

Chuck

787

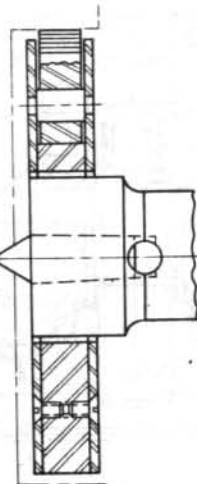
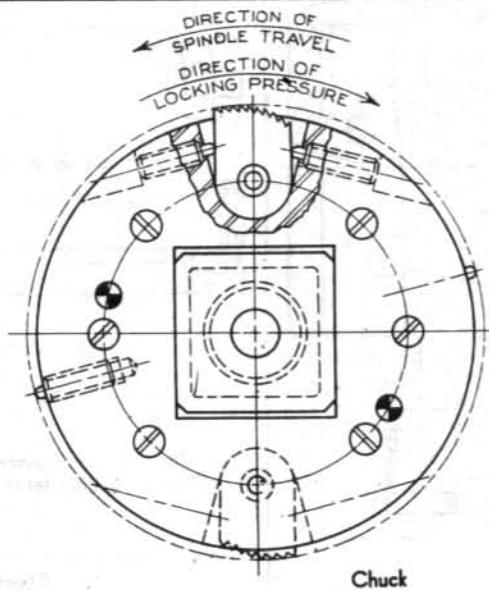


788

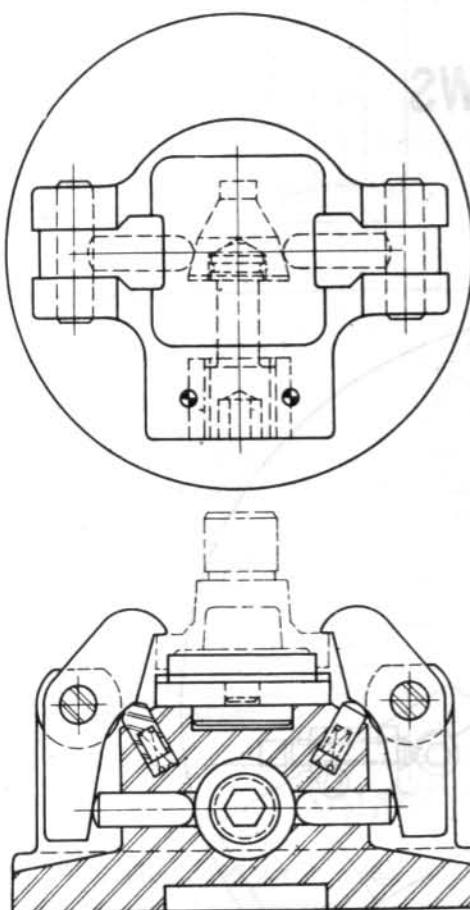


The grinding chuck can be adjusted to center the part.
Chuck

789



790



Chuck

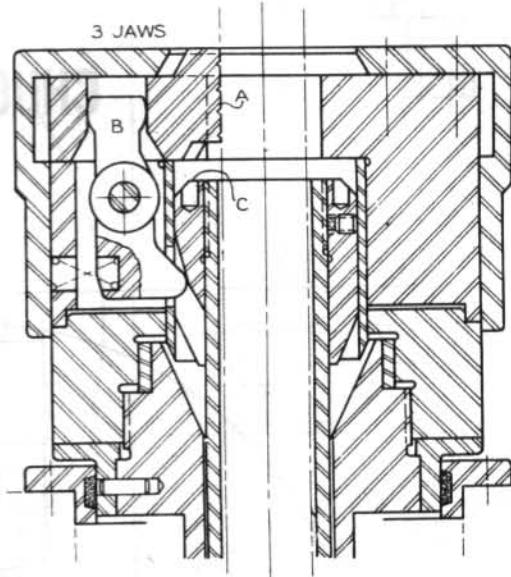
"The outstanding leaders of every age are those who set up their own quotas and constantly exceed them."

THOMAS J. WATSON

"The more a man gives of himself to his work, the more he will get out of it, both in wages and satisfaction."

J. T. MACKEY

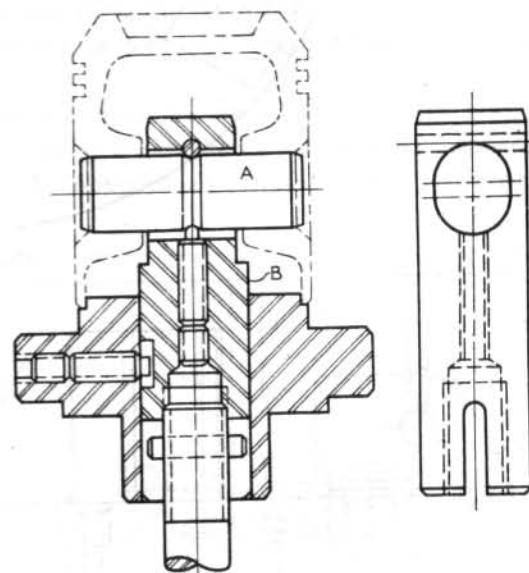
791



The hollow drawbar accommodates a long part. Cam C spreads the three rocker arms B that actuate the three jaws A to move horizontally.

Chuck

792

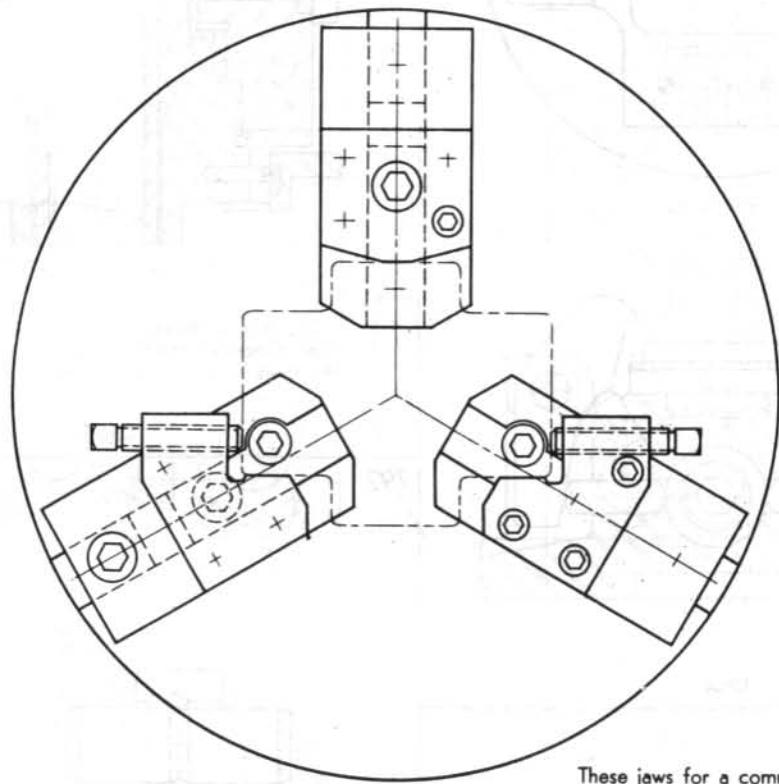


The pin and the spring-loaded plunger hold A in place before the drawbar is pulled down in the clamping operation. The set screw prevents B from turning while the part is being machined. A is removed in the unclamping operation.

Chuck

CHUCK JAWS

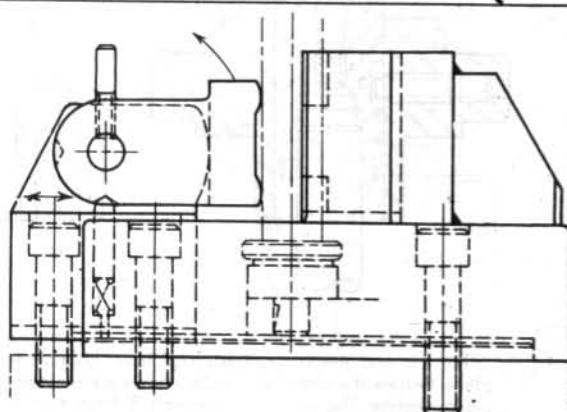
793



Chuck Jaws

These jaws for a commercial three-jaw chuck are designed to hold an irregular-shaped part.

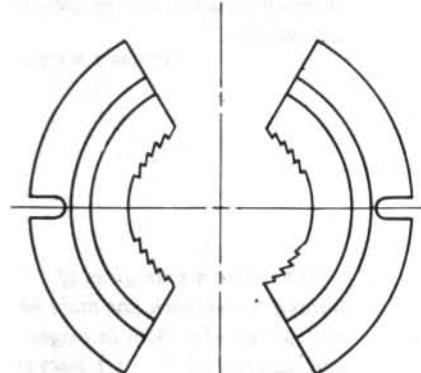
794



This design can be used when the jaws do not retract far enough to clear the part.

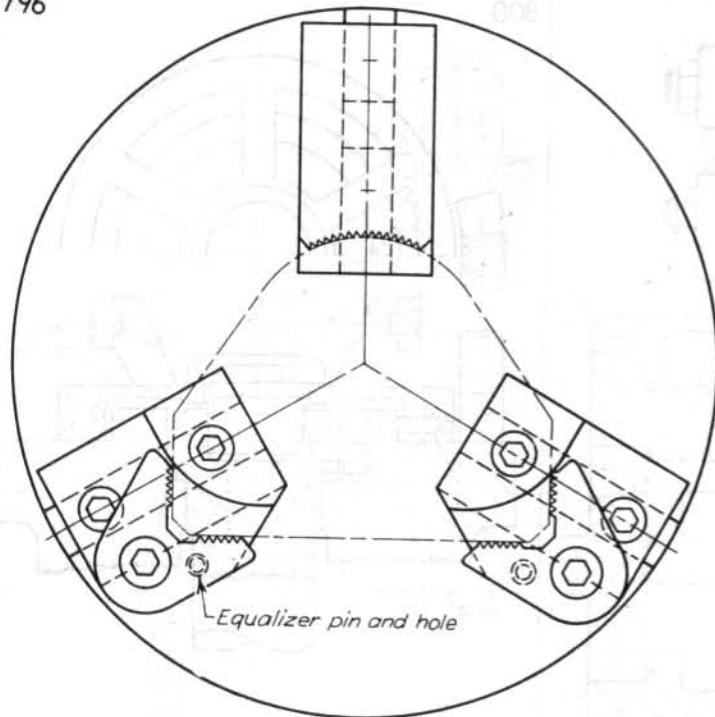
Chuck Jaws

795



Chuck Jaws

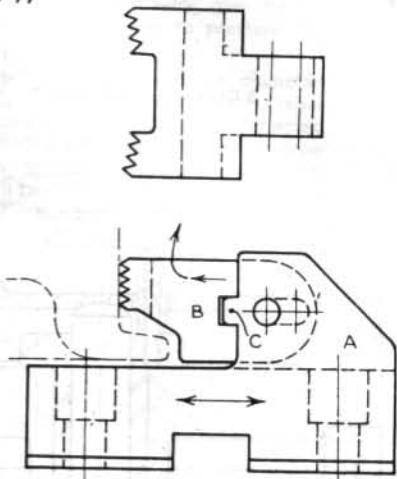
796



These jaws for a commercial three-jaw chuck are designed to hold an irregular-shaped part.

Chuck Jaws

797



When the three jaws of a chuck cannot be retracted far enough to clear the part, this design can be utilized. The retraction of jaw A permits supplementary jaw B to be moved far enough to the left to disengage the keyway of B from tongue C of A in order that B may be rotated upward, thereby clearing the part for removal. Only one of the three chuck jaws requires a supplementary jaw.

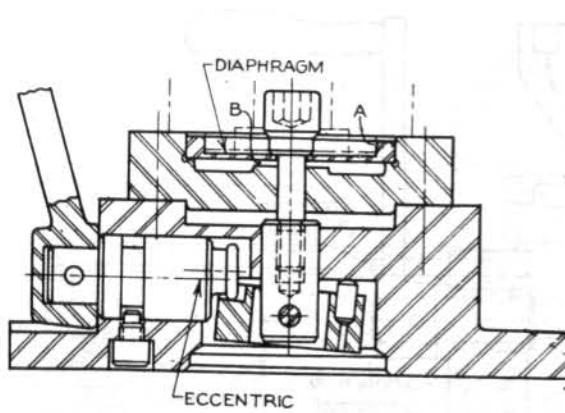
Chuck Jaws

DIAPHRAGM CLAMPING

A diaphragm chuck is based on the principle that a thin plate may be forced to become dish-shaped. The plate (called a diaphragm) is round. Its outer rim, which is thicker than the diaphragm, is fastened to the body.

Force applied to the center of the plate causes it to take the shape of a dish. The part is then inserted between the jaws and the force actuating the diaphragm is removed, allowing the now prestressed jaws to clamp the part firmly. Reapplication of force to the diaphragm unclamps the jaws, freeing the part.

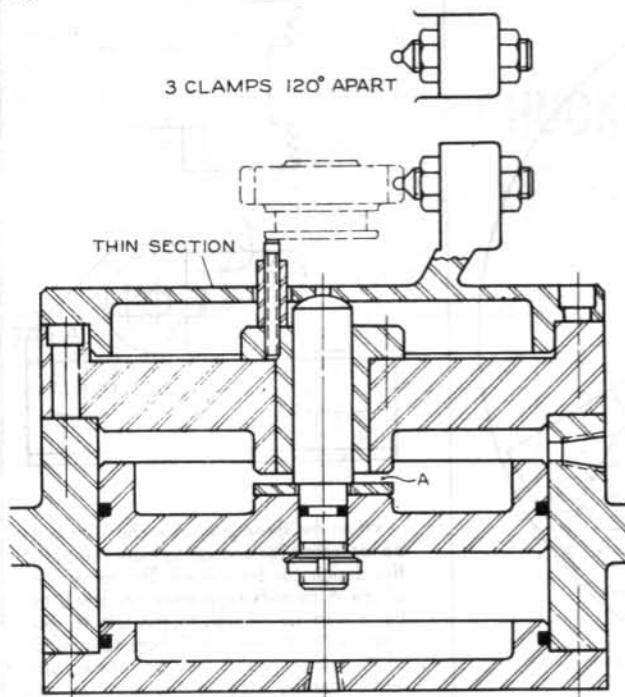
798



The eccentric causes the diaphragm to dish downward and to actuate the jaws to clamp the part on the bore of the diaphragm at A. B controls the extent to which the diaphragm can be dished.

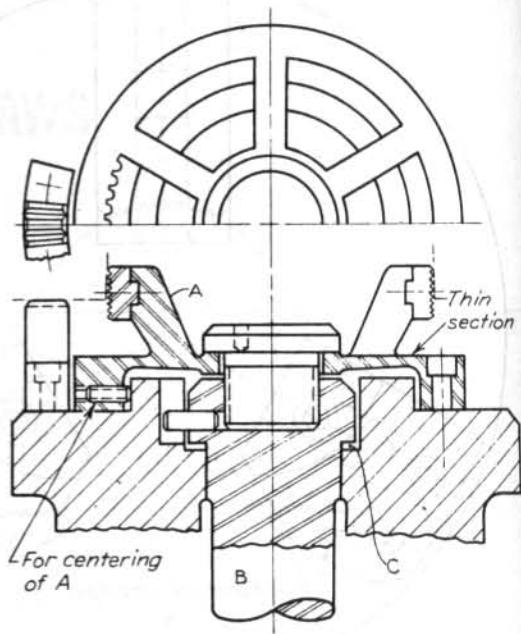
Diaphragm

799



Diaphragm

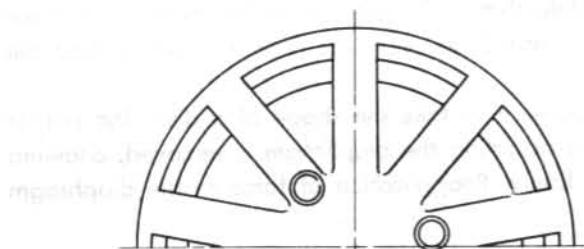
800



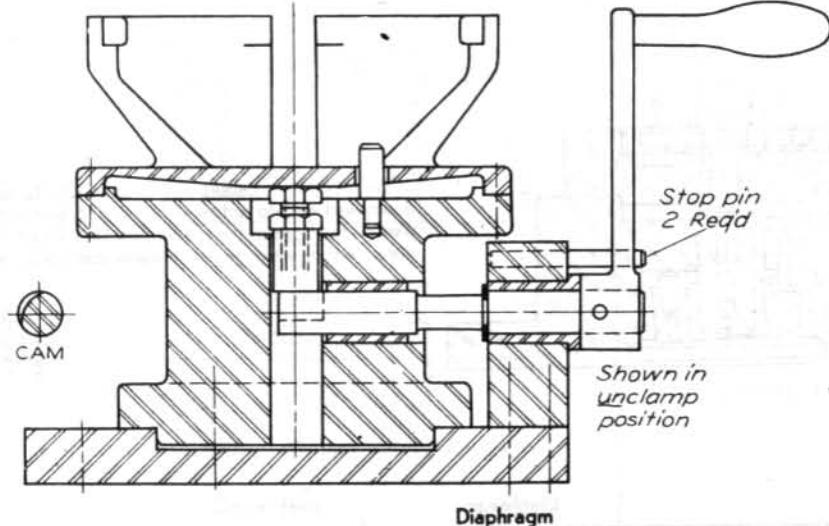
When B is pulled down, the diaphragm is dished downward, collapsing the six prestressed jaws A. The pin prevents B from turning. The extent to which the diaphragm can be dished is limited by C.

Diaphragm

801

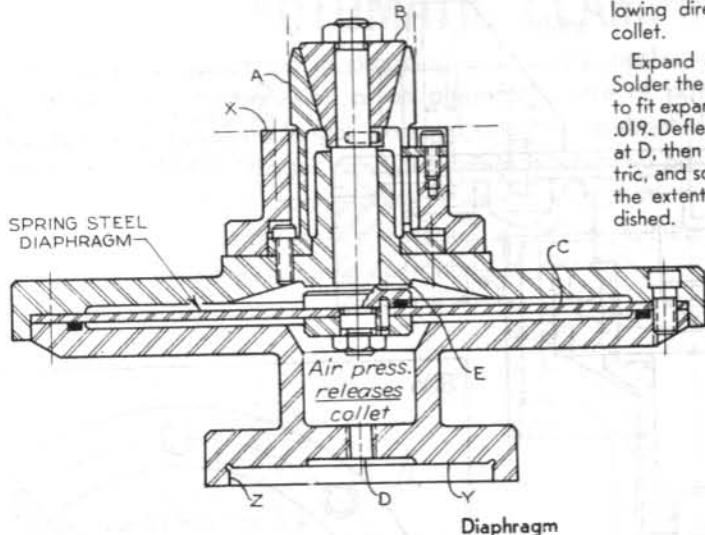


The cam causes the diaphragm to dish and to spread the nine prestressed jaws. The cylindrical portion of the shaft is the cam.



Diaphragm

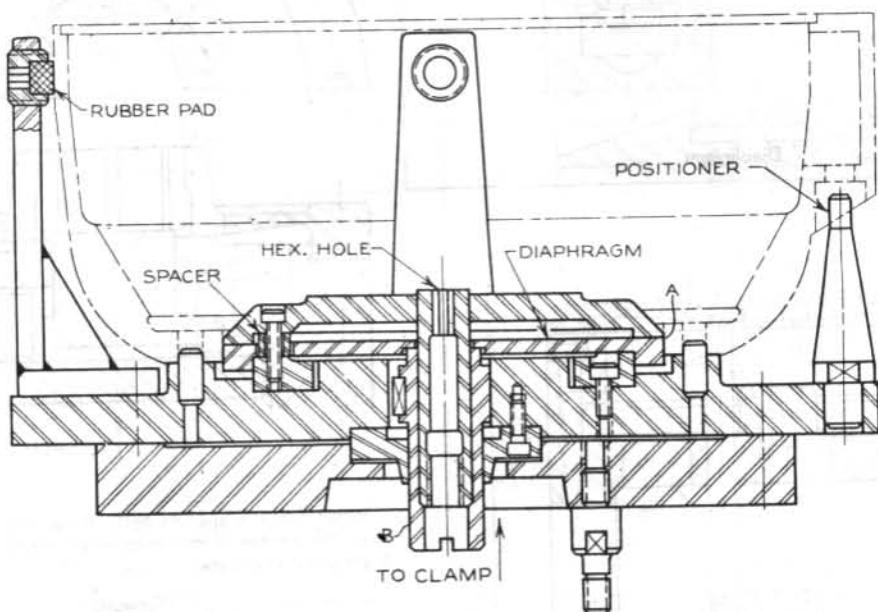
802



Instructions on the drawing give the following directions on how to prestress the collet.

Expand collet A .010 on the diameter. Solder the slots of the collet and grind taper to fit expander B with diaphragm C deflected .019. Deflect diaphragm C by inserting screw at D, then grind collet A to size, and concentric, and square with surfaces X, Y, Z. E limits the extent to which the diaphragm can be dished.

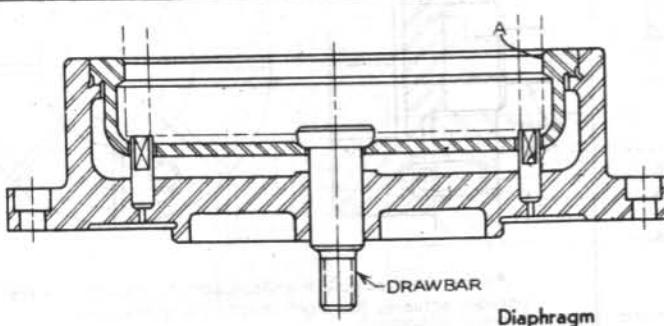
803



When B raises the diaphragm, the jaws are actuated to clamp the bore of the part on the periphery of the diaphragm at A. The four rubber pads dampen the vibration of the thin part.

Diaphragm

804

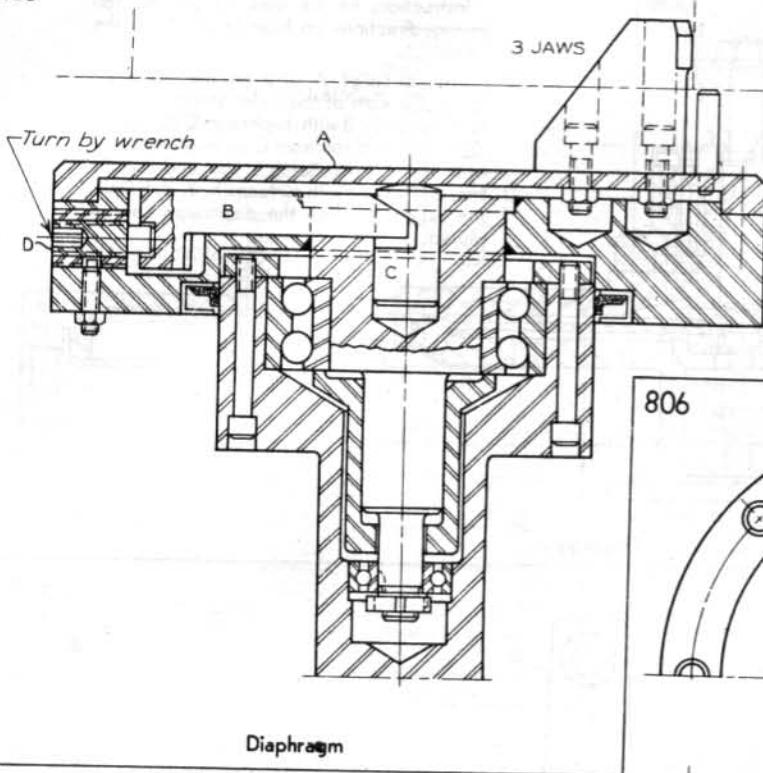


The drawbar forces the diaphragm to dish downward, thereby clamping the part on the periphery of the bore of the diaphragm at A.

Diaphragm

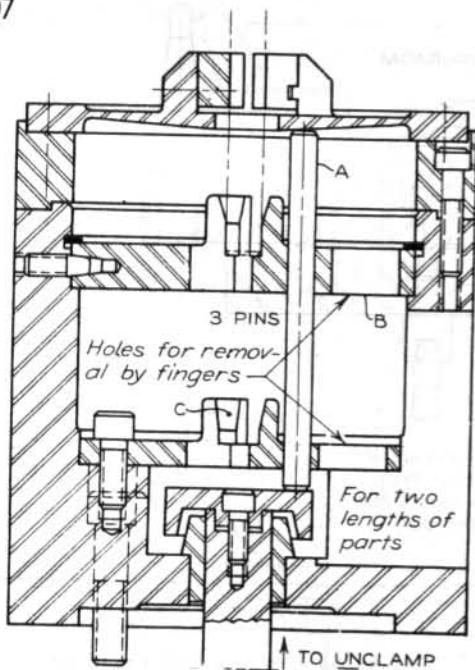
805-808

805



Turning screw D moves B and raises C, which dishes diaphragm A upward, clamping the part internally. This chuck is designed for the part that must be rotated during the machining process.

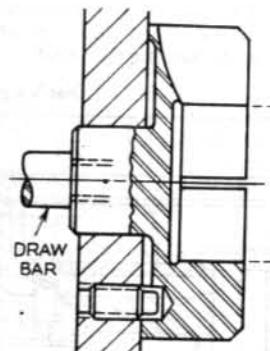
807



Pins A unclamp the prestressed jaws. When the longer of the two parts the chuck accommodates is positioned for machining, B is replaced with another part that guides the three pins and allows the longer part to pass through to C.

Diaphragm

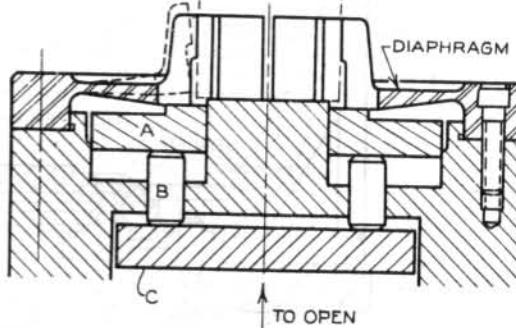
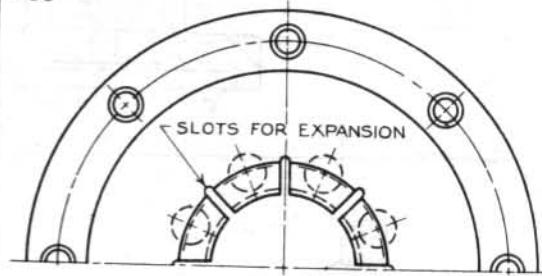
808



As the drawbar pulls the diaphragm to the left, the diaphragm actuates the eight jaws to clamp the part.

Diaphragm

806



When force is applied to C, the eight pins B force A to raise the center of the diaphragm, thereby spreading the eight prestressed jaws.

Diaphragm

809

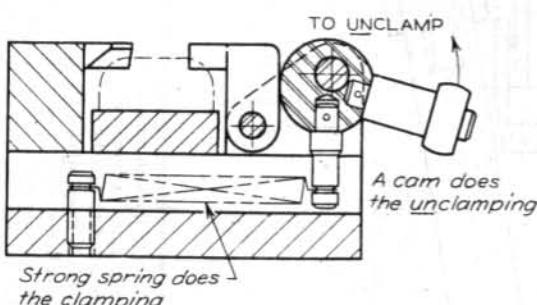
811

AUTOMATIC CLAMPING

An automatic clamp is held in clamping position by mechanical means when the clamping power source fails. The provision of an alternate source of power avoids the continued machining of a part that is no longer clamped and the resultant damage.

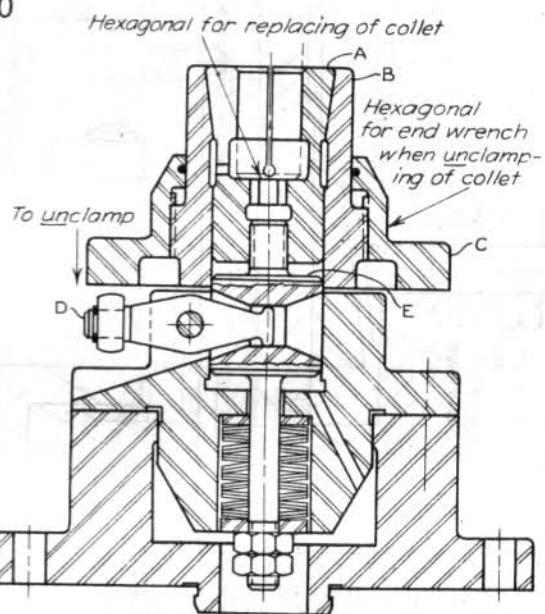
Strong springs, toggle linkages, cone locks, wrench-pressured oil, prestressed diaphragm clamps, small angle wedge cams, or spring-loaded collets or chucks are the mechanical means of holding automatic clamps. Frequently stops are added to prevent damage to the fixture in the event no part is in place during the clamping operation.

809



Automatic Clamp (Cam)

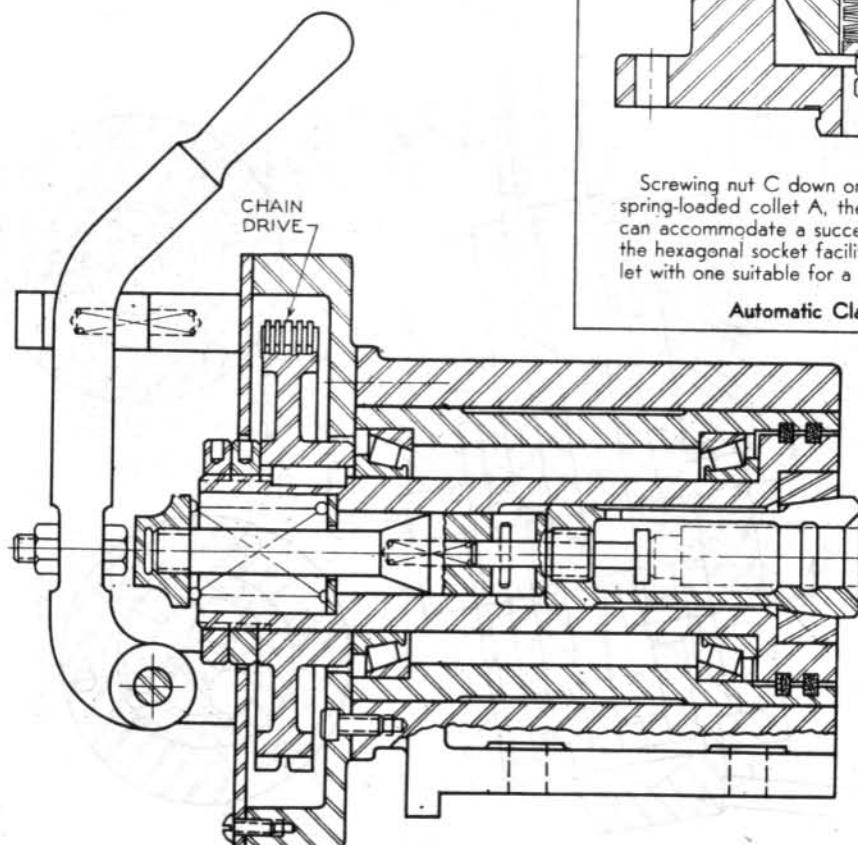
810



Screwing nut C down onto rocker arm D forces E to raise spring-loaded collet A, thereby unclamping it. This design can accommodate a succession of different parts because the hexagonal socket facilitates the replacement of the collet with one suitable for a different part.

Automatic Clamp (External Collet)

811

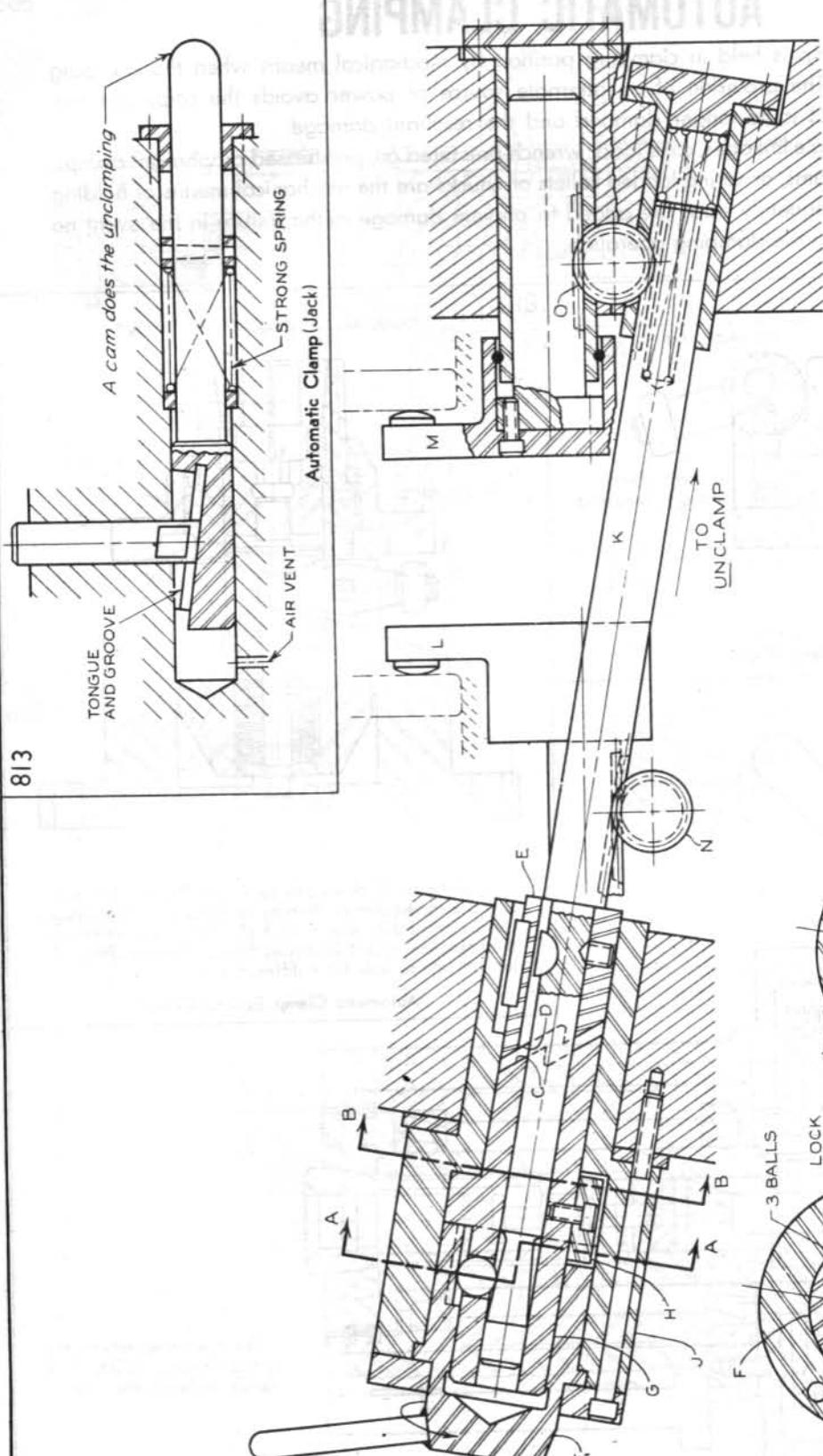


The chain drive rotates the spring-loaded collet. The handle unclamps the collet.

Automatic Clamp (Rotating External Collet)

812

813

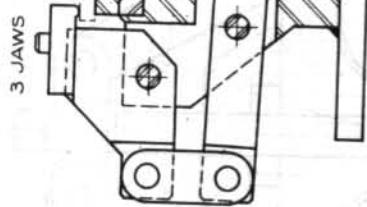


The two strong springs move the racks of K, which actuate clamps L and M through pinions N and O. In the unclamping operation the handle of F is turned clockwise. As F turns, it moves key H, which is fastened to G. Helical cam C of G forces helical cam D of E to move K down against the springs. As this occurs, the racks reverse the direction in which pinions N and O rotate, thereby unclamping L and M. H strikes a stop in the groove of Section BB, and the three balls of Section AA then lock the unclamped jaws in open position.

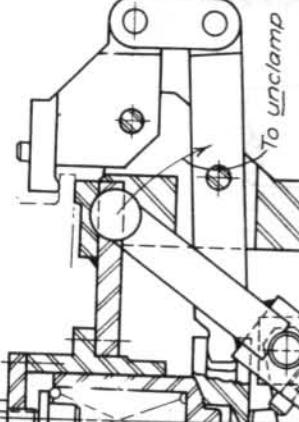
fastened to G. Helical cam C of G forces helical cam D of E to move K down against the springs. As this occurs, the racks reverse the direction in which pinions N and O rotate, thereby unlatching L and M. H strikes a stop in the groove of Section BB, and the three balls of Section AA then lock the uncamped jaws in open position.

SECTION AA
Automatic Clamp (Internal)

814

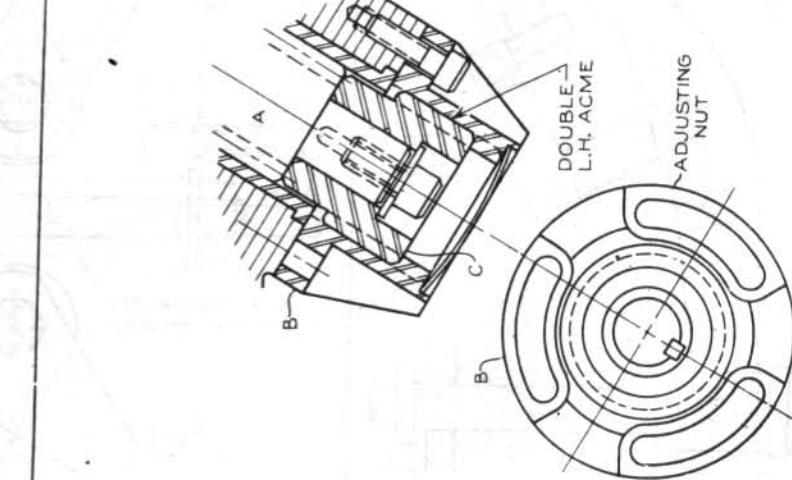


This spring-loaded clamp is unclamped manually.

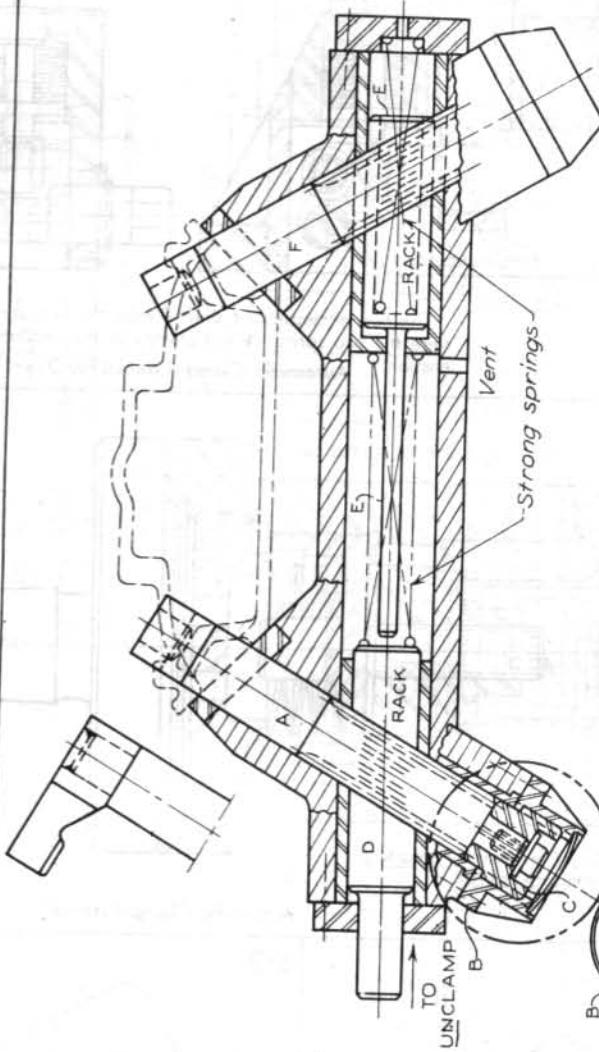


To unclamp

815



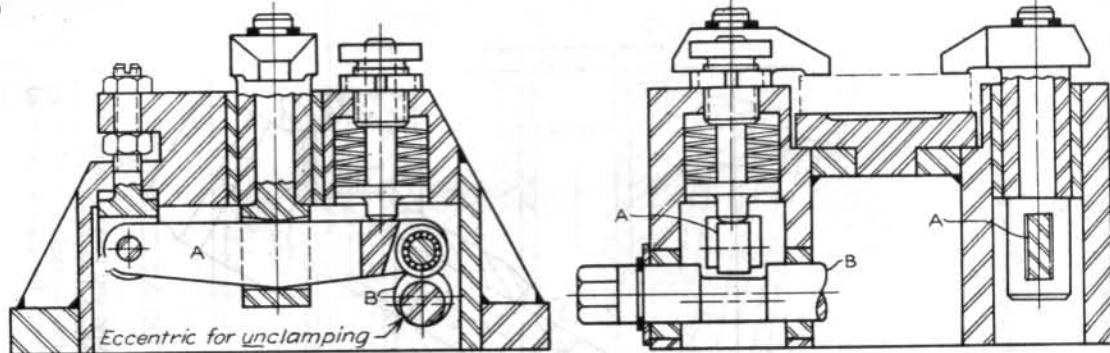
Automatic Clamp (External Swing)



In the unclamping operation, the rack of D raises and rotates clamp A. D strikes the pin portion of E, causing its rack to raise and rotate clamp F. In the clamping operation, two strong springs cause the two racks, D and E, to rotate clamps A and F to clamping position and clamp. The clamps may be adjusted by turning B.

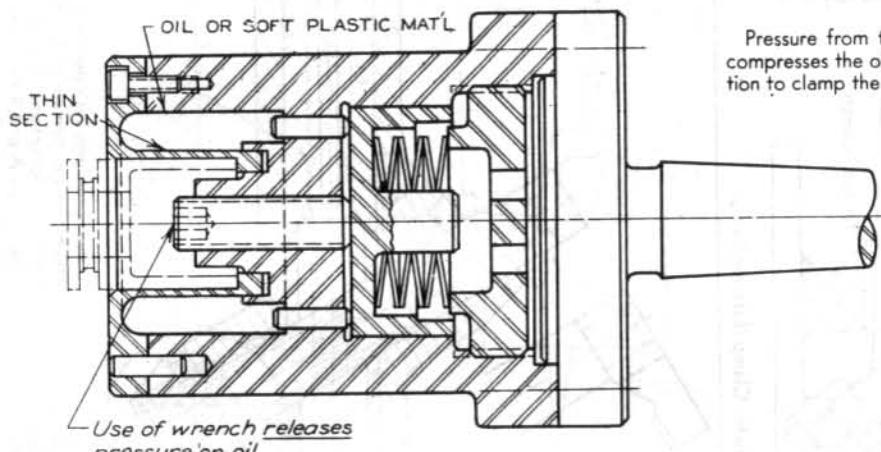
Automatic Clamp (External Swing)

816



The two eccentrics of shaft B raise the two arms A that raise the two spring-loaded clamps in the unclamping operation. **Automatic Clamp (External Pull Down)**

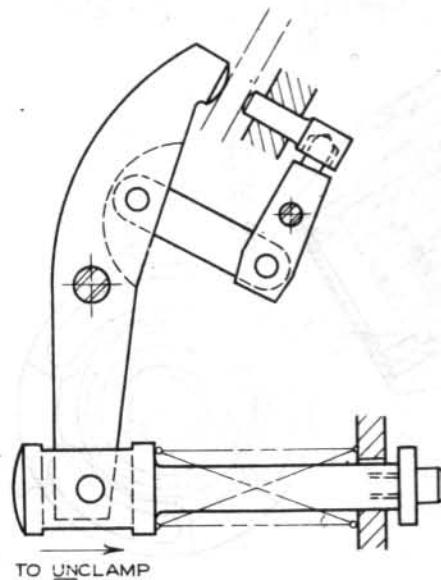
817



Pressure from the spring on the pins compresses the oil, causing the thin section to clamp the part.

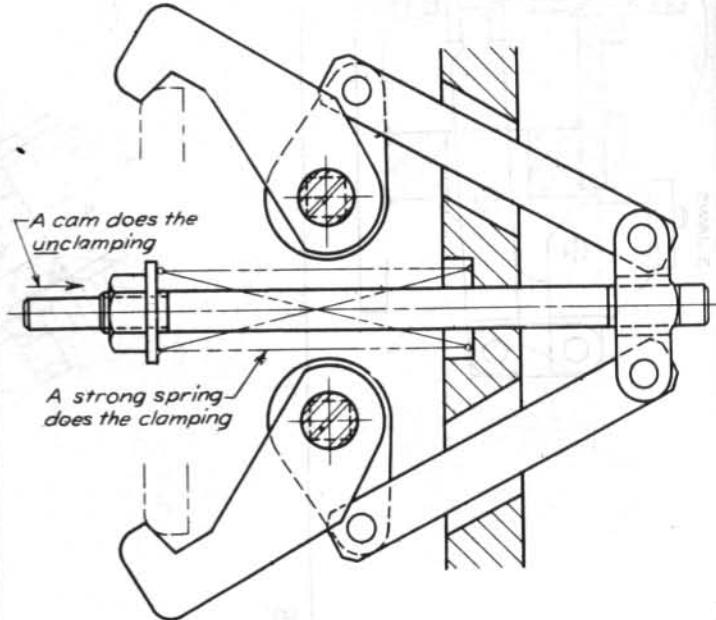
Automatic Clamp (External)

818



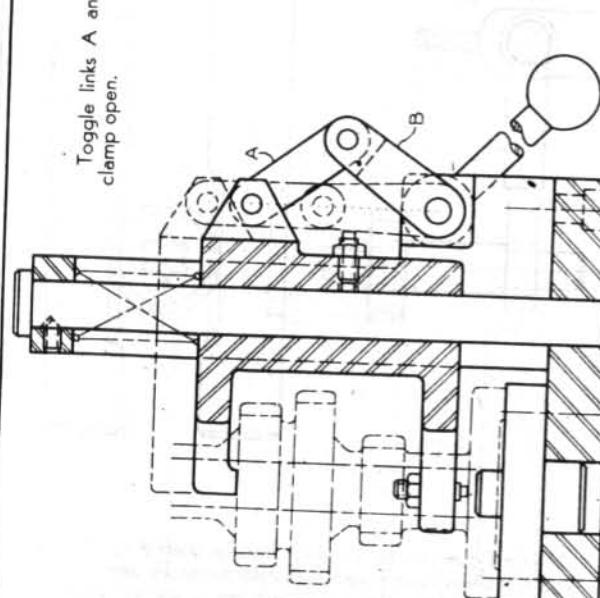
Automatic Clamp (External Equalizing)

819

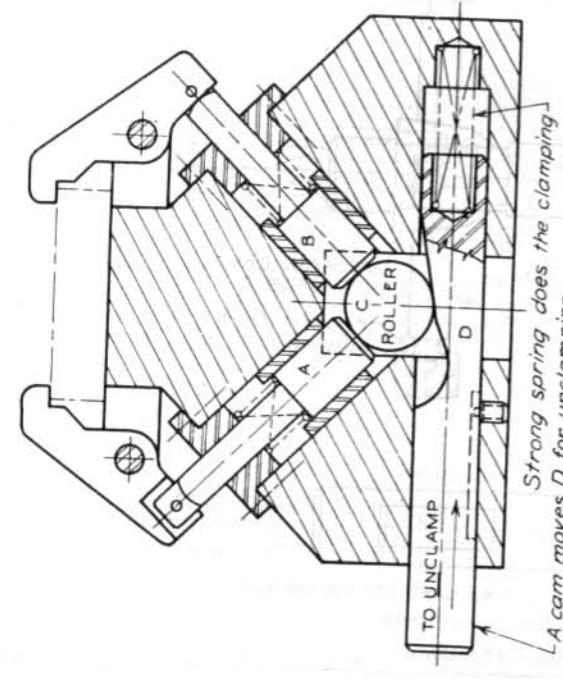


Automatic Clamp (External)

820



821

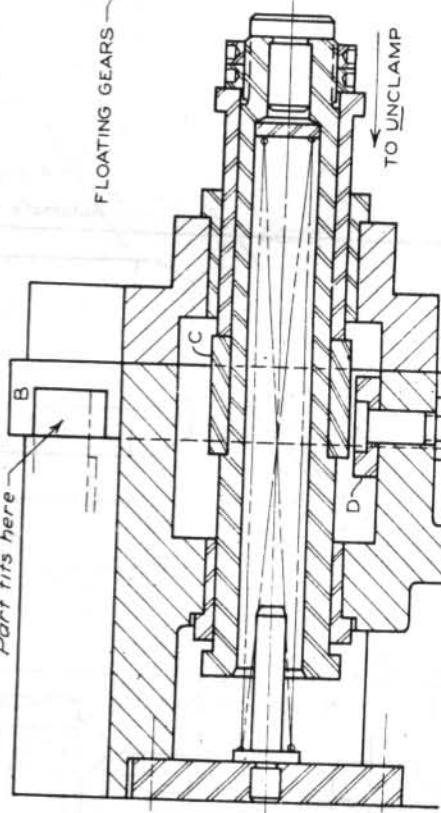


822

In the unclamping operation, double gear C, which has helical teeth, raises jaws A and B. In the clamping operation, the spring forces gear C to pull jaws A and B down. Note that gear C moves horizontally.

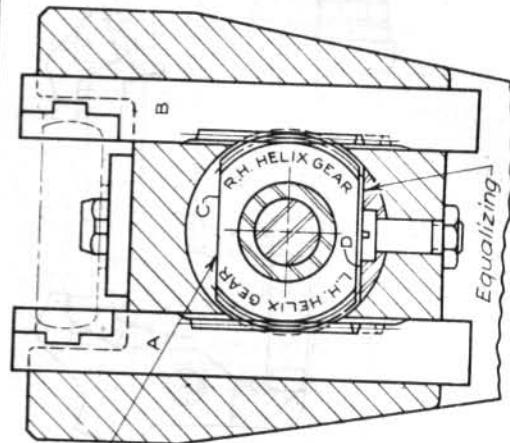
Automatic Clamp (External Pull Down)

Part fits here

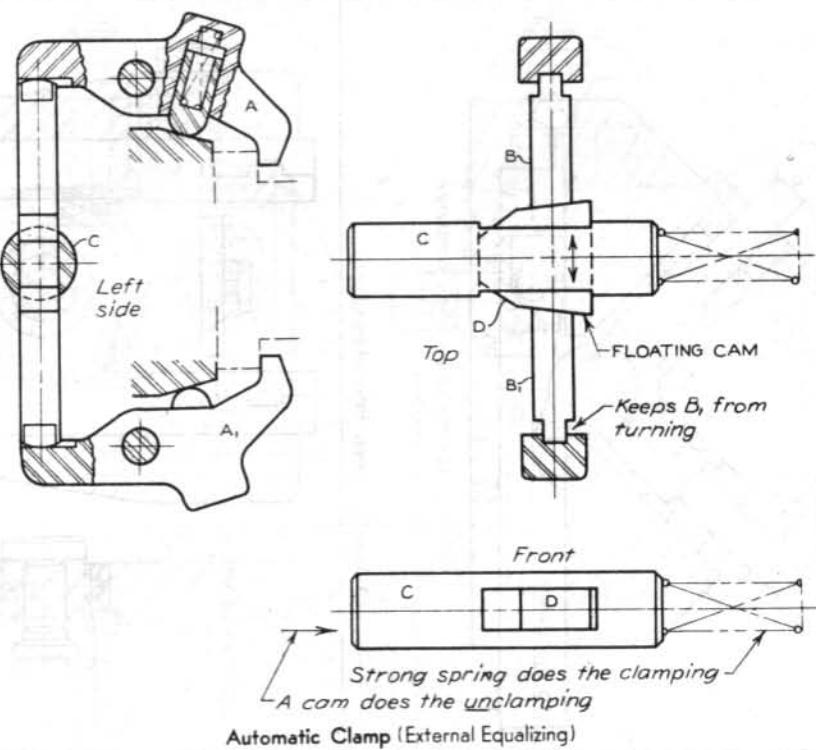


DIRECTION OF HELIX 23° HELIX, FOR BOTH GEARS
Automatic Clamp (External Pull Down)

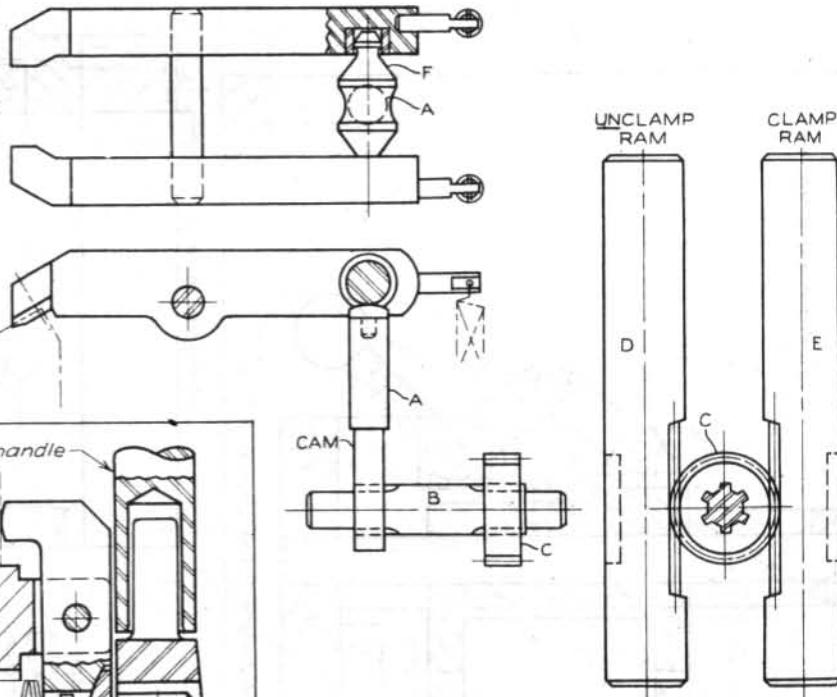
Automatic Clamp (External Equalizing)



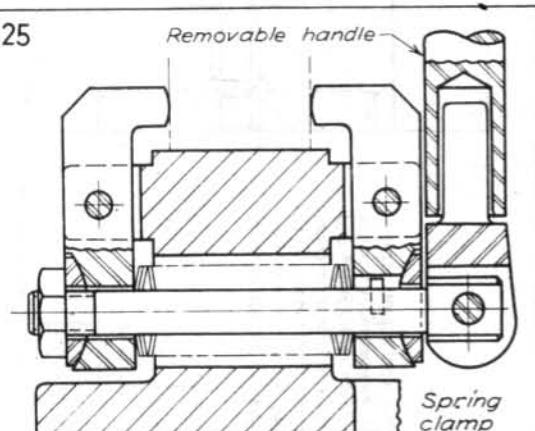
823



824



825



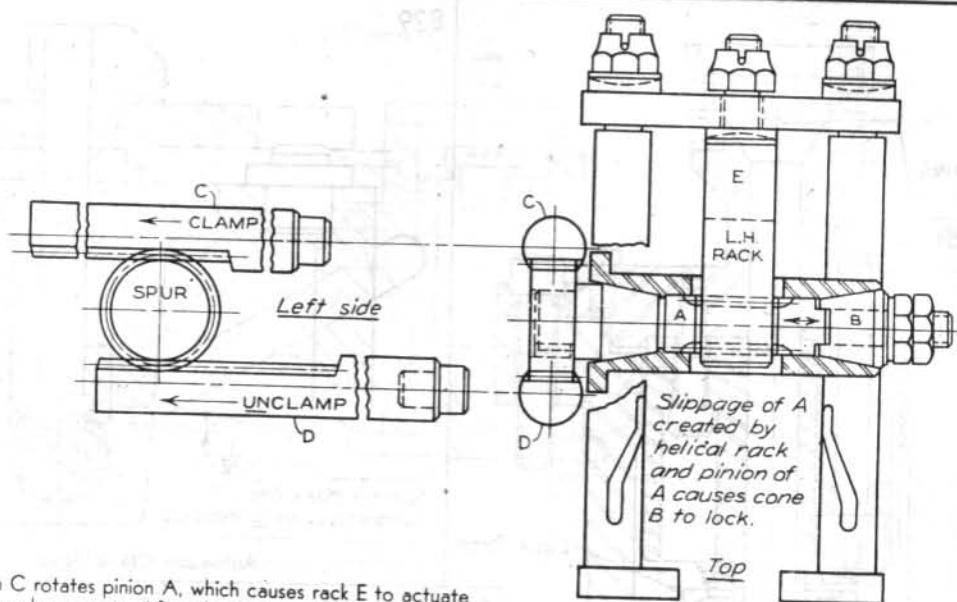
The handle - actuated cam unclamps the spring-loaded clamps.

Automatic Clamp (External Equalizing).

Ram E turns pinion C, which through shaft B rotates the cam, thereby raising post A that forces rocker arm F to actuate the clamps. The unclamping ram is spring-loaded to prevent vibration from causing unclamping action.

Automatic Clamp (External)

826

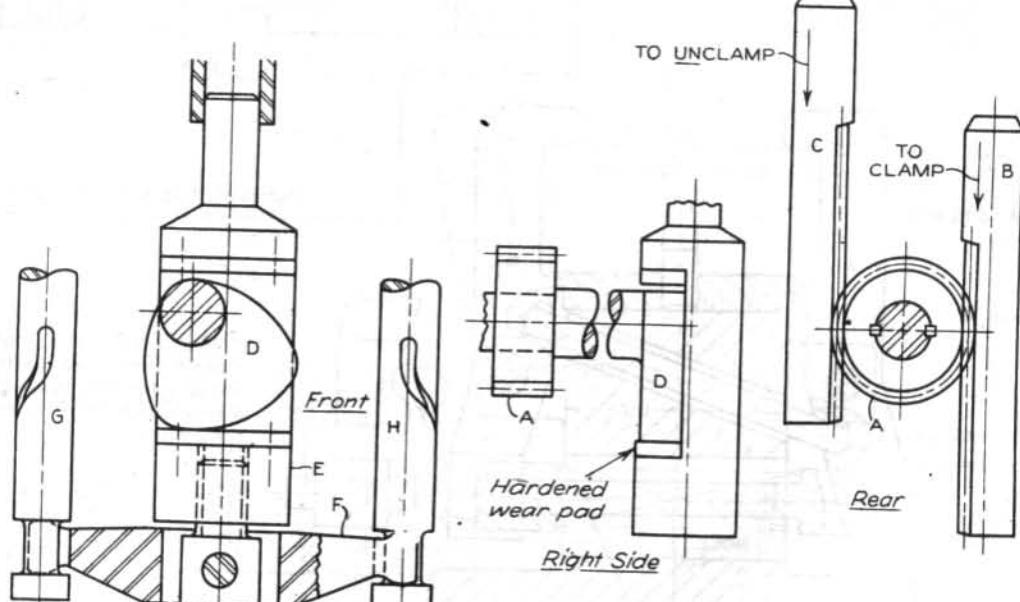
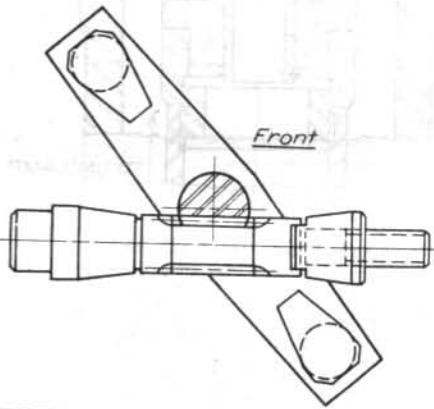


Ram C rotates pinion A, which causes rack E to actuate the two clamp posts. After the part is clamped, the slippage of A occurs, causing cone B to lock.

Automatic Clamp (External Swing)

827

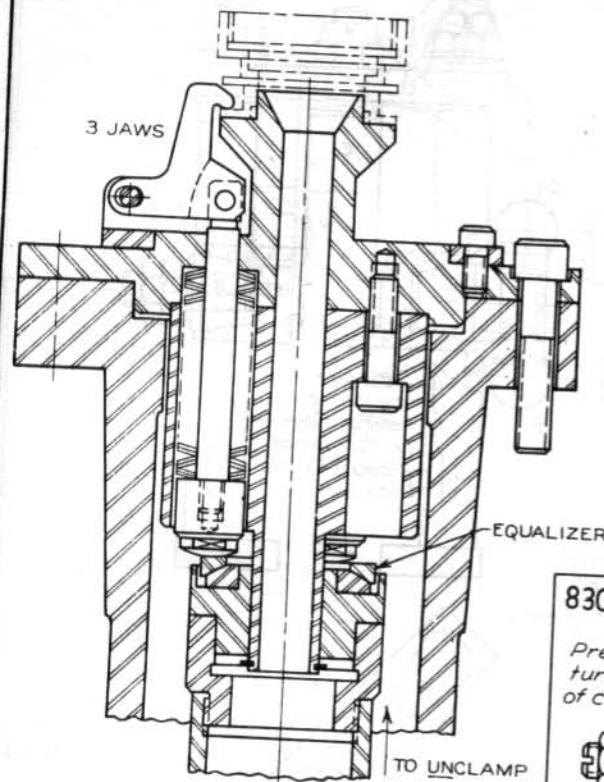
Ram clamp B rotates pinion A and cam D, forcing E down as rocker arm F draws down clamp posts G and H. During the unclamping operation, cam D raises E and, in turn, clamp posts G and H. The unclamping ram is spring-loaded to prevent vibration from causing unclamping action.



Automatic Clamp (External Swing)

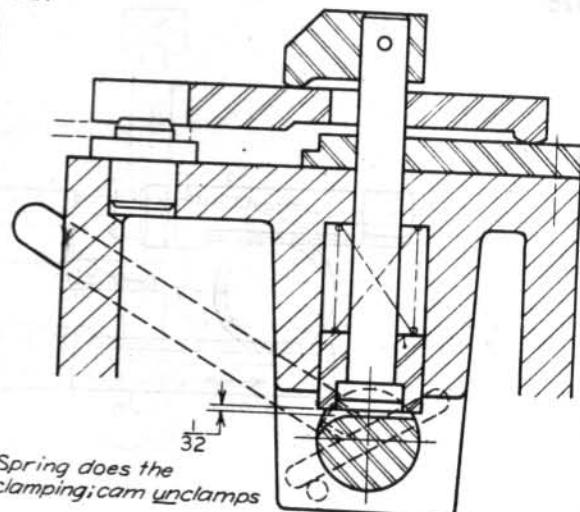
828-831

828

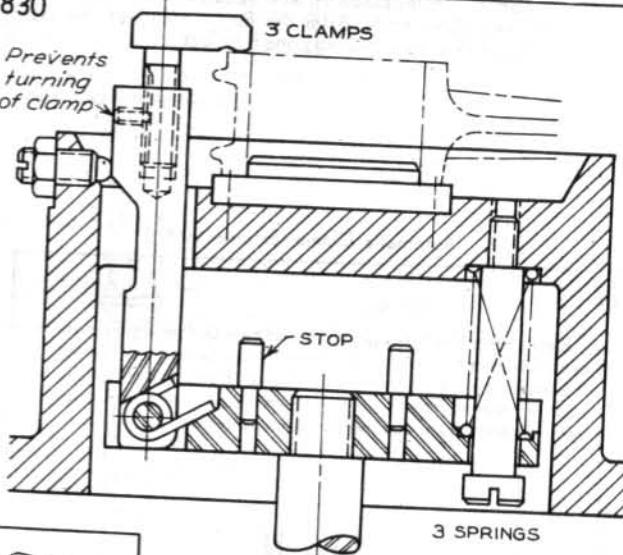


Automatic Clamp (External Swing)

829

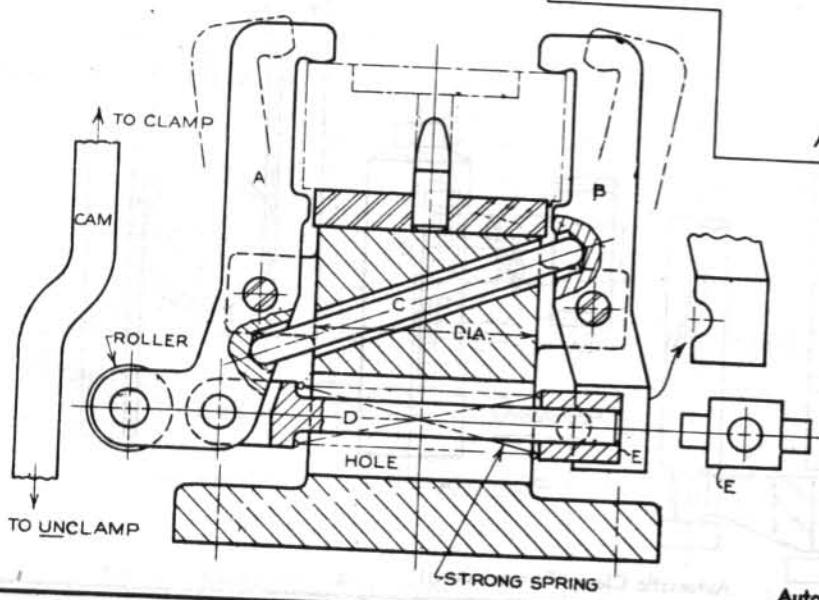


830



Automatic Clamp (External Swing)

831

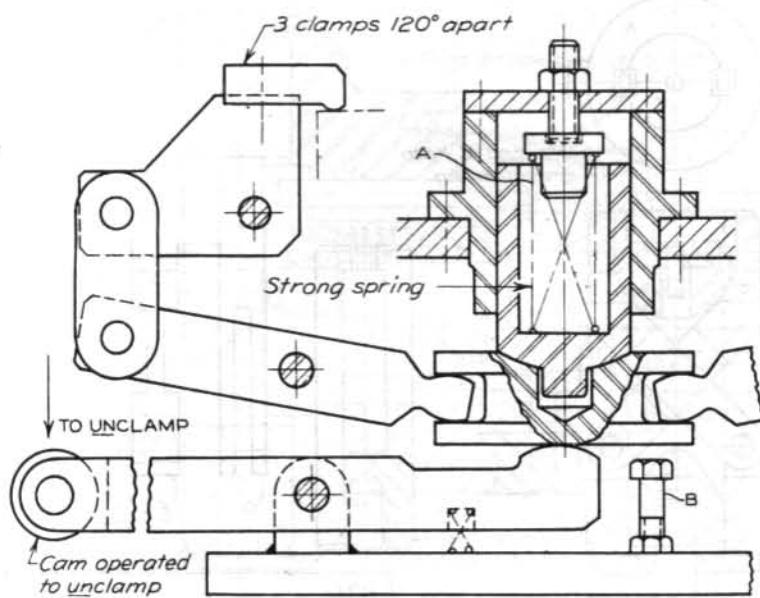


When the fixture is unclamped, clamp A swings away from the part and actuates pin C to swing clamp B away. D slides into E as the spring compresses.

Automatic Clamp (External Swing)

833

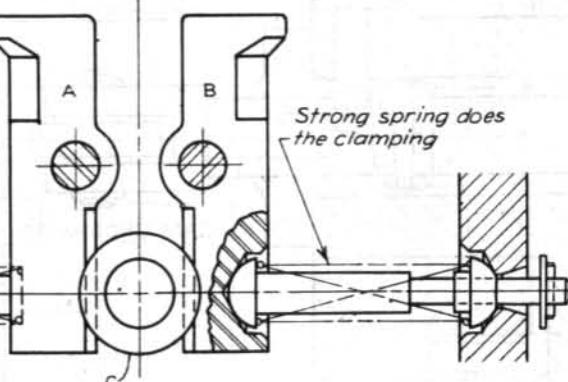
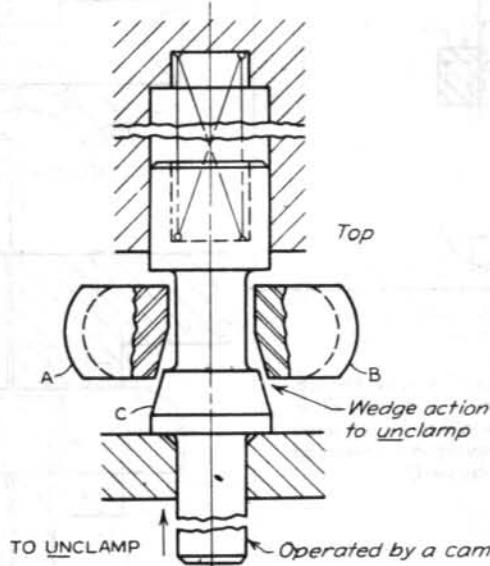
832



Automatic Clamp (External Swing)

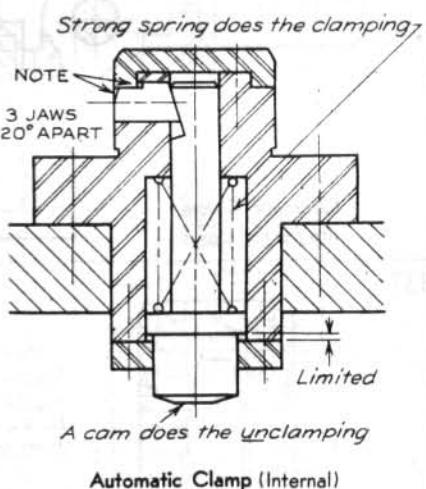
A cam actuates the unclamping action in this design. Bolt B prevents damage to the clamps if there is no part in the fixture during the clamping operation. Adjusting spring A changes the amount of clamping pressure.

833



Automatic Clamp (Internal)

834

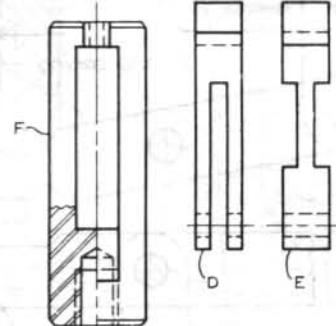
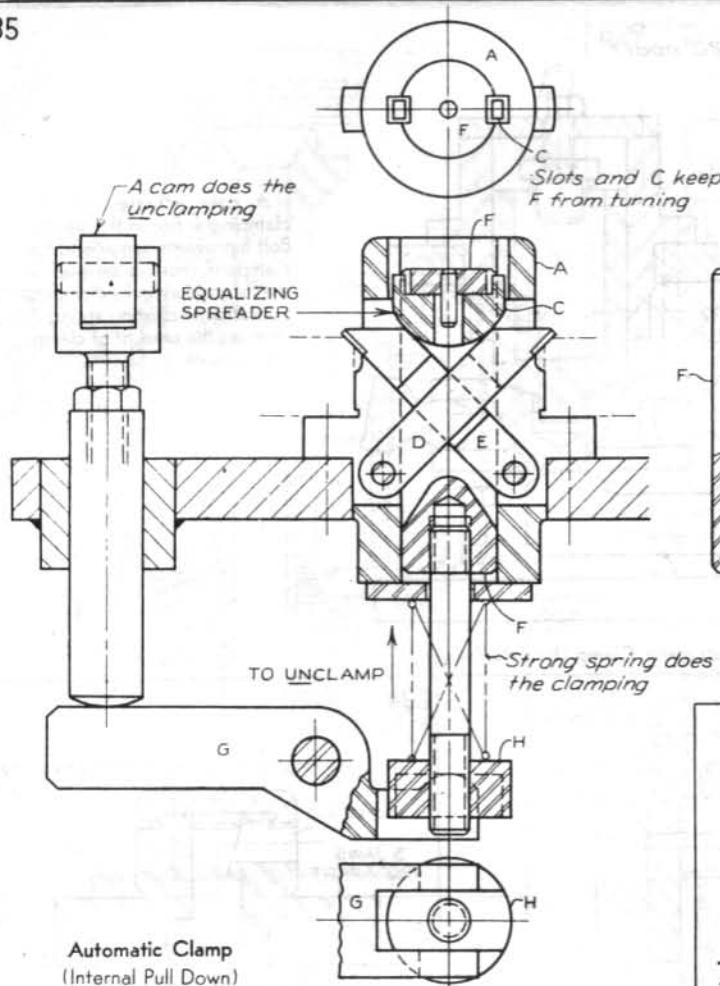


Automatic Clamp (Internal)

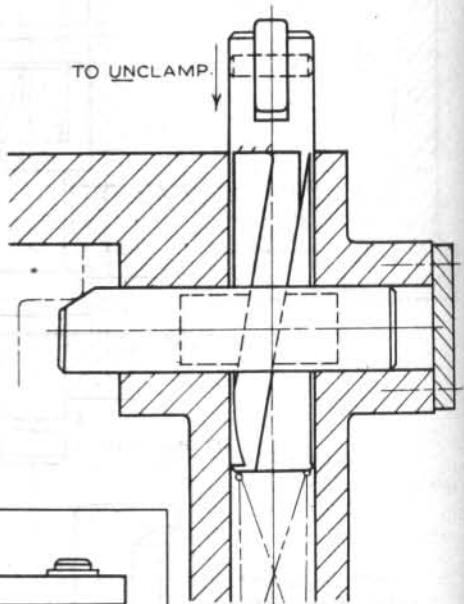
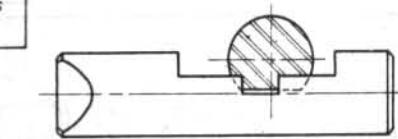
is unclamped, from the part to swing clamp as the spring

Swing)

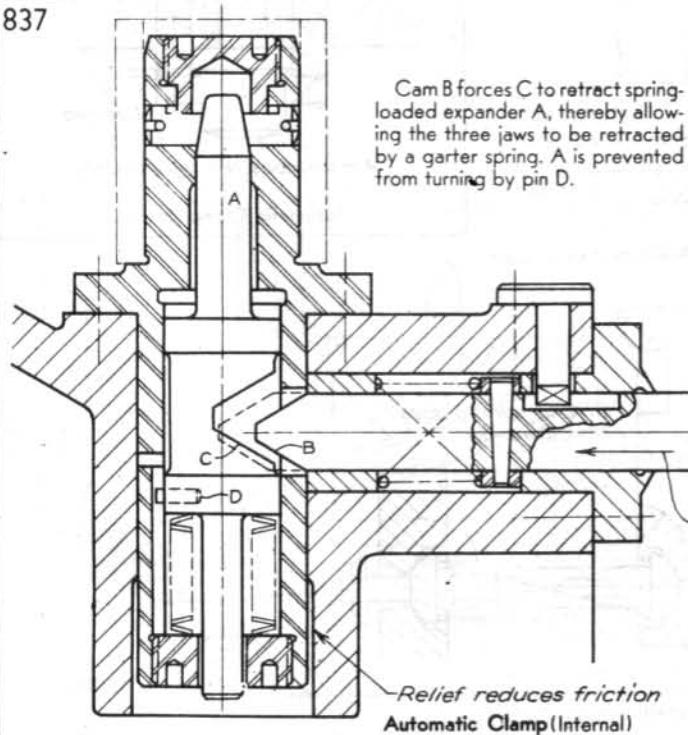
835



836



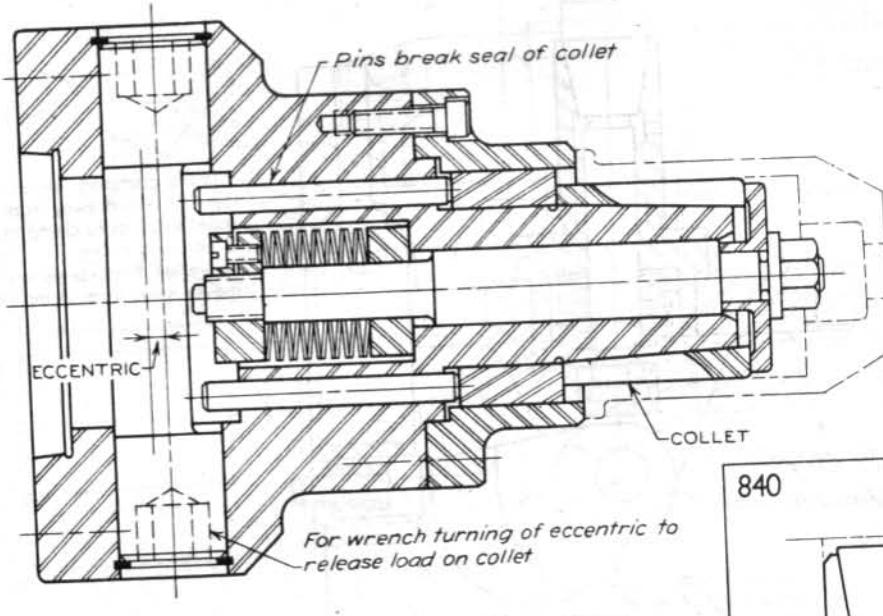
837



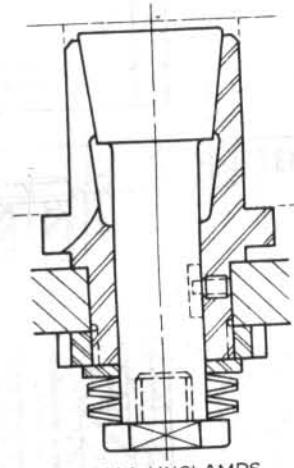
CAM UNCLAMPS

Automatic Clamp (Underneath)

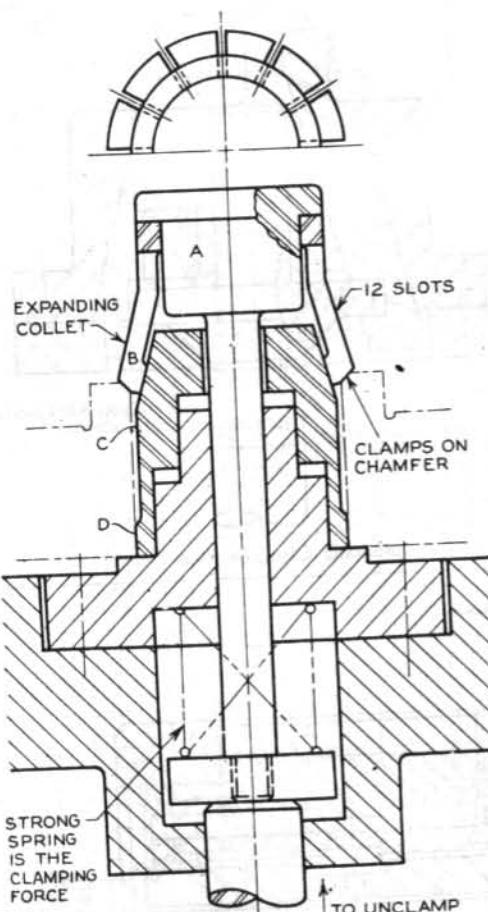
838



840

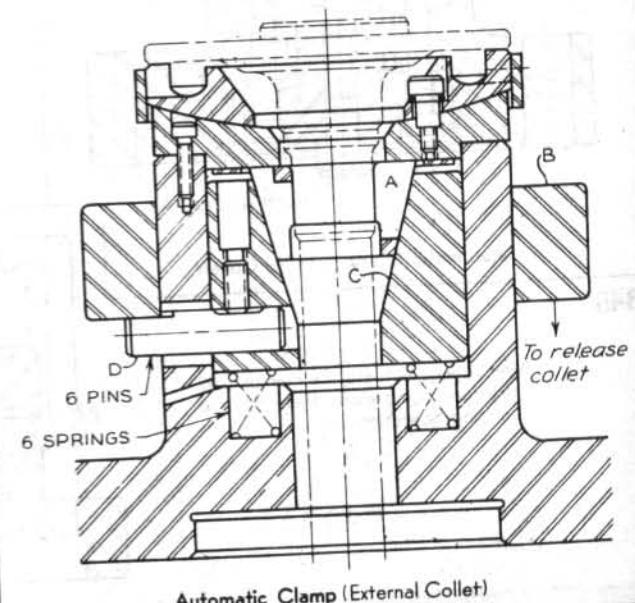


839

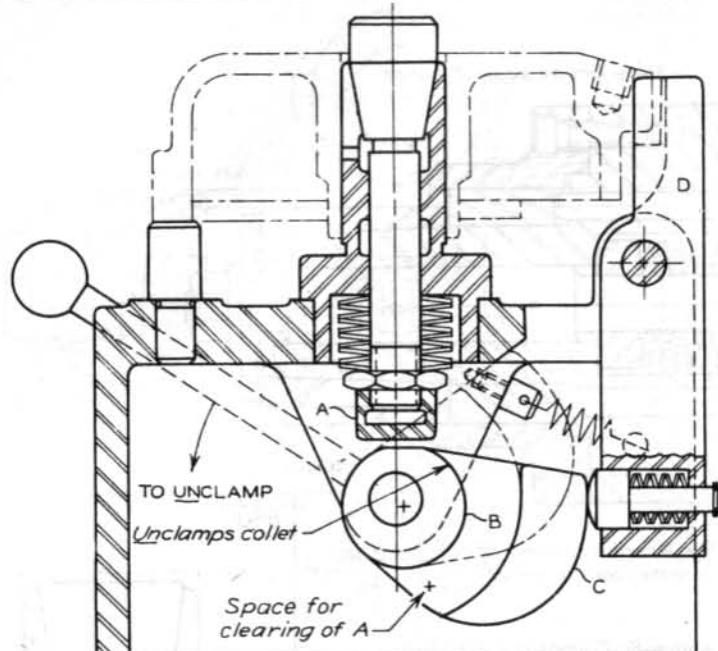


841

Six springs raise squeezer C, which forces collet A to clamp. When B is forced down on the six pins D, the squeezer is retracted.



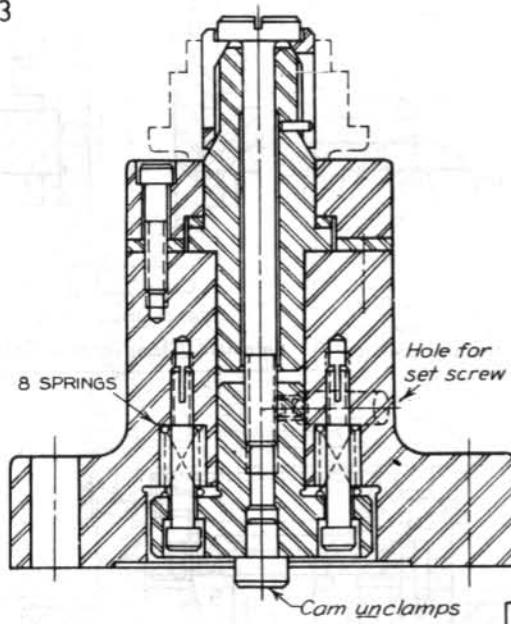
842



In the clamping operation, the movement of cam B away from A allows the collet's springs to clamp the collet. Cam C actuates clamp D. In the unclamping operation, B unclamps the collet, and C moves away from clamp D.

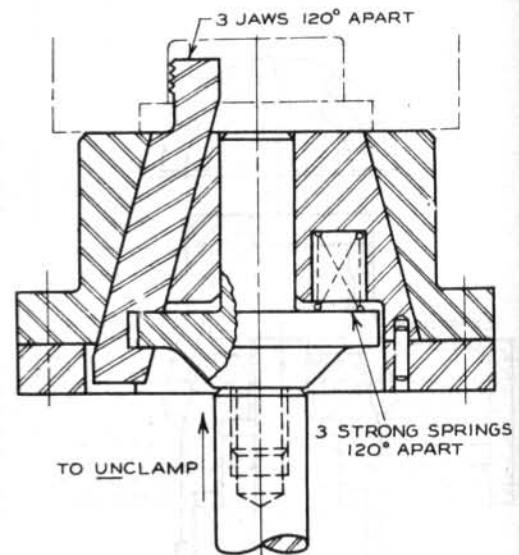
Automatic Clamp (Internal Collet and Pusher)

843



Automatic Clamp (Internal Collet)

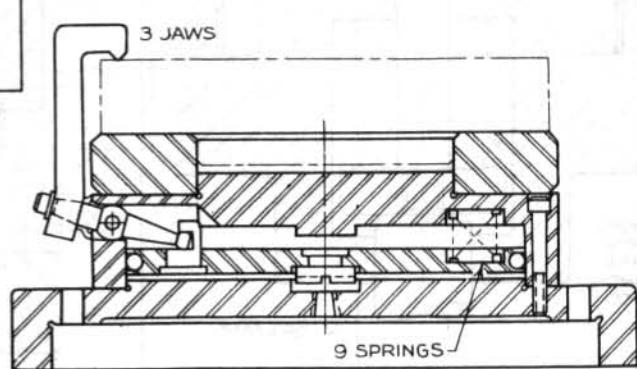
844



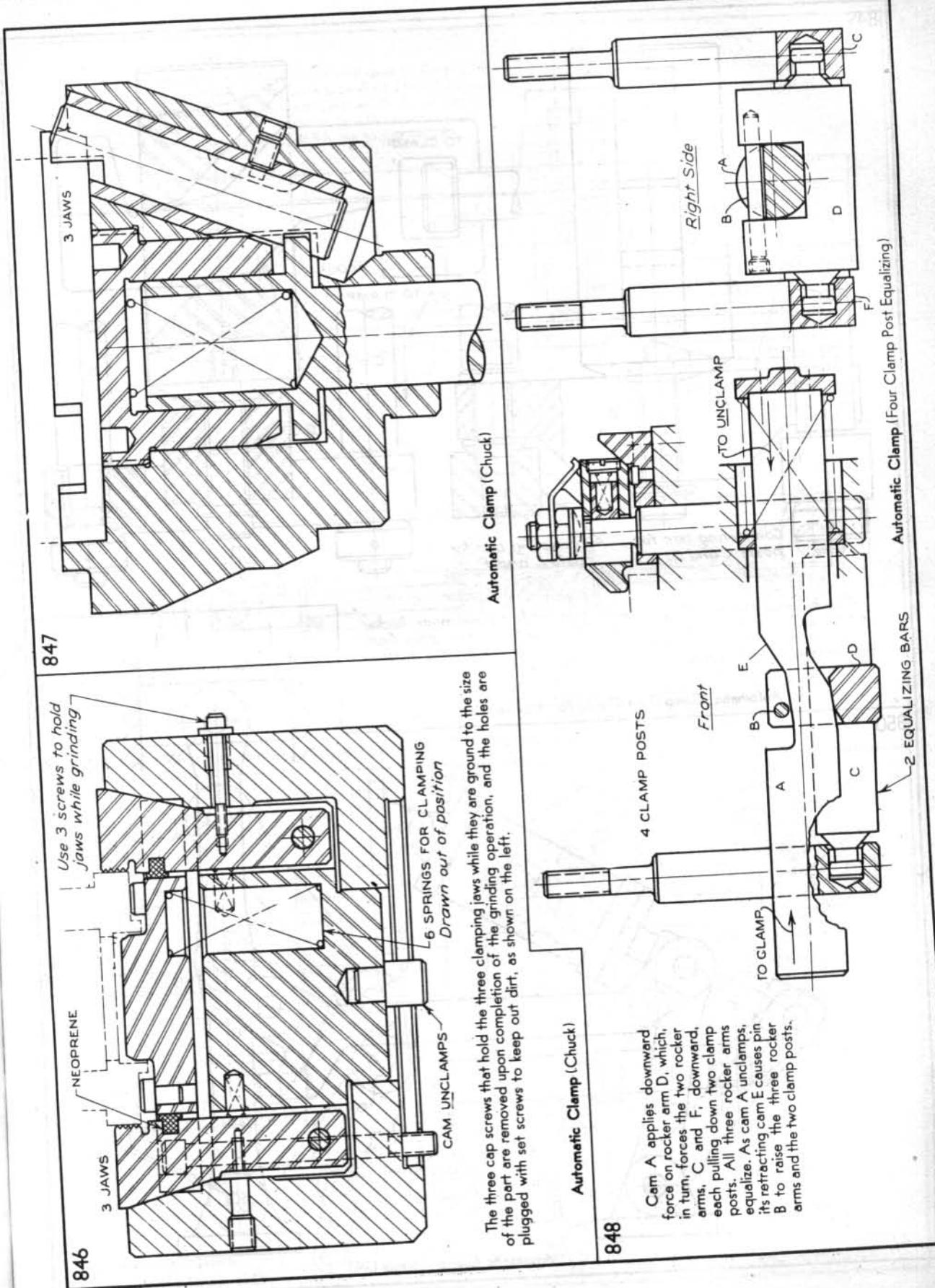
Automatic Clamp (Internal Chuck)

845

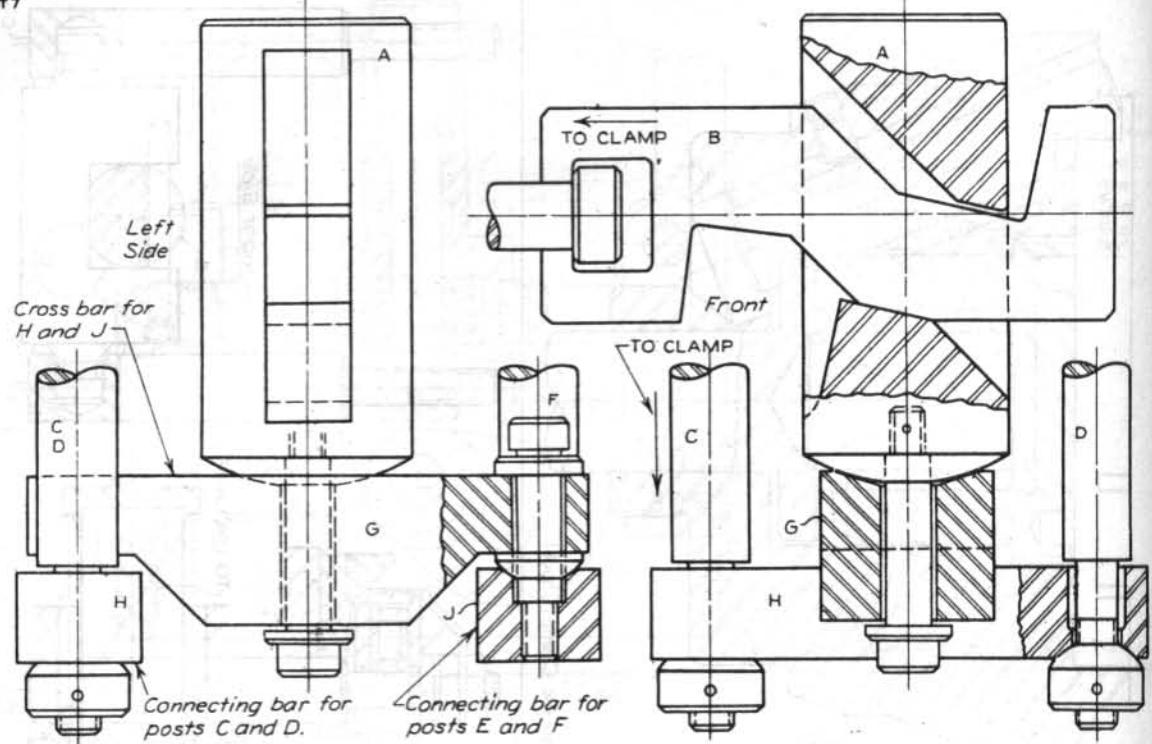
Nine springs actuate the clamps until air pressure compresses them for the unclamping operation.



Automatic Clamp (Chuck)



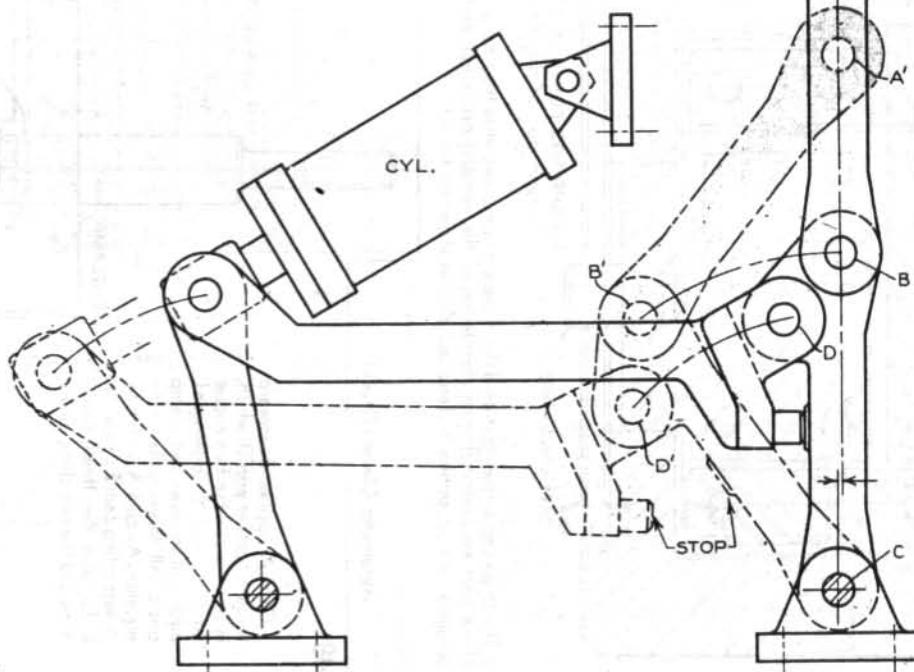
849



Cam B clamps and its small clamp angle locks the four clamp posts. Rocker arm G applies force to two other rocker arms, H and J, and equalizes them. H, in turn, equalizes and pulls down two clamp posts as does J. In the unclamping operation, cam B raises A, which raises all four clamp posts.

Automatic Clamp (Four Clamp Post Equalizing)

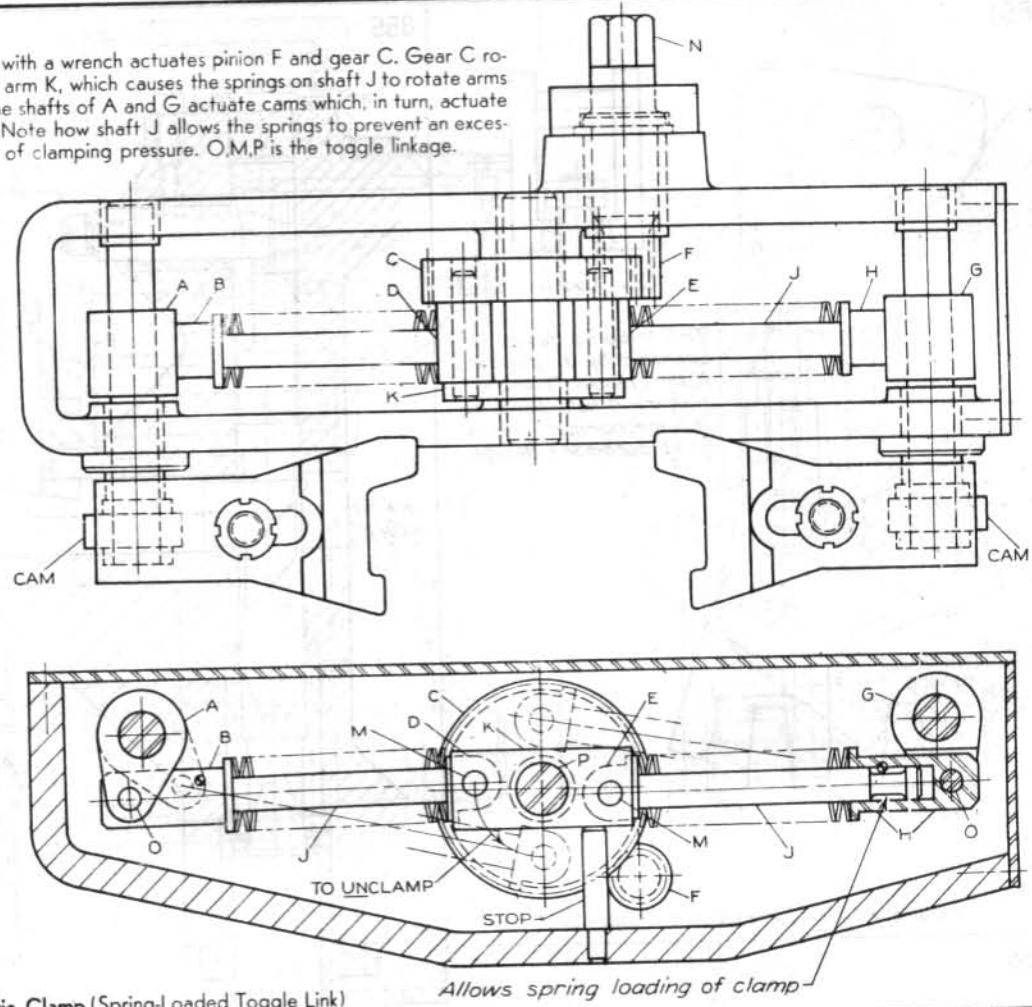
850



Automatic Clamp (Toggle Link)

851

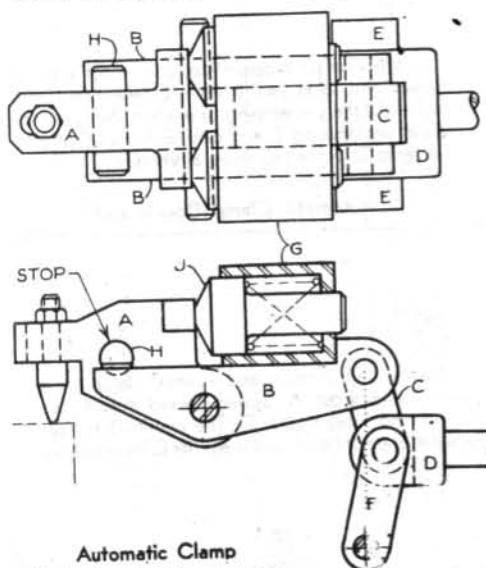
Turning N with a wrench actuates pinion F and gear C. Gear C rotates rocker arm K, which causes the springs on shaft J to rotate arms A and G. The shafts of A and G actuate cams which, in turn, actuate the clamps. Note how shaft J allows the springs to prevent an excessive amount of clamping pressure. O,M,P is the toggle linkage.



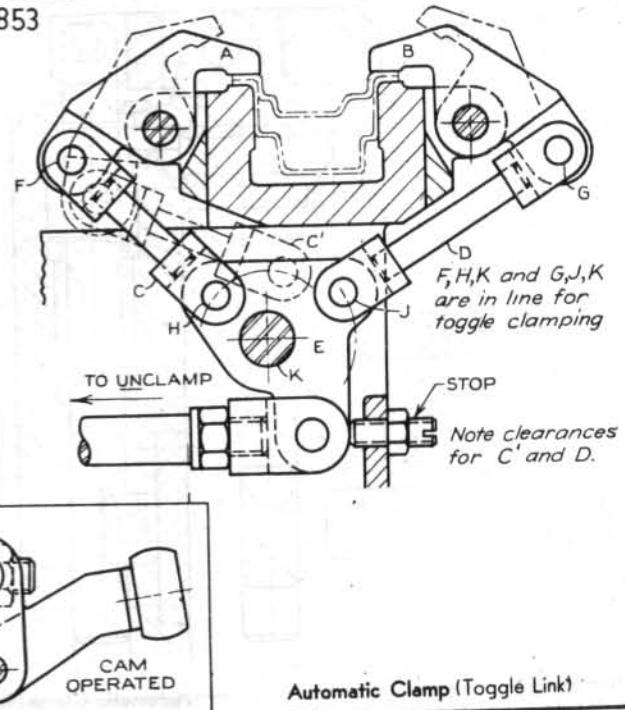
Automatic Clamp (Spring-Loaded Toggle Link)

852

A cam holds the toggle link in clamping position until the unclamping action begins. The two spring-loaded buttons prevent overclamping.

Automatic Clamp
(Spring-Loaded Toggle Link)

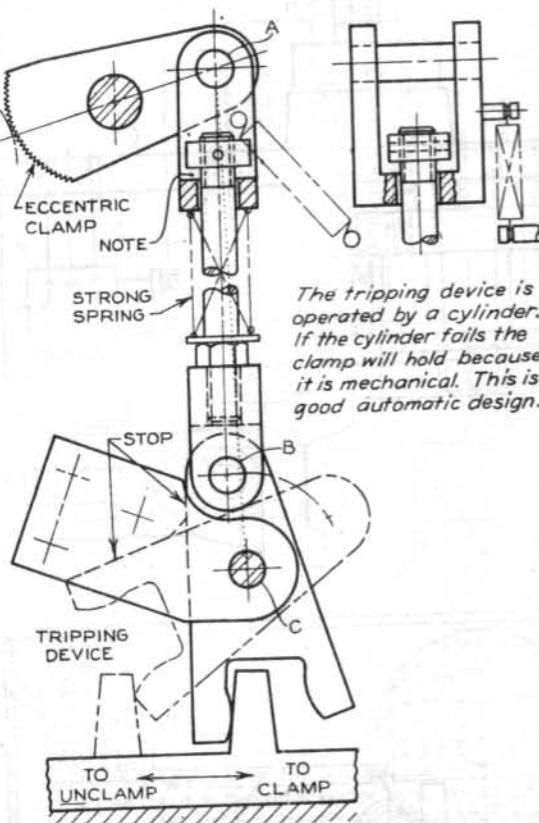
853



Automatic Clamp (Toggle Link)

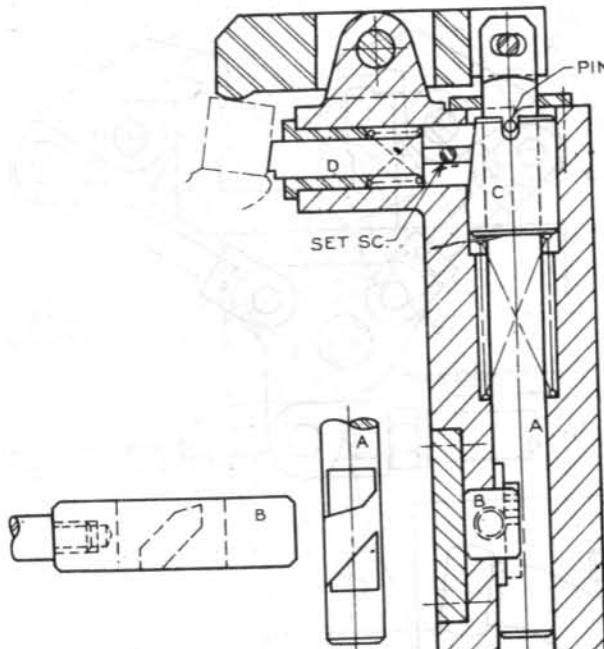
854-856

854



The tripping device is operated by a cylinder. If the cylinder fails the clamp will hold because it is mechanical. This is good automatic design.

856

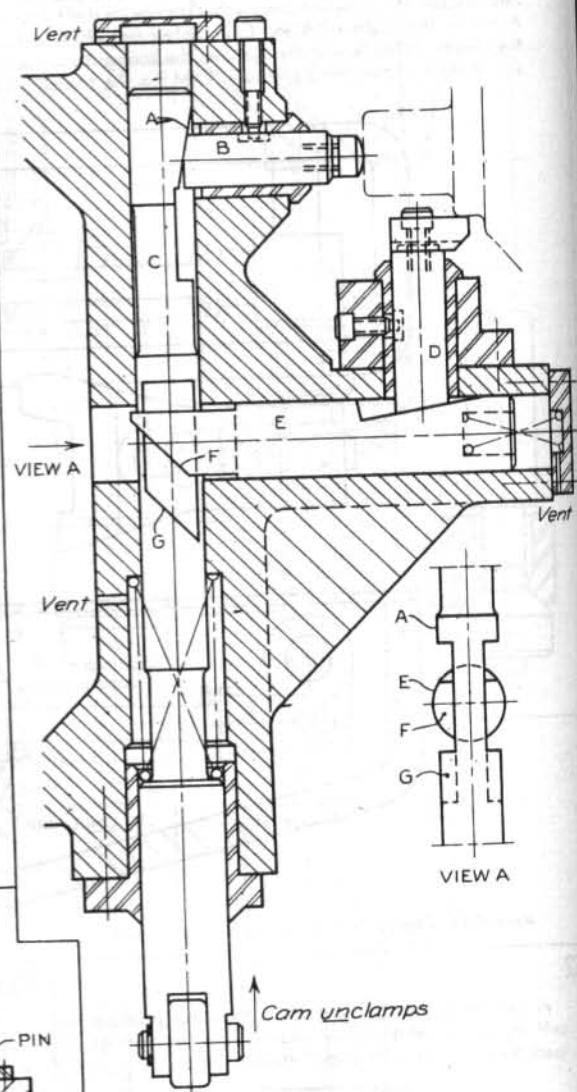


Automatic Clamp (Double Jack)

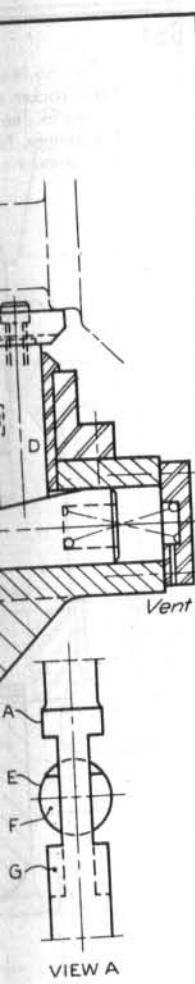
Wedge cam B raises and its small clear $\frac{1}{2}$ angle locks clamp post A. Spring-loaded cam C actuates and locks pusher D. The pin limits the upward movement of A and prevents C from turning.

Automatic Clamp (Toe and Pusher)

855



Automatic Clamp (Toe and Pusher)

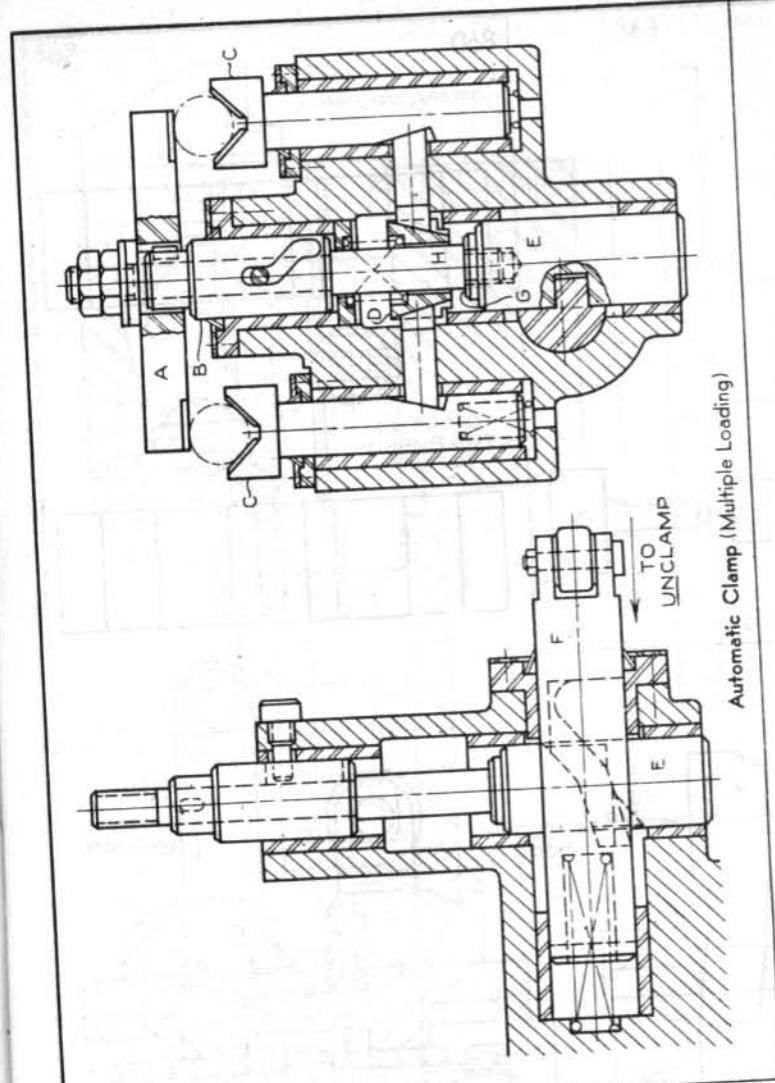


mps

on, cam A of post C while E raises and locks operation. A moves up, cam G forces F of E to air vents.

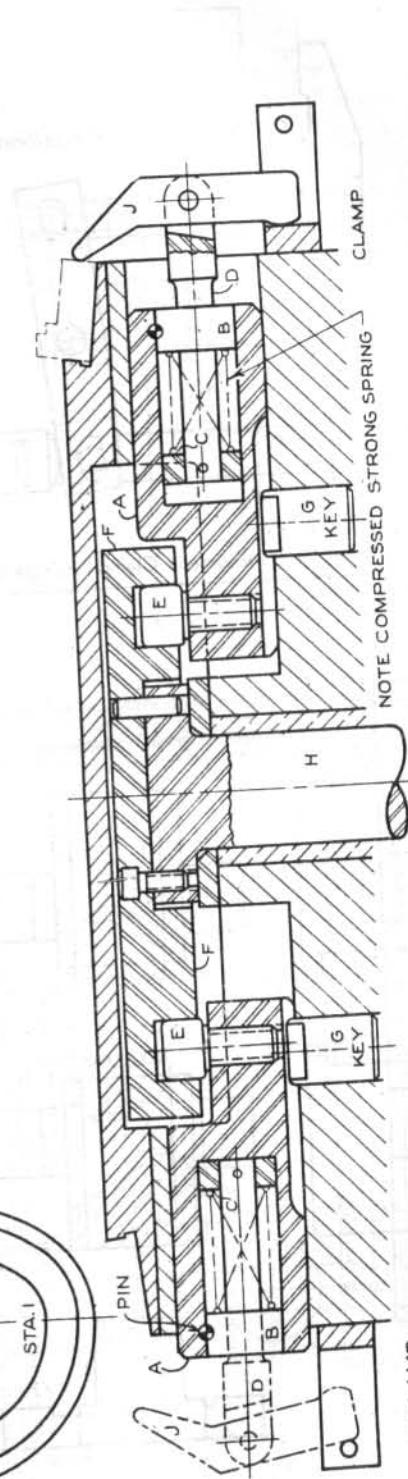
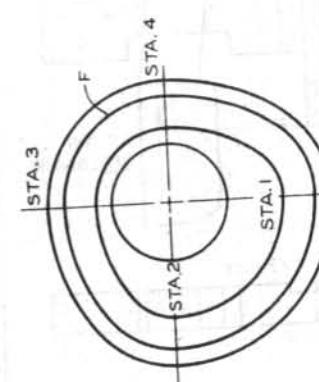
o (Double Jack)

and its small clear p angle
ng-loaded cam C ac-
The pin limits the up-
revents C from turning.



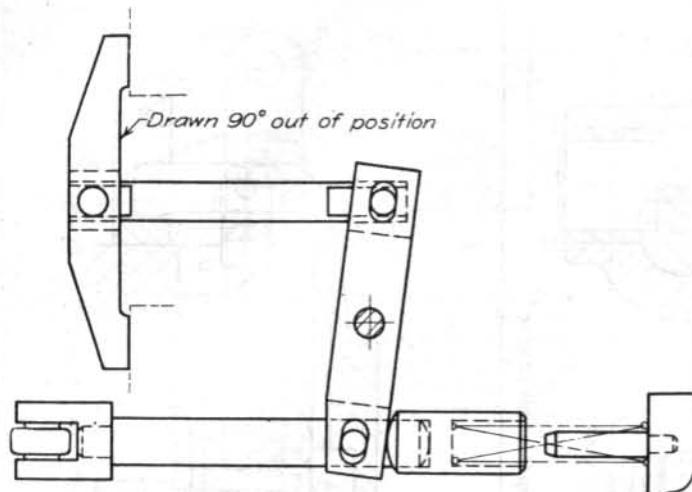
857
As cam F pulls E down, shoulder G frees expander D, enabling the spring to force D to spread the two jaws that lock the two jaws C. As clamp A is rotated into clamping position by B, it is pulled down by E and bolt H to clamp two parts.

858
This fixture is designed to machine two parts simultaneously. Followers E move A move inward as cam F is rotated by H. Clamp J is tightened after it contacts the part by pressure created by compressing the strong spring. Stations 1 and 2 are loading stations; stations 3 and 4 are machining stations. Key G keeps A from turning. B is pinned to A.



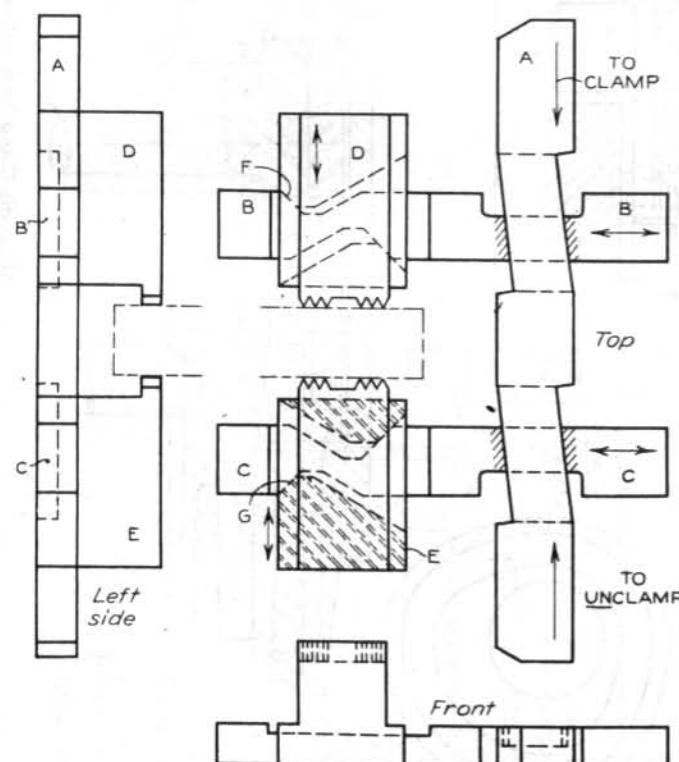
Automatic Clamp (Multiple Loading)

859



Automatic Clamp (Multiple Loading)

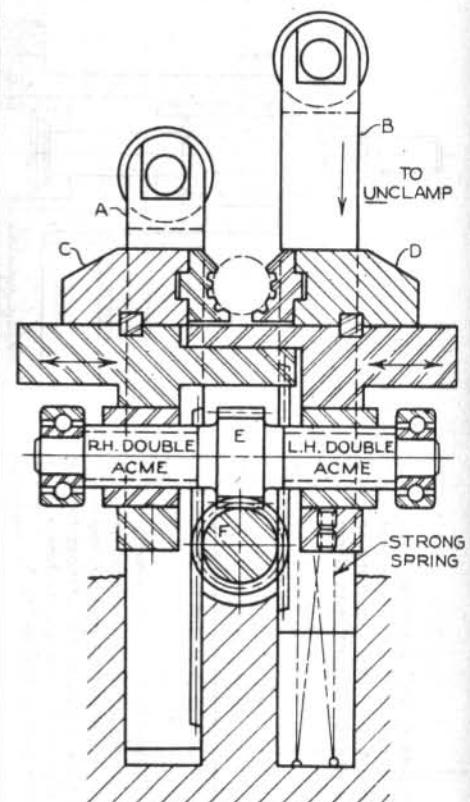
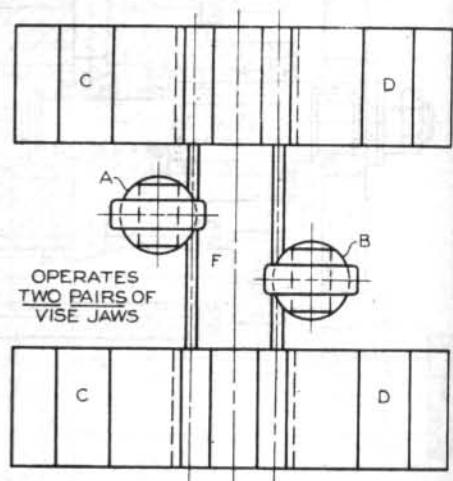
861



Cam A actuates and locks cams B and C, which, in turn, actuate jaws D and E. F and G are retracting cams for D and E.

Automatic Clamp (Vise Type)

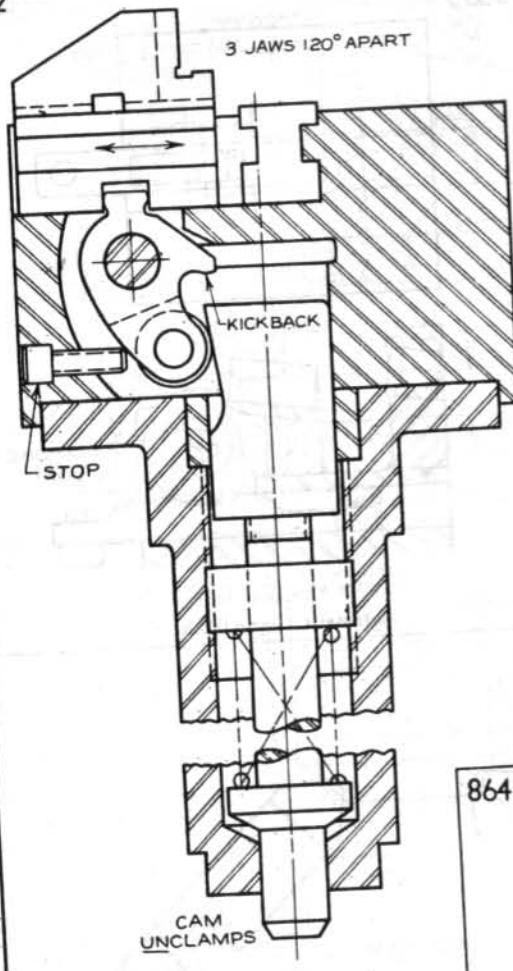
860



Ram A rotates pinion F, which forces the two gears E and the acme threads to actuate the two pair of vise jaws horizontally. Ram B reverses this action. Because B is spring-loaded, it prevents vibration from causing unclamping action.

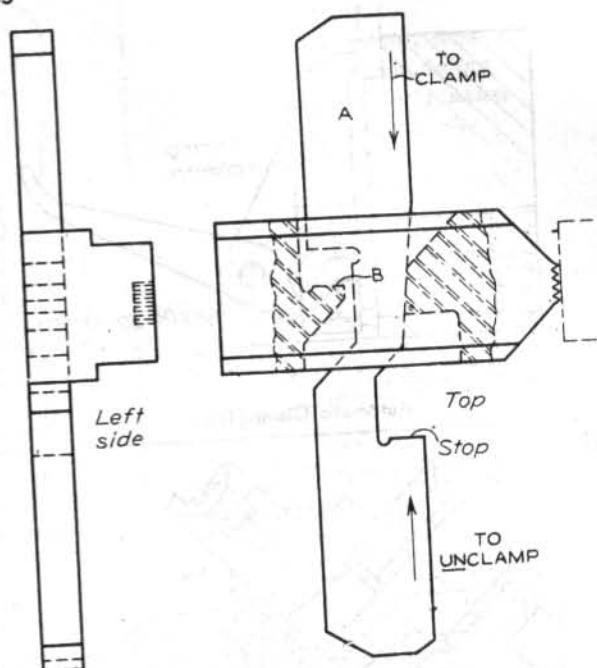
Automatic Clamp (Vise Type)

862



Automatic Clamp (Vise Type)

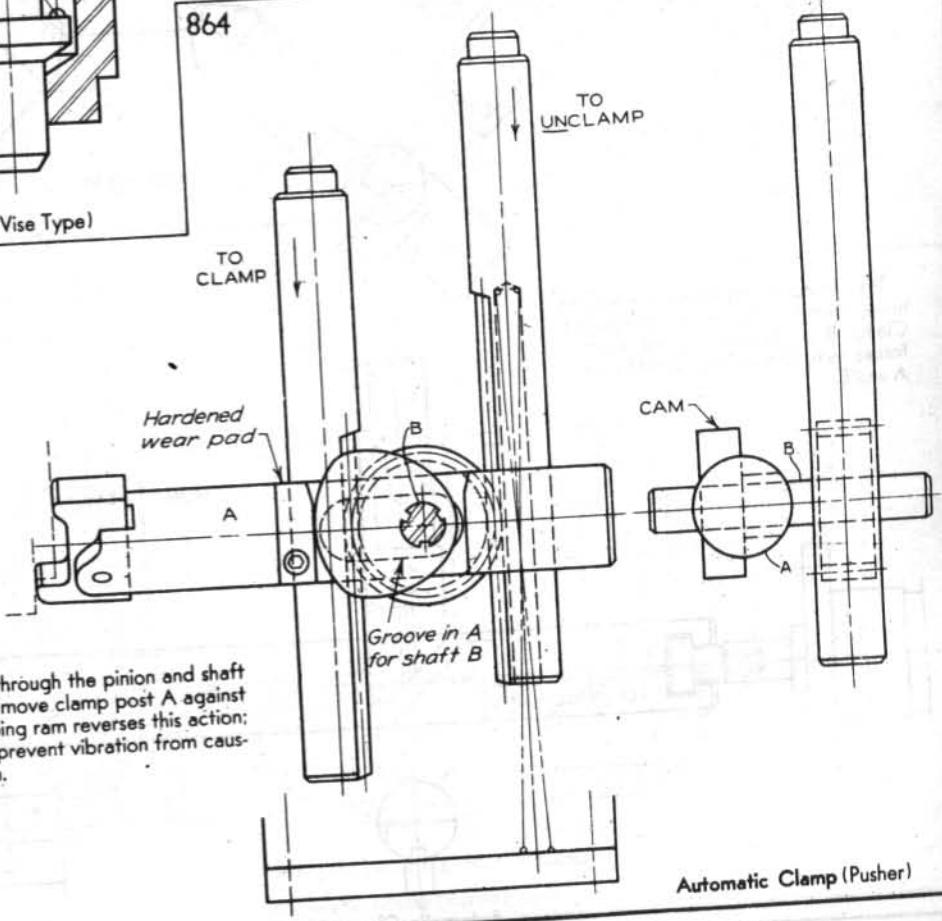
863



B stops cam A when there is no part in the fixture.

Automatic Clamp (Pusher)

864

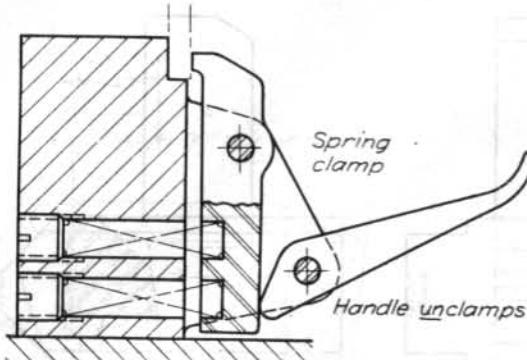


on F, which forces the
Acme threads to actuate
jaws horizontally. Ram B
Because B is spring-
vibration from causing

on F, which forces the
Acme threads to actuate
jaws horizontally. Ram B
Because B is spring-
vibration from causing

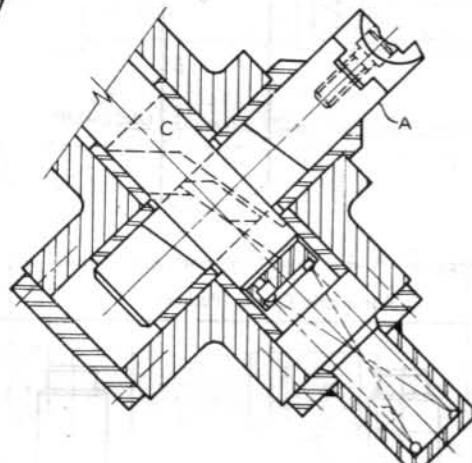
amp (Vise Type)

865

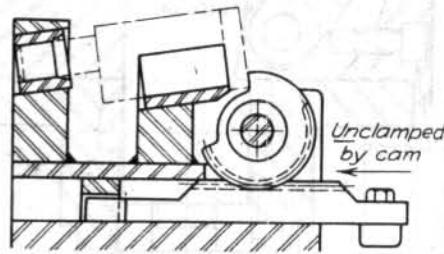
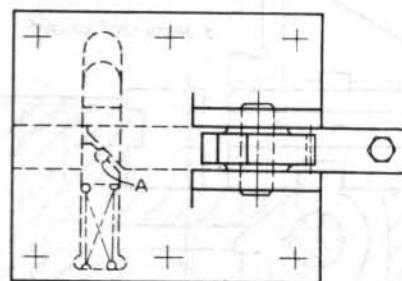


Automatic Clamp (Toe)

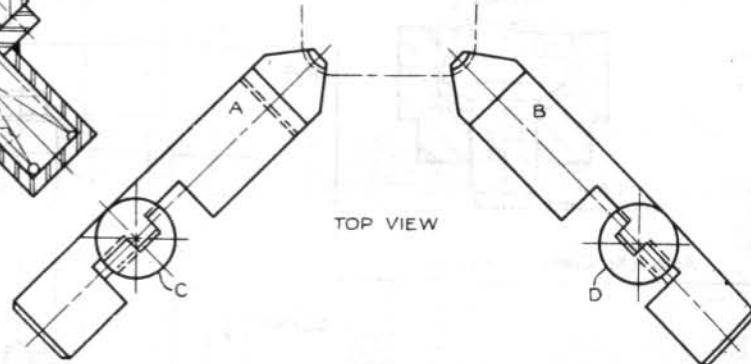
867

Pin A reduces friction.
Automatic Clamp (Pusher)

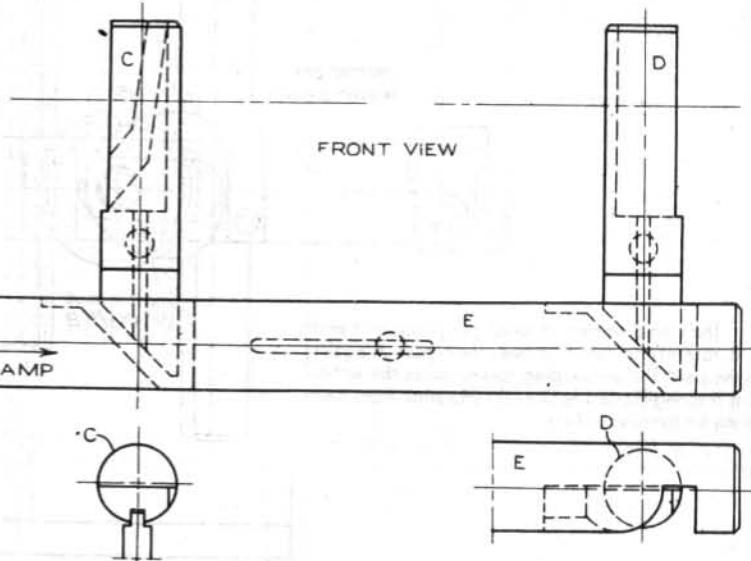
866



The strong spring forces cam C to move clamp A to clamping position. Clamp B is similarly moved. Cam E forces cams C and D to retract clamps A and B.



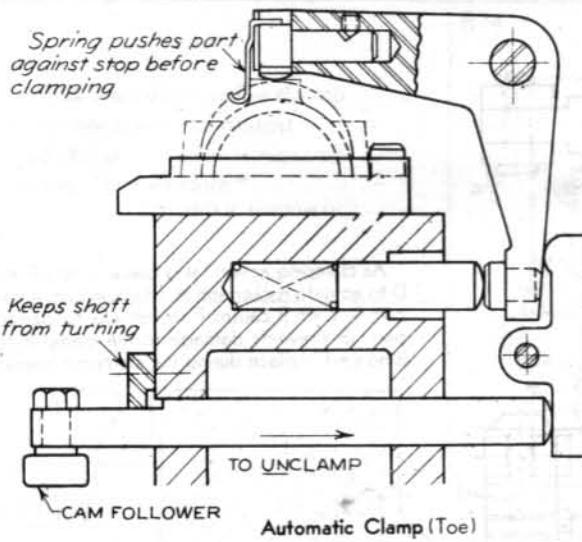
TOP VIEW



FRONT VIEW

Automatic Clamp (Pusher)

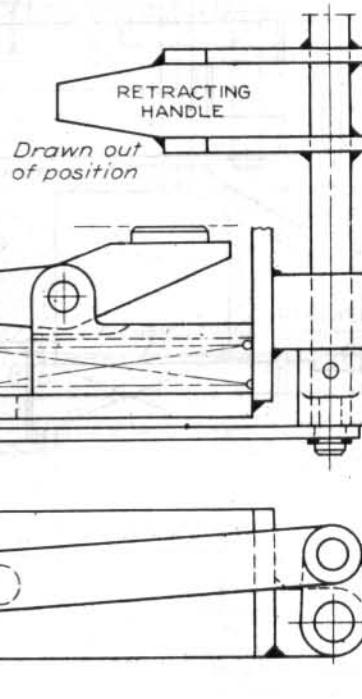
868



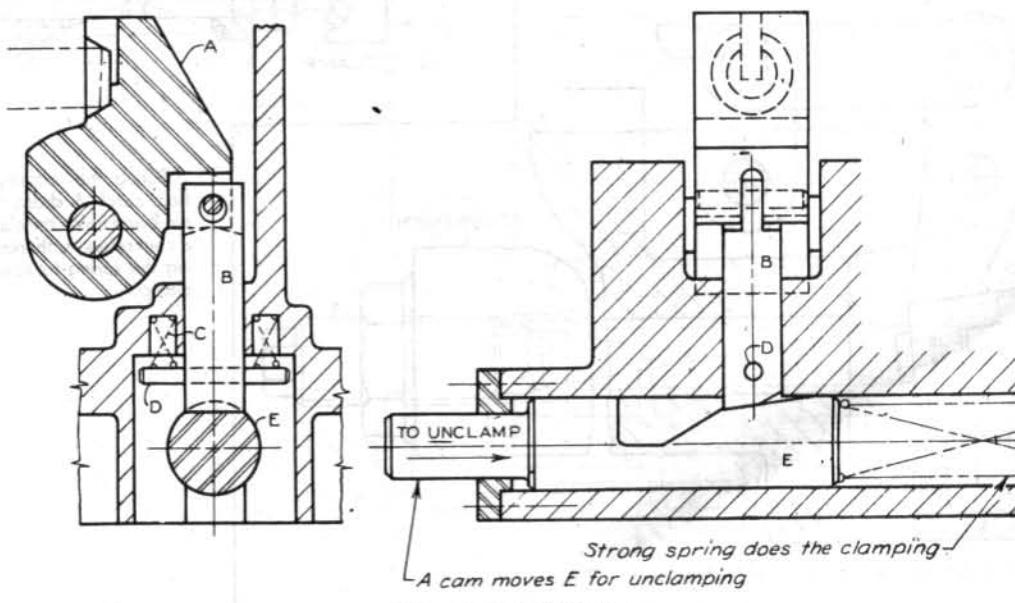
"There is nothing more disappointing than failing to accomplish a thing, unless it is to see somebody else accomplish it."

HENRY S. HASKINS

869

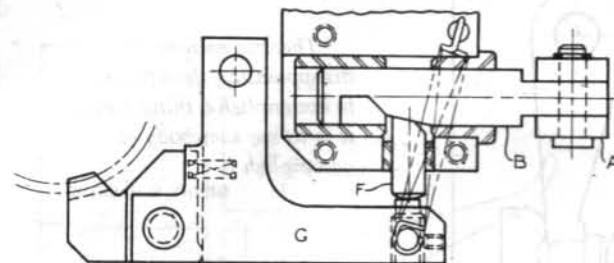


870

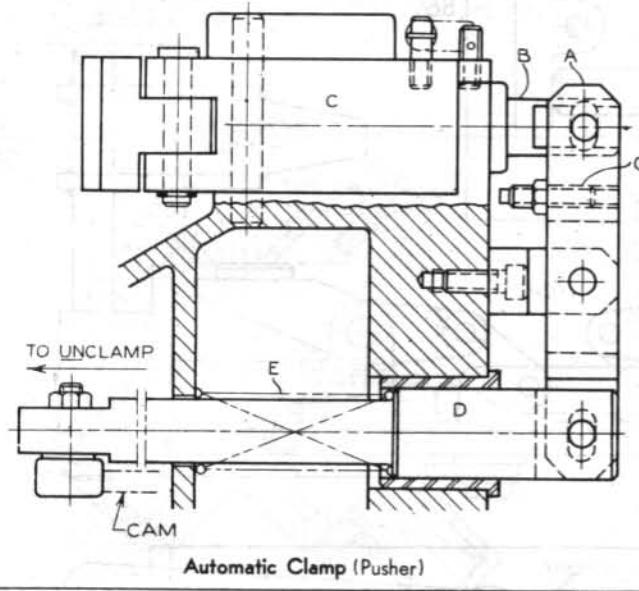


871-873

871

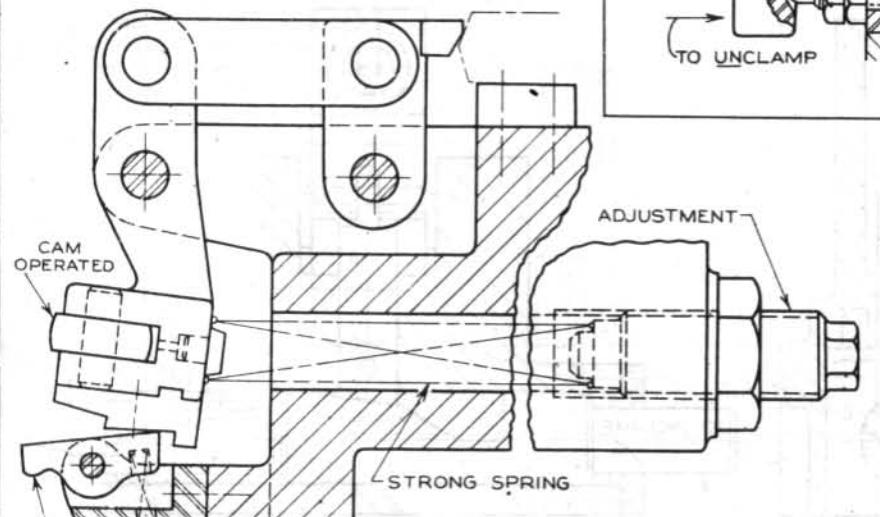


As clamping action takes place, spring E moves D to actuate rocker arm A, which, in turn, actuates cam B. Cam B causes F to force C to clamp the part. G prevents damage to the clamp if there is no part in place during the clamping operation.



Automatic Clamp (Pusher)

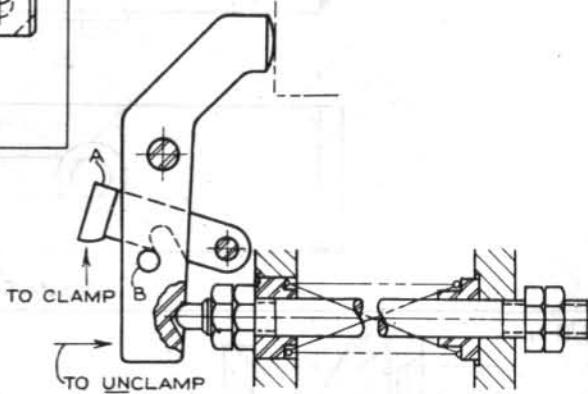
873



Catch holds clamp open until tripped

Automatic Clamp (Pusher)

872



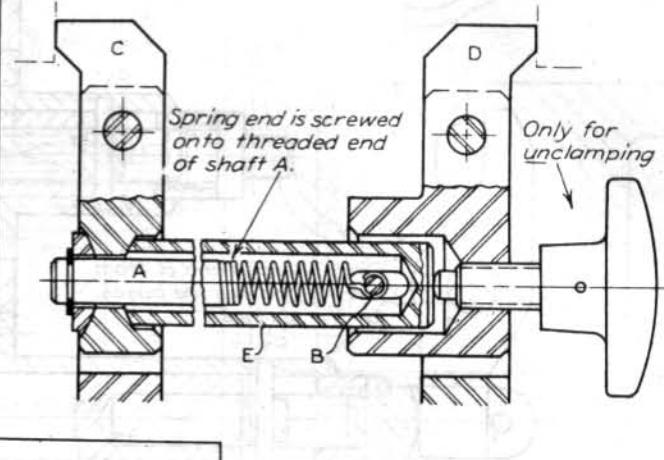
During the unclamping action, catch A drops to catch pin B and holds the clamp until a cam raises A, thereby allowing the spring to actuate the clamp.

Automatic Clamp (Toe)

*"The man who reaches the top
is the one who is not content
with doing just what is required
of him. He does more."*

EDWARD H. HARRIMAN

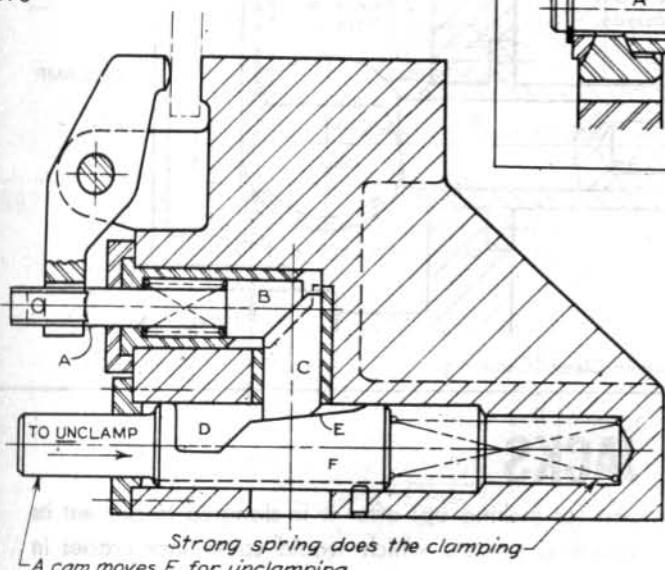
874



The spring clamps C through its pull on A and clamps D through its pull on pin B, which is pinned to D. Unclamping sleeve E has a slot to accommodate pin B.

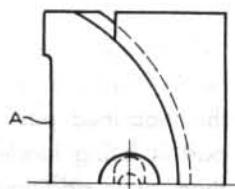
Automatic Clamp (Centering)

875

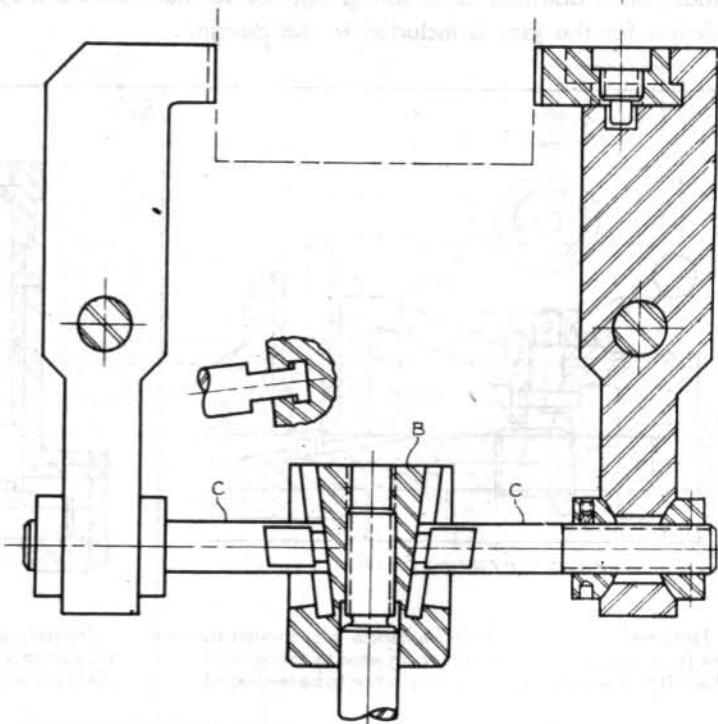


Automatic Clamp (Toe)

876

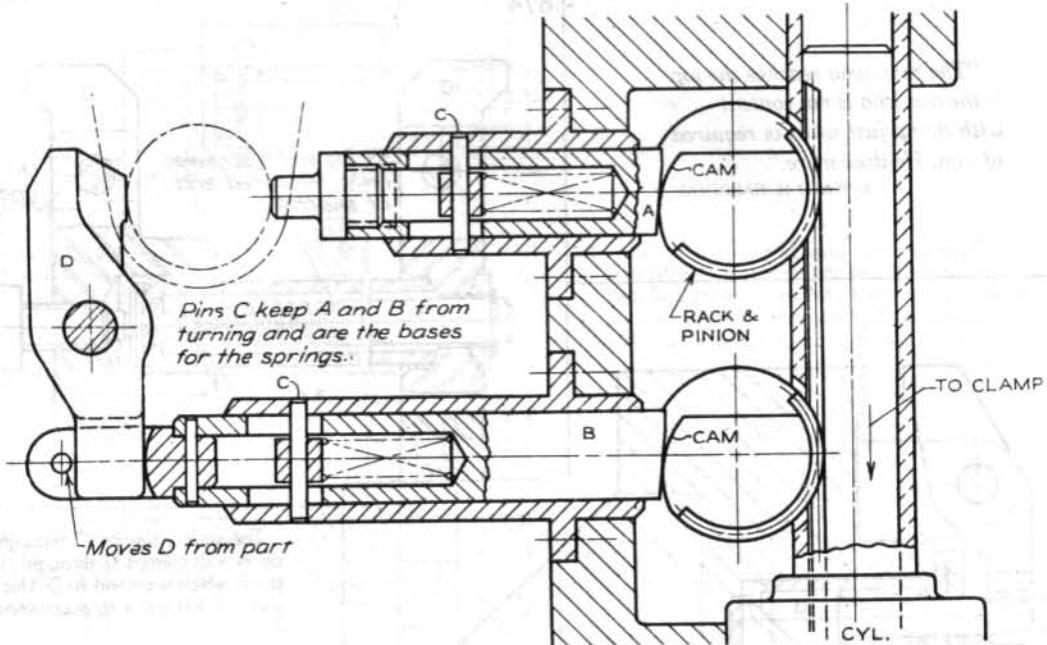


The two T-slot cams of B move the rods C that actuate the clamps. The 7° angle of the cams locks the clamps. Note the design of equalizer A.



Automatic Clamp (Centering)

877

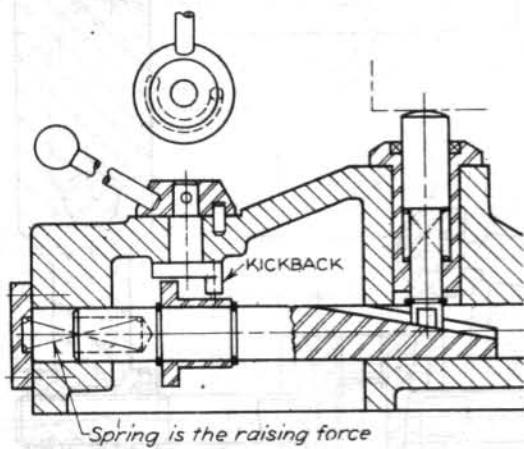


880

JACKS

In many instances a part requires support (or jacking up) after it is clamped to prevent its being distorted or vibrated during the machining process which would cause inaccuracies in the machined part. Often a jack is designed to function as a spring-loaded button while the part is being loaded and as a jack after the part is clamped. Some jacks have force other than, or in addition to, a spring applied to them before they are locked. Usually a retracting device for the jack is included in the design.

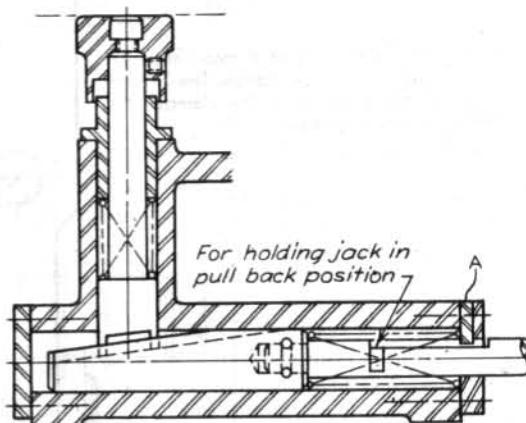
878



Note how the movement of the handle is controlled by the pin in a groove. If the kickback pin were to rotate more than 180°, it would permit clamping action to be reinitiated.

Jack

879



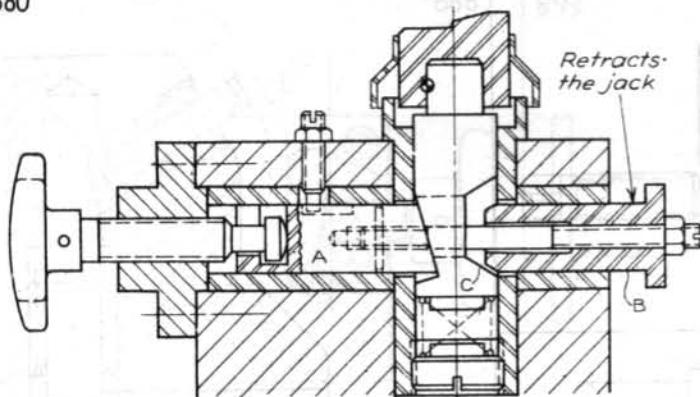
The flats on opposite sides of the jack post fit in a groove in the cam to prevent the jack post from turning. After the handle is pulled back and turned, it catches on A as indicated.

Jack

882

883

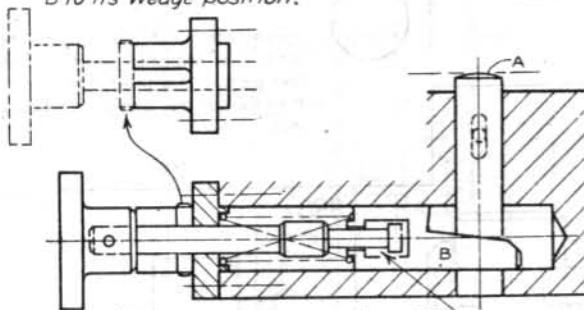
880



As lock A is retracted, B actuates C to lower the jack.
Jack

882

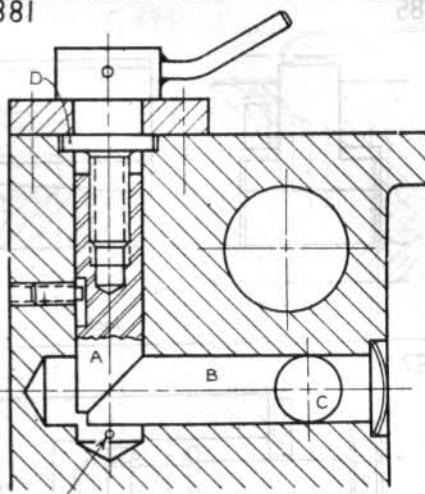
Pull outward on handle and turn to hold B in unclamp position. Release and spring will snap B to its wedge position.



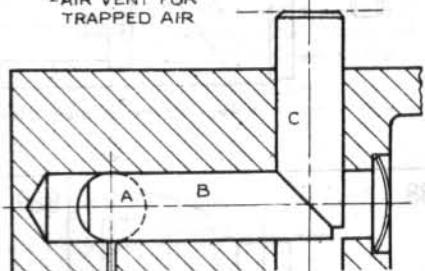
This allows shock unclamping of B

Jack

881



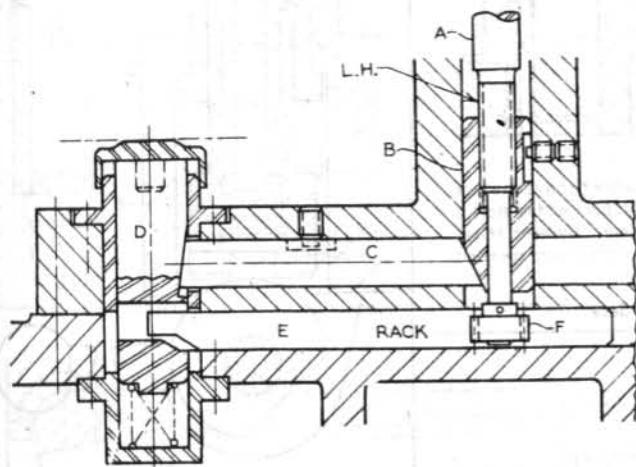
AIR VENT FOR TRAPPED AIR



Sometimes it is inconvenient to jack a part directly. Because jack post C and cam A are necessarily offset, an intermediate cam B is needed. Axial movement of the screw is prevented by D.

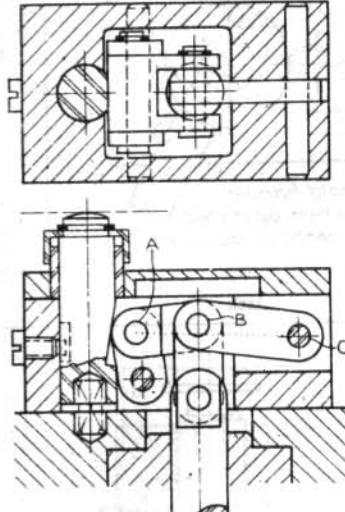
Jack

883



Jack

884

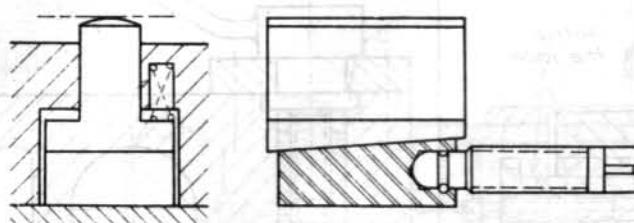


A Toggle Linkage Lock

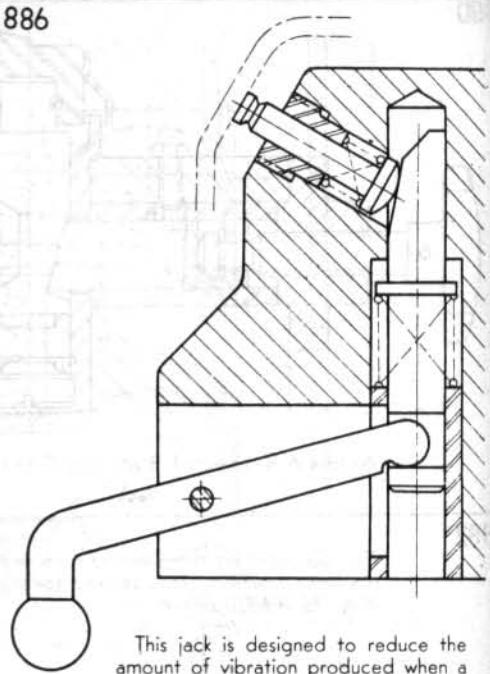
Jack

As A is rotated counterclockwise, B raises, freeing lock C, and pinion F moves rack E to retract jack D.

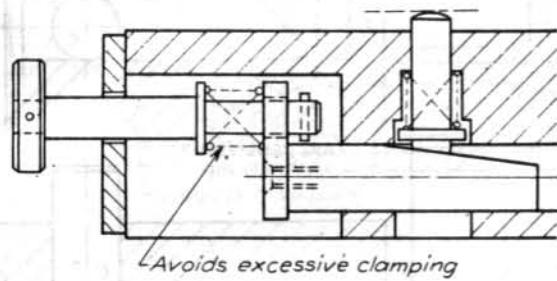
885



886

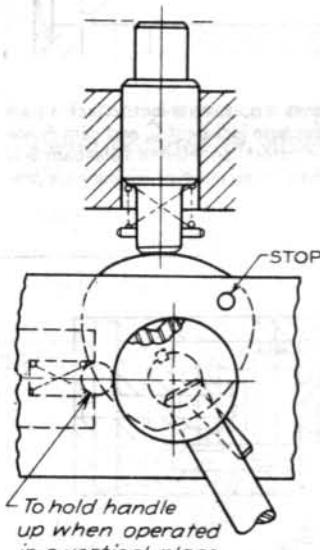


887



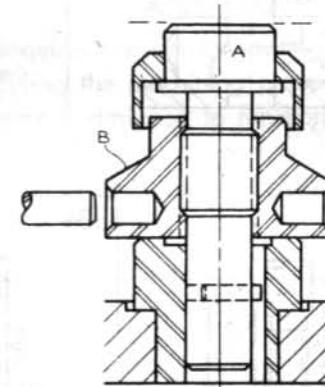
Jack

888



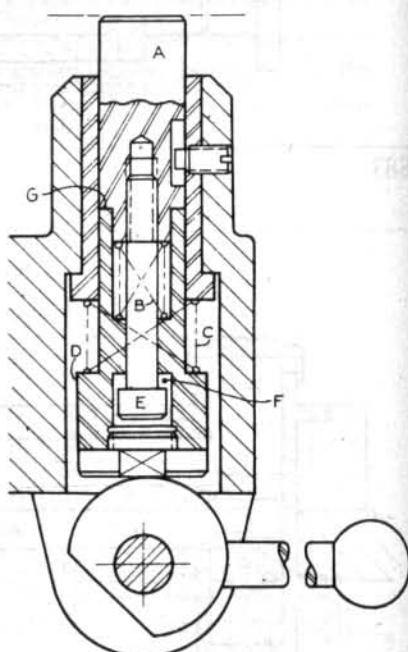
Jack

889



Jack

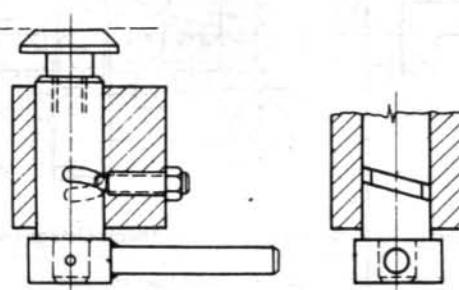
890



Before jack post A is clamped by the cam, spring C lowers D, and spring B raises A, allowing A to act as a spring-loaded button. As jack post A is clamped, the cam raises D, which, in turn, forces A at shoulder G to rigidly support the part.

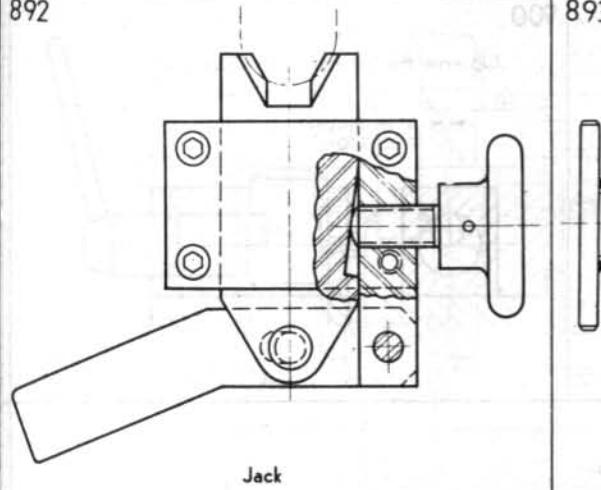
Jack

891



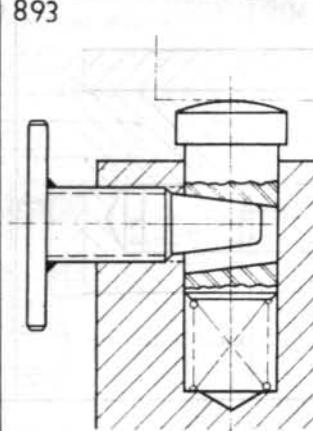
Jack

892



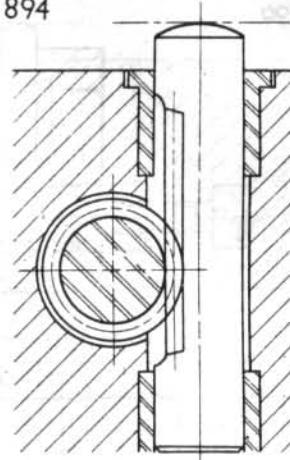
Jack

893



Jack

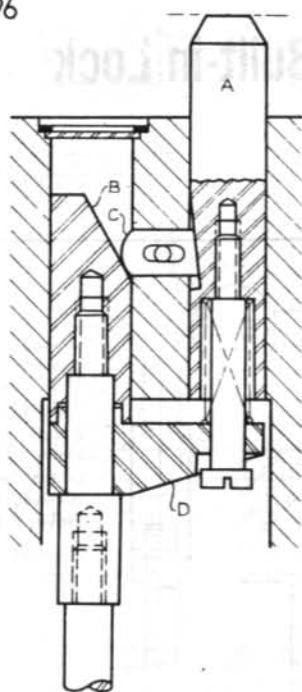
894



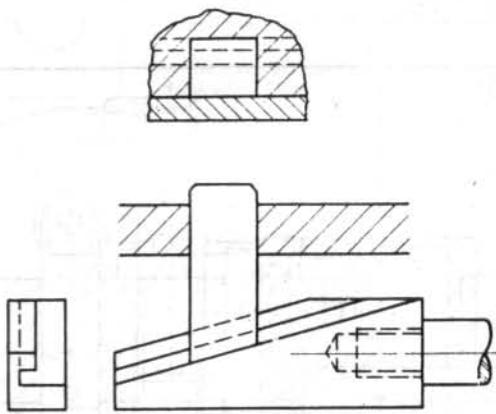
Frequently a jack is operated by a rack and a pinion and sometimes several such jacks use the same power source.

Jack

896



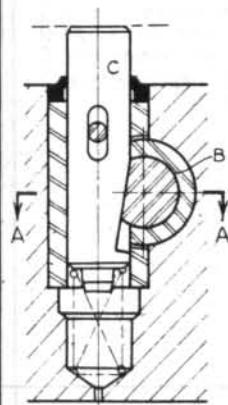
897



This design illustrates L-slot movement of a jack post.

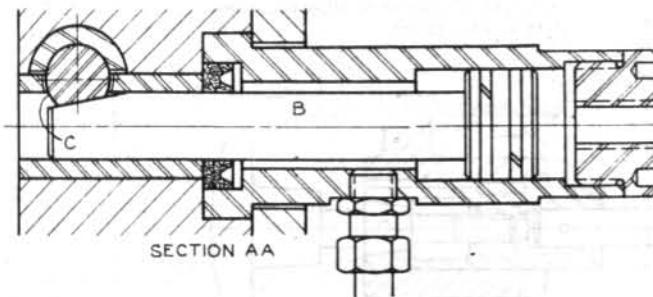
Jack

895



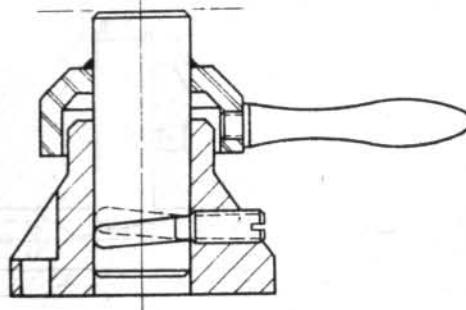
Cam B forces lock C to lock jack post A. Later D retracts the spring-loaded jack.

Jack



Jack

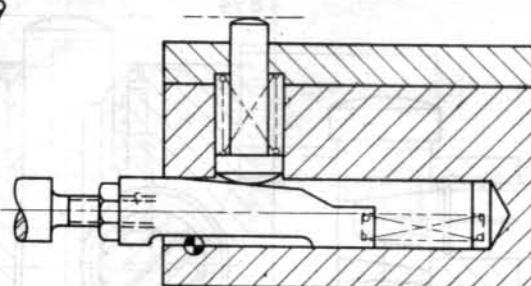
898



Jack

899-902

899

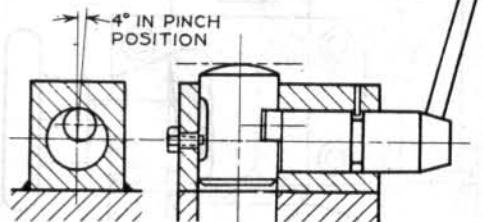


Note the use of the pin and the flat to keep the cam from turning.

Jack

900

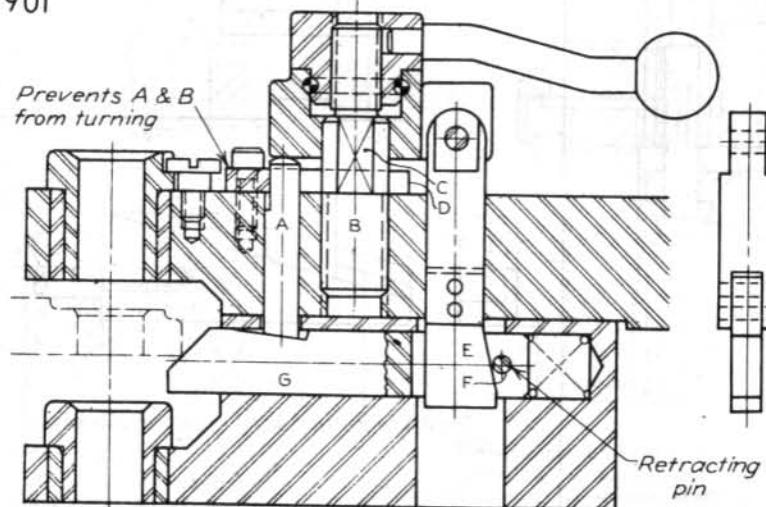
Observe the eccentric cam jacking force.



Jack

Jacks with Built-in Lock

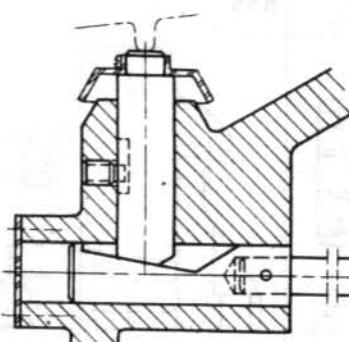
901



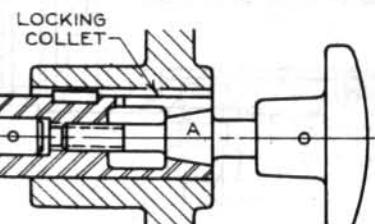
Flats C prevent screw B, which fits into a slot of D, from turning. Lock A is clamped by the handle. The two dowel pins allow the handle to rotate. After E is raised in the unclamping operation, it strikes F and retracts G.

Jack with Built-in Lock

902

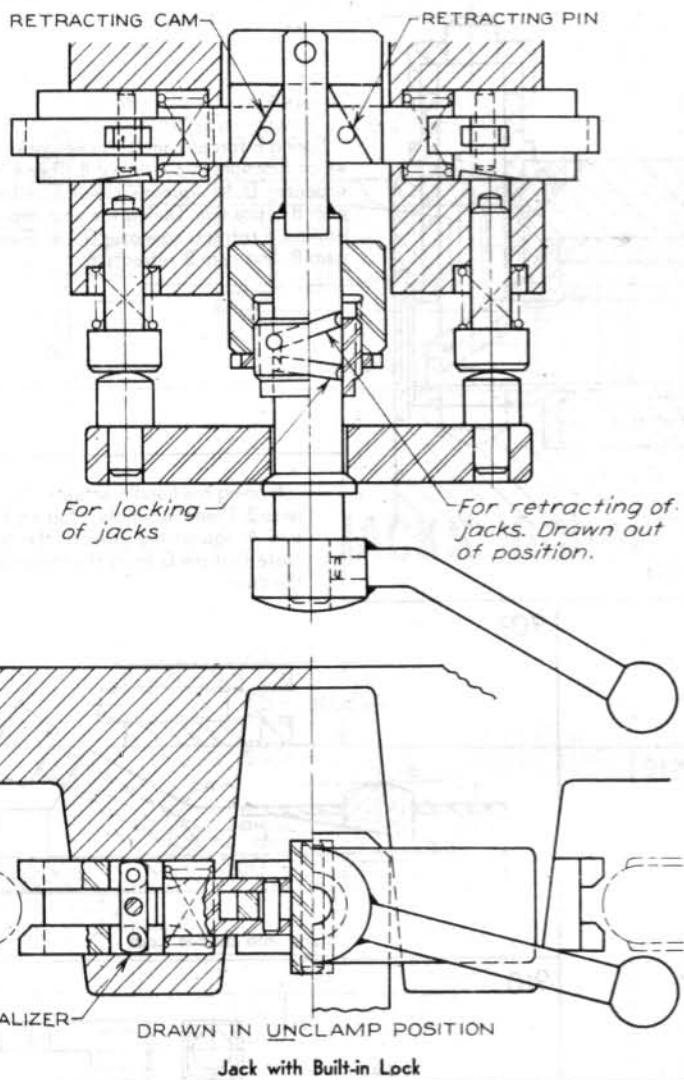


After the handle is pulled to raise the jack post, it is turned to allow expander A to lock the collet.

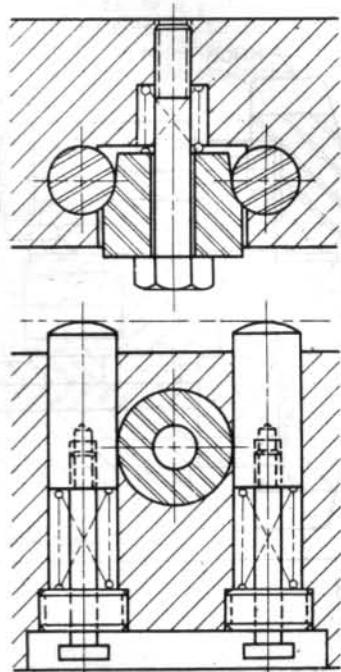


Jack with Built-in Lock

903

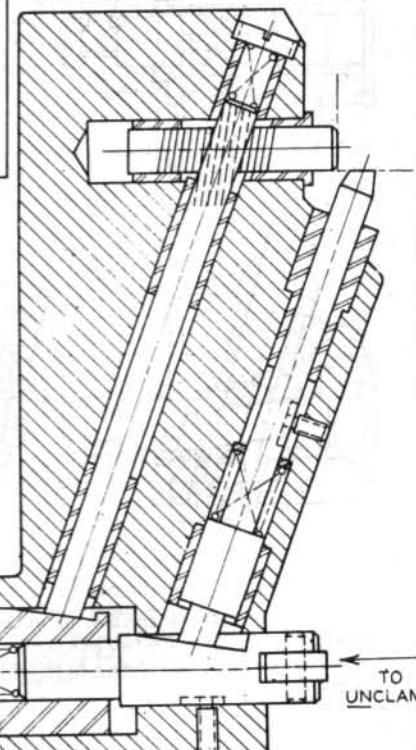


904

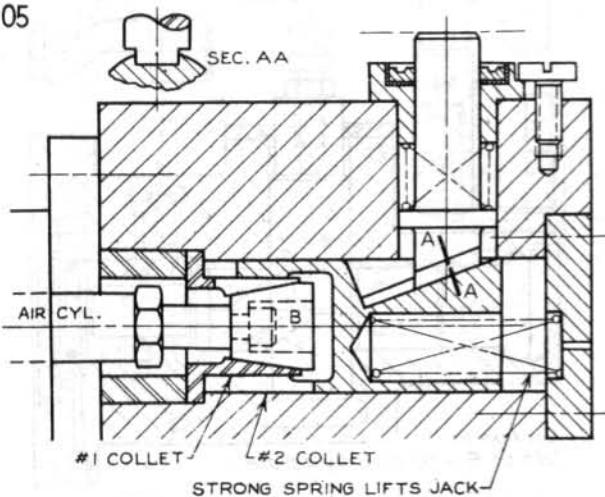


Jack with Built-in Lock

Each of the two springs holds a jack post lock in position.

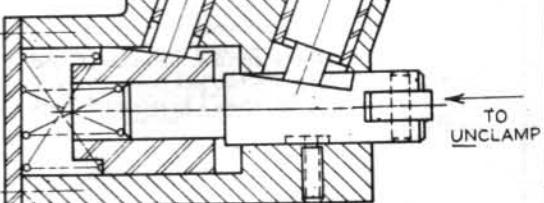


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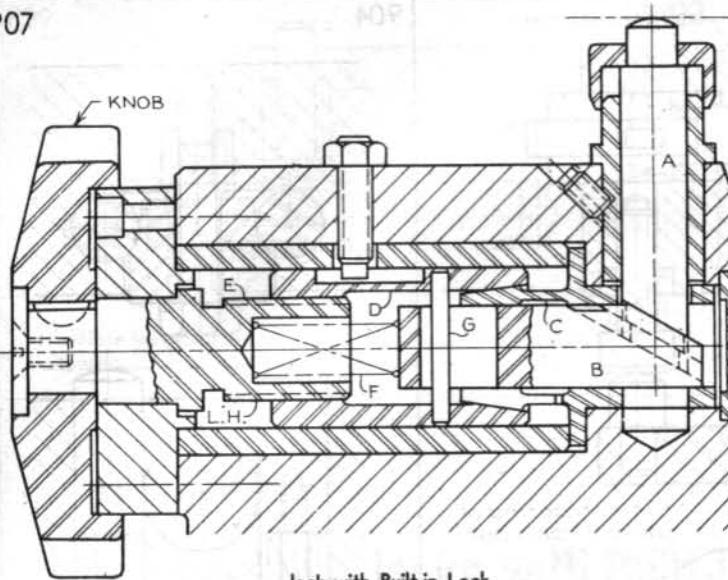
Jack with Built-in Lock

906



Jack with Built-in Lock

907

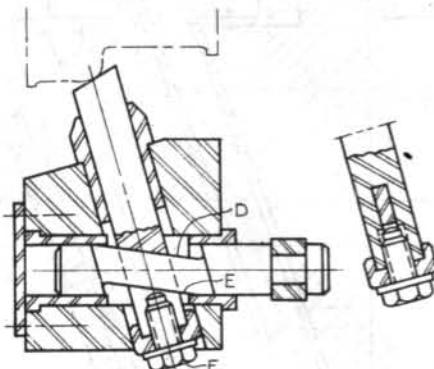
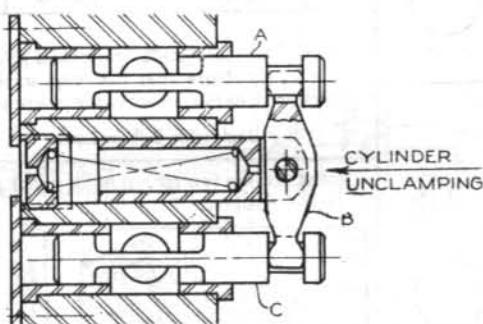


Jack with Built-in Lock

Spring F forces cam B to raise jack post A which functions in a T-slot of B. Then E moves squeezer D to squeeze collet C, clamping cam B in position. During the unclamping operation, E retracts squeezer D, pin G retracts cam B, and cam B retracts A.

Pushing the handle actuates cam C to raise B. Then the handle is turned, locking pins A against the sides of the groove. Note that pin D limits the movement of the cam.

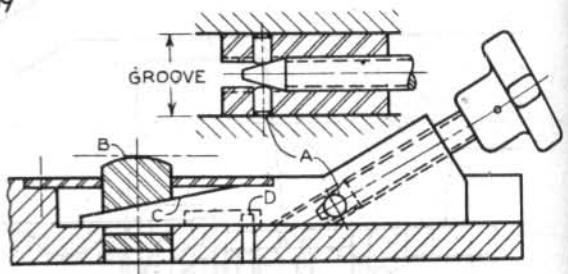
908



Spring-loaded rocker arm B actuates cam C and cam D of A to force the two jack posts into position. Cam E moves cap screw F to retract the jack posts.

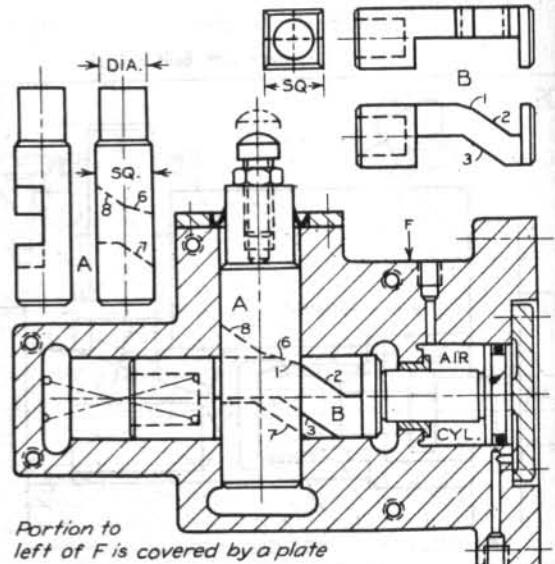
Jack with Built-in Lock

909



Jack with Built-in Lock

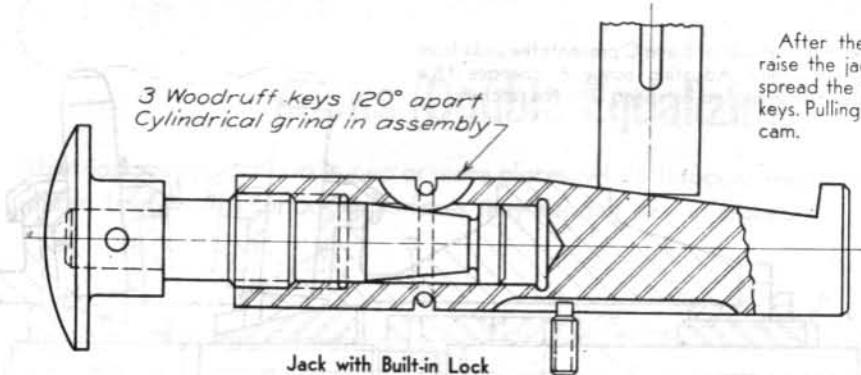
910



The spring holds cam B in locking position until the air cylinder retracts B to the left. Retraction of cam 3 of B pulls down A.

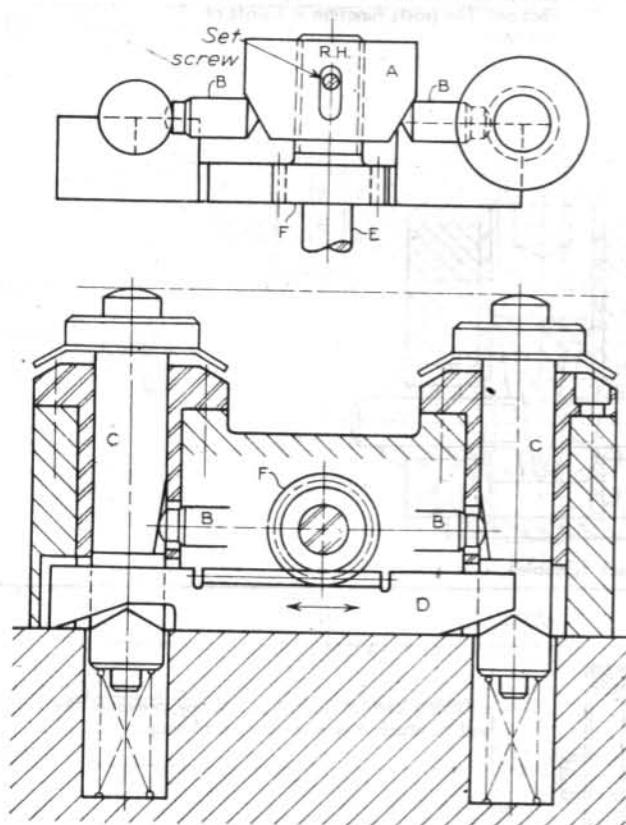
Jack with Built-in Lock

911

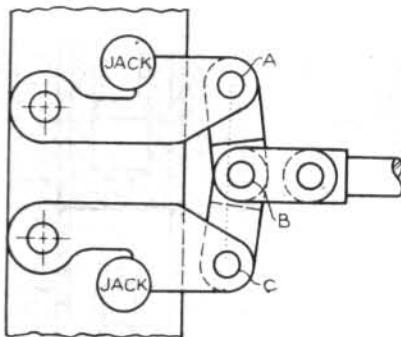


JACKS (DOUBLE)

912



913



Two jack posts are locked simultaneously by an equalizing toggle linkage.

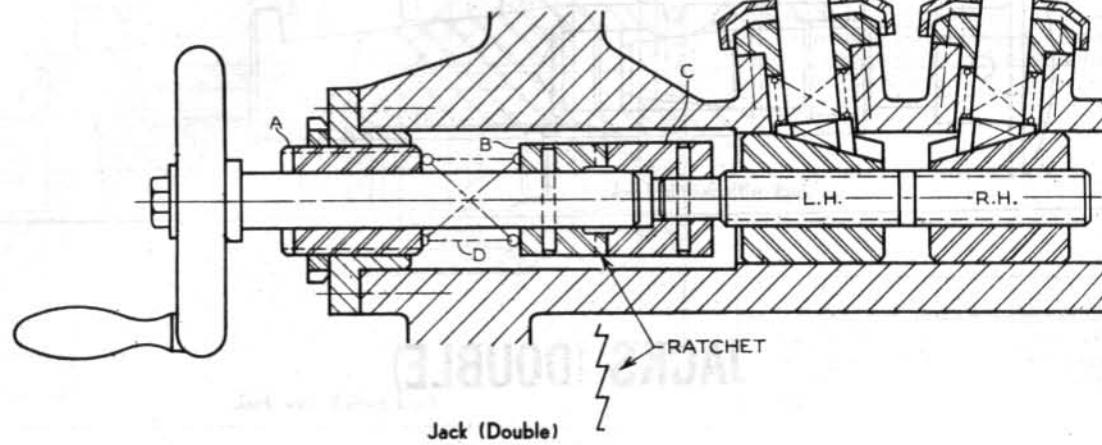
Jack (Double)

As shaft E is turned in the clamping operation, its pinion F moves D via a rack to free the two spring-loaded jack posts C. Then cam A actuates the two locks B to lock the posts. A is prevented from turning by the set screw.

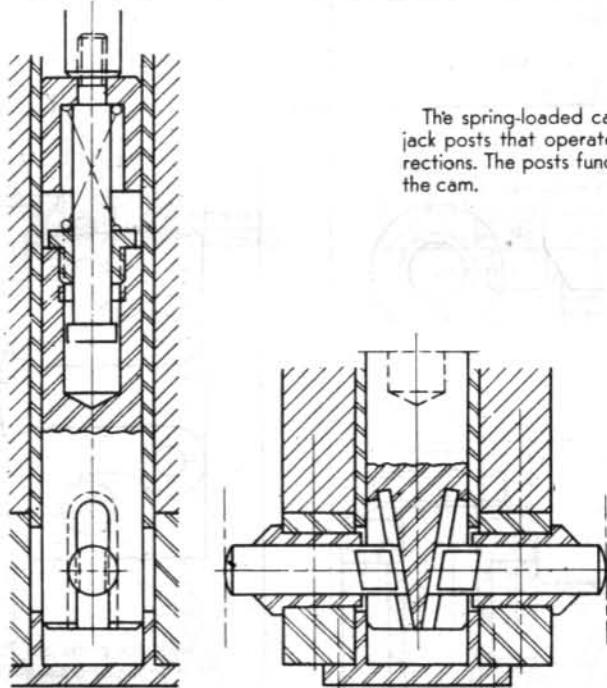
Jack (Double)

914

Slippage of the ratchet of B and C prevents the jacks from becoming overloaded. Adjusting screw A changes the amount of pressure applied by spring D to the ratchet.

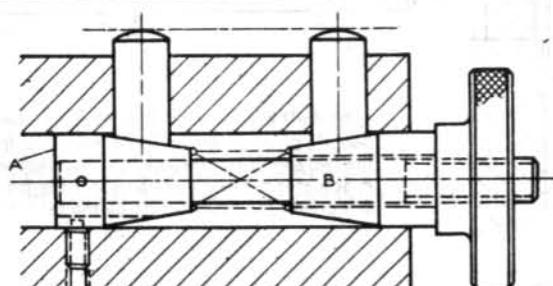


915



The spring-loaded cam locks the two jack posts that operate in opposite directions. The posts function in T-slots of the cam.

916

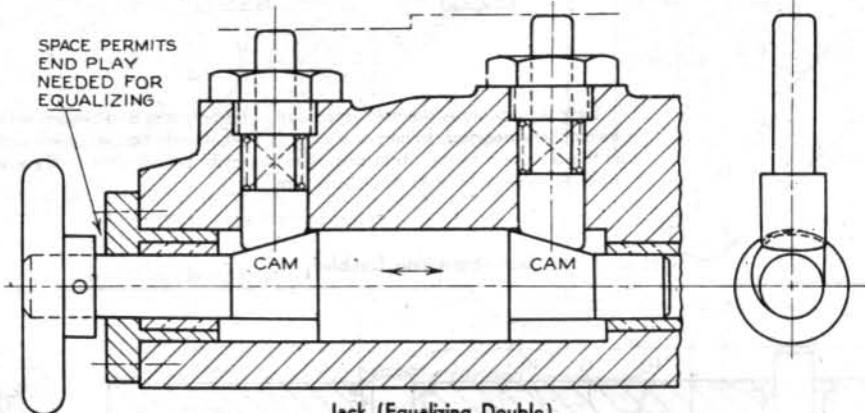


Keying cam A with a set screw prevents the bolt to which A is pinned from turning.

Jacks (Double Equalizing)

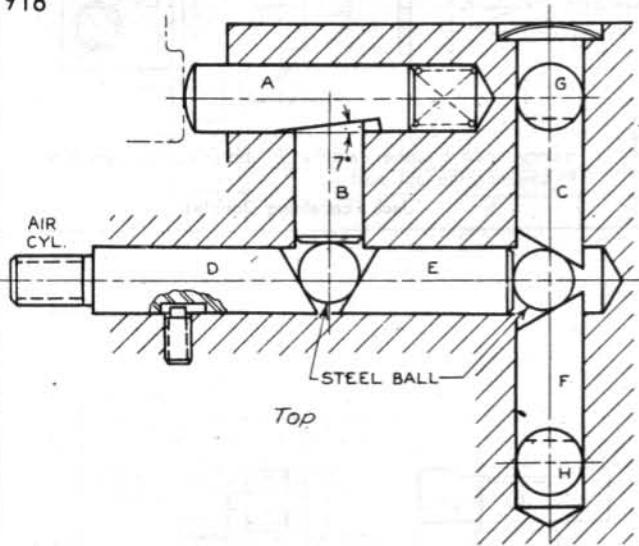
When jacks support a part in two or more places, which happens frequently, the jacks must be equalized because the surface or surfaces they support are unfinished.

917

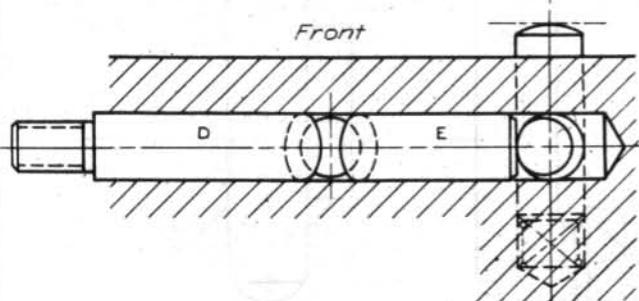


Jack (Equalizing Double)

918

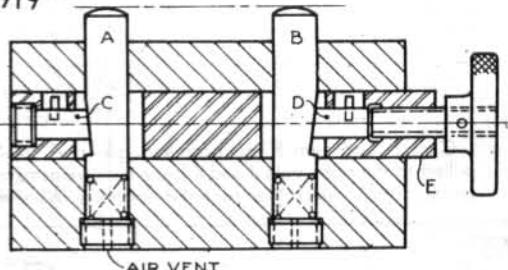


Front



Jack (Equalizing Double)

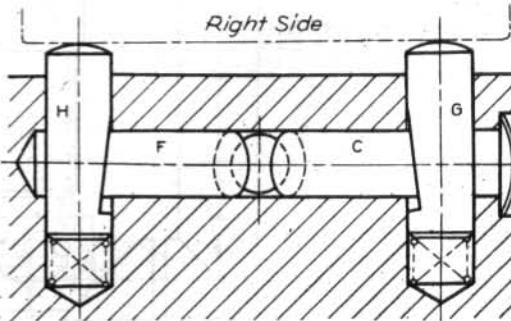
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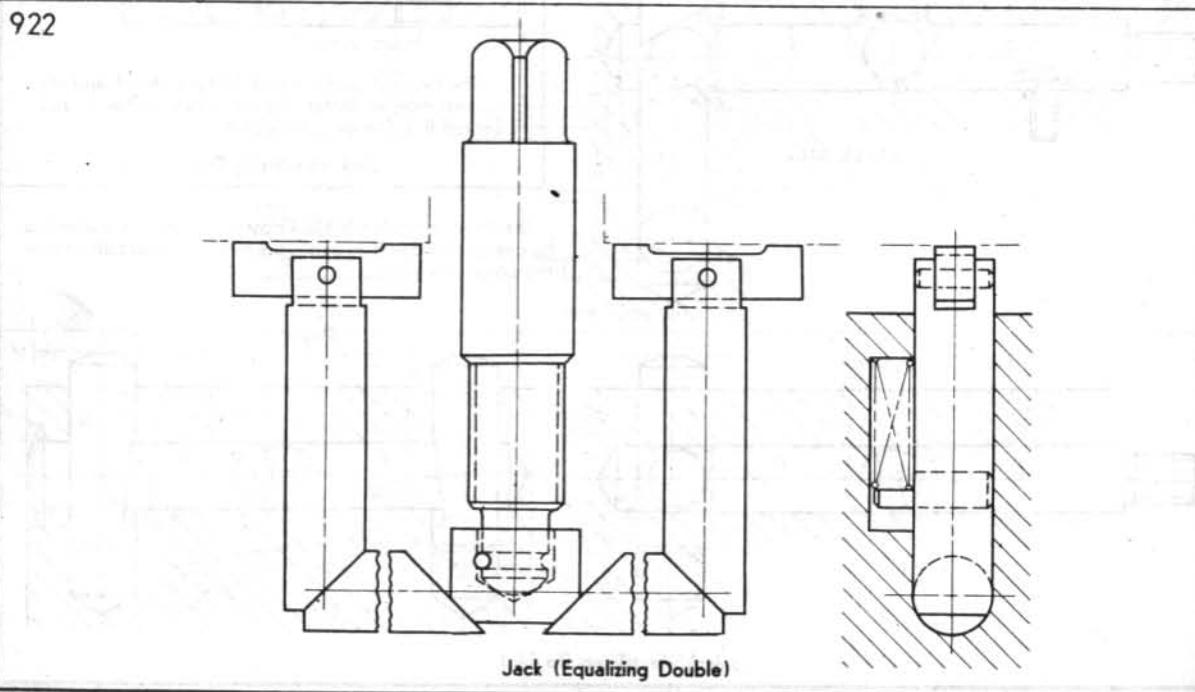
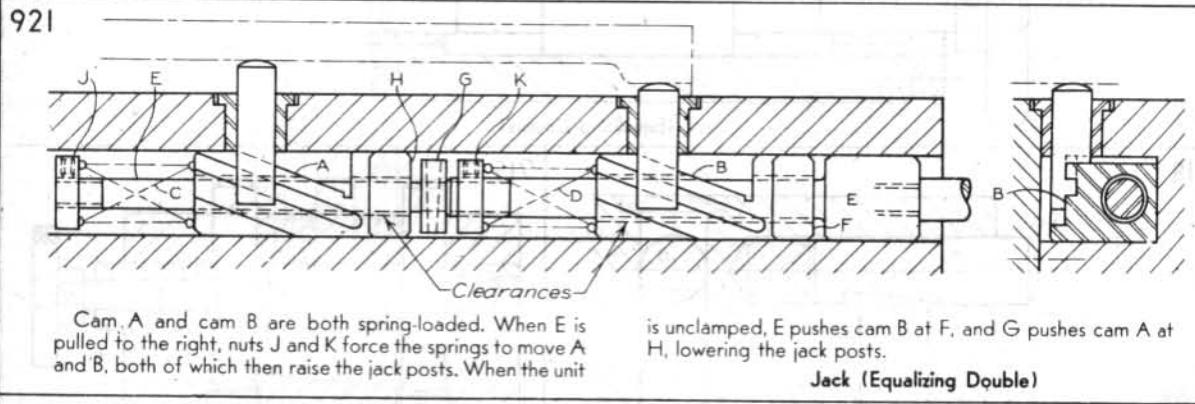
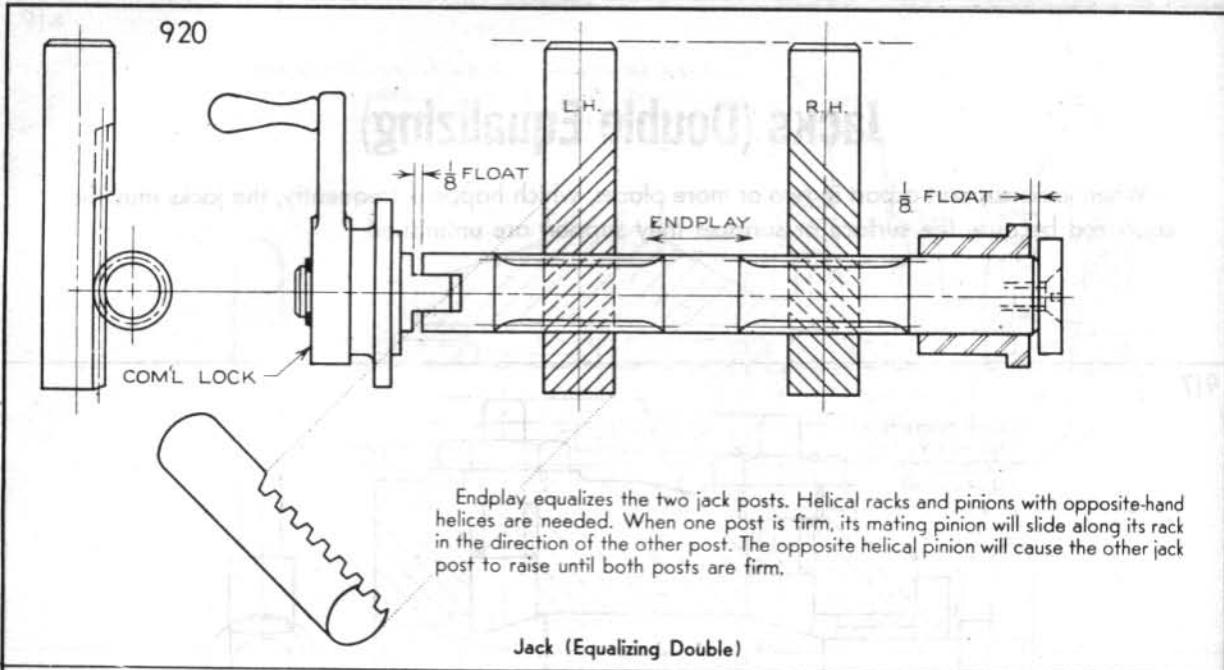


The two jack posts, A and B, fit in slots in E and are locked independently of each other. After D has locked B, E forces C to lock A.

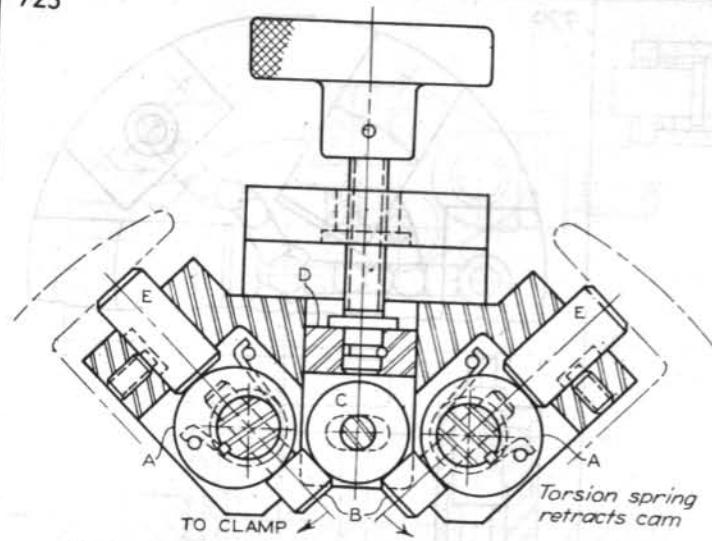
Jack (Equalizing Double)

The three spring-loaded jack posts, A, H, and G, are locked by one air cylinder. B, F, and C are the locks. Two balls create the equalizing action.



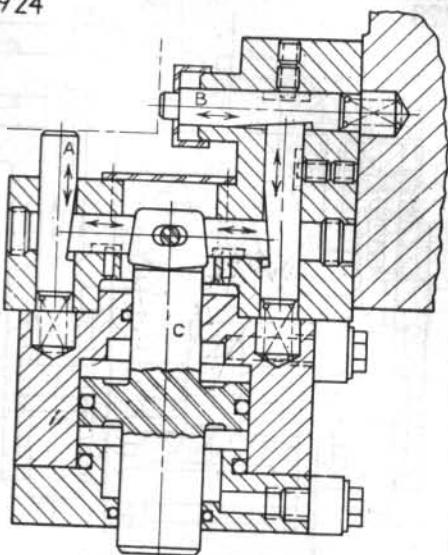


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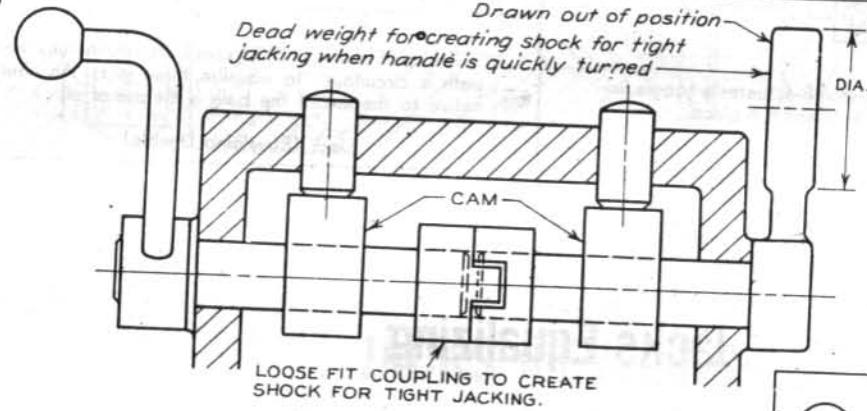
Jack (Equalizing Double)

924



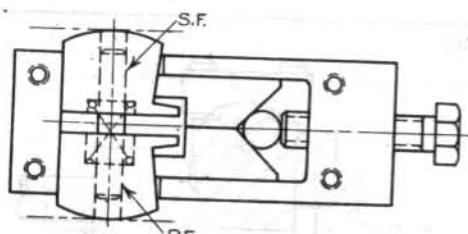
Jack (Equalizing Double)

925



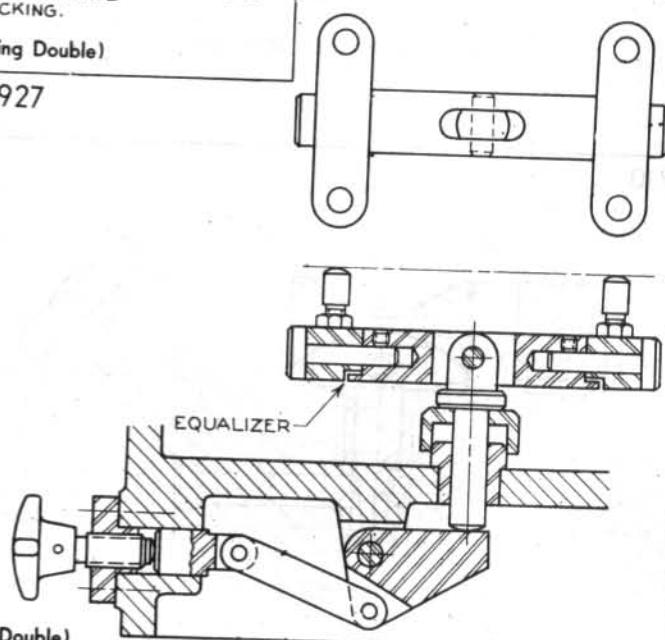
Jack (Equalizing Double)

926



Jack (Equalizing Double)

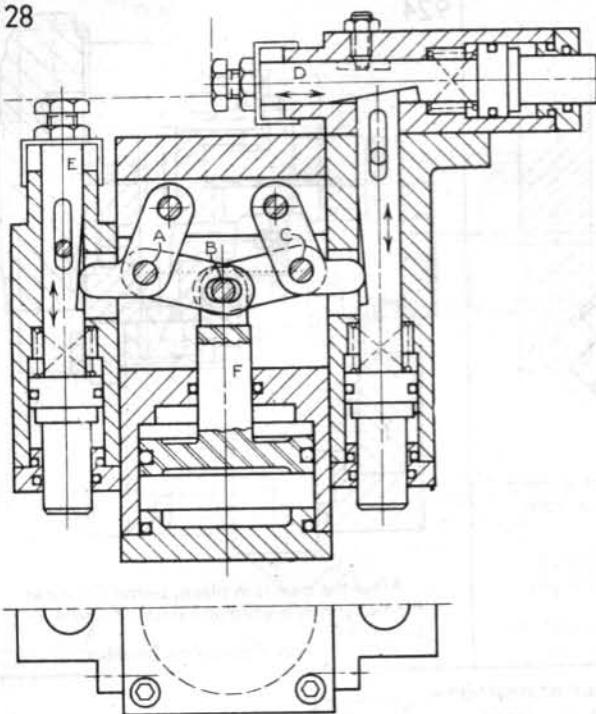
927



Jack (Equalizing Double)

923-927

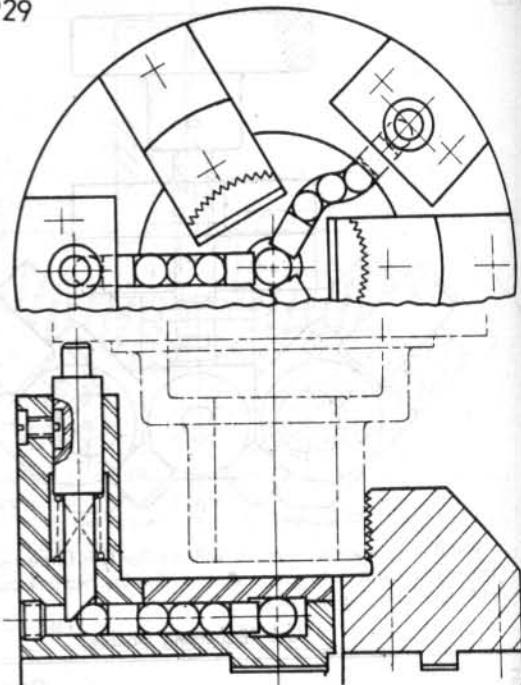
928



After the part is located, piston F actuates a toggle linkage to lock spring-loaded jacks D and E in place.

Jack (Equalizing Double)

929

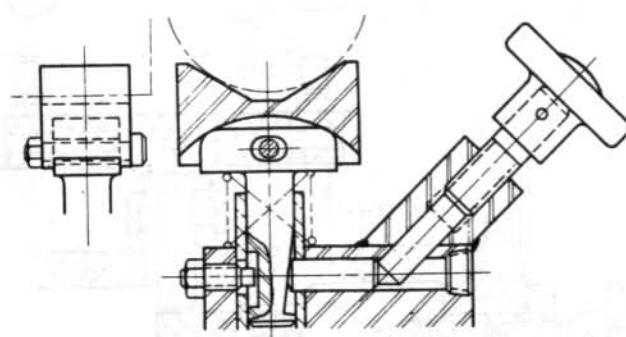


The small three-jaw chuck uses balls (sometimes their path is circuitous) to equalize three jacks. An alternative to the use of the balls is the use of oil.

Jack (Equalizing Double)

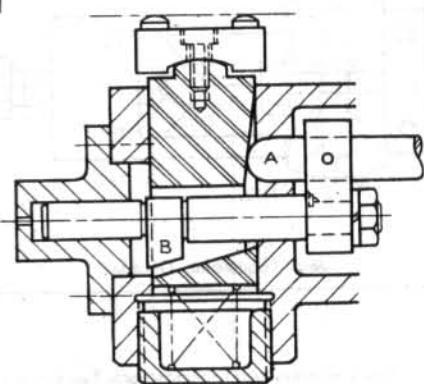
Jacks Equalizing

930



Jack (Equalizing)

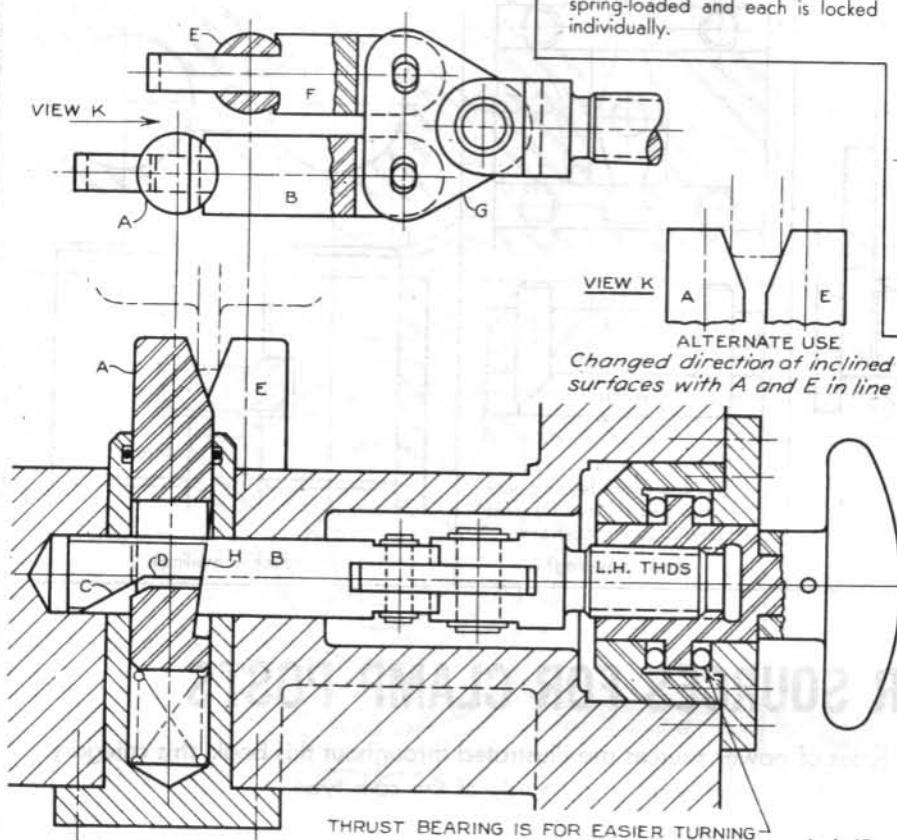
931



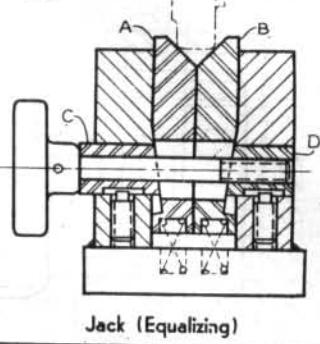
A locks the spring-loaded jack post and B retracts it. Note the frequent use of airvents.

Jack (Equalizing)

932



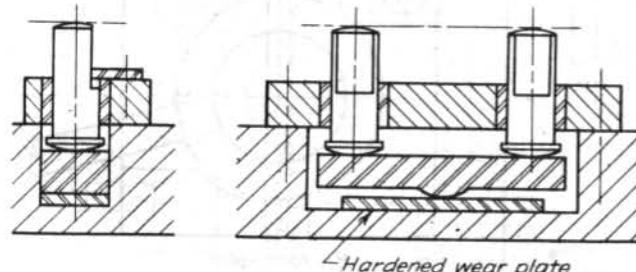
933



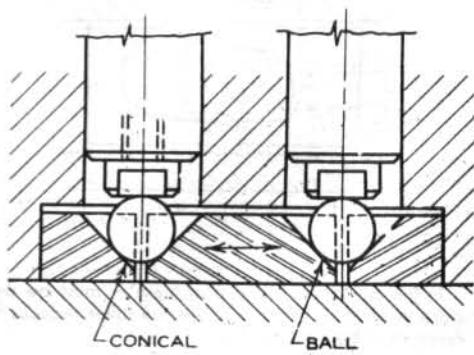
JACKS (LEVELING)

A leveling jack functions as an equalizer. It is not used to jack up a part.

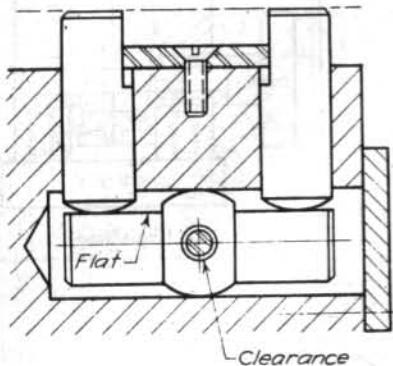
934



935

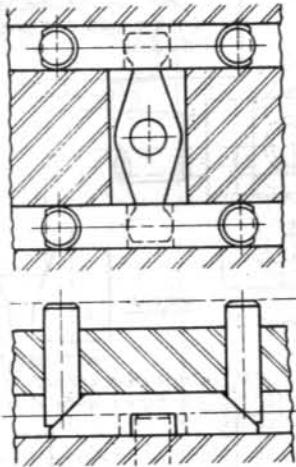


936



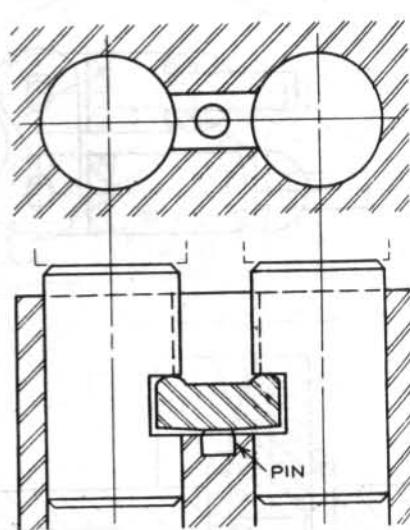
Jack (Leveling)

937



Jack (Leveling)

938

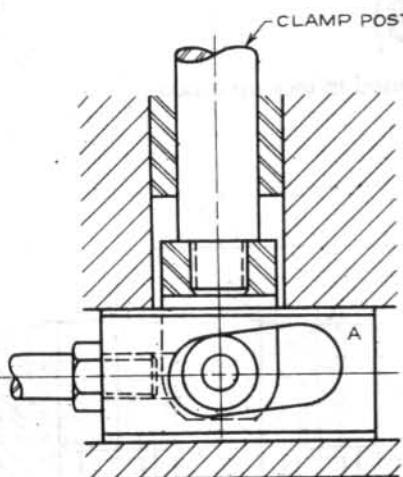


Jack (Leveling)

POWER SOURCES FOR CLAMP POSTS

Since many different types of power sources are illustrated throughout this book, this category presents only special heavy duty power sources, primarily of the cam type.

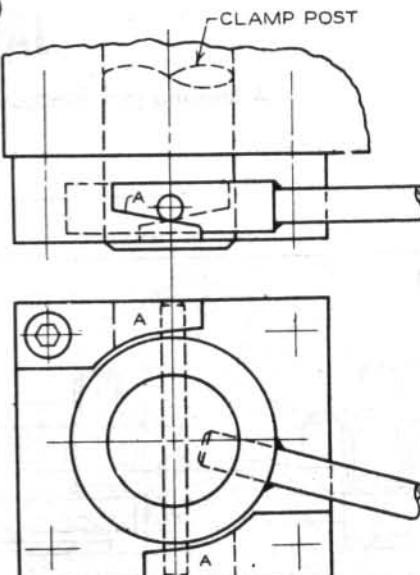
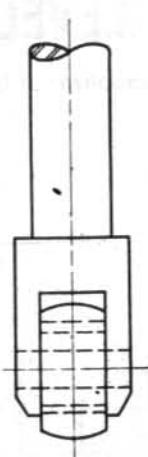
939



In this pull down clamp post, cam A must be designed to fit the bore in which it slides. Because the roller reduces friction, continued force must be applied to A.

Power Source for Clamp Post

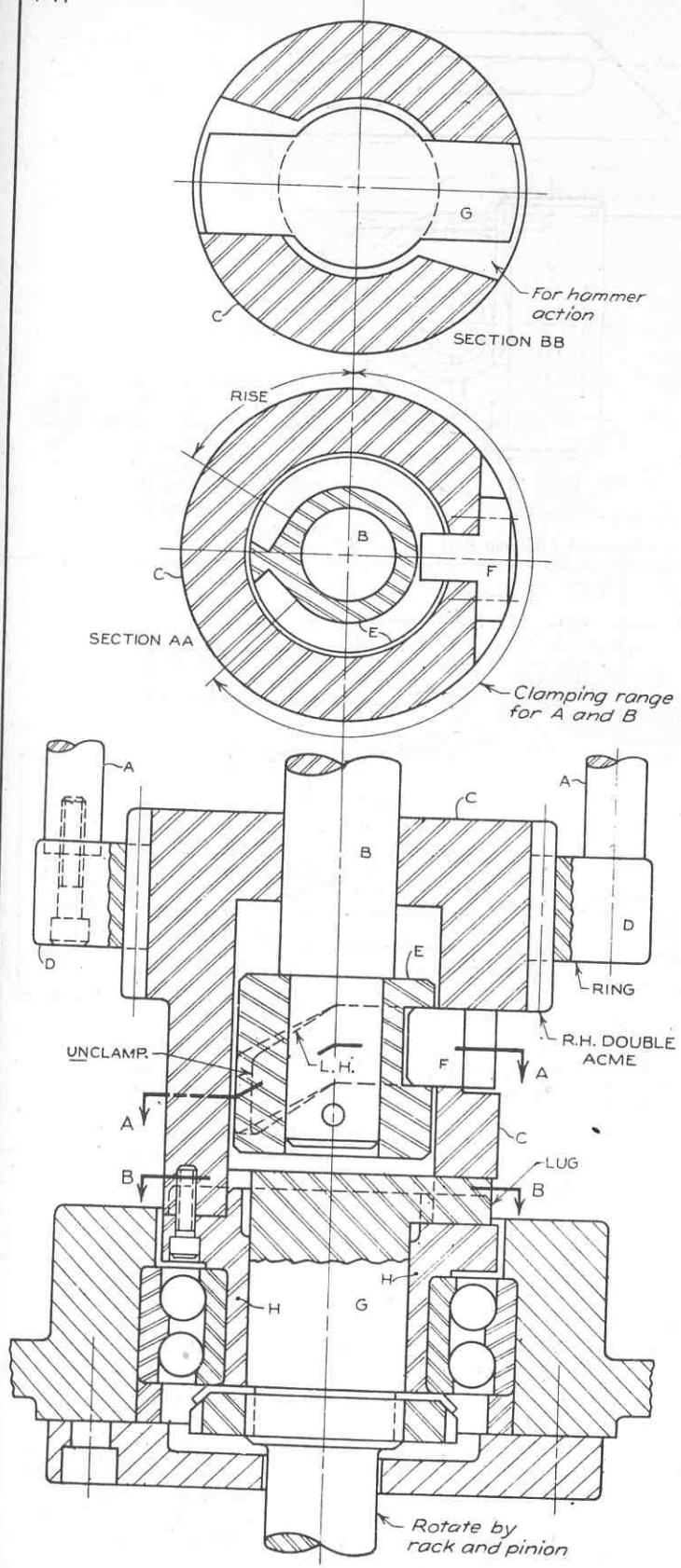
940



Place cams A on other side of pin to pull down on shaft.

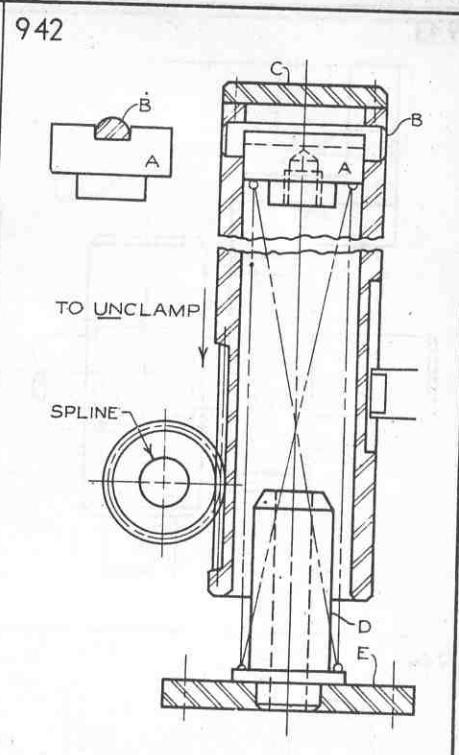
Power Source for Clamp Post

941



Power Source for Clamp Post

941-942



The power source of this design is a strong spring that actuates via the pinion either a clamp post that has a rack on it or a wedge cam, illustrated elsewhere in this category. An air cylinder applied at C unclamps the clamping action created by the spring.

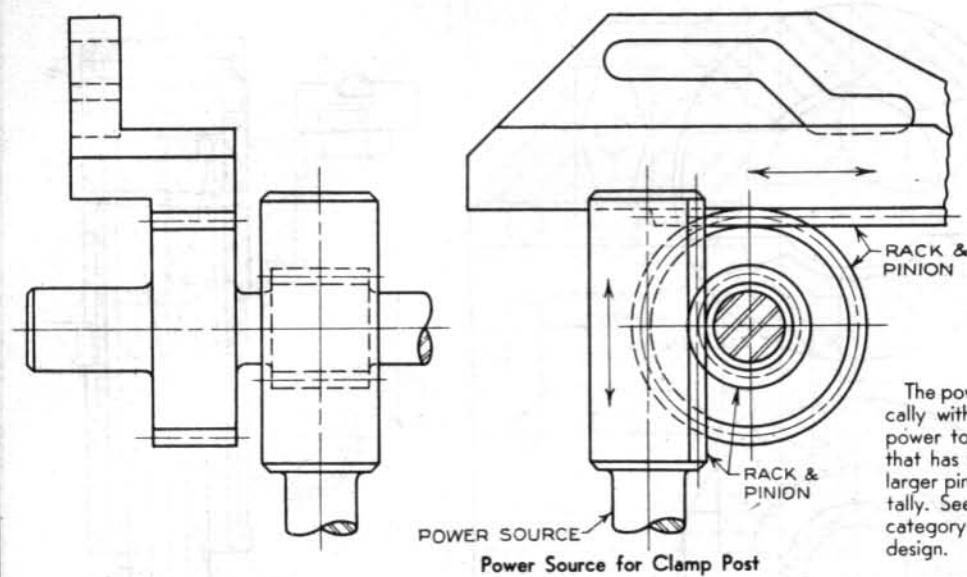
The following instructions are given on the original drawing.

The spring is so strong that it would shoot D and E out if they were missiles if the cap screws of E were removed without providing some other means of controlling the spring. To assemble or disassemble the spring, insert a long threaded rod through D and screw it into A. Nuts on the lower end of the rod may be turned slowly to reduce the compression after the cap screws for E are removed. The rod should be prevented from becoming unscrewed from A during the disassembling operation.

Power Source for Clamp Post

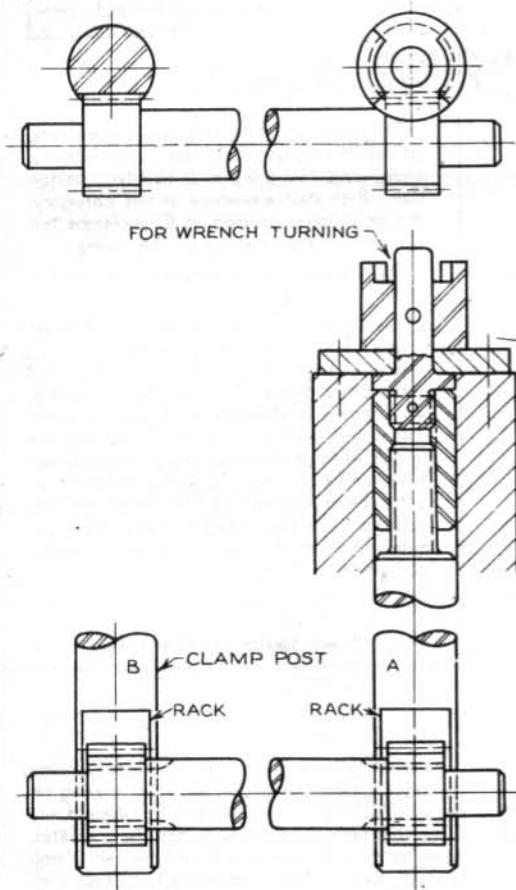
As shaft G is rotated clockwise (from top view point), two lugs of G that fit in mating recesses of C and H (see Section BB) cause H and C, which is fastened to H, to rotate. As C rotates, its acme threads raise ring D and the two clamp posts A. Key F, which is fastened to C (see Section AA), moves in the groove of E, pulling down spring-loaded internal clamp post B.

943

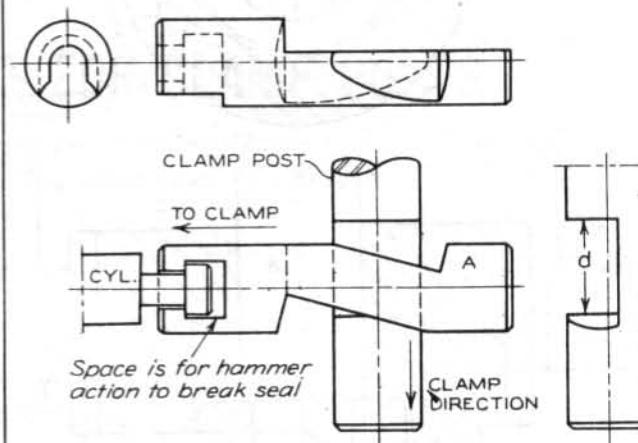


The power source operates vertically with its rack transferring its power to a pinion and to a shaft that has another pinion on it. The larger pinion moves a cam horizontally. See Walking Strap Clamps category for an application of this design.

944

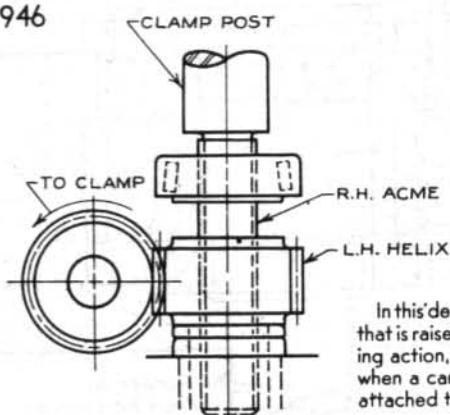


945



Power Source for Clamp Post

946

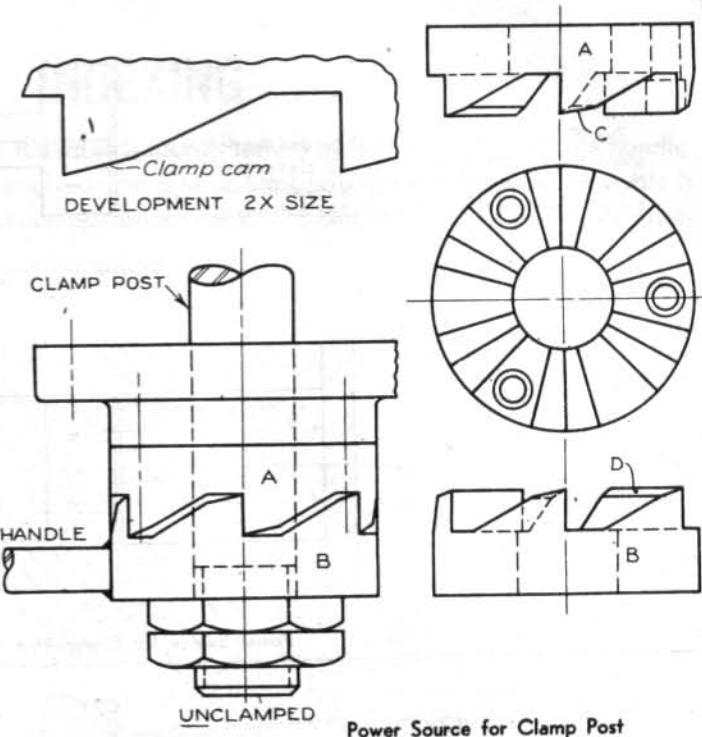


Power Source for Clamp Post

Power Source for Clamp Post

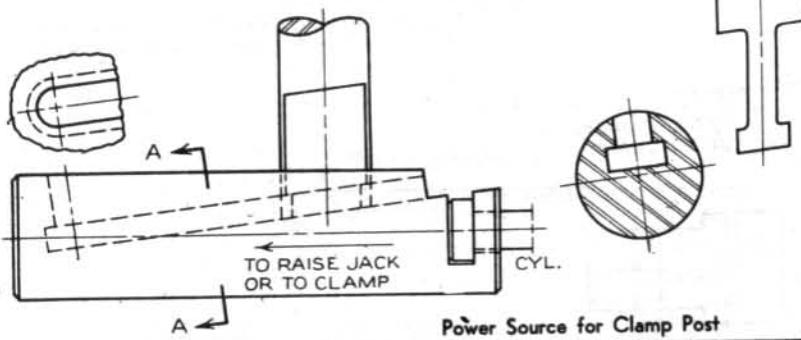
947

This is a pull down clamp post. A is fastened to the frame. C and D are the clamping cam surfaces.



Power Source for Clamp Post

948

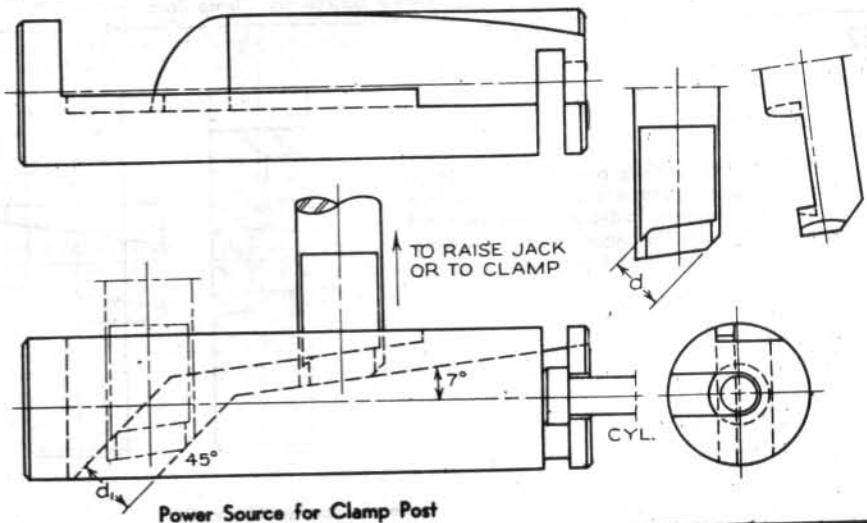


The T-slot design of the cam is used to retract the post.

Power Source for Clamp Post

949

Dimensions d and d_1 must mate if the post is to fit in the retracting portion of the cam groove.

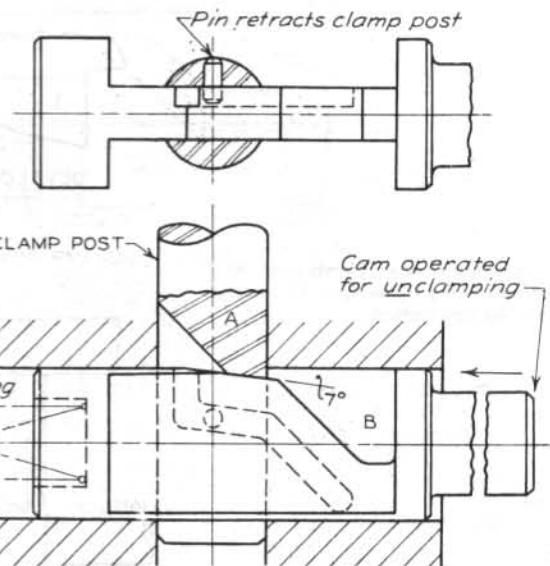


Power Source for Clamp Post

950-952

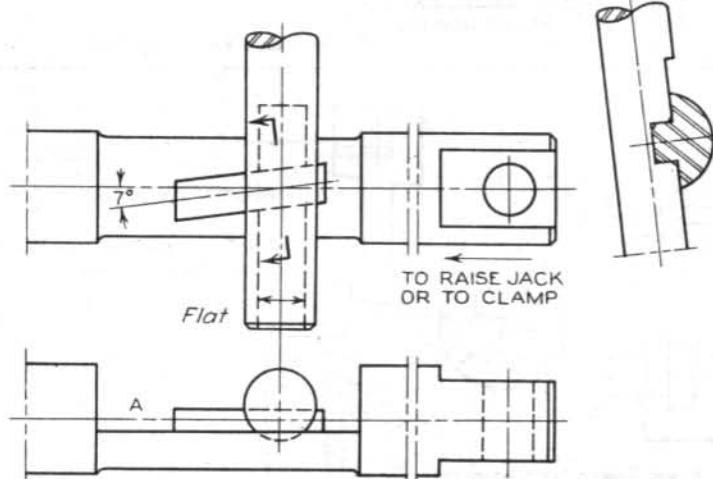
950

The 7° angle is the clamping angle and the 45° angle the retracting angle for the clamp post. Note the retracting pin and its groove. The sectioned area A of the post fits in area B during retraction.



Power Source for Clamp Post

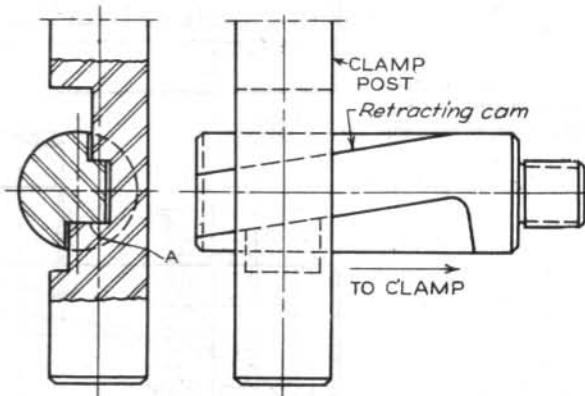
951



Power Source for Clamp Post

952

This is a pull down clamp post. Note that surface A on the clamping cam is larger than the surface on the retracting cam. To design a clamp post that raises, merely slope the cam in the alternate direction and put surface A on top.

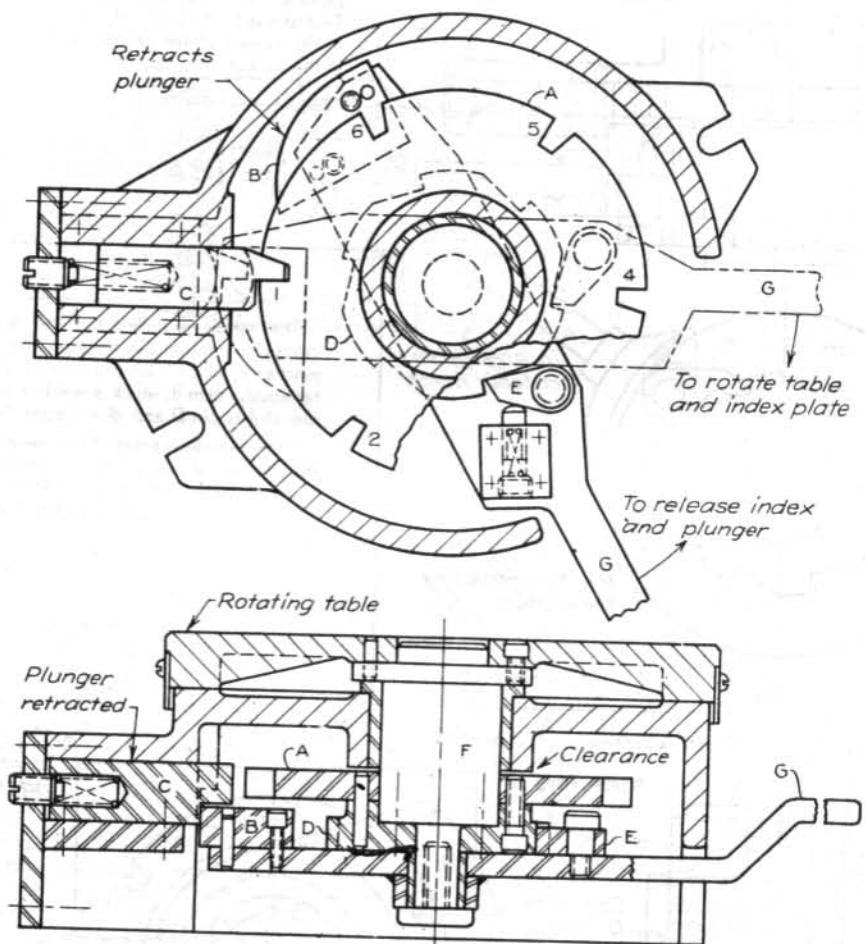


Power Source for Clamp Post

INDEXING

In the simpler indexing operations, the table is usually turned by hand or by a separate handle. When the operations become more involved and a number of positions are indexed, the table is turned and the indexing performed in one operation. Table clamping is normally a separate operation, performed as needed.

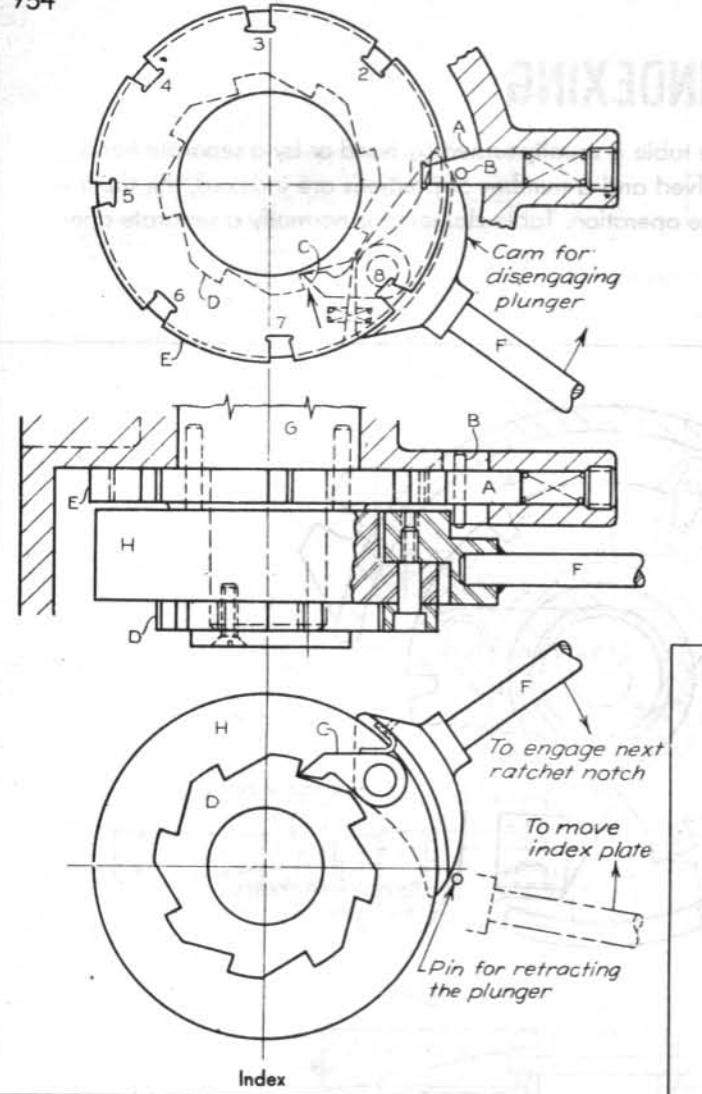
953



Handle G rotates freely about shaft F of the table to which index plate A and ratchet D are fastened. When handle G is moved counterclockwise, cam B, which is attached to it, retracts plunger C, and catch E drops into the next ratchet notch, as shown in the illustration.

As handle G is moved clockwise, it rotates ratchet D, index plate A, and the rotating table. Cam B releases plunger C, allowing it to ride on the periphery of A until it drops into socket 2.

954



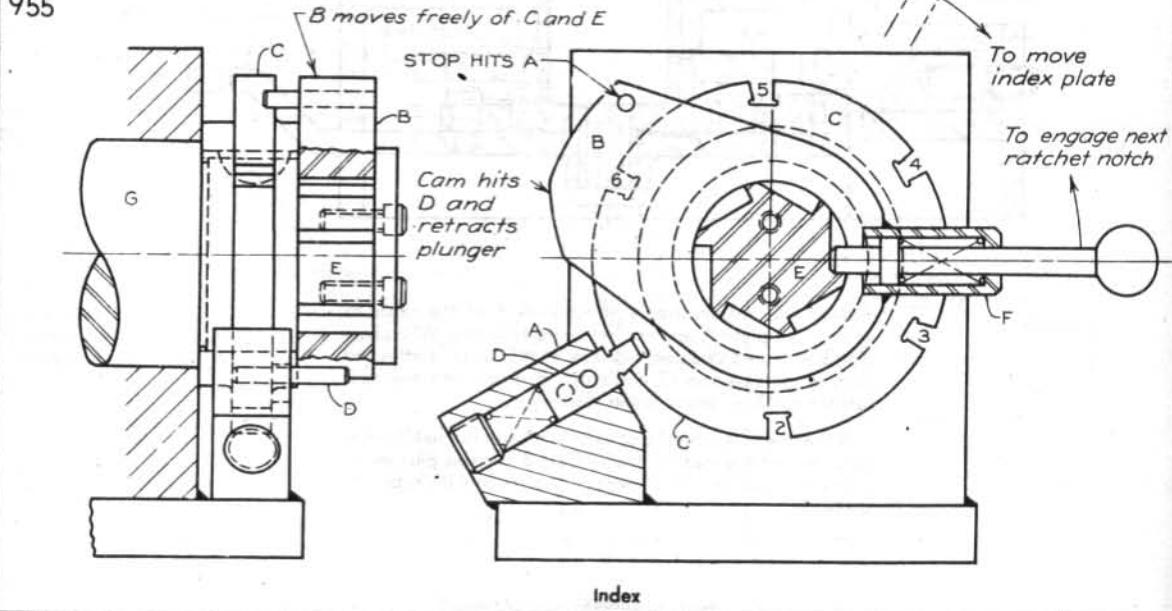
H slides independently of shaft G. Index plate E, ratchet D, and a rotating table are fastened to shaft G. When handle F is moved counterclockwise (top view position), the cam strikes pin B of plunger A and retracts the plunger, allowing catch C to drop into the next notch of ratchet D.

As handle F is turned clockwise, the cam leaves pin B, thereby allowing plunger A to ride on the periphery of index plate E until it drops into socket 2. Turning the handle clockwise also moves index plate E, ratchet D, shaft G, and a rotating table (not shown). The point of catch C should not be in the corner of the ratchet when the plunger is in the socket.

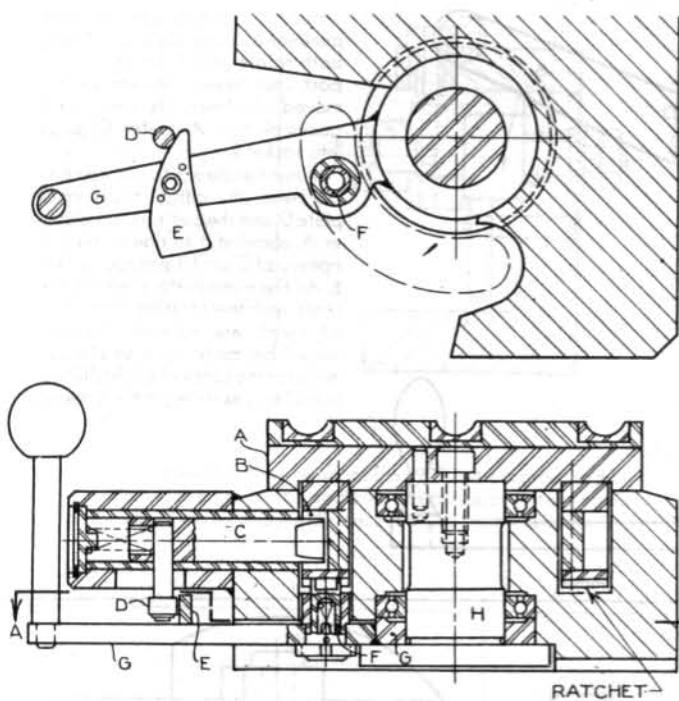
The handle is pulled out and moved counterclockwise until its pin engages the next notch of ratchet E, which is bolted to index plate C. Simultaneously, cam B, which is welded to F of the handle, strikes pin D and disengages the plunger.

As the handle is rotated clockwise, the cam frees the plunger, allowing it to ride on the periphery of C until it drops into socket 2. Ratchet E is part of shaft G to which index C and a rotating table are attached.

955

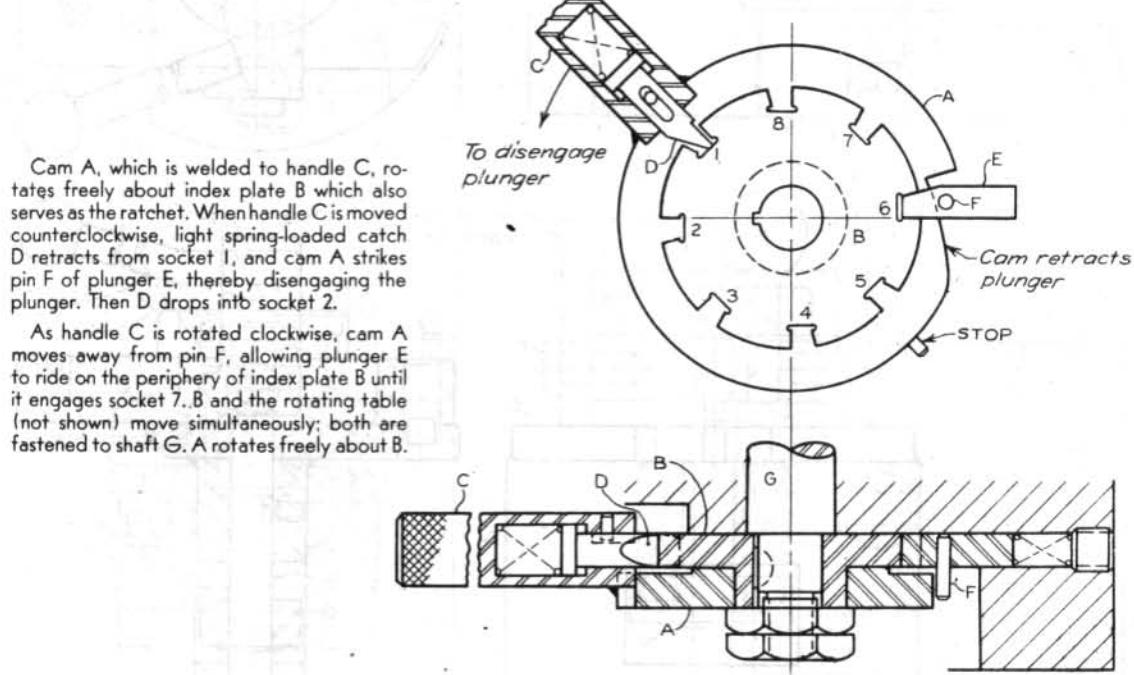


956



When handle G is turned clockwise, cam D strikes roller D of plunger C, retracting it, and spring-loaded ratchet catch F engages the next ratchet notch. The handle is then reversed, rotating table A until the now released plunger C drops into the next index socket of B. Index plate B and the ratchet are fastened to table A. Handle G rotates freely about shaft H.

957

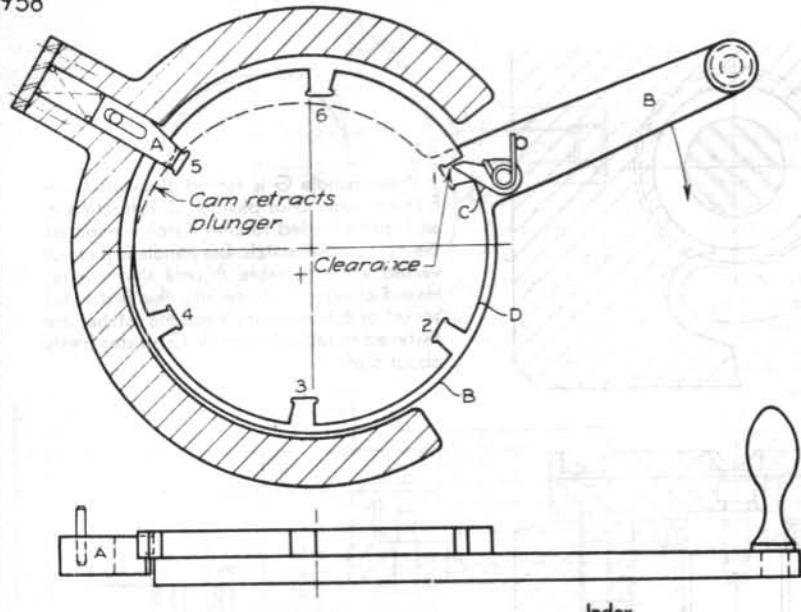


Cam A, which is welded to handle C, rotates freely about index plate B which also serves as the ratchet. When handle C is moved counterclockwise, light spring-loaded catch D retracts from socket 1, and cam A strikes pin F of plunger E, thereby disengaging the plunger. Then D drops into socket 2.

As handle C is rotated clockwise, cam A moves away from pin F, allowing plunger E to ride on the periphery of index plate B until it engages socket 7. B and the rotating table (not shown) move simultaneously; both are fastened to shaft G. A rotates freely about B.

Index

958

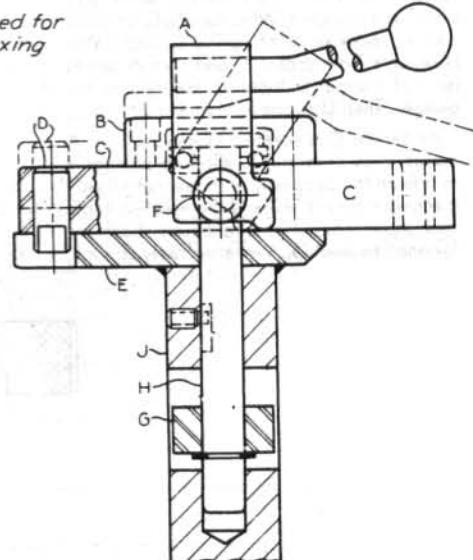
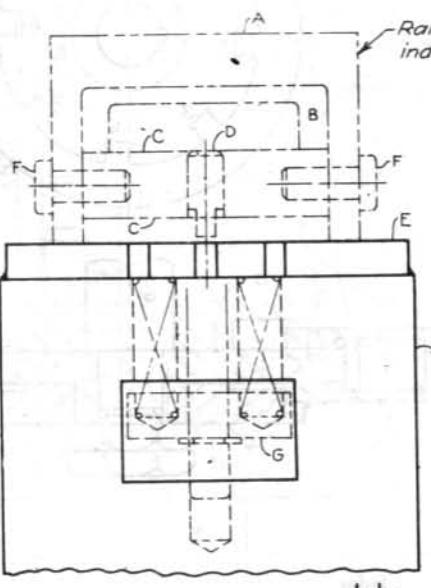
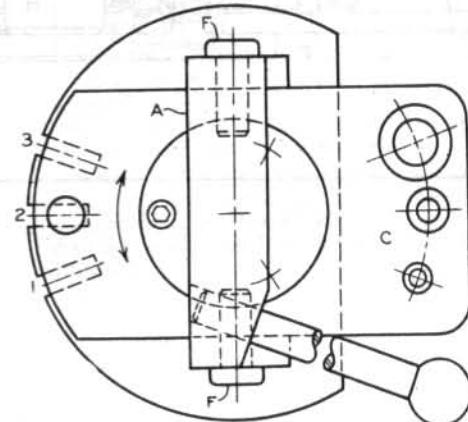


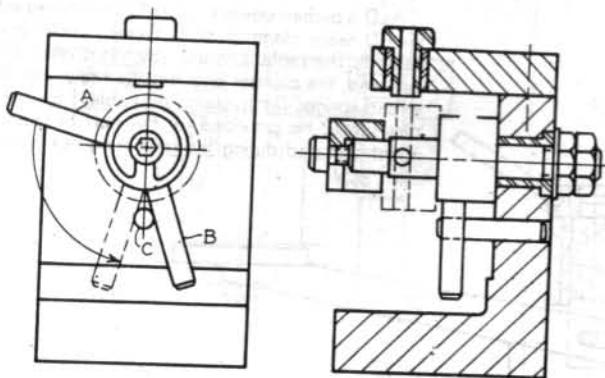
Handle B and its cam are independent of index plate D although both rotate about the same shaft post (not shown). As handle B is moved clockwise, its cam disengages plunger A. Catch C drops into socket 2.

When handle B is turned counter-clockwise, the catch moves index plate D, and the cam releases plunger A, allowing it to ride on the periphery of D until it engages socket 6. As the index plate is moved, the shaft and the rotating table (not shown) are rotated. Provision should be made for a small clearance for the catch when the plunger is in place, as shown in the drawing.

959

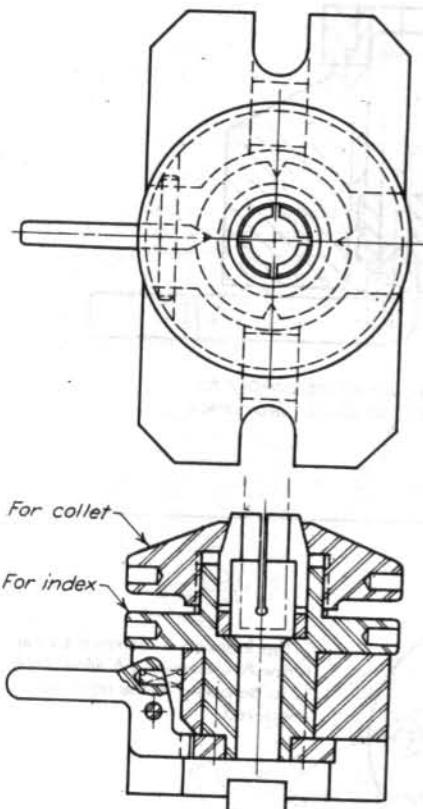
Pushing down the handle, which is pinned to plate C, raises plate C and plunger D. As the handle is pushed sideways, D engages another of the plunger's slots. The two springs via G hold bushing plate C down firmly.





Handle A and handle B must be more than 90° apart in order to provide 90° indexing. The size of the angle will depend upon the size of the handles, the size of pin C, and the distance pin C is from the center.

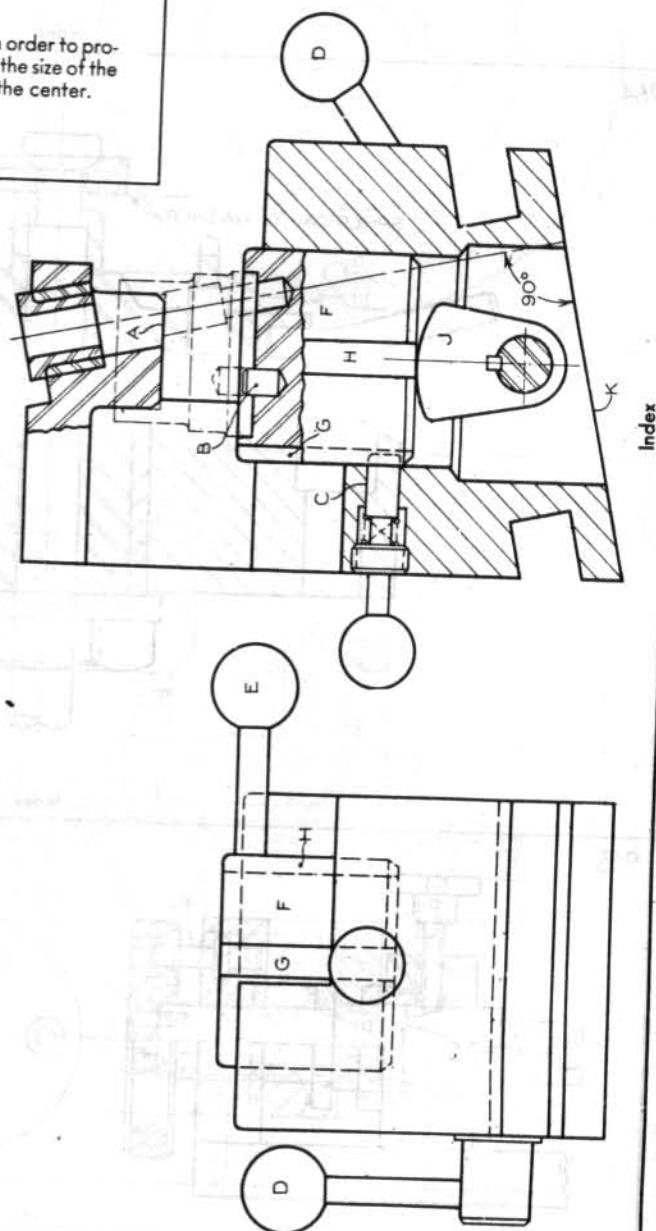
Index



Index

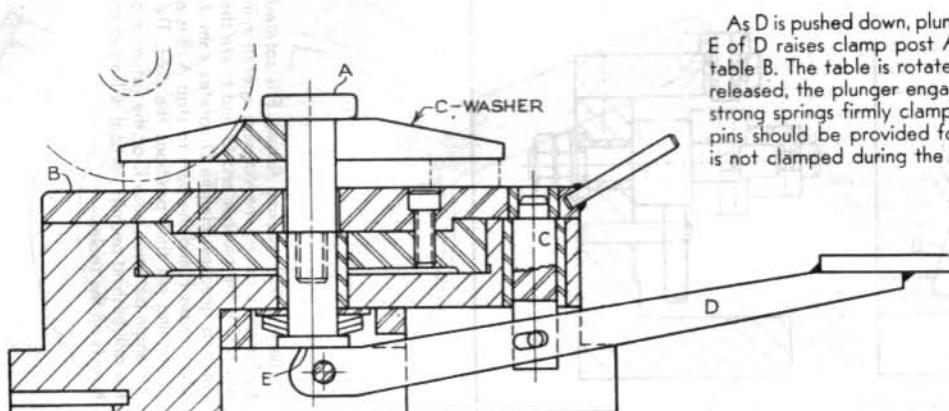


This is a 90° indexing fixture. F is rotated by handle E during the indexing operation in which C is the plunger and G and H are the indexing grooves; Handle D rotates cam J, which raises F and the part to stop A. B is a positioning pin that positions the part. The 90° angle between base K of the fixture and the drill bushing permits vertical drilling when K rests on the table.



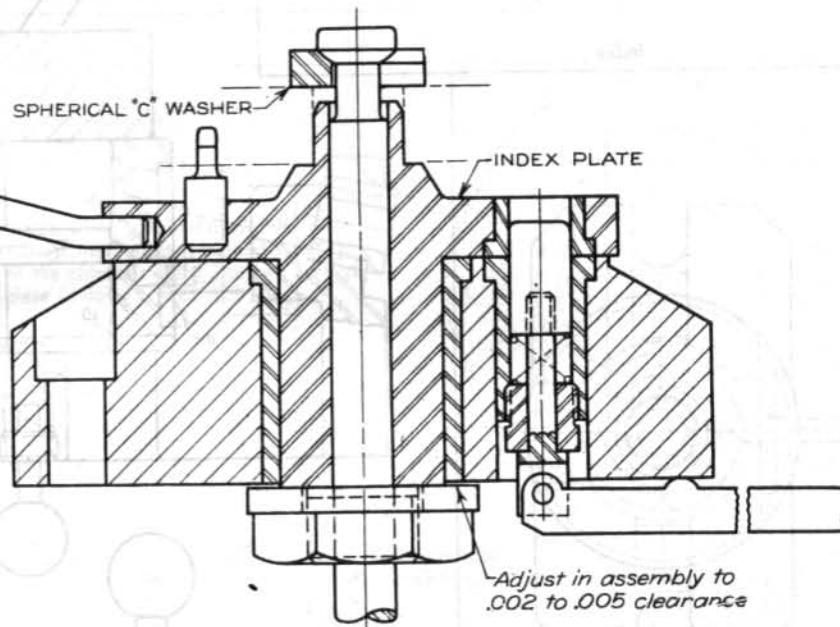
963-965

963



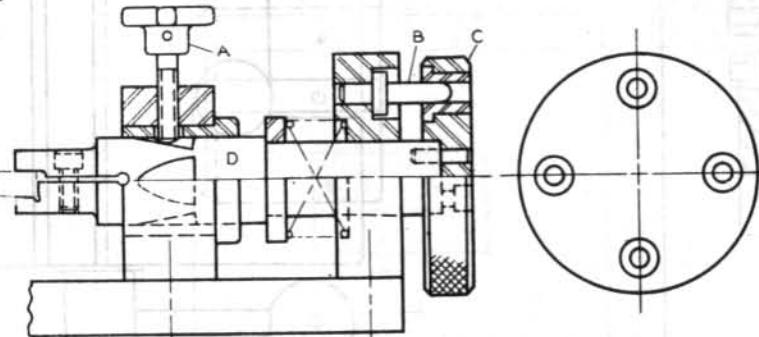
Index

964



Index

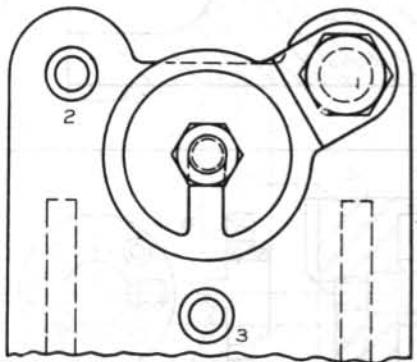
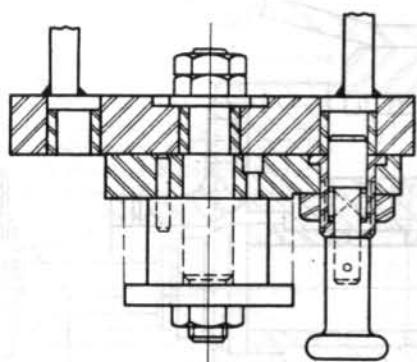
965



Index

The indexing is clamped by cap screw A. Unscrewing A allows knob C to be pulled to the right and be reindexed.

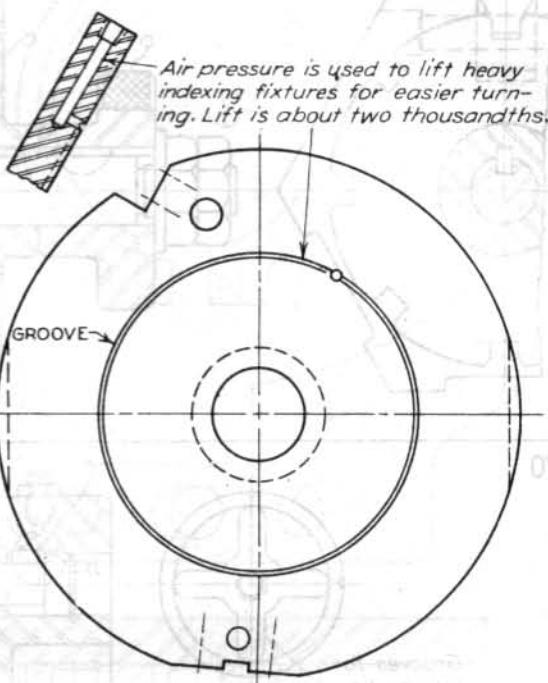
966



In this three-position index, the handle of the plunger rotates the index plate and the part.

Index

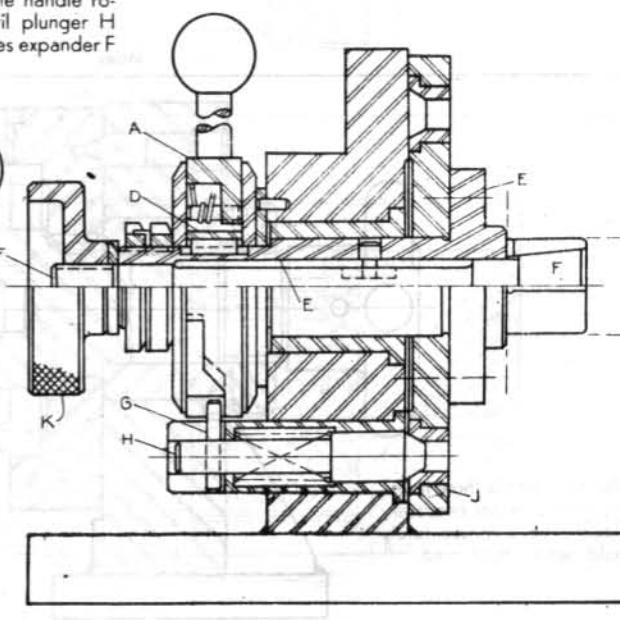
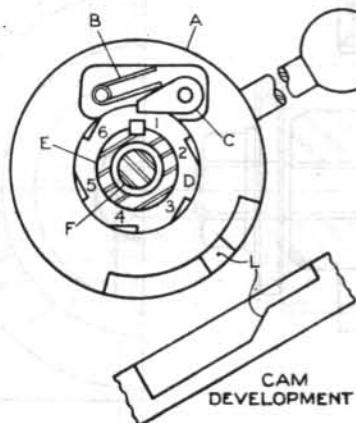
967



Index

968

As the handle, which is attached to A, is turned clockwise (from the left side view position), cam L strikes pin G and retracts plunger H. Then catch C, pinned to A, drops into ratchet notch 2. Reversing the direction of the handle rotates, via ratchet D, E and index plate J until plunger H drops into the next index socket. Knob K causes expander F to spread the collet.

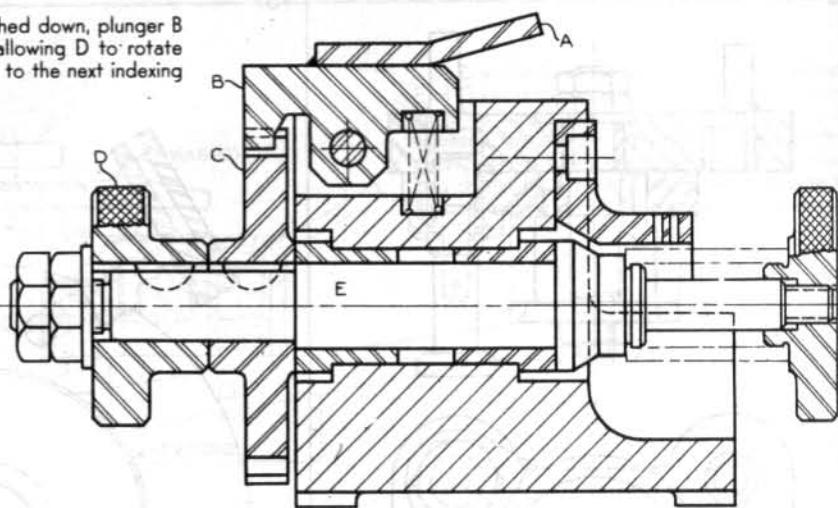
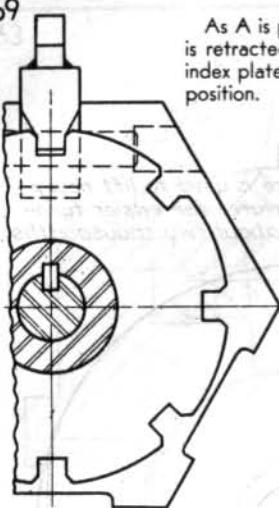


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969-971

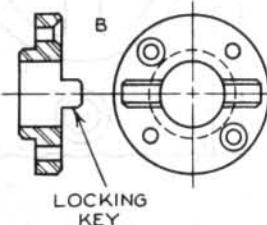
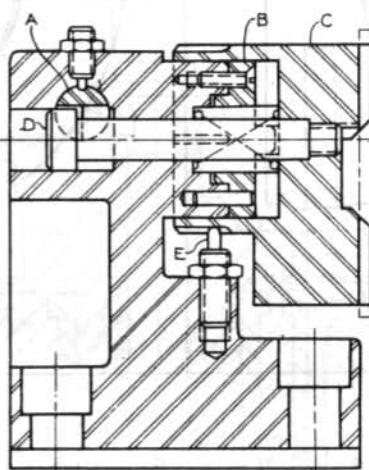
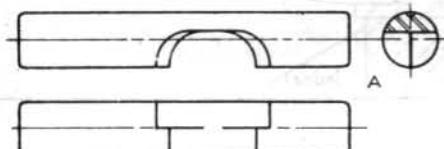
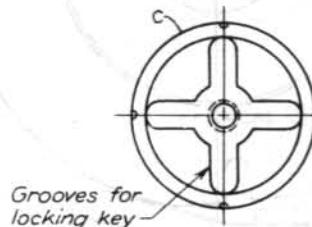
969

As A is pushed down, plunger B is retracted, allowing D to rotate index plate C to the next indexing position.



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970

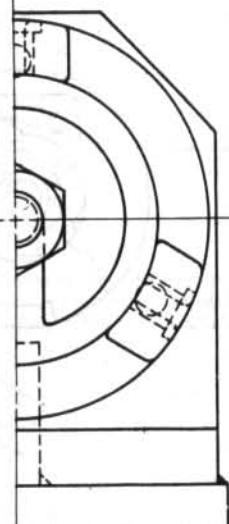
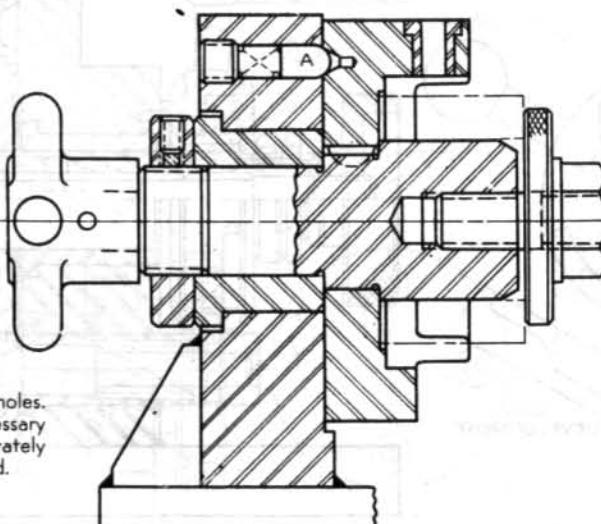


When the opening of A is centered about the head of D, indexing chuck jaw C is moved to the right by the spring. With its grooves free of the locking key of B, C can be rotated to another indexing position. Spring plunger E fits in the indexing grooves. Pushing C to the left allows A to be moved horizontally to lock the head of D, thereby holding C in locked position.

Index

971

This fixture drills three holes. Only when it is not necessary to locate the holes accurately should detent A be used.



Index

972

Handle M rotates shaft H and its three eccentrics, J, K, and L. Each eccentric actuates a link (see detail of H), links C and D moving half clamp A, and link E moving half clamp B. Observe in the left side view how B clamps the table. Bolt N may be used to adjust the amount of clamping pressure.

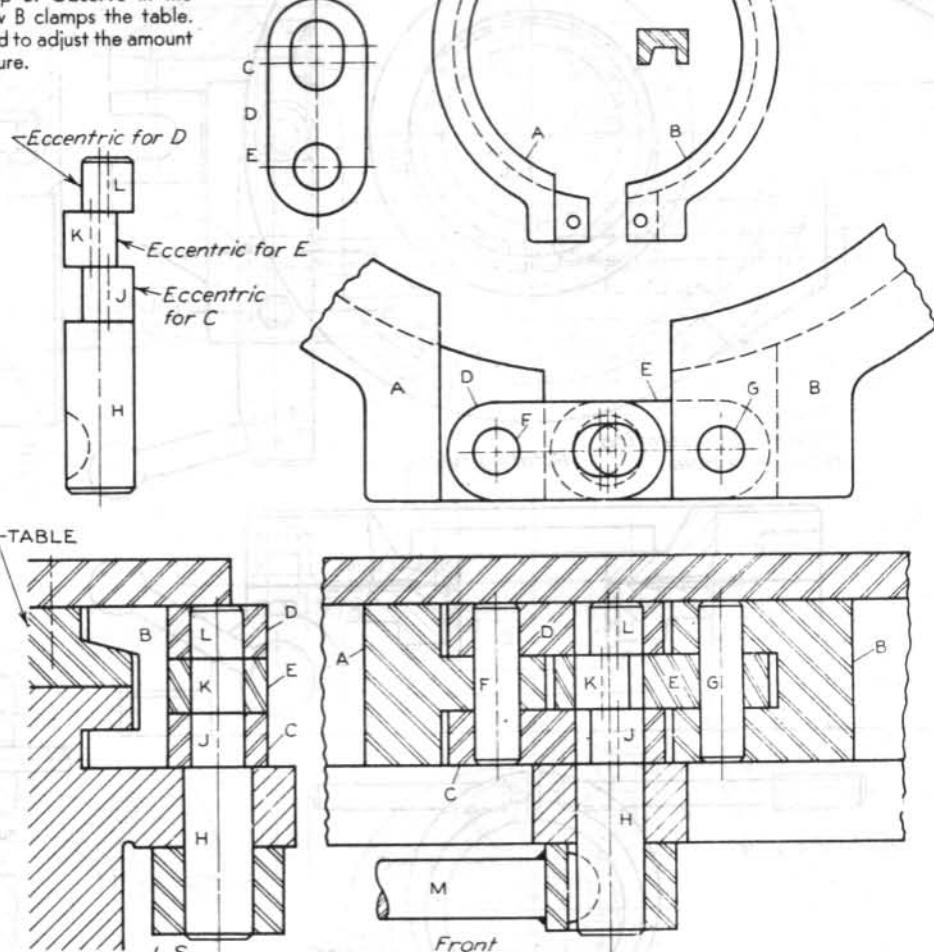


Table Clamp

973

When the air pressure raises C, cone F forces the balls inward, drawing down bolt A and firmly clamping the table. During the unclamping action, the air pressure raises B and lowers C. B raises A and the table. Groove E around C allows air to enter through several holes.

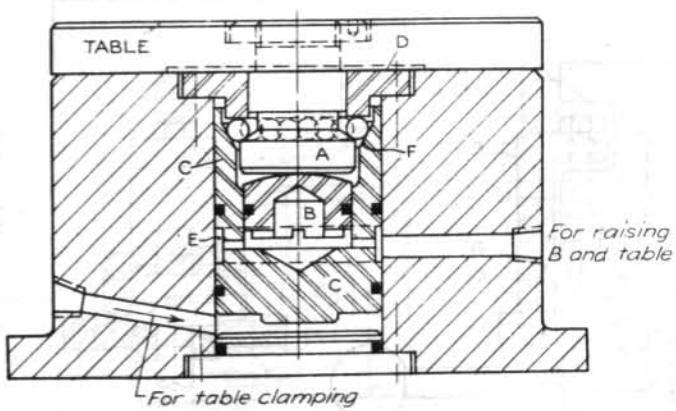
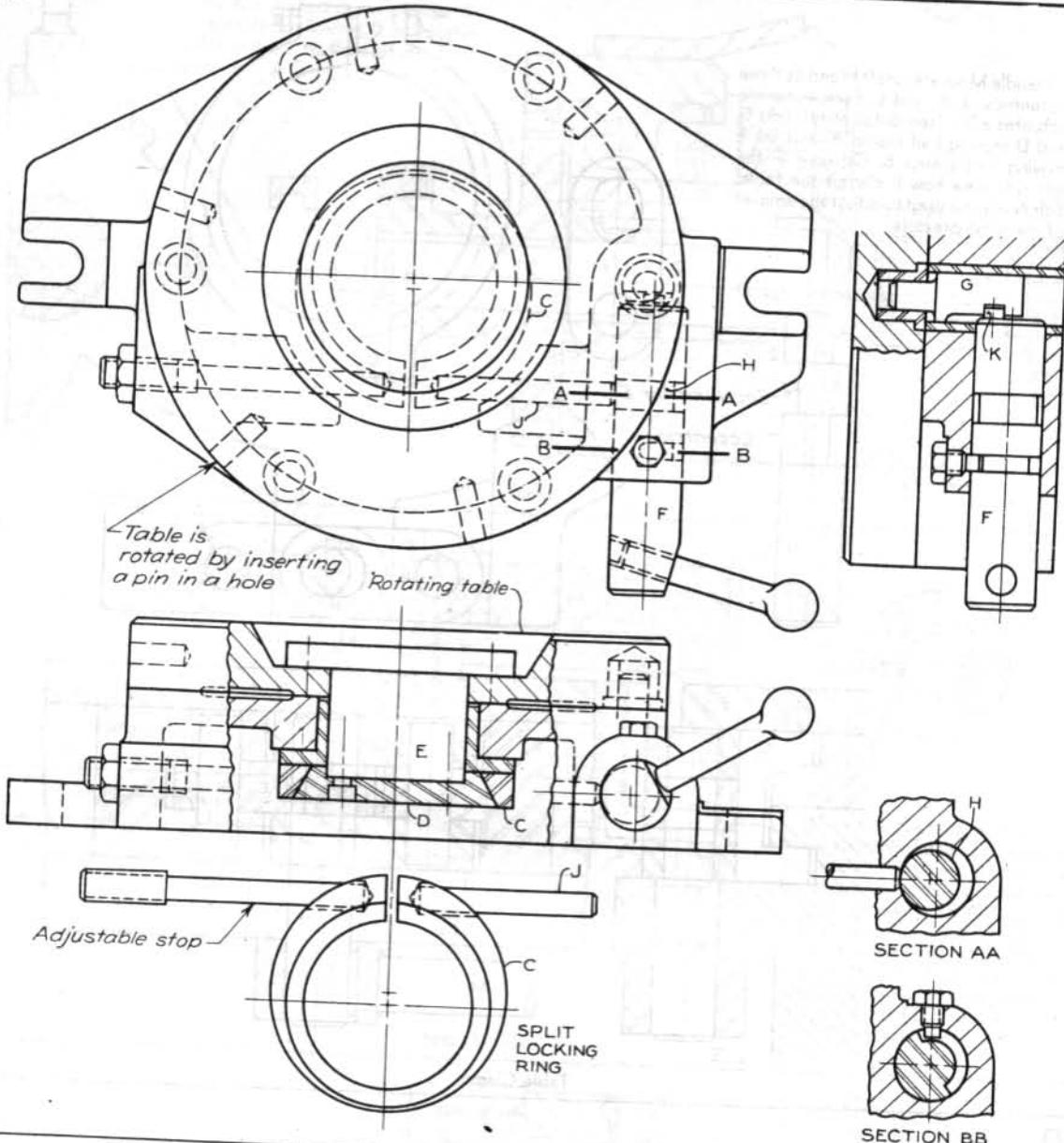
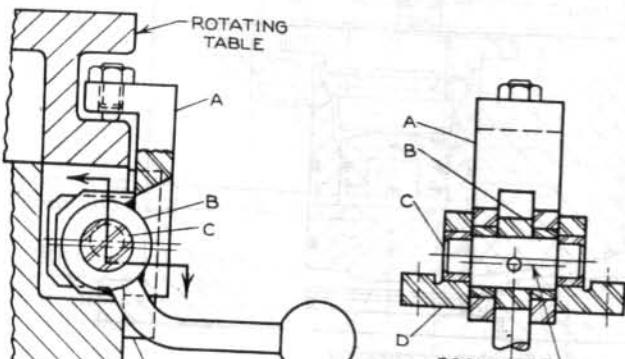


Table Clamp

974



975



An eccentric pulls down the adjustable arm that locks the table.
Table Clamp

When the handle is turned clockwise, plunger G is raised by eccentric pin K. At the same time eccentric H of shaft F forces pin J to squeeze conical split ring C, which forces D to pull shaft E down, firmly clamping the table. The eccentric split ring provides tighter clamping action than a concentric split ring. The rotation of F is limited by the set screw and groove of Section BB.

Table Clamp

976

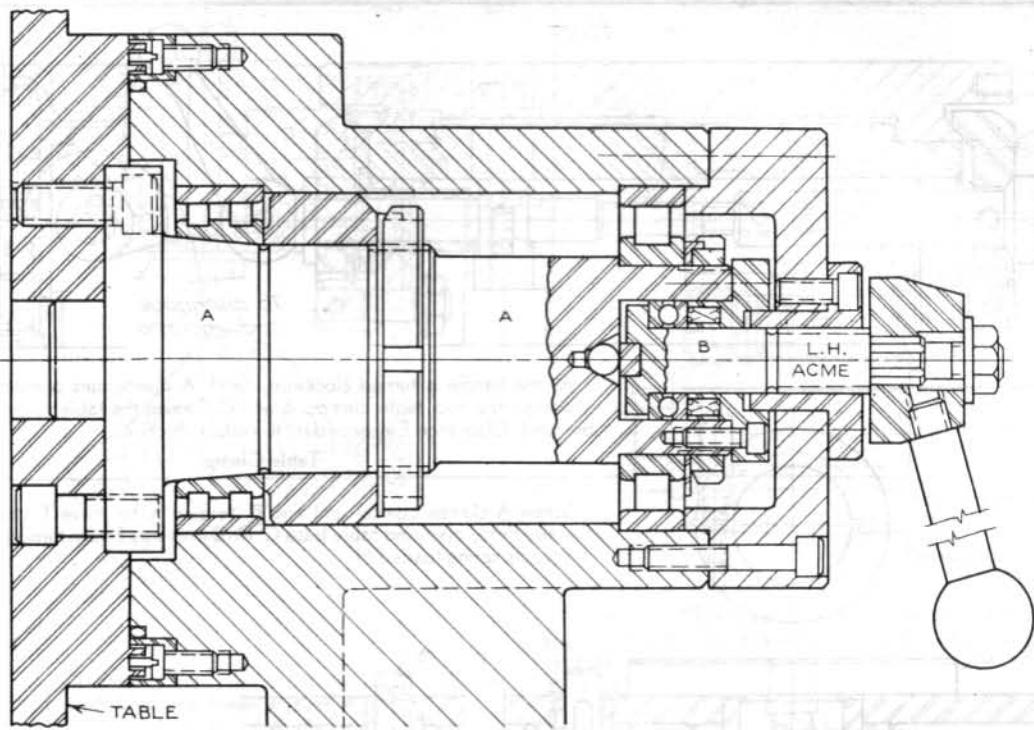
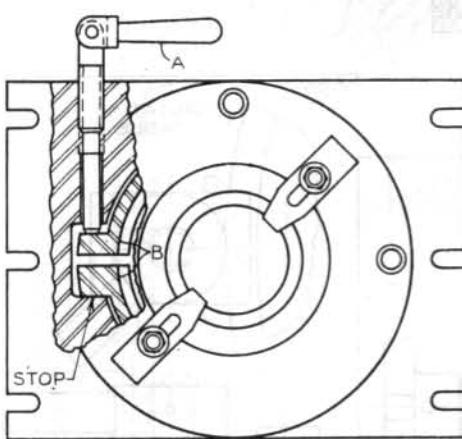
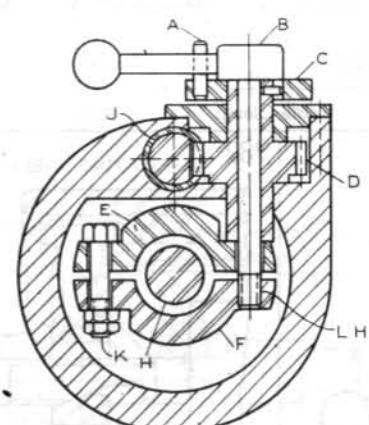


Table Clamp

977



978



In the clamping operation the handle is turned counter-clockwise away from pin A, allowing spring-loaded plunger J to engage H. Bolt B draws E and F together, forcing cone G to draw H down and firmly hold it.

In the unclamping operation the handle strikes A, causing C, which is keyed by a pin to pinion D, to rotate. Pinion D retracts plunger J. H is rotated by hand.

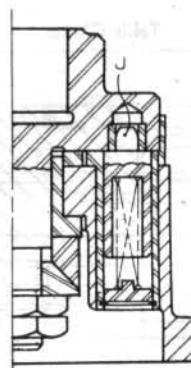
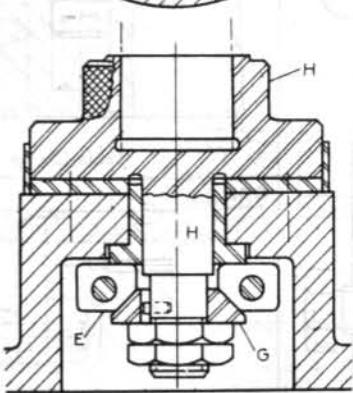
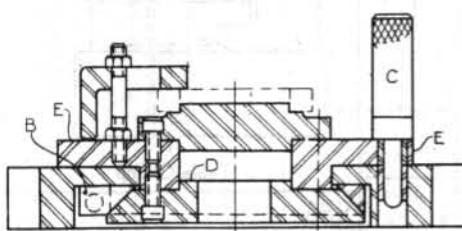
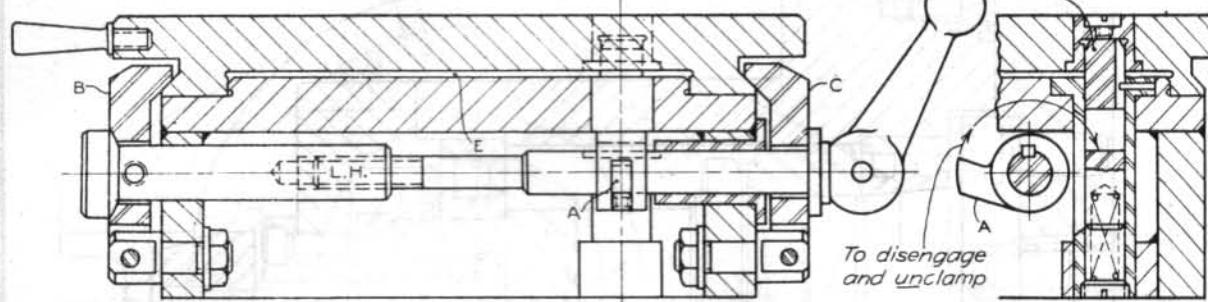


Table E is indexed by C, which is operated manually. Handle A clamps the table. The bolt of A is forced against conical-shaped split ring B, which, in turn, forces D to pull the table down and hold it firmly in position.

Table Clamp

Index

979



As the handle is turned clockwise, catch A disengages plunger D and unclamps the two table clamps, B and C, freeing the table to be rotated by hand. Clearance E is provided to reduce friction.

Table Clamp

980

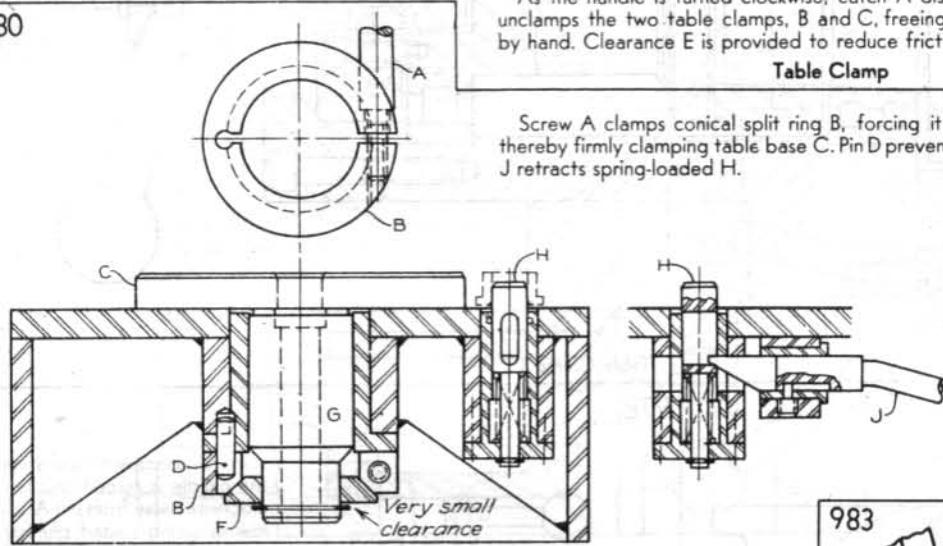


Table Clamp

981

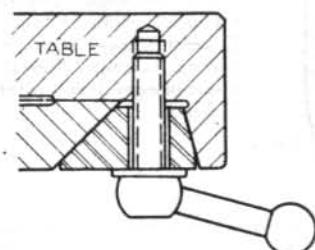


Table Clamp

982

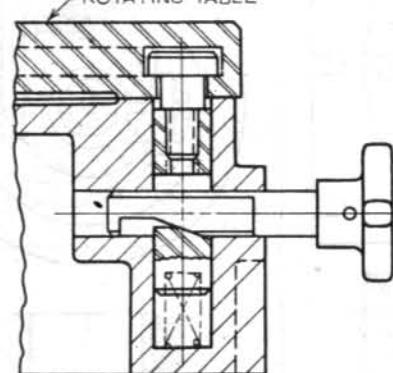


Table Clamp

983

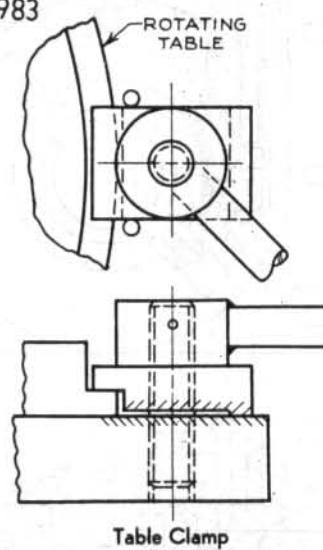


Table Clamp

984

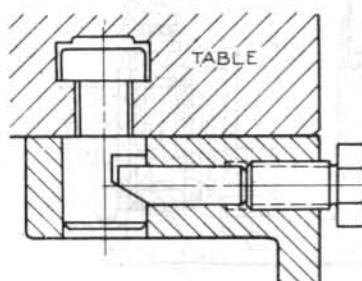


Table Clamp

985

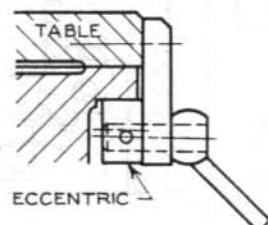


Table Clamp

986

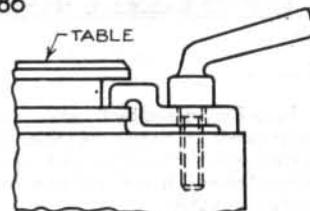
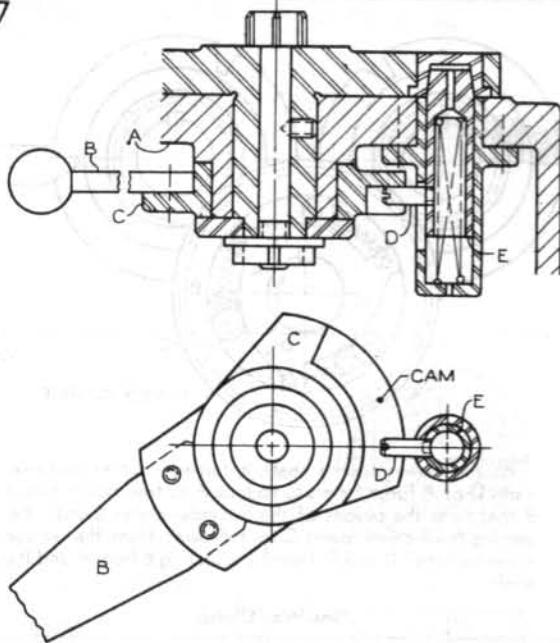


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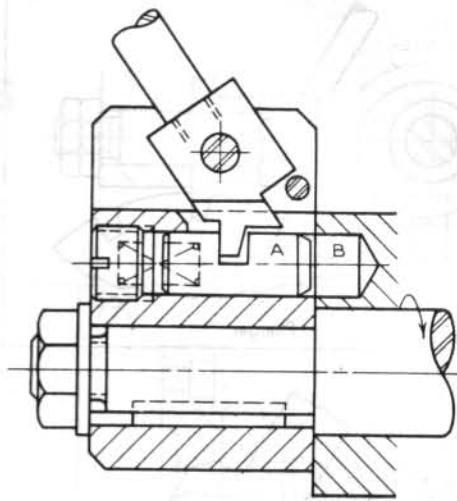
987



When handle B rotates cam C, the cam moves pin D of plunger E, retracting E. Cam C rotates freely about frame A.

Index

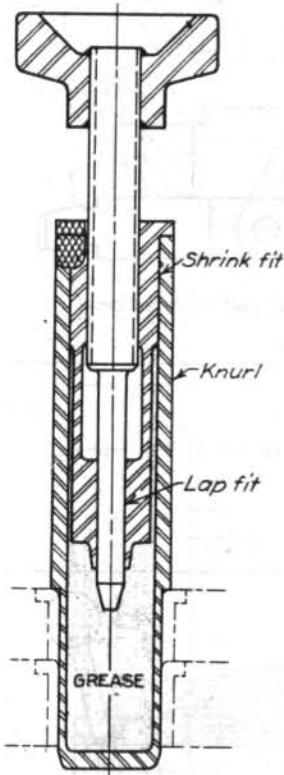
988



Plunger A is shown in its retracted position. Providing B with a bushing makes it possible to index the table with greater accuracy.

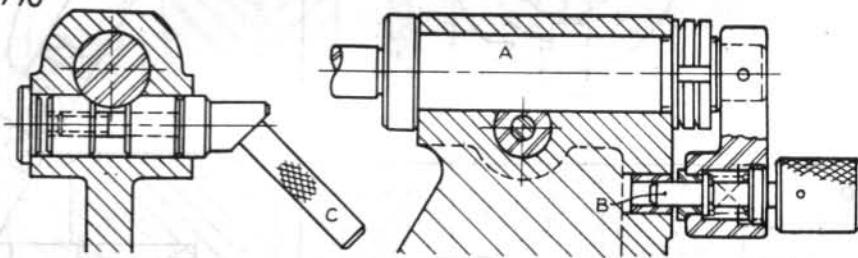
Shaft Indexing

989



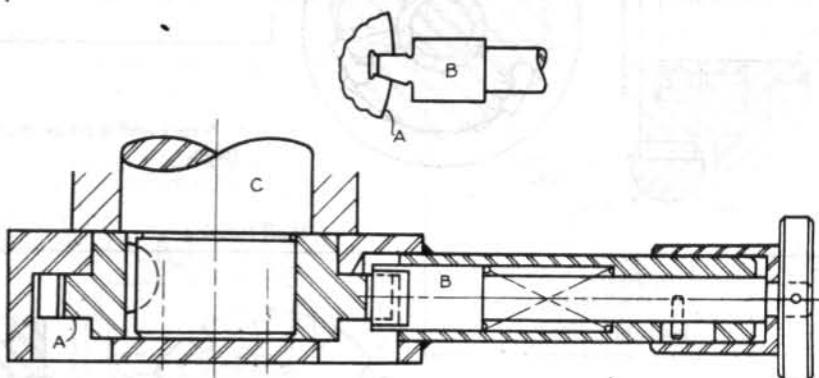
Index Pin

990



B indexes shaft A and then handle C locks the shaft.
Shaft Indexing

991

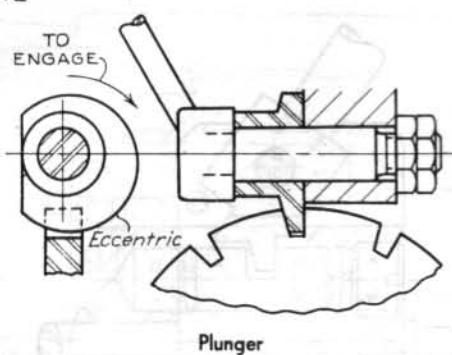


After the handle is pulled out to disengage plunger B, it is moved clockwise until plunger B engages the next socket in plate A. Then the handle is moved counterclockwise until it strikes a stop, and then the table is clamped. The counterclockwise movement of the handle rotates plate A and shaft C, to which both A and the rotating table are fastened. Note the pin which prevents rotation of the plunger.

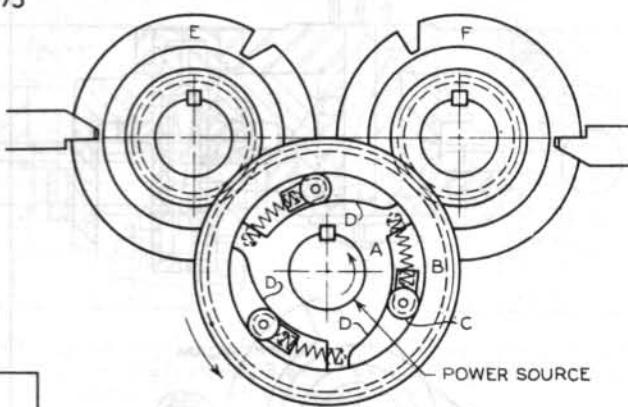
Table Turning

992-997

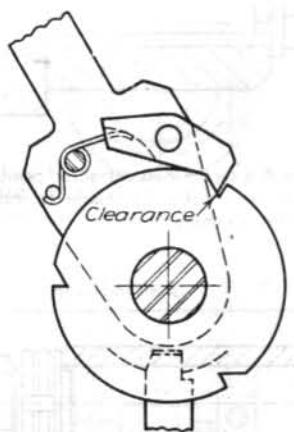
992



993

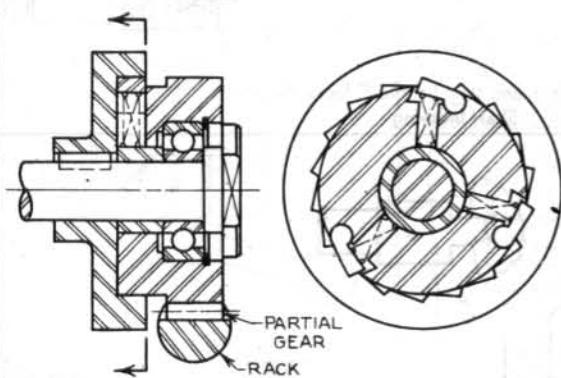


994

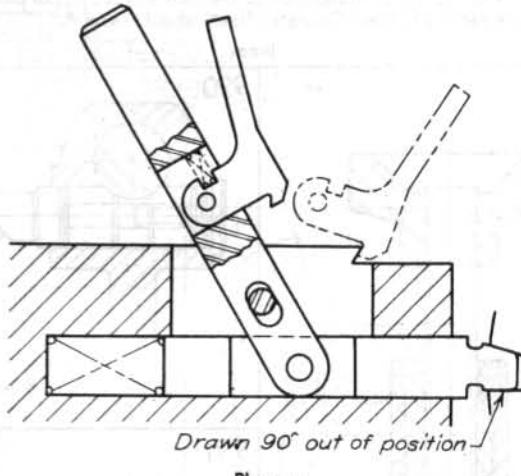


Index

996



995



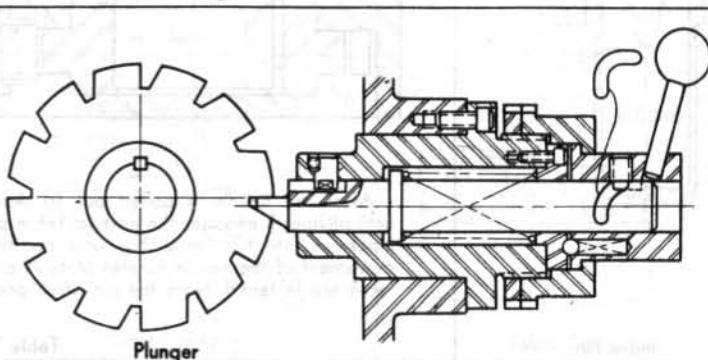
Plunger

A rack and a pinion move the ratchet of the indexing table.

Shaft Indexing

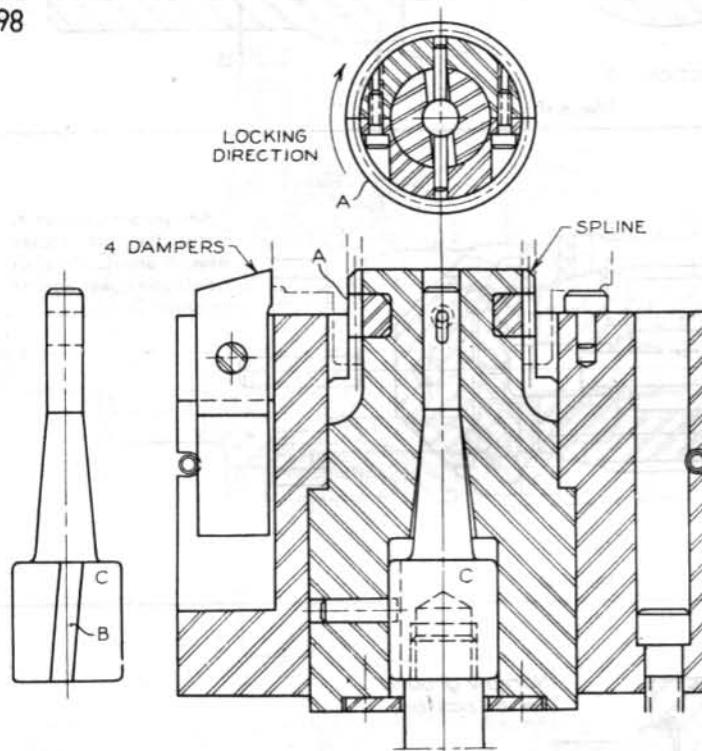
997

Rotating the handle counterclockwise will disengage the plunger and hold it in its disengaged position.

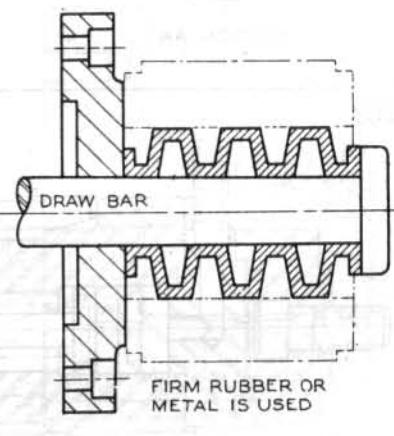


Mandrels

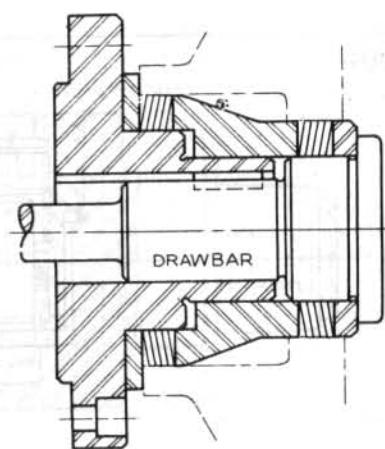
998



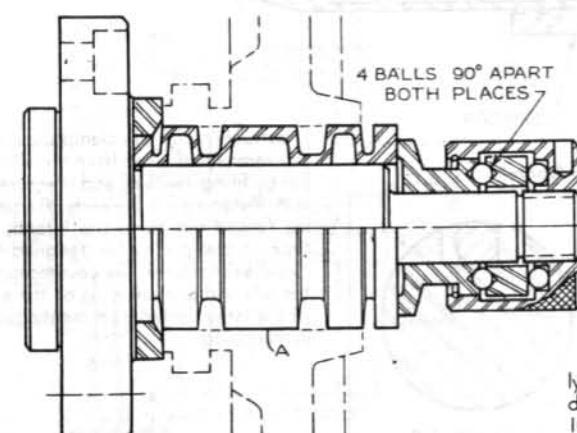
999



1000



1001



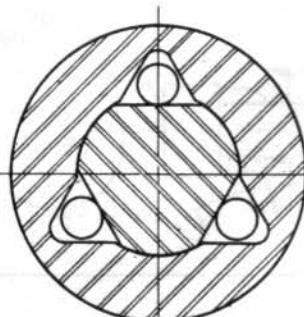
Mandrel

Accordion A expands when it is compressed longitudinally. The accordion may be designed to accommodate a two-diameter bore. The Belleville washer mandrel, Illustration 1000, is a two-diameter clamp.

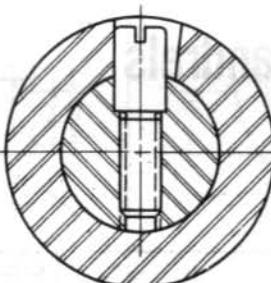
Mandrel

1002-1005

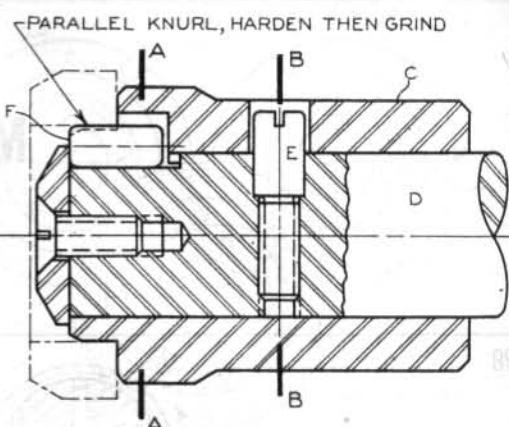
1002



SECTION AA

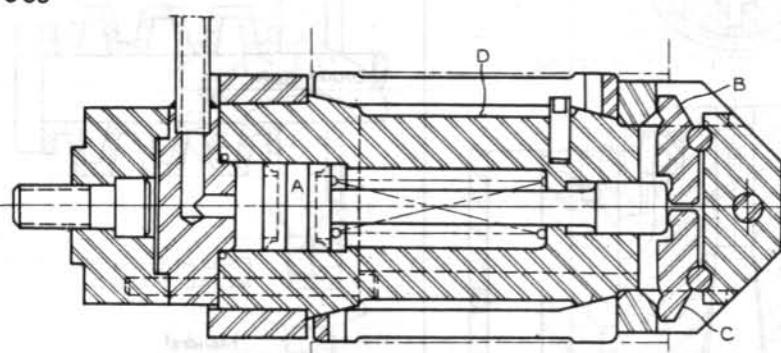


SECTION BB



Mandrel

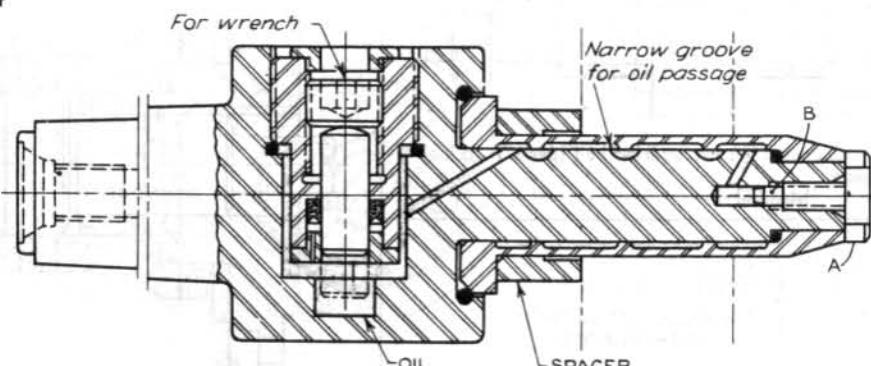
1003



Air-operated piston A forces the two rocker arms, B and C, to push the double collet against expander D.

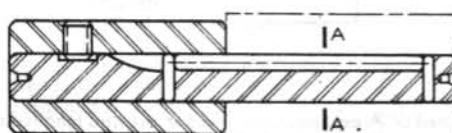
Mandrel

1004



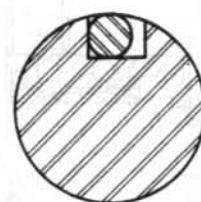
Mandrel

1005



See Shaft Clamping category for variations of this design.

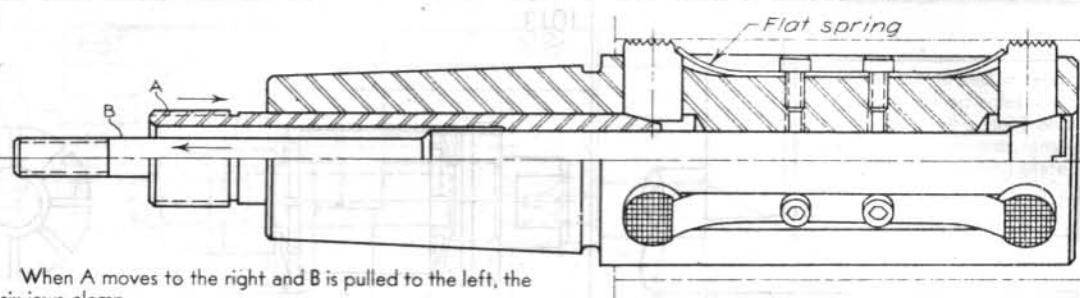
Mandrel



SECTION AA
4X SIZE

Instructions for this clamp should specify removal of all air from the oil chamber by filling it with oil and then screwing in A. Piston B of A prevents oil from being forced out along the threads. This type of clamp may be designed for a two-diameter bore. The counterbores at the left end prevent nicks on the edges of the lathe center from creating errors in machining.

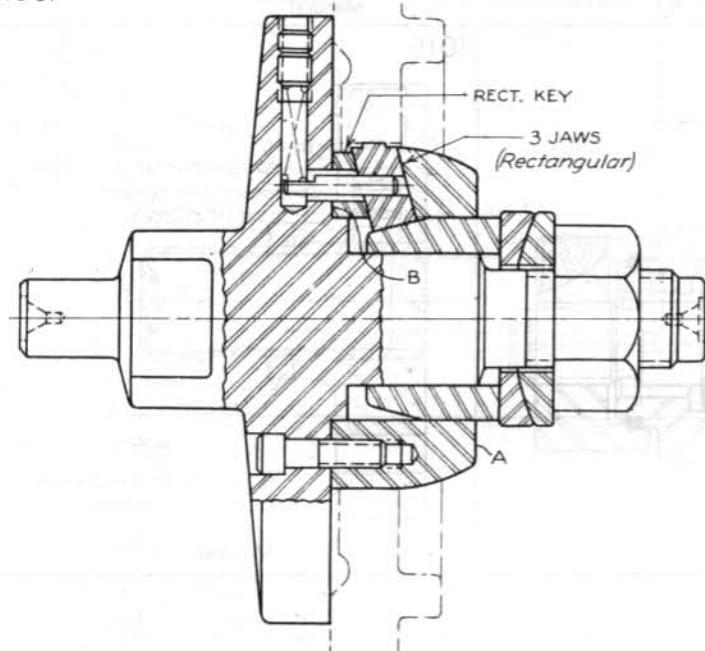
1006



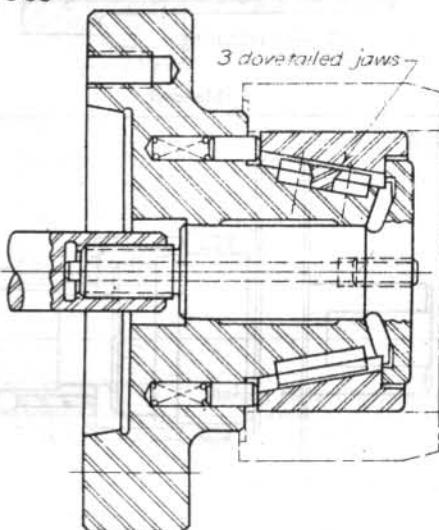
When A moves to the right and B is pulled to the left, the six jaws clamp.

Mandrel

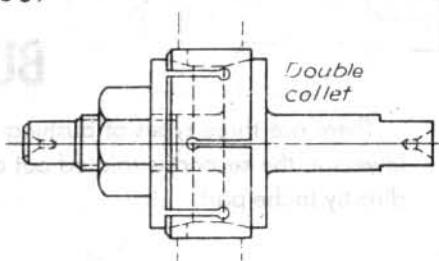
1007



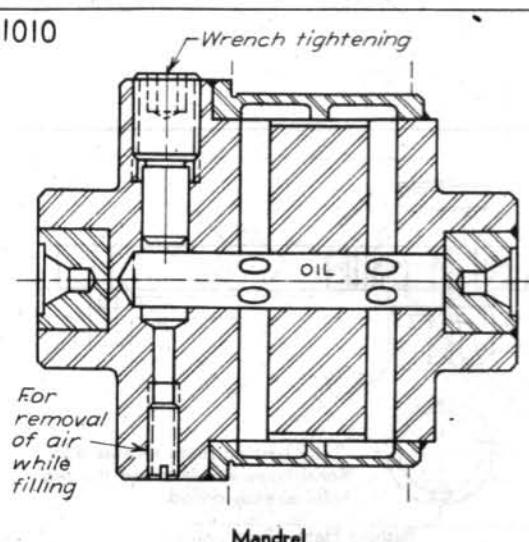
1008



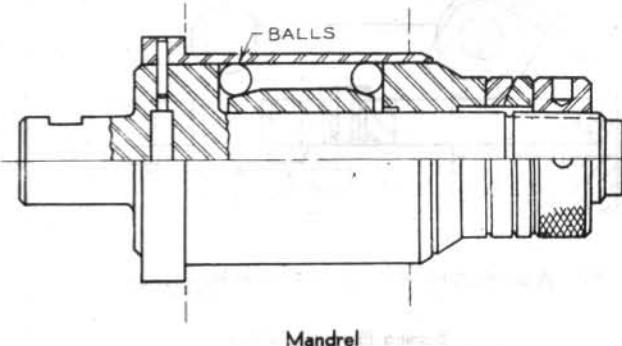
1009



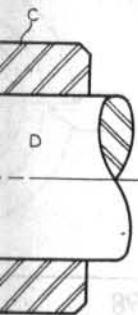
1010



1011



H GRIND

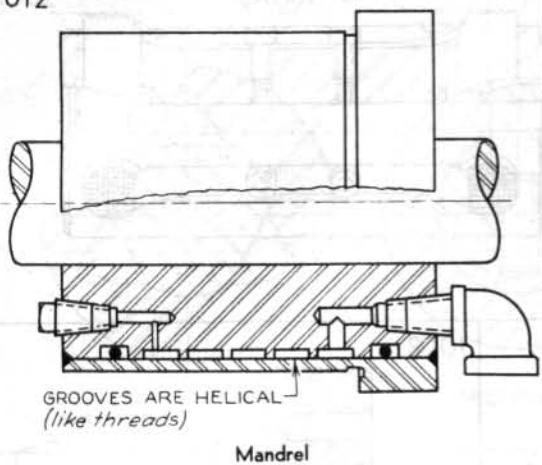


ated piston A
the two rocker
and C, to push
collet against
D.

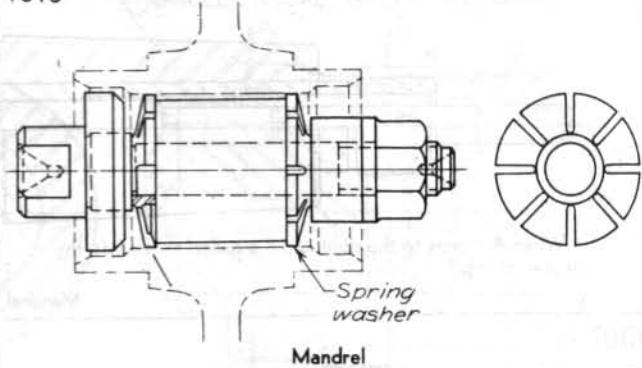
mp should spe-
in the oil cham-
and then screwing
ents oil from be-
e threads. This
designed for a
counterbores at
s on the edges
creating errors

1012-1017

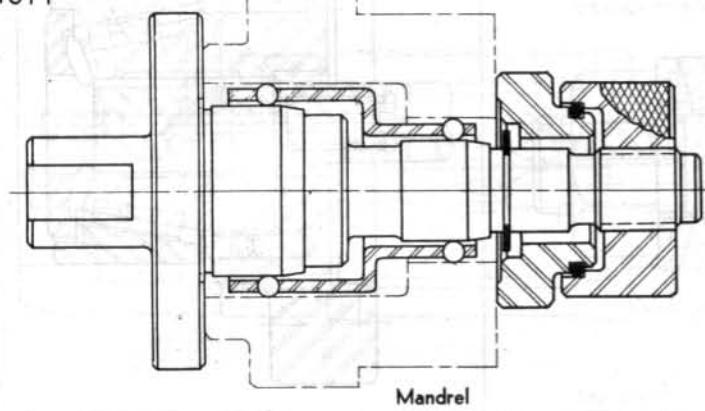
1012



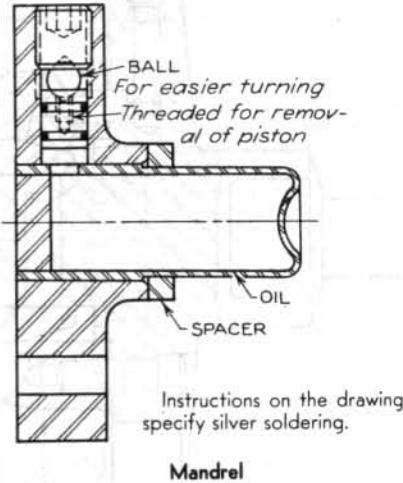
1013



1014



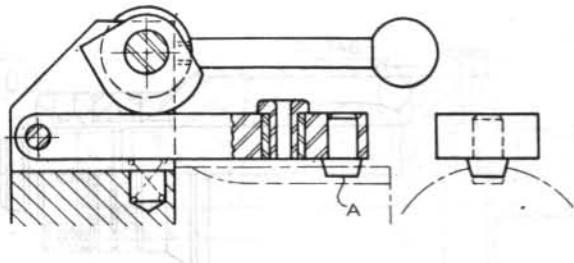
1015



BUSHING PLATES

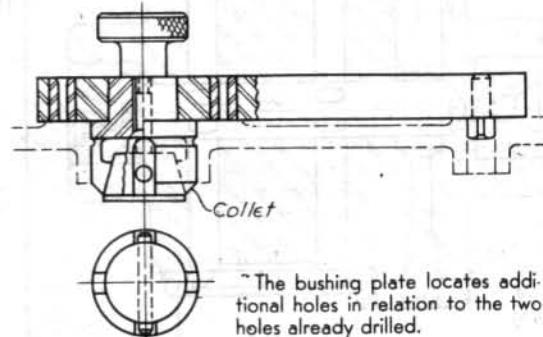
There are three types of bushing plates. The first is a top portion of a drill jig which raises and lowers it; the second is rotated out of position in order to clear the part; and the third is clamped directly to the part.

1016



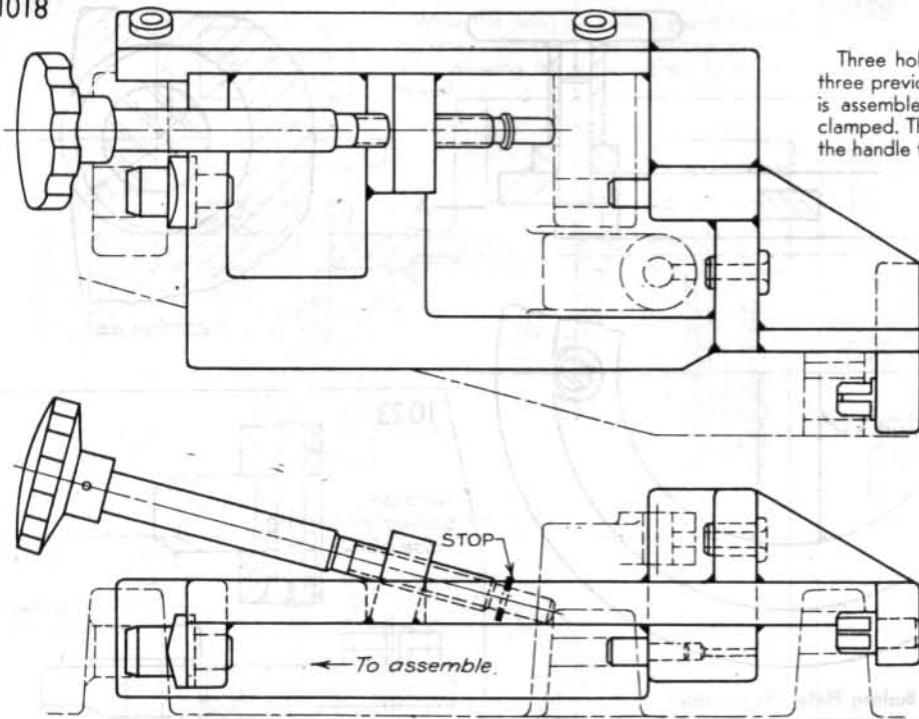
Bushing Plate (Rotating)

1017



Bushing Plate (Removable)

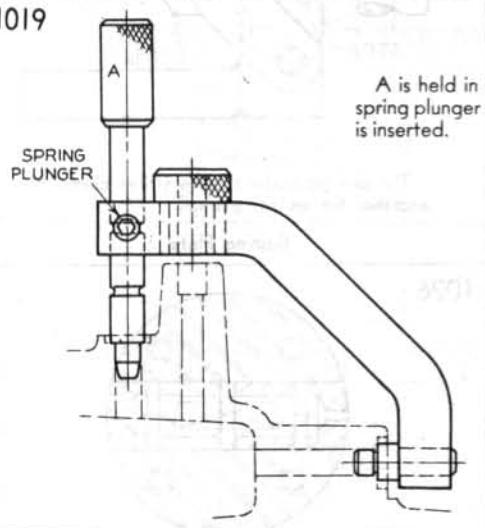
1018



Three holes are drilled in relation to three previously drilled holes. The plate is assembled from the right and then clamped. The stop prevents removal of the handle from the bushing plate.

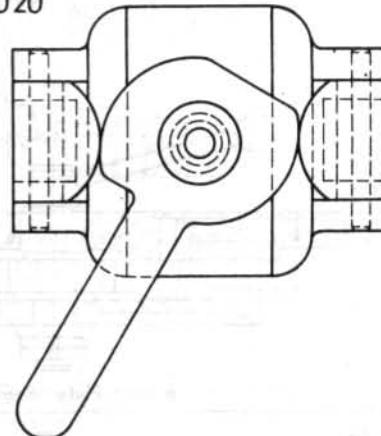
Bushing Plate (Removable)

1019

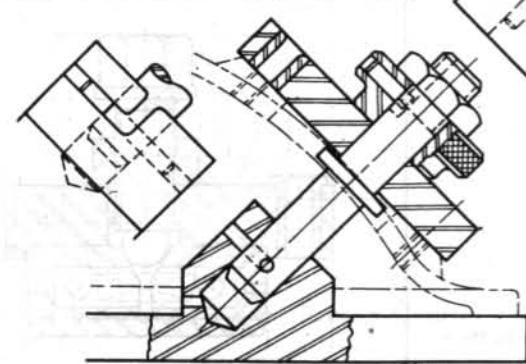


A is held in its raised position by the spring plunger until the right locating pin is inserted.

1020



1021



The hole is centered, between two rough surfaces.

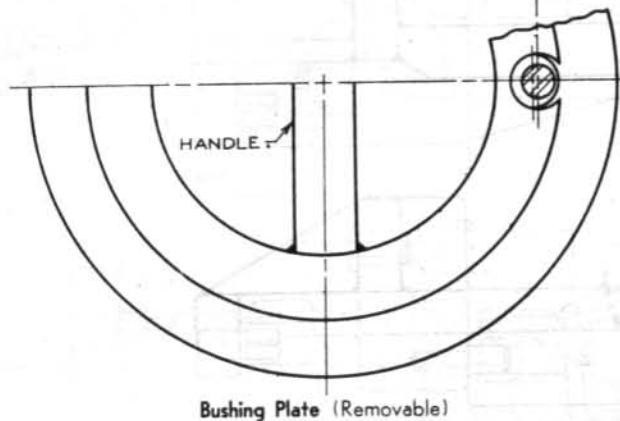
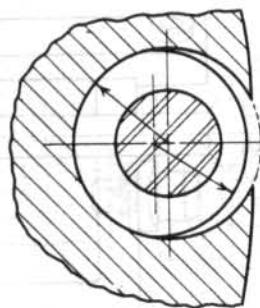
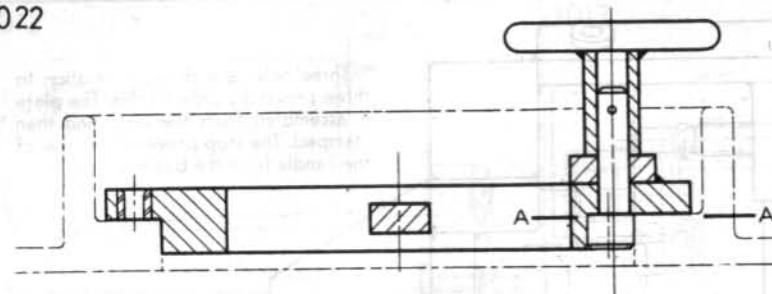
Bushing Plate (Removable)

The bayonet lock allows the bushing plate to be removed quickly.

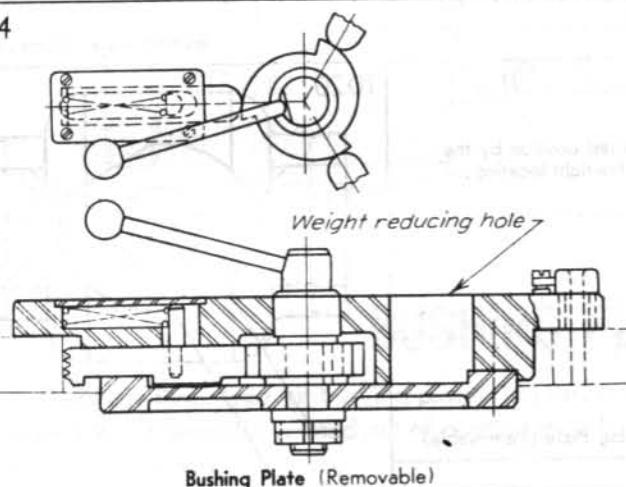
Bushing Plate (Removable)

1022-1026

1022

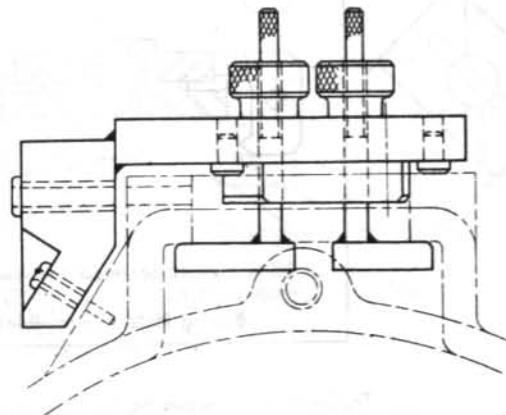


1024



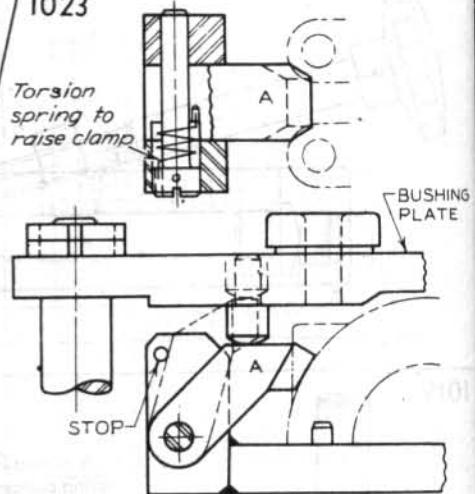
Bushing Plate (Removable)

1025



An inclined and a horizontal hole are positioned in relation to the bore and the top surface.
Bushing Plate (Removable)

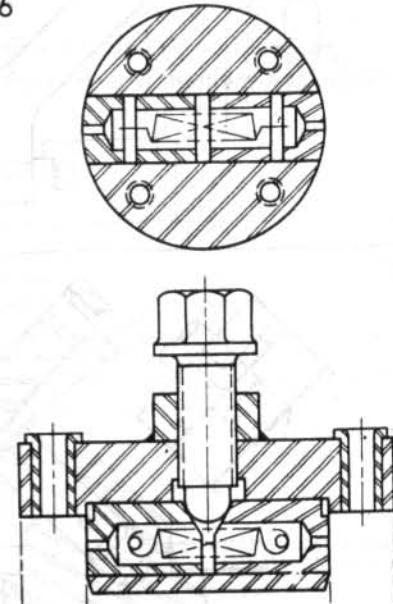
1023



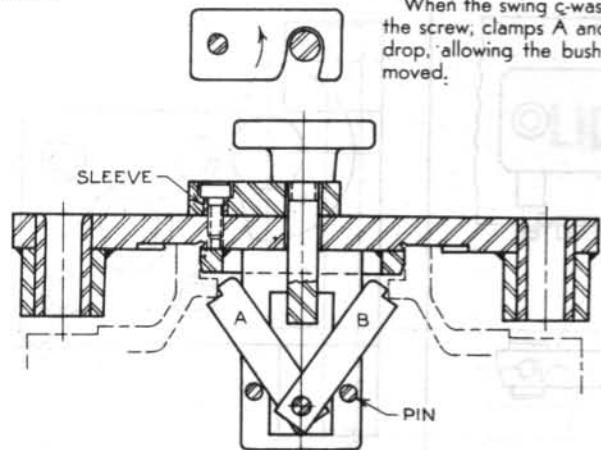
The drill jig bushing plate strikes clamp A and then forces it to clamp.

Bushing Plate

1026



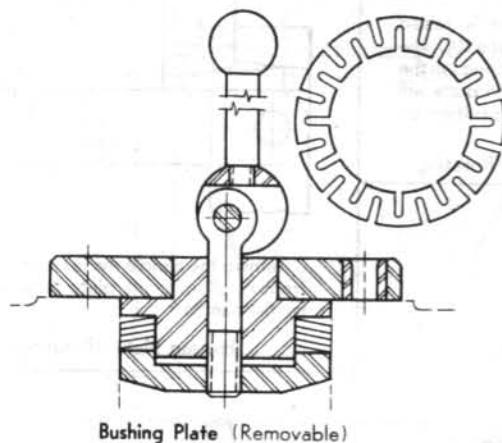
1027



When the swing c-washer is swung free of the screw, clamps A and B collapse as they drop, allowing the bushing plate to be removed.

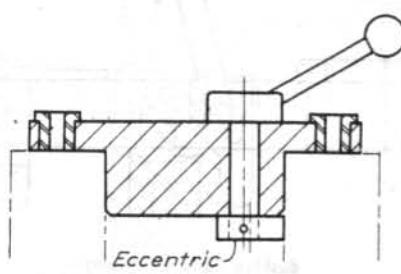
Bushing Plate (Removable)

1030



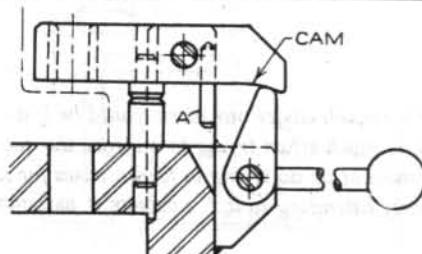
Bushing Plate (Removable)

1032



Bushing Plate (Removable)

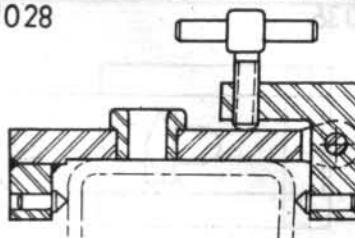
1034



When the handle is raised, the cam strikes pin A, thereby raising the plate.

Bushing Plate (Rotating)

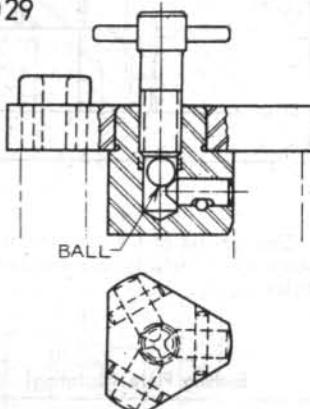
1028



The bushing plate locates a hole in relation to the left side.

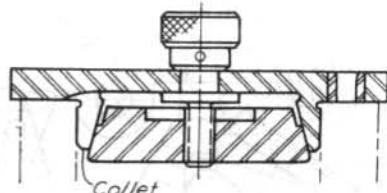
Bushing Plate (Removable)

1029



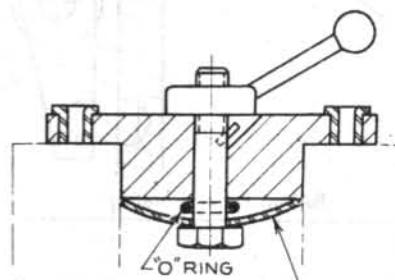
Bushing Plate (Removable)

1031

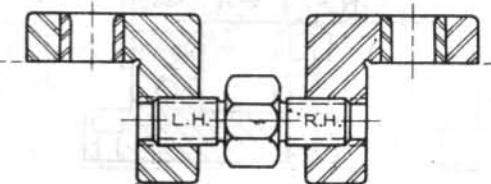


Bushing Plate (Removable)

1033

SLOTTED SPRING WASHER
Bushing Plate (Removable)

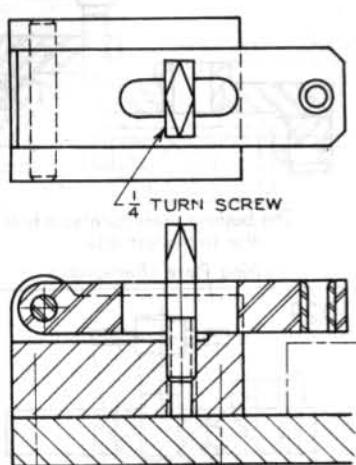
1035



Bushing Plate (Removable)

1036-1041

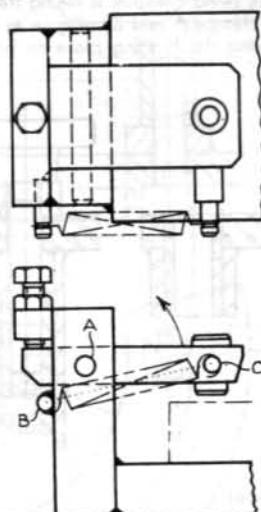
1036



One quarter of a turn of the thumb screw will unclamp the plate, allowing it to be raised.

Bushing Plate (Rotating)

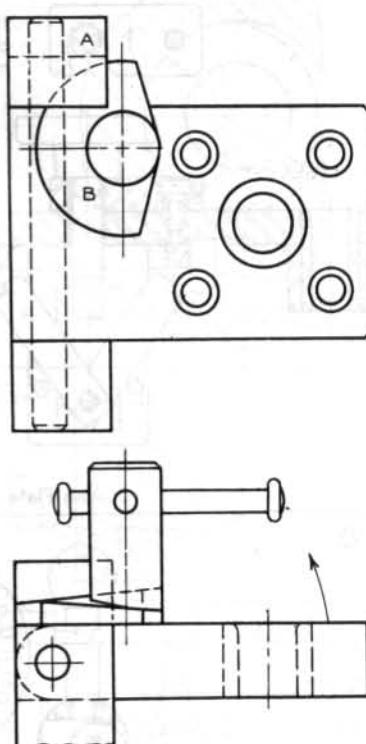
1037



When the plate is raised high enough to place B,C, the centerline of the spring, on the other side of A, the plate will be held in open position by the spring.

Bushing Plate (Rotating)

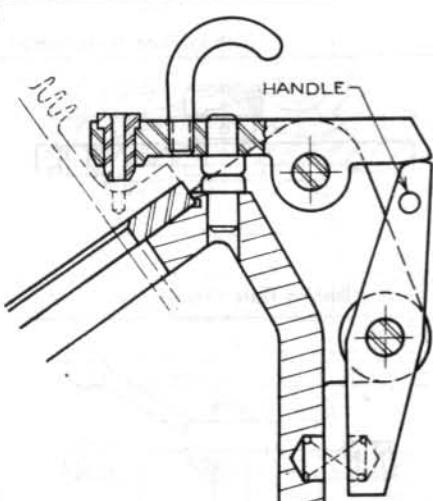
1038



Turning the handle moves cam B away from A, allowing the plate to be swung by the handle.

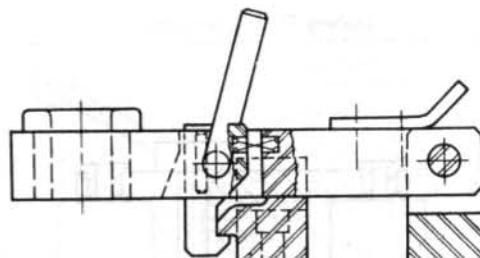
Bushing Plate (Rotating)

1039



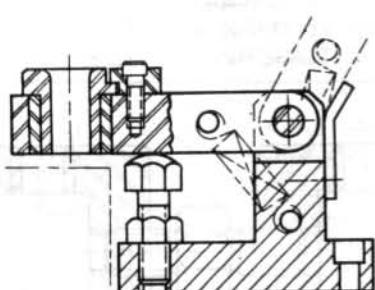
Bushing Plate (Rotating)

1040



Bushing Plate (Rotating)

1041



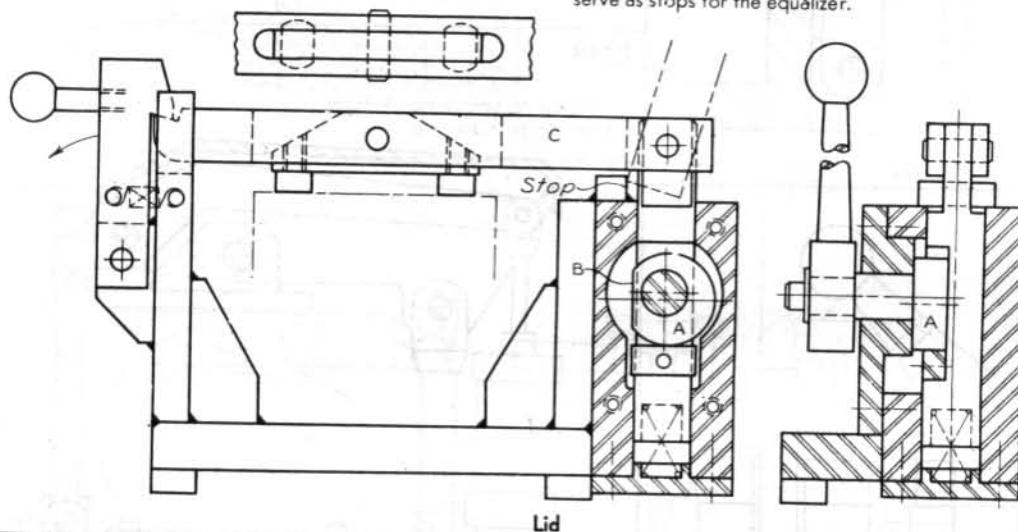
Bushing Plate (Rotating)

"How much easier our work would be if we put forth as much effort trying to improve the quality of it as most of us do trying to find excuses for not properly attending to it." GEORGE W. BALLINGER

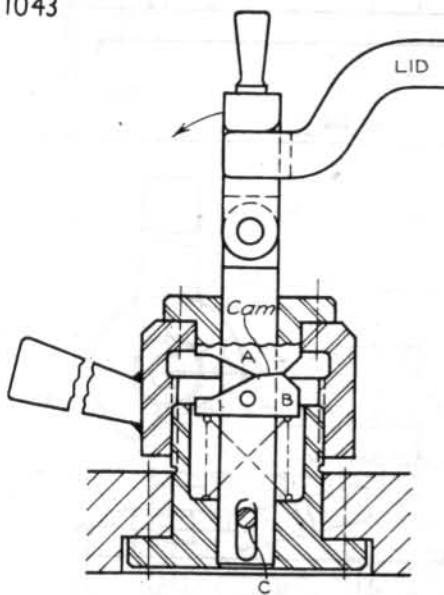
LIDS

1042

Eccentric A clamps lid C. Flat B allows the spring to raise C to its maximum height. Note how the equalizer pads also serve as stops for the equalizer.



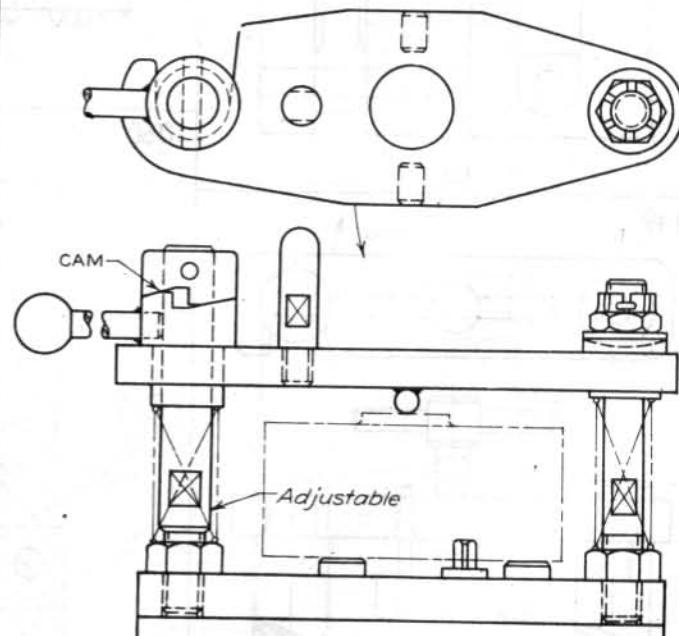
1043



Cam A forces down B, which is pinned to the post, thereby clamping the lid. Pin C prevents the post from rotating.

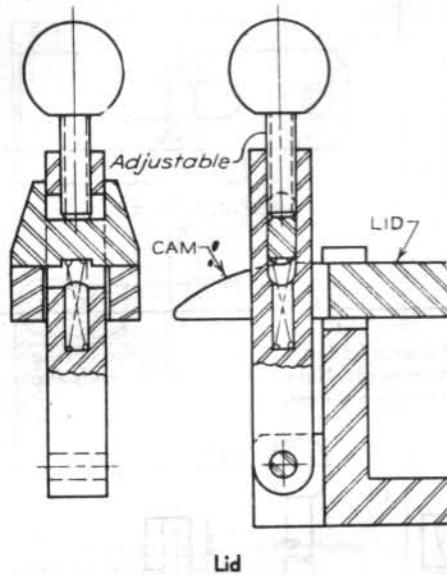
Lid

1044

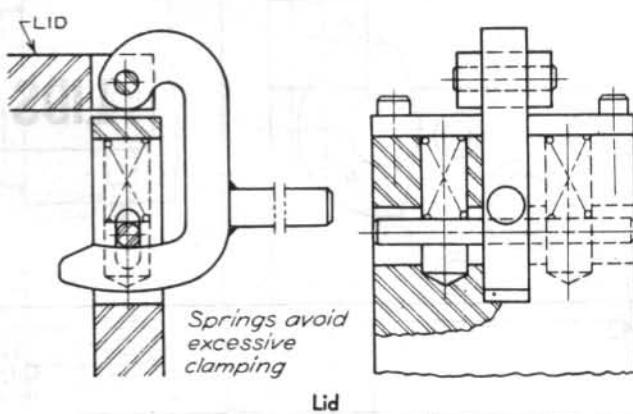


Lid

1045

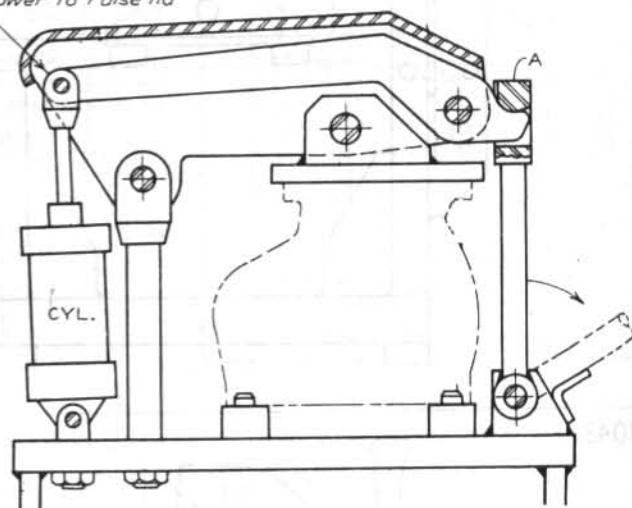


1046

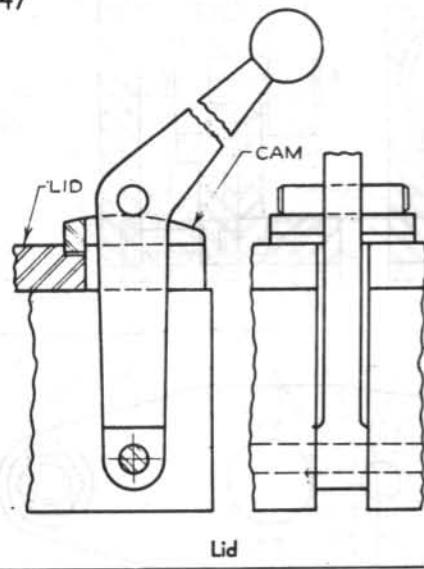


1048

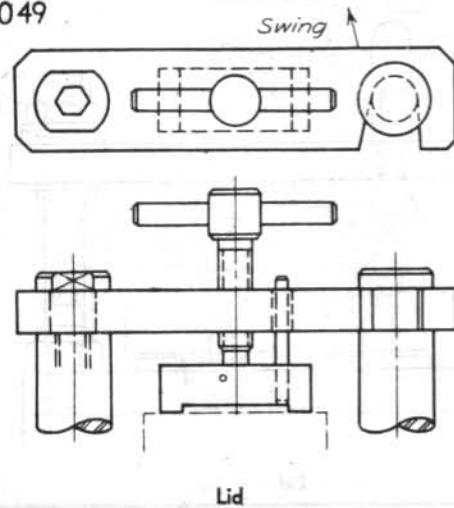
Raise to unclamp A then lower to raise lid



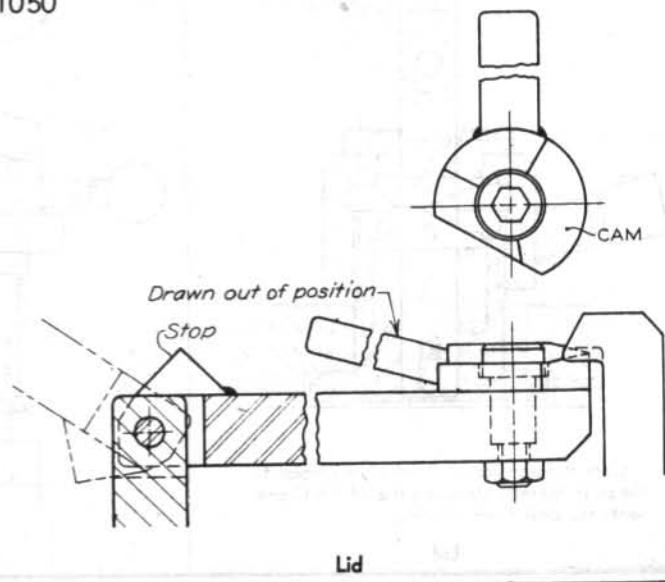
1047



1049

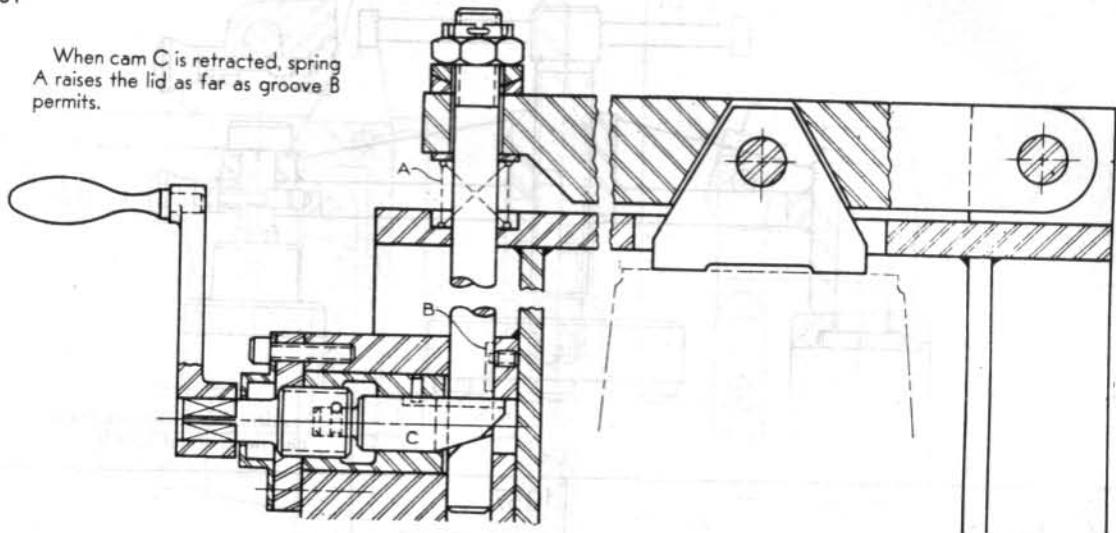


1050



1051

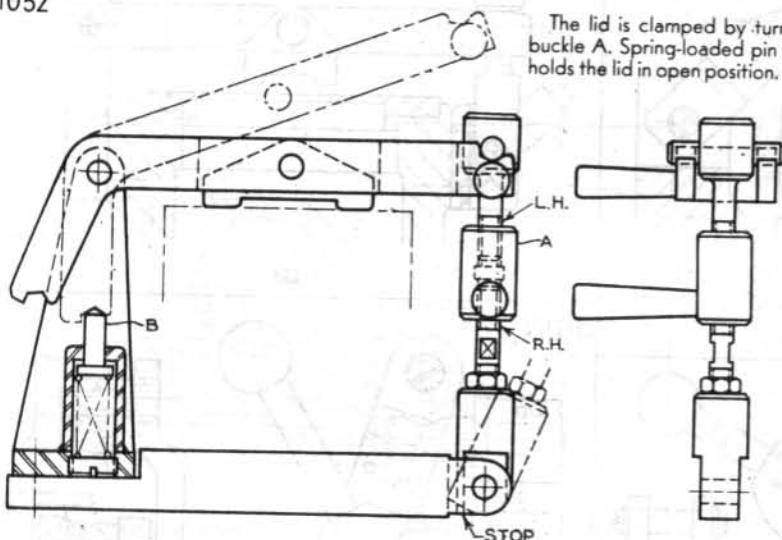
When cam C is retracted, spring A raises the lid as far as groove B permits.



Lid

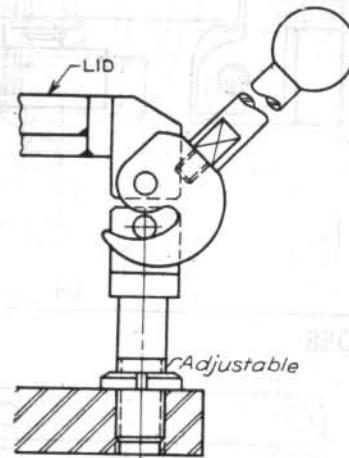
1052

The lid is clamped by turn-buckle A. Spring-loaded pin B holds the lid in open position.



Lid

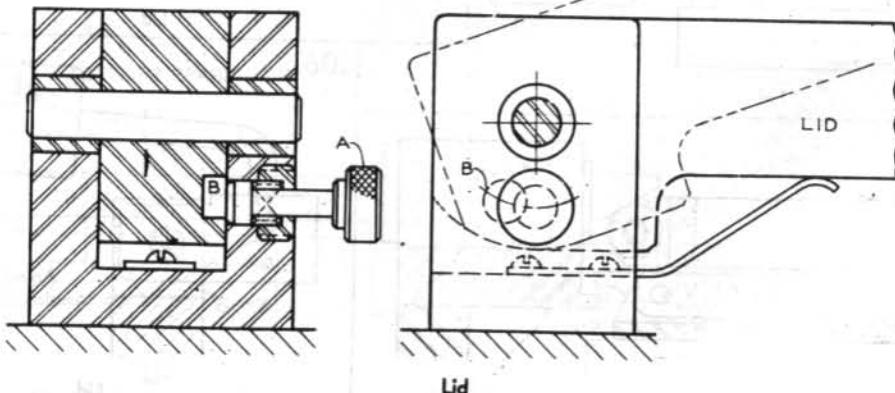
1053



Lid

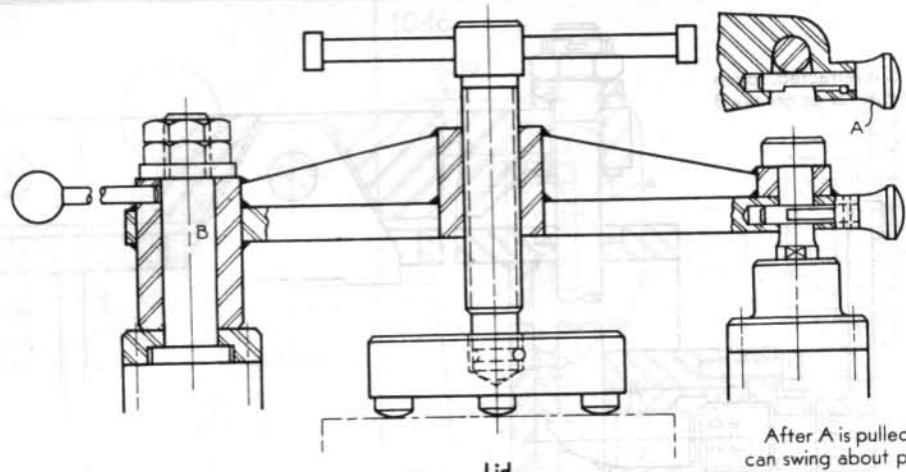
1054

Lid is held open by plunger A in hole B.



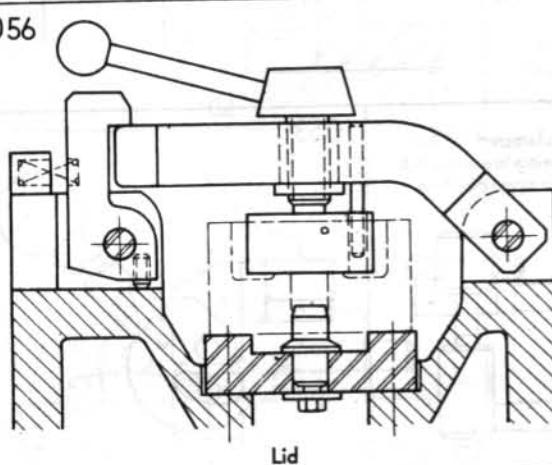
1055-1061

1055

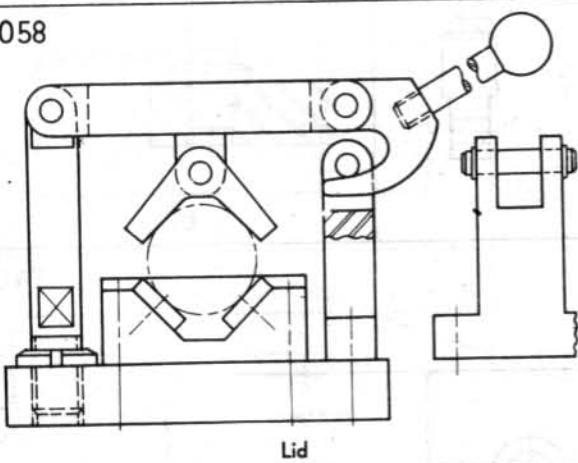


After A is pulled out, the lid can swing about post B.

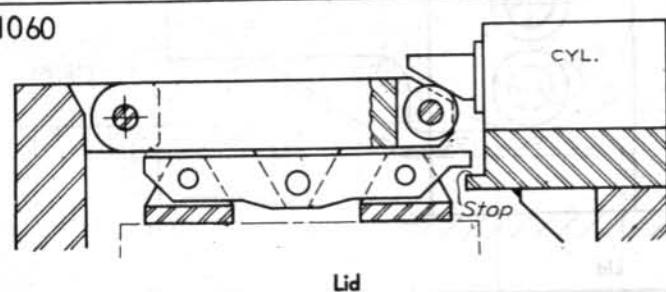
1056



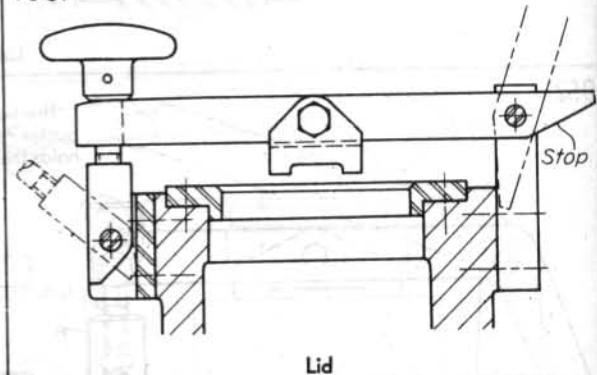
1058



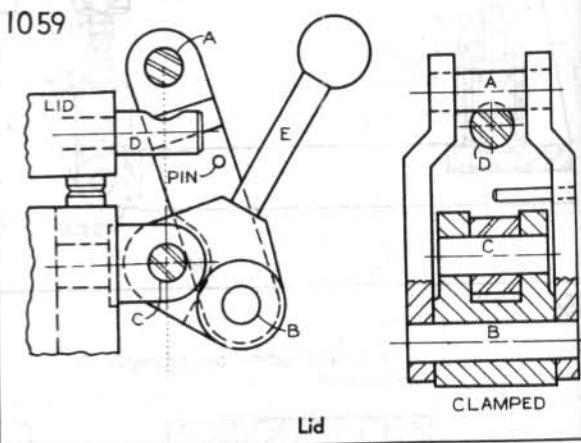
1060



1057

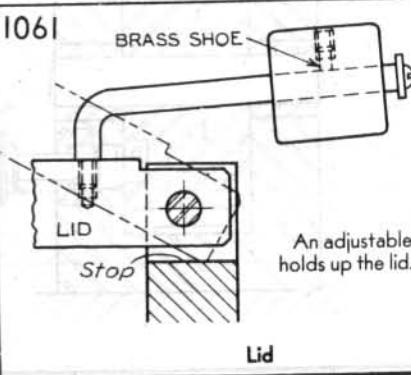


1059



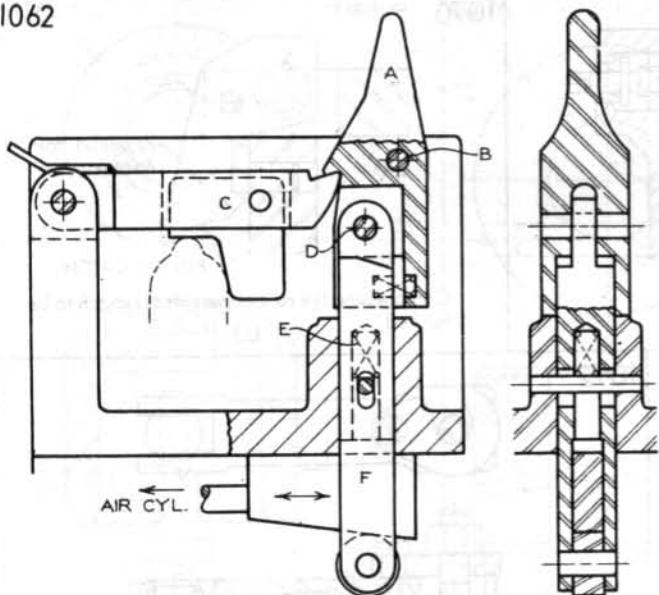
Lid

1061



Lid

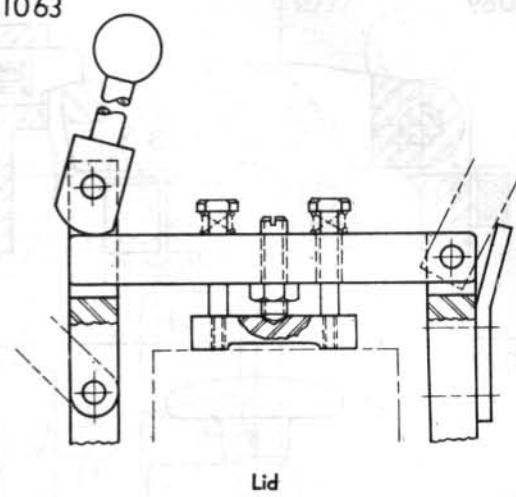
1062



Because pin D is offset in relation to B, post F is allowed to actuate A to pull down lid C. During the unclamping action, spring E raises F and catch A.

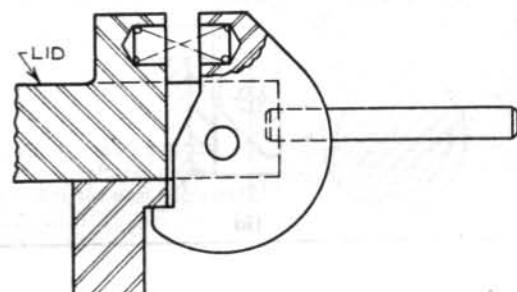
Lid

1063



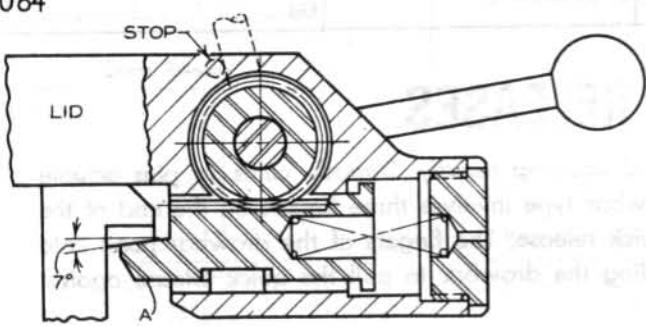
Lid

1065



Lid

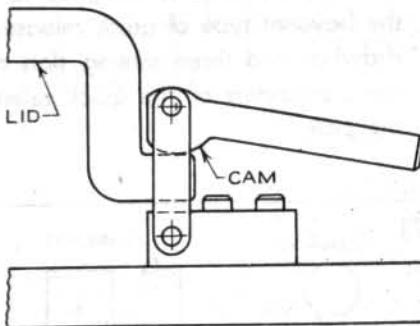
1064



Spring-loaded catch A is clamped and unclamped by a rack and a pinion.

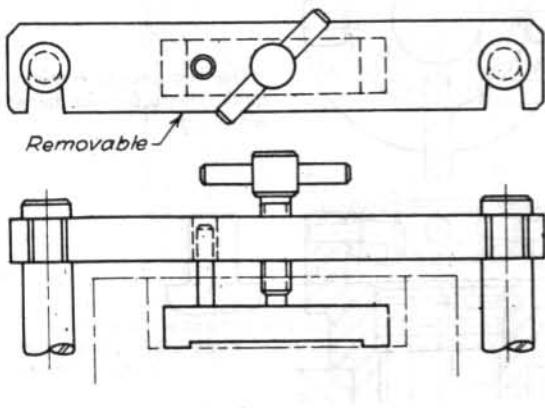
Lid

1066



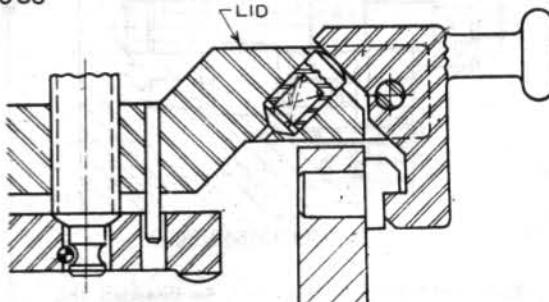
Lid

1067



Lid

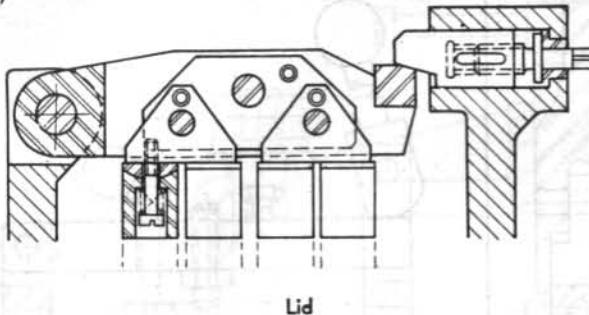
1068



Lid

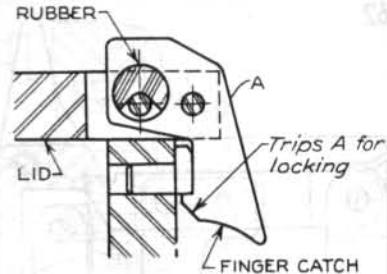
1069-1074

1069



Lid

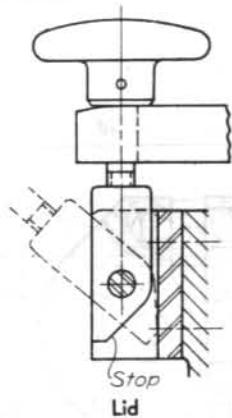
1070



Compressing the rubber permits the catch to be unhooked.

Lid

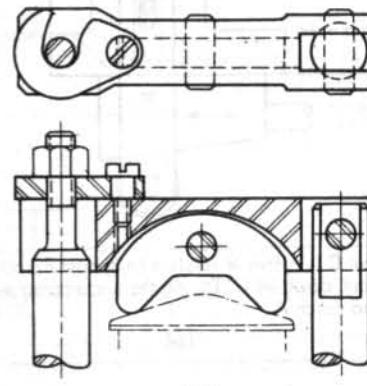
1071



Stop

Lid

1072

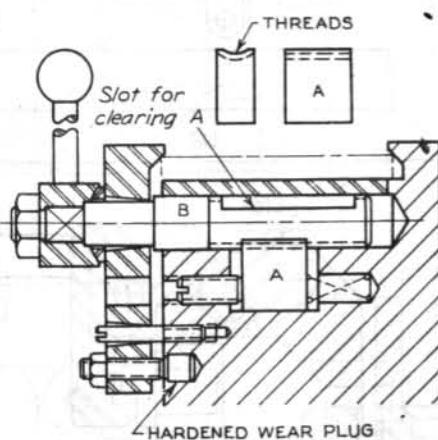


Lid

QUICK RELEASES

A quick release is designed to clamp and unclamp rapidly. Threads, cams, or pins actuate the bayonet type of quick release. The drawbar type involves three fingers on the end of the drawbar and three mating slots on the quick release. The fingers of the drawbar hook onto three shoulders of the quick release, enabling the drawbar to pull the quick release against the part.

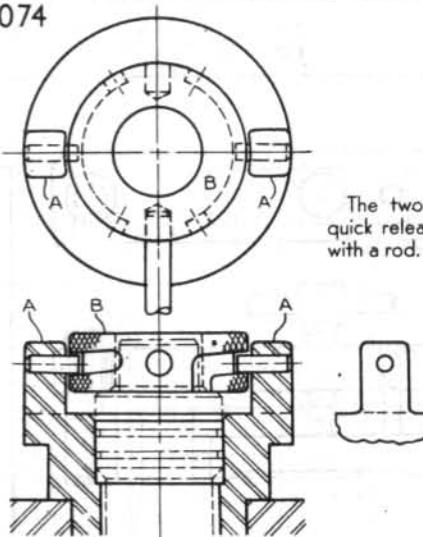
1073



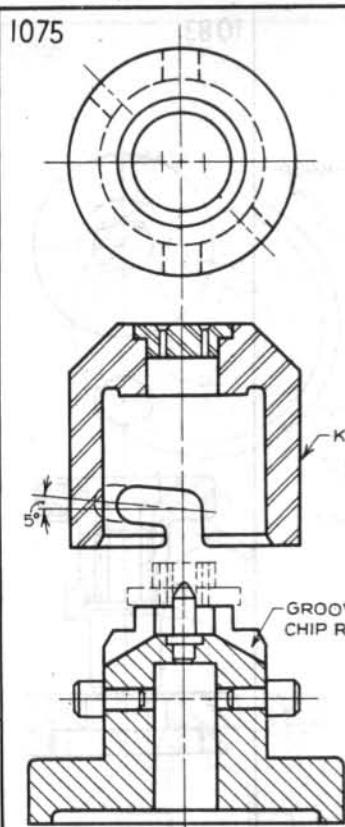
Both shaft B and fractional nut A are threaded. This is a modified bayonet type of quick release.

Quick Release

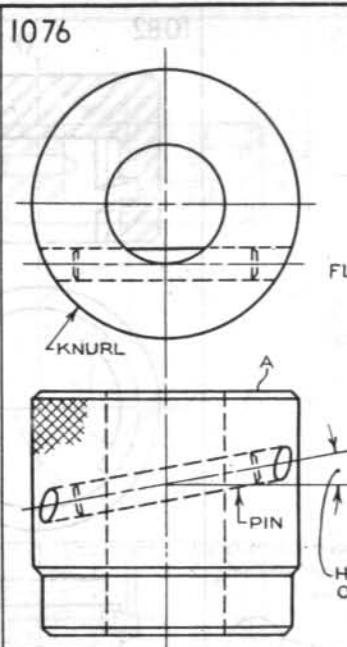
1074



Quick Release

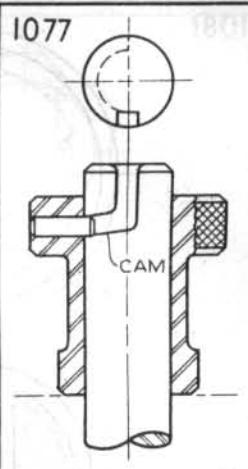


Quick Release



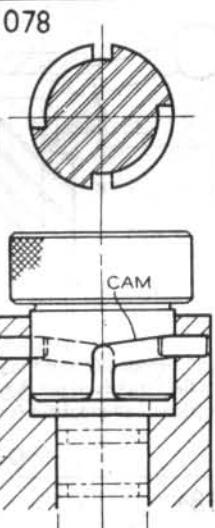
Note that a flat is needed on shaft B to allow A to be placed over the shaft. The angle of the pin must be identical to the small angle of the helical cam.

Quick Release



In this one pin and cam design, clockwise clamping is preferred.

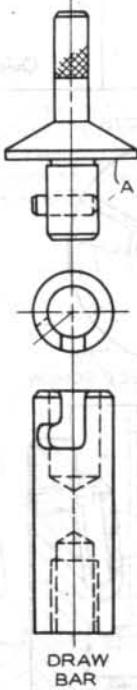
Quick Release



A Two Pin and Cam Design.

Quick Release

1079

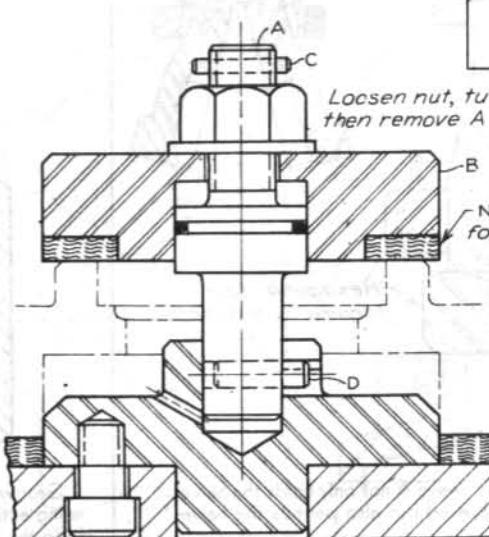


After the pin is inserted and turned, the drawbar pulls down, clamping A against the part.

Quick Release

1080

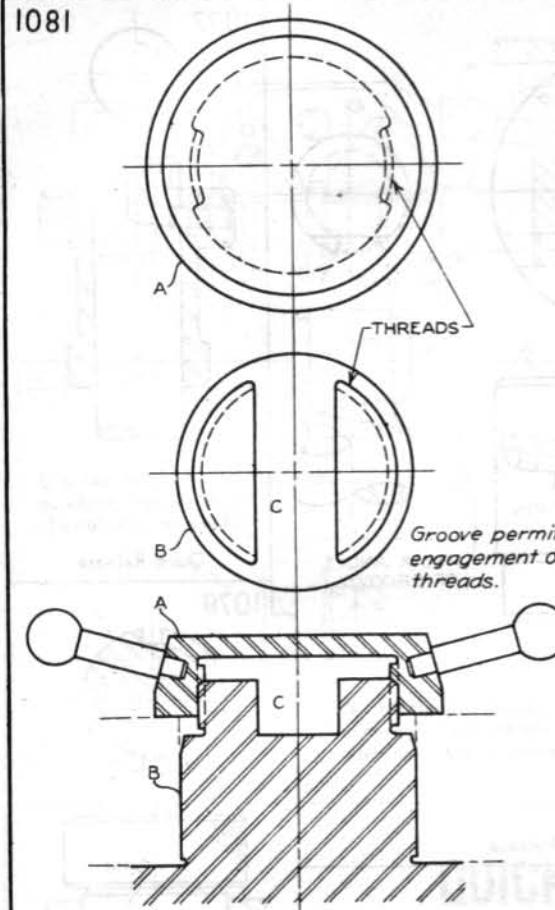
Pin C restricts the movement of the nut and indicates the direction of hook pin D. Note the air vent.



Quick Release

1081-1085

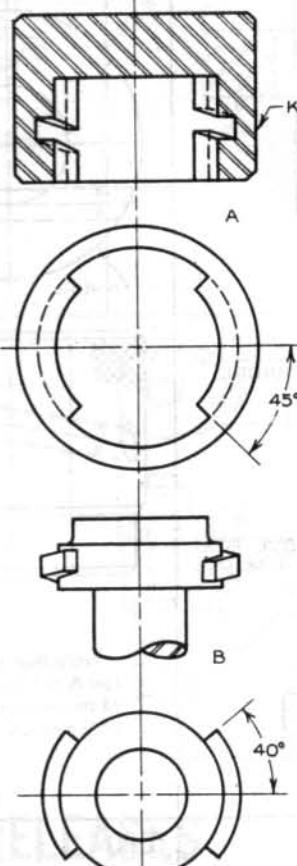
1081



Groove C and the partial threads of B allow the partial threads of nut A to engage those of B. Only a fraction of a turn of nut A clamps it against the part.

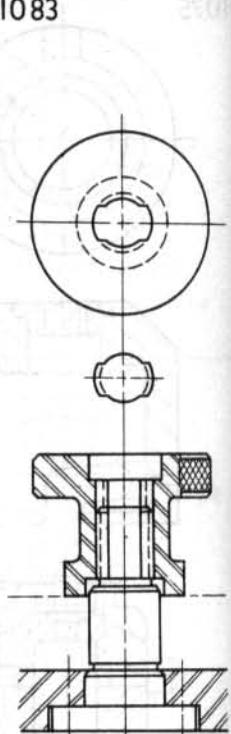
Quick Release

1082



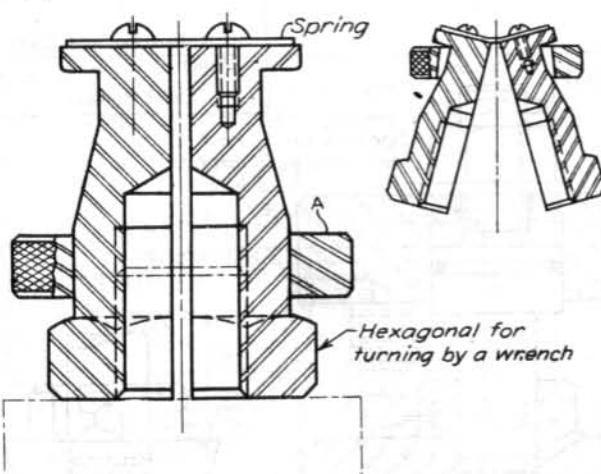
Quick Release

1083



Quick Release

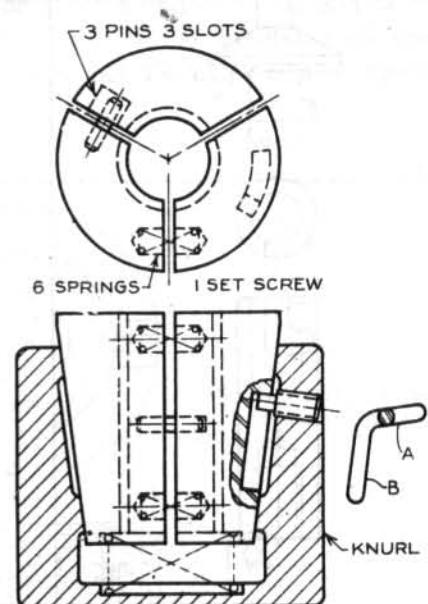
1084



In this quick release nut, sleeve A not only holds the halves together as the nut is tightened but also permits the halves to be quickly released.

Quick Release

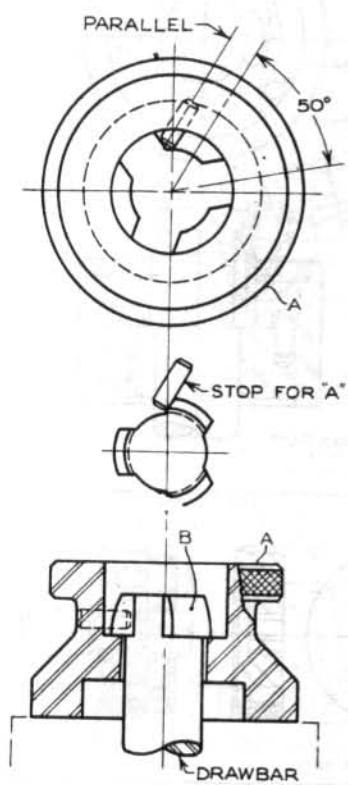
1085



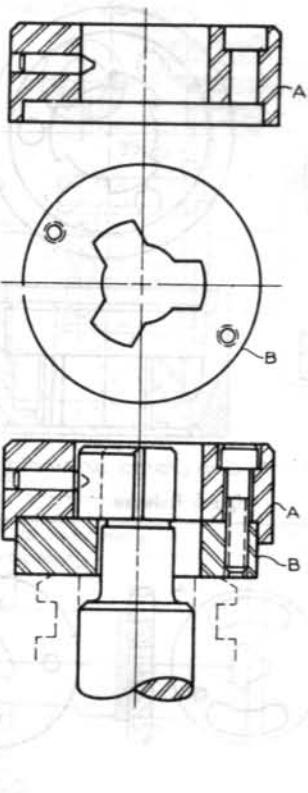
Groove B creates the quick release and cam A the tightening action in the quick release nut. The three pins and slots keep the threads of each section in the proper relationship.

Quick Release

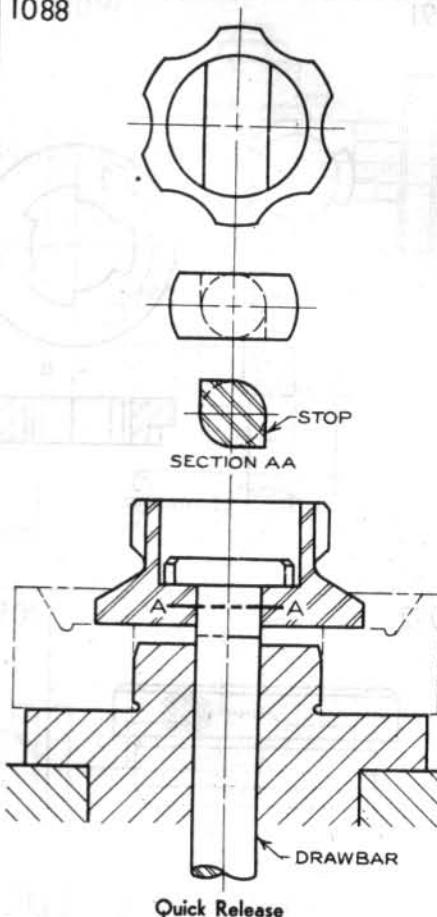
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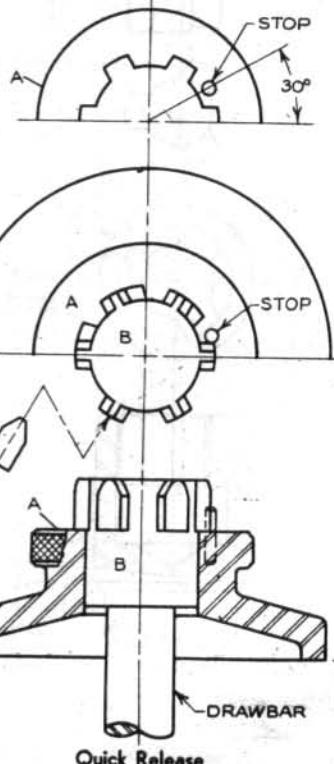
1087



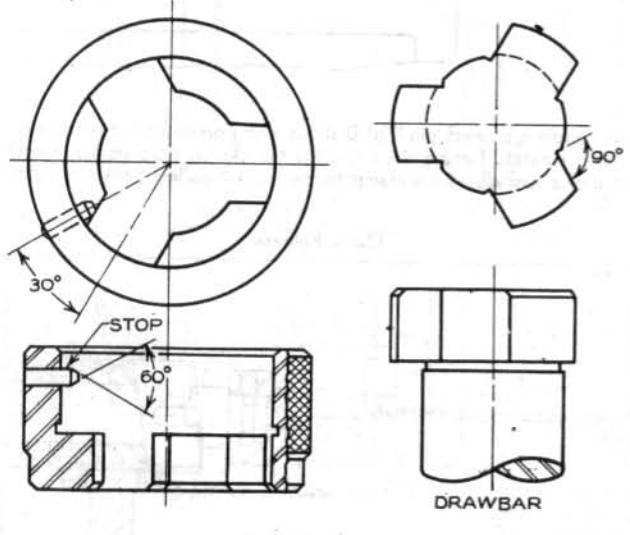
1088



1090

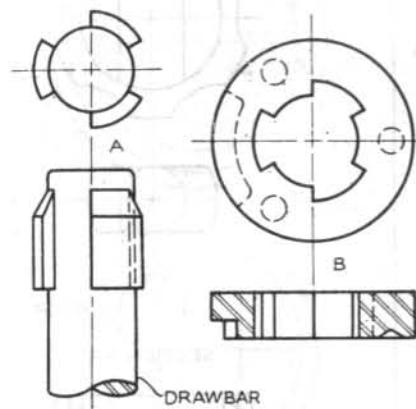


1089



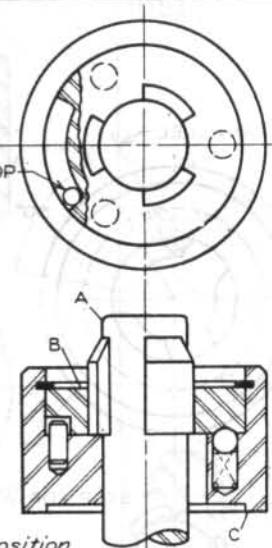
Quick Release

1091

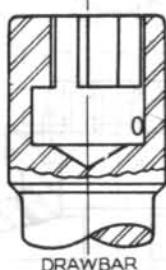
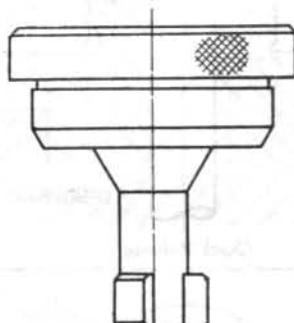


Balls hold C in clamp or unclamp position

Quick Release

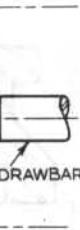
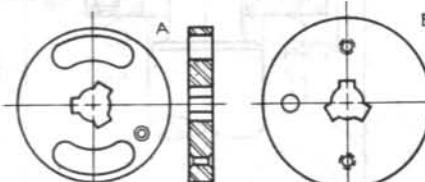
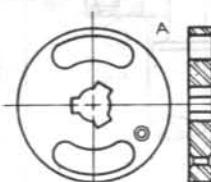


1092



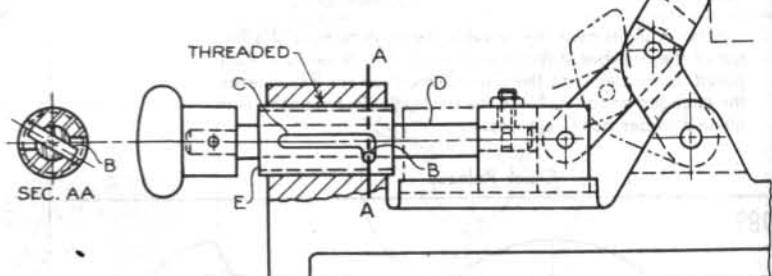
Quick Release

1093



Quick Release

1094

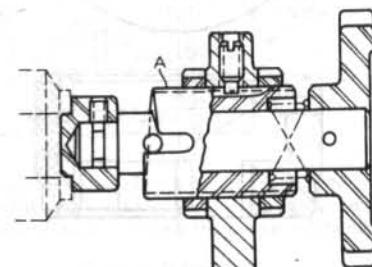


As the handle is pushed, pin B of D slides along groove C of nut E and then turns into the catch. Turning nut E cinches the clamp. Conversely, releasing E a fraction of a turn allows the clamp to be quickly pulled back the length of groove C.

Quick Release

1095

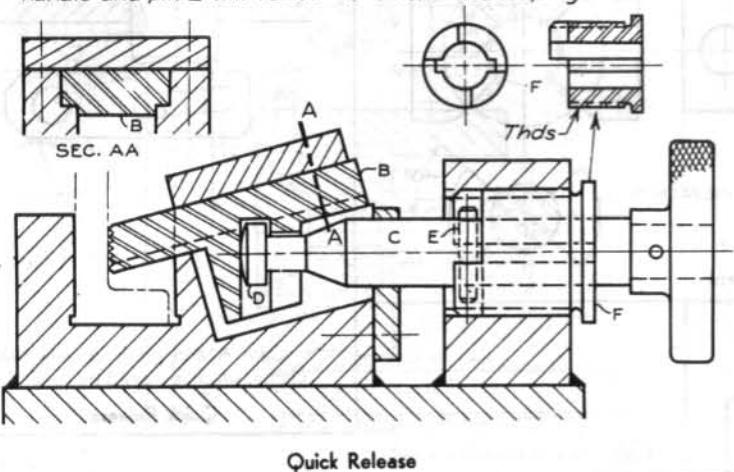
The cam can be adjusted by turning nut A.



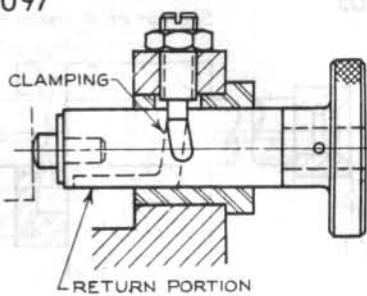
Quick Release

1096

Pin E slides in keyways of F until B contacts the part. Turn handle and pin E will turn F to cinch the clamping.

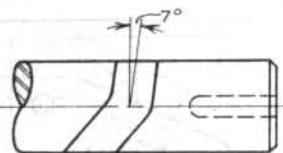


1097



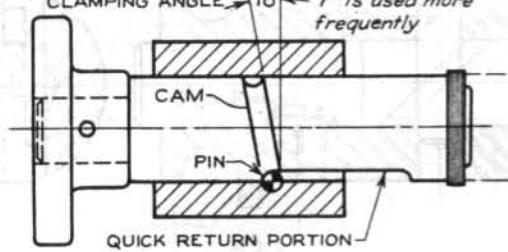
The end of the groove is a built-in stop.

Quick Release



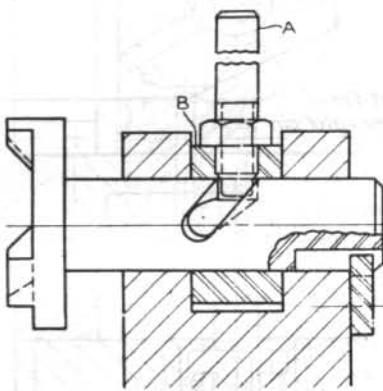
1098

CLAMPING ANGLE 10° 7° is used more frequently



The cam cinches the clamp and the flat provides a quick return.
Quick Release

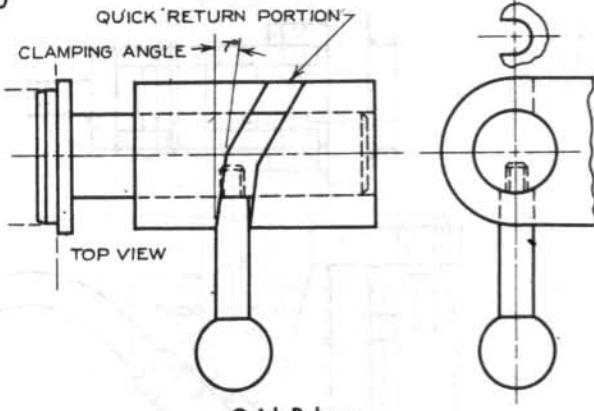
1099



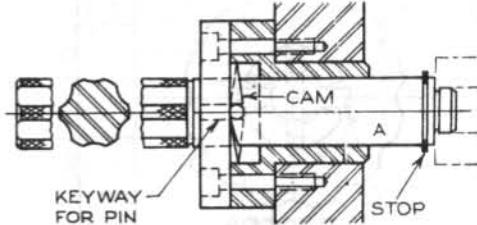
Handle A rotates nut B and provides a follower for the cam.

Quick Release

1100



1101

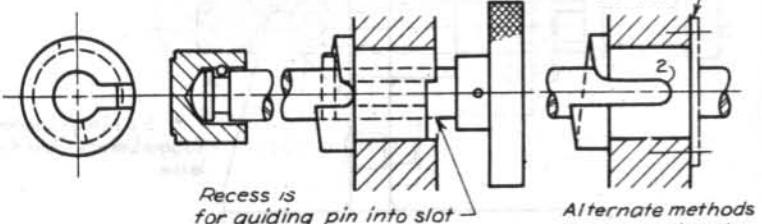


KEYWAY FOR PIN

The keyway in the cam permits the quick return of A. There are two cams in this design, one for each end of the pin. Note the need for a stop.

1102

Recess is for guiding pin into slot



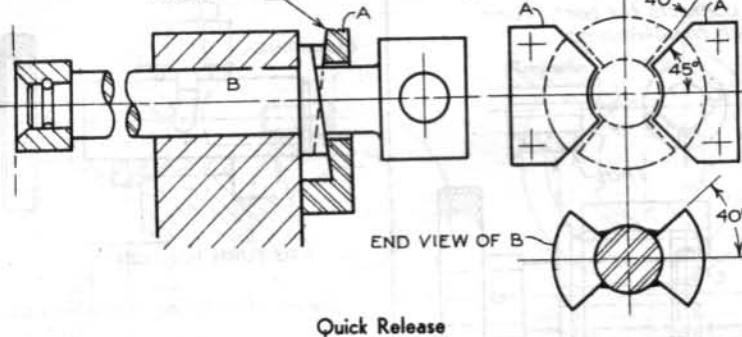
Alternate methods for preventing the removal of pin

Quick Release

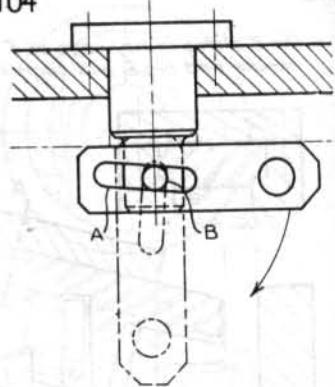
1103-1108

1103

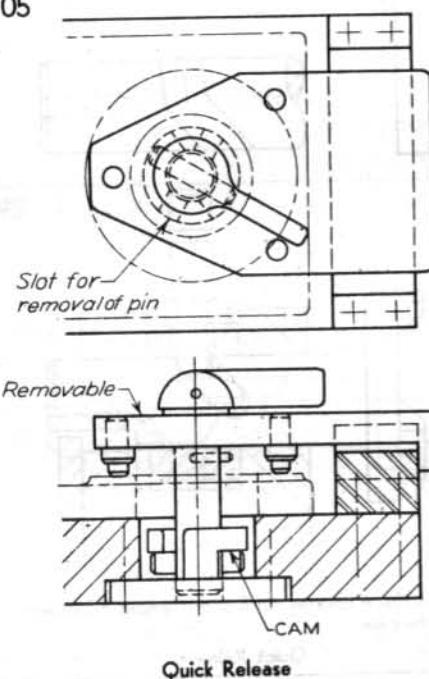
Section of A taken horizontally



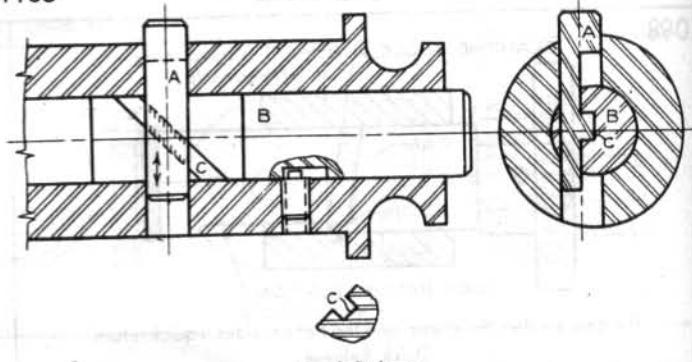
1104



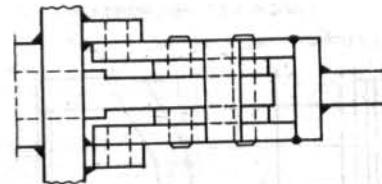
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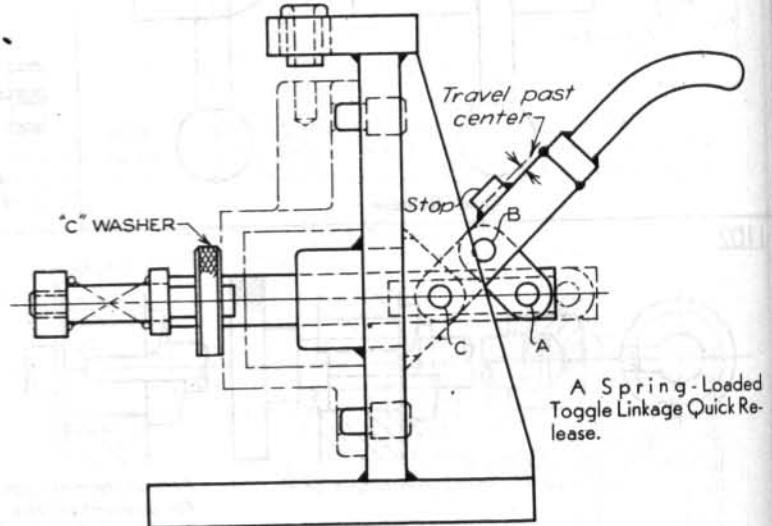
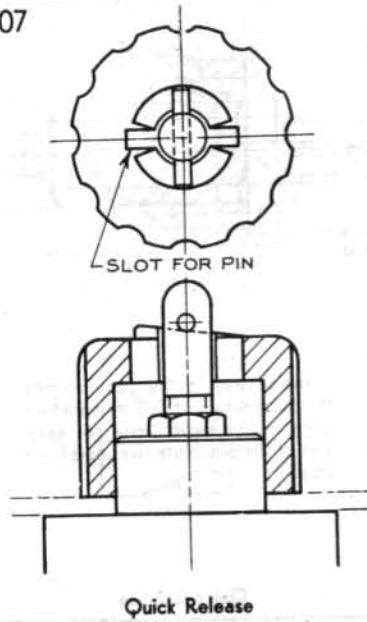
1106



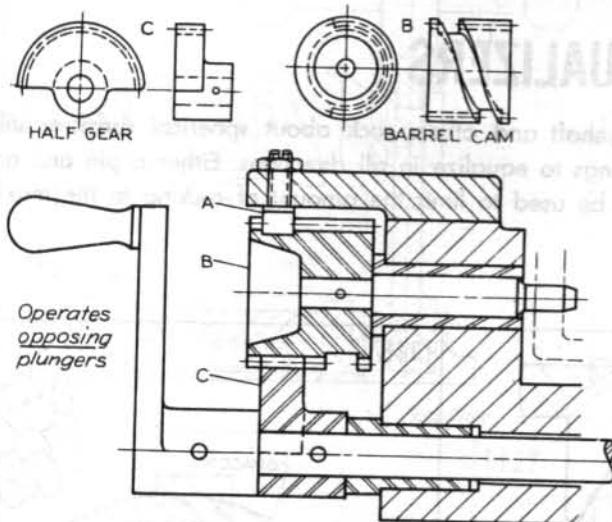
1108



1107



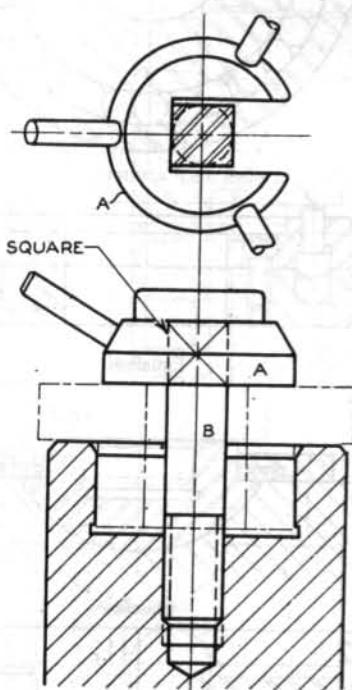
1109



Follower A engages barrel cam B which moves the plunger. The end of the cam groove acts as a stop for the fractional gears.

Quick Release

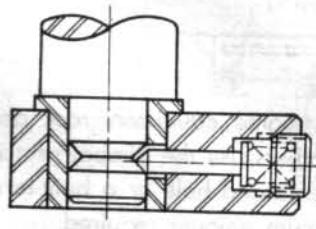
1112



The c-washer also tightens bolt B.

Quick Release

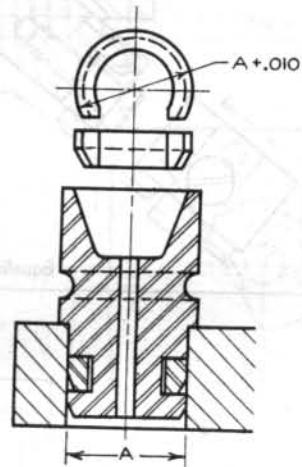
1110



The shaft may be readily snapped in and out.

Quick Release

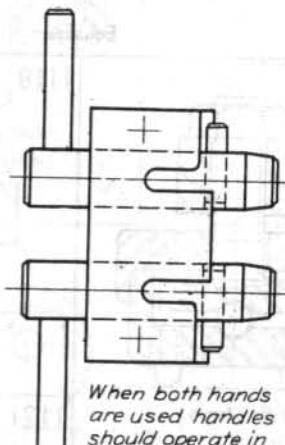
1111



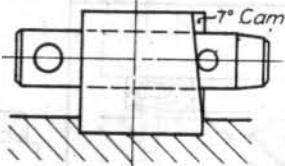
The shaft may be readily snapped in and out.

Quick Release

1113



When both hands are used handles should operate in opposite directions

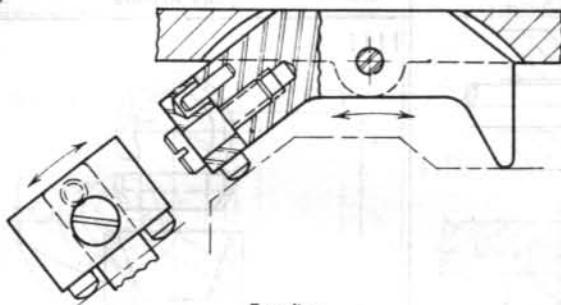


Quick Release

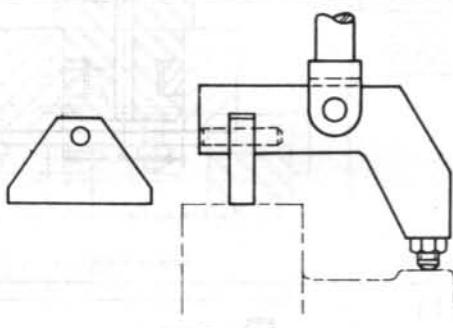
EQUALIZERS

Some equalizers rock about a small shaft and others rock about spherical surfaces; still others use the gimbal principle or "o" rings to equalize in all directions. Either a pin and an enlarged hole or a built-in method may be used to limit the amount of rocking to the maximum amount required.

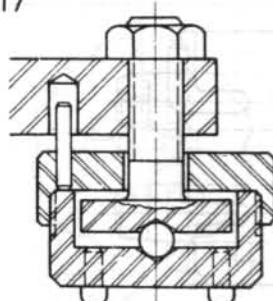
1114



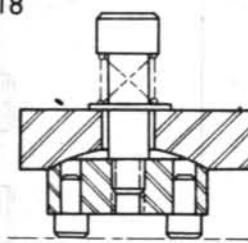
1116



1117

3 Buttons
Equalizer

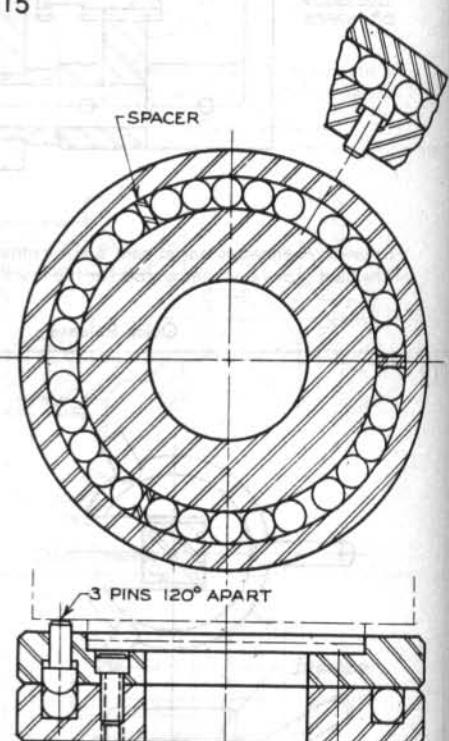
1118



3 BUTTONS 120° APART

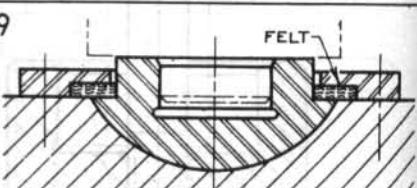
Equalizer

1115



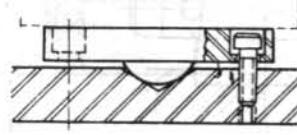
Equalizer

1119



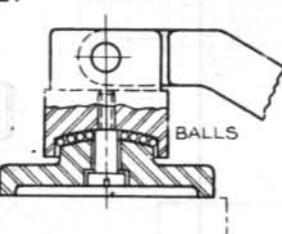
Equalizer

1120

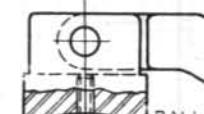


Equalizer

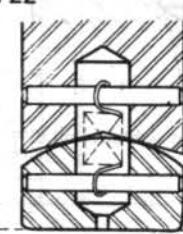
1121



Equalizer

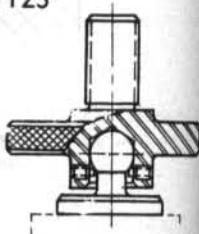


1122



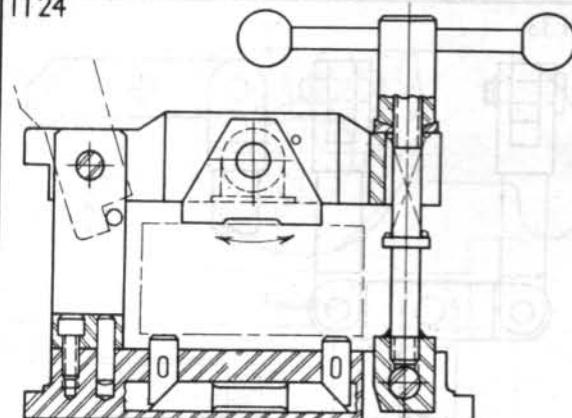
Equalizer

1123



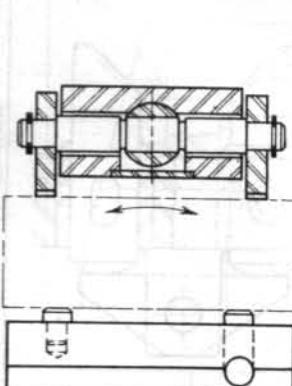
Equalizer

1124



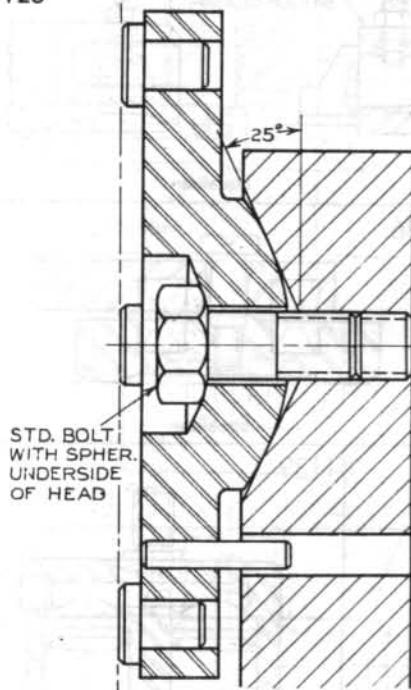
Equalizer

1125



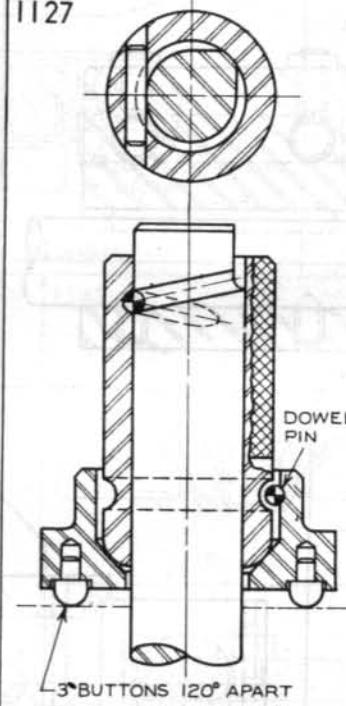
Equalizer

1126



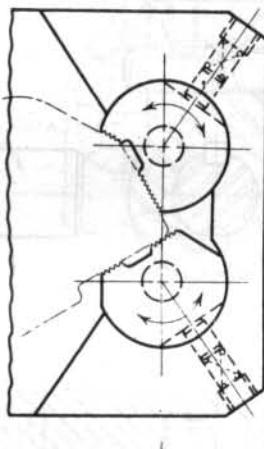
Equalizer

1127



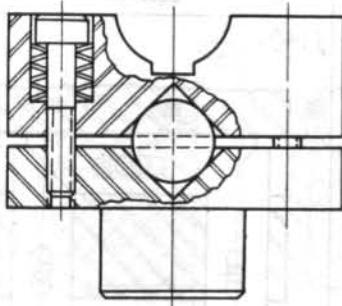
Equalizer

1128



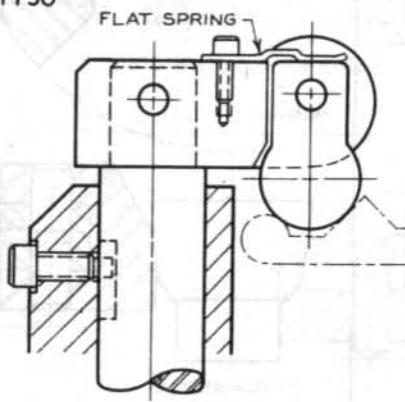
Equalizer

1129



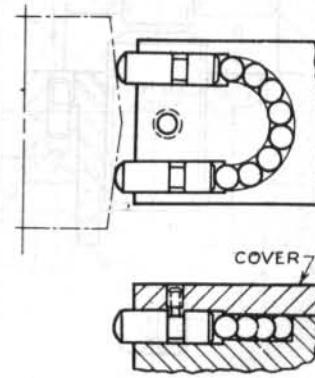
Equalizer

1130



Equalizer

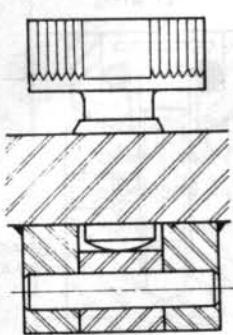
1131



Equalizer

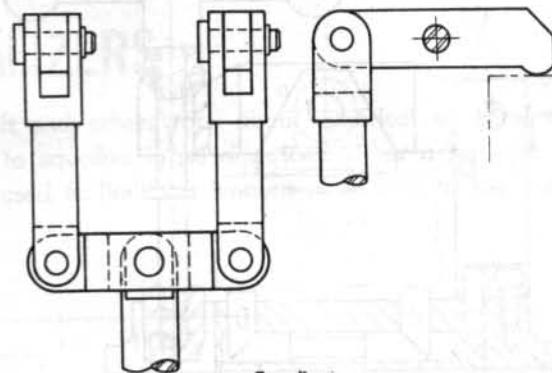
1132-1140

1132



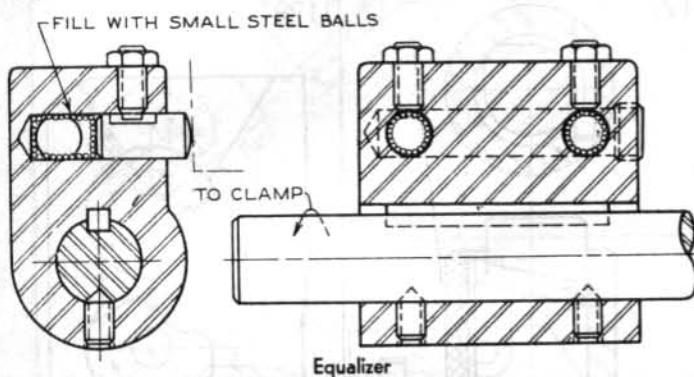
Equalizer

1133



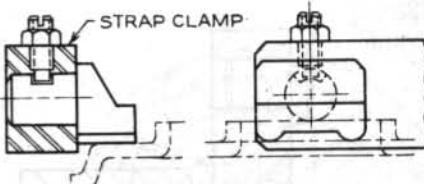
Equalizer

1134



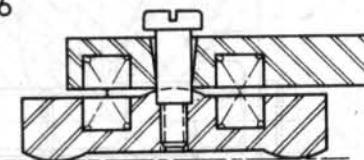
Equalizer

1135



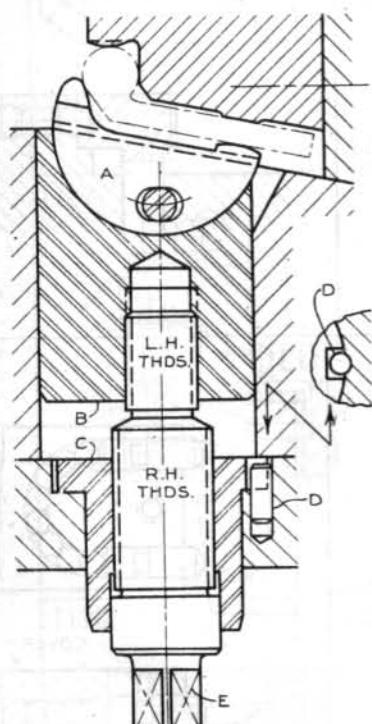
Equalizer

1136



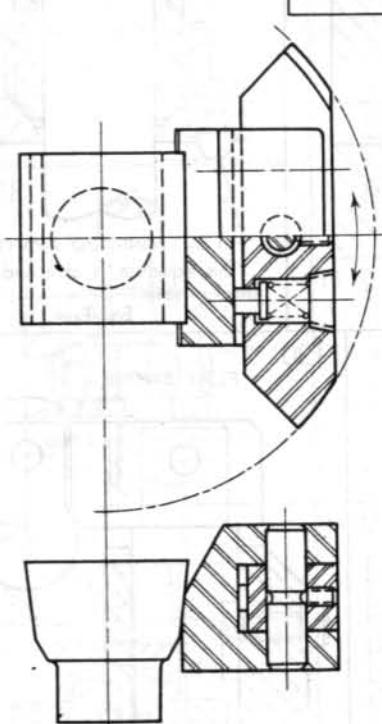
Equalizer

1137



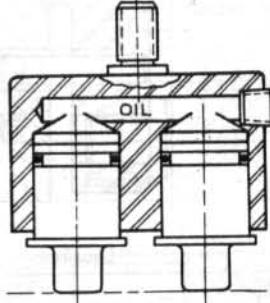
Equalizer

1138



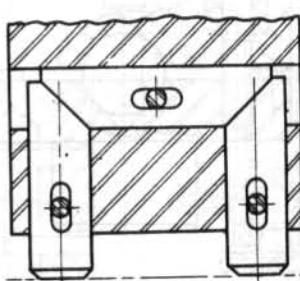
Equalizer

1139

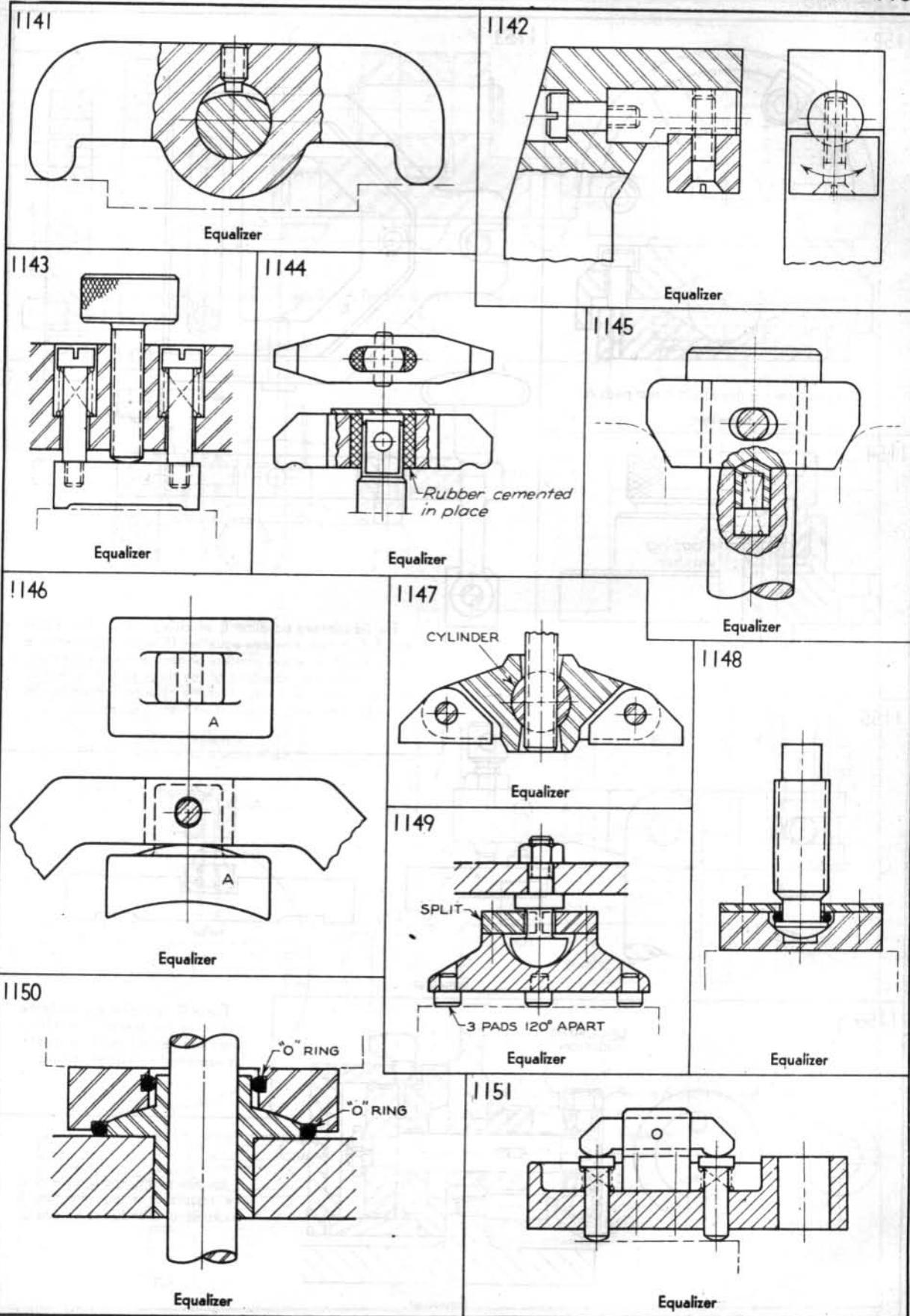


Equalizer

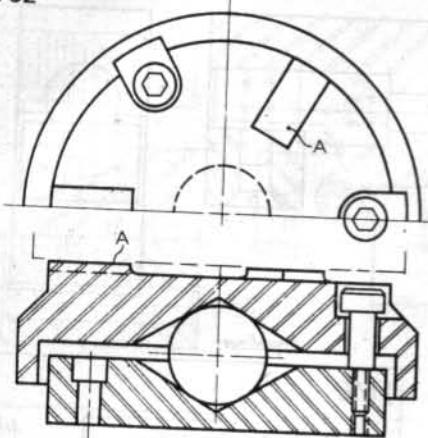
1140



Equalizer

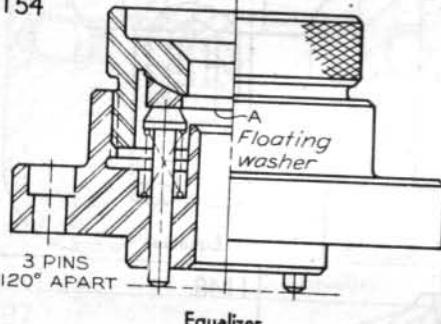


1152



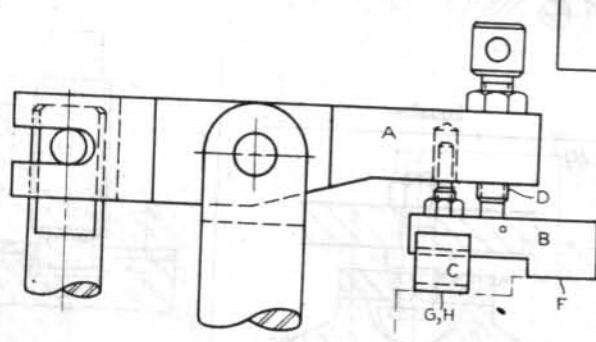
This equalizer has three built-in rest pads A.
Equalizer

1154



Equalizer

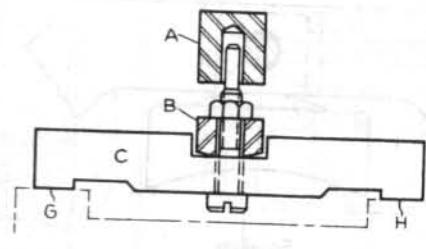
1155



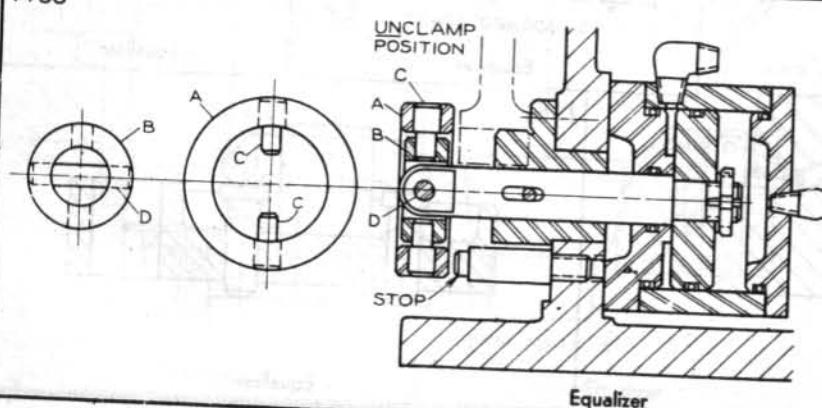
Equalizer

The lid contains equalizer E, which is pinned to the lid at A and B. E, in turn, contains equalizer D, which is pinned to E by C. To obtain equal pressure on each of the three buttons, F, G, and H, the centerlines of the three pins, A, B, and C, should intersect at center J of the triangle formed by the three buttons, with J equidistant from F, G, and H.

Equalizer



1156

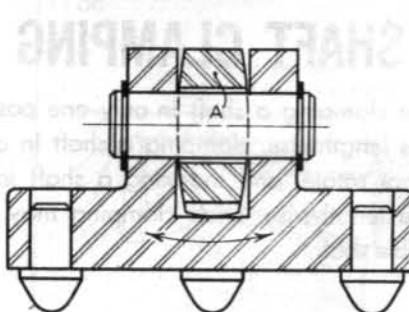
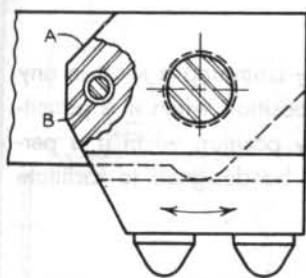


Force D should be applied to the center of the triangle created by the three flat buttons, F, G, and H, as explained in Illustration 1153.

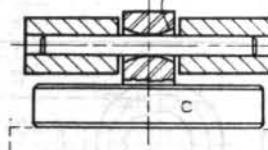
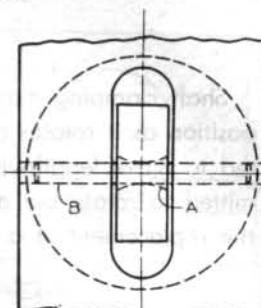
Gimbal pins C and D allow A to be equalized in any direction. B rocks about D and A about pins C.

Equalizer

1157



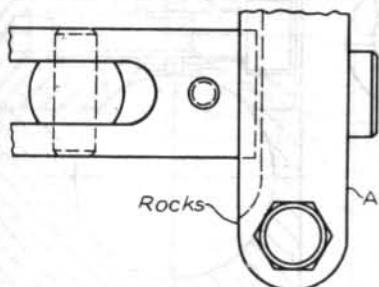
1158



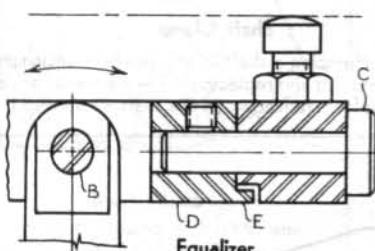
Hourglass hole A allows full equalization of C.

Equalizer

1159

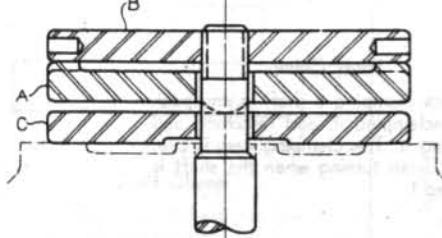
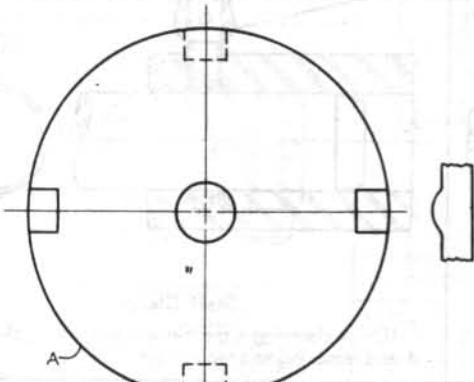


4 BUTTONS

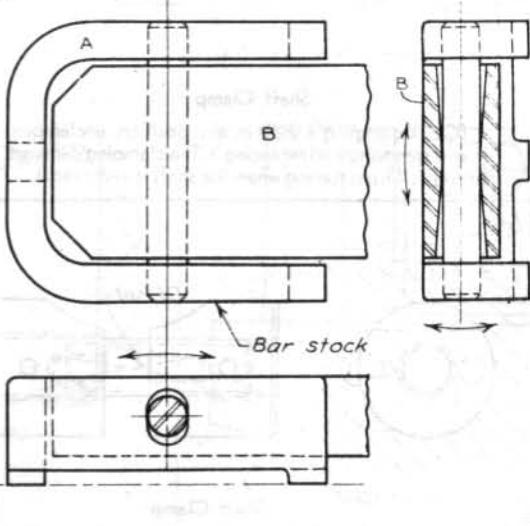


D rocks about B and has an equalizer A at each end. Equalizer A rocks about C, shoulder E limiting the extent to which it is allowed to rock.

1161



1160



The oblong tapered holes in A allow the equalizer to rock in an additional direction.

Equalizer

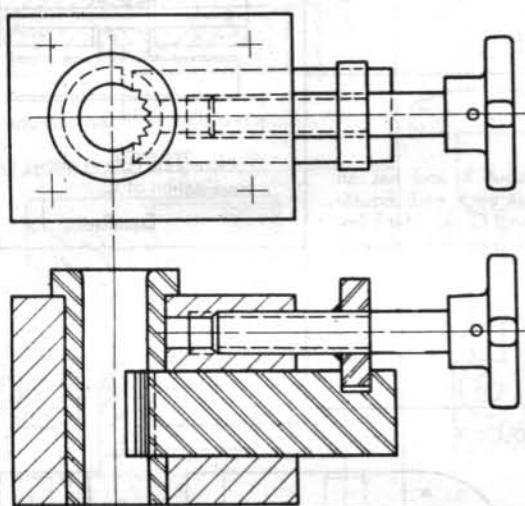
Two pair of rounded buttons perpendicular to each other are located on opposite sides of an intermediate washer A to create an equalizer.

Equalizer

SHAFT CLAMPING

Shaft clamping may include clamping a shaft in only one position; clamping a shaft in any position as it rotates or moves lengthwise; clamping a shaft in any position when it is permitted to move lengthwise but not rotate; and indexing a shaft in any position when it is permitted to rotate but not move lengthwise. Shaft clamping may also be designed to facilitate the replacement of a removable shaft.

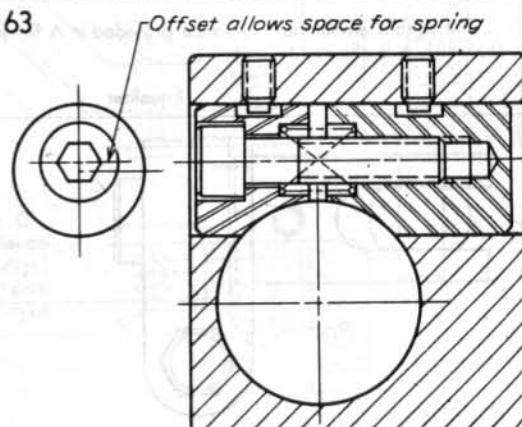
1162



Shaft Clamp

(Quick clamping a shaft in any position, unclamping it, and removing and replacing it. The clamping cams are prevented from turning when the shaft is removed.)

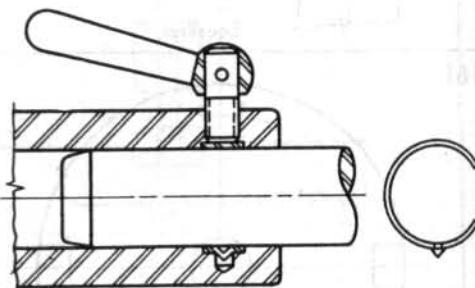
1163



Shaft Clamp

(Quick clamping a shaft in any position, unclamping it, and removing and replacing it. The clamping cams are prevented from turning when the shaft is removed.)

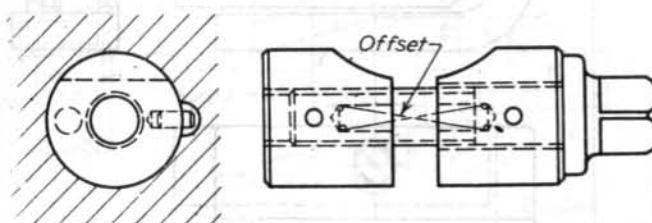
1165



Shaft Clamp

(Quick clamping a shaft in any position, unclamping it, and removing and replacing it.)

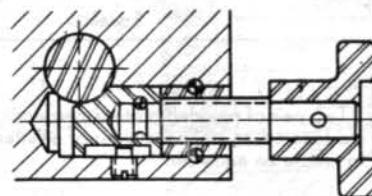
1164



Shaft Clamp

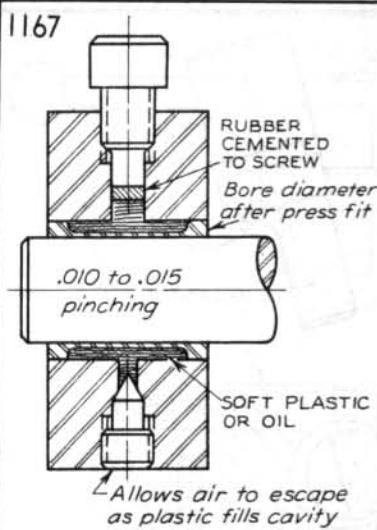
(Quick clamping a shaft in any position, unclamping it, and removing and replacing it. The clamping cams are prevented from turning when the shaft is removed.)

1166

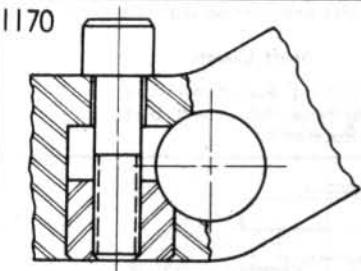


Shaft Clamp

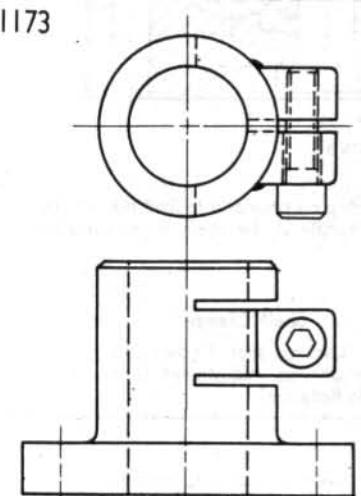
(Quick clamping a shaft in any position, unclamping it, and removing and replacing it. The clamping cam is prevented from turning when the shaft is removed.)



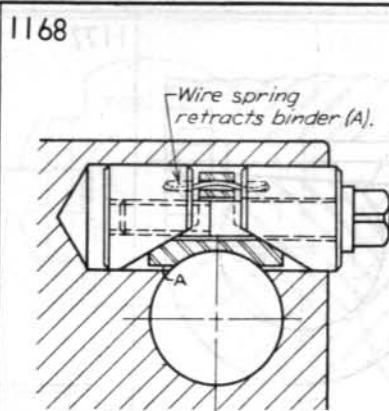
Shaft Clamp
(Quick clamping a shaft in any position, unclamping it, and removing and replacing it. The clamping cams are prevented from turning when the shaft is removed.)



Shaft Clamp
(Quick clamping a shaft in any position; removal of the shaft is not included.)

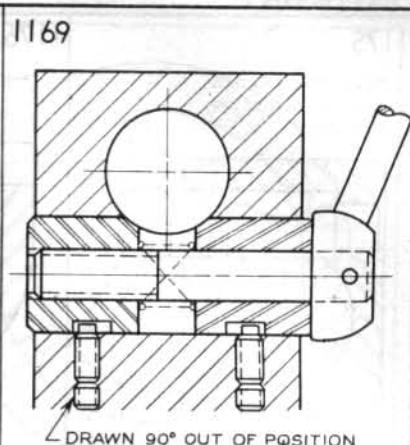


Shaft Clamp
(Stationary Clamping a Shaft in Any Position)



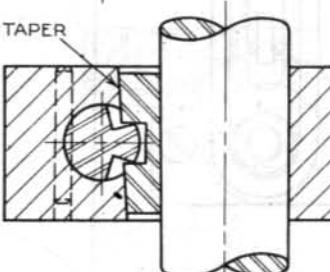
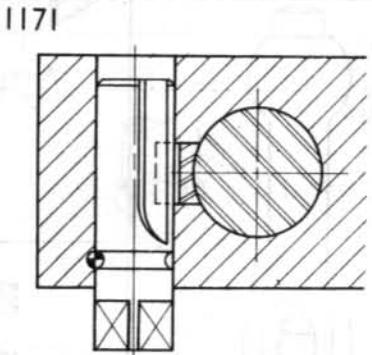
Shaft Clamp

(Quick clamping a shaft in any position, unclamping it, and removing and replacing it. The clamping cams are prevented from turning when the shaft is removed.)

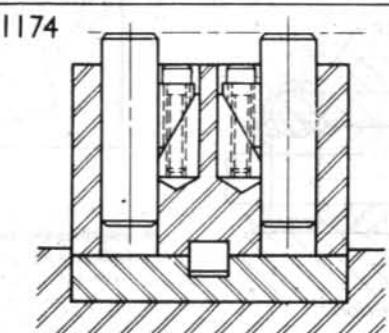


Shaft Clamp

(Quick clamping a shaft in any position, unclamping it, and removing and replacing it. The clamping cams are prevented from turning when the shaft is removed.)



Shaft Clamp
(Stationary Clamping a Shaft in Any Position)

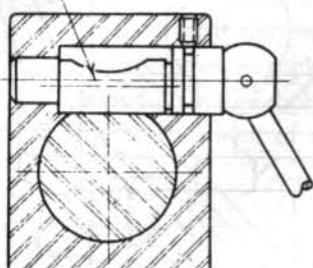


Shaft Clamp
(Stationary Clamping a Shaft in Any Position)

1175-1180

1175

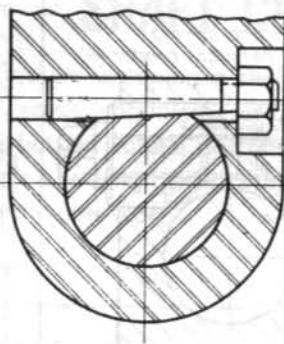
Eccentric clamps against a flat on the shaft



Shaft Clamp

(Locking that Provides Lengthwise Adjustment but No Rotation)

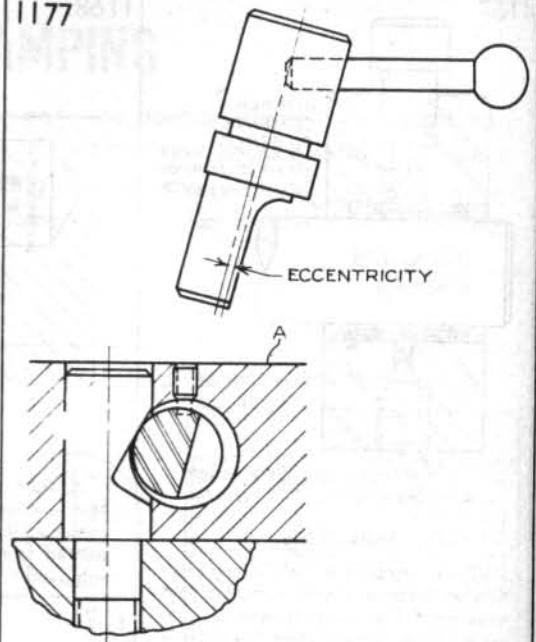
1176



Shaft Clamp

(Locking that Provides Lengthwise Adjustment but No Rotation)

1177

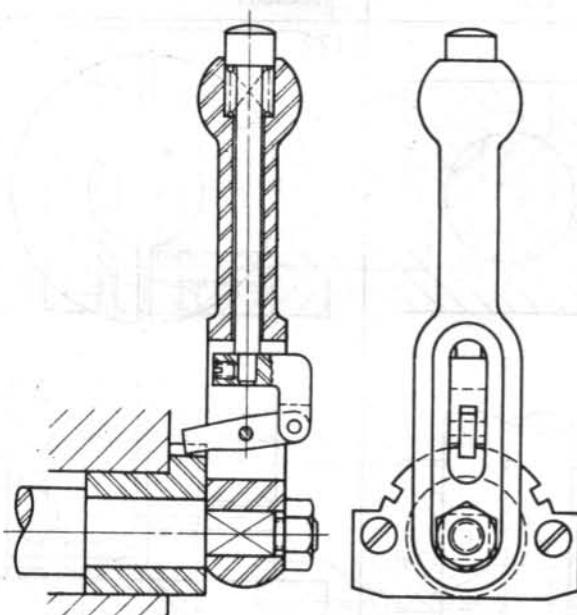


A may be readily unclamped and removed. This design illustrates one-position shaft clamping.

Shaft Clamp

(Locking that Provides Lengthwise Adjustment but No Rotation)

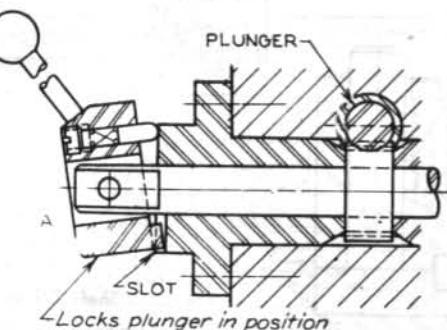
1178



Shaft Clamp

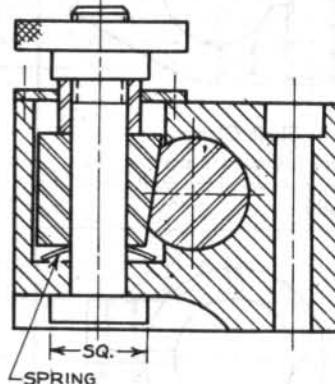
(Shaft Indexing)

1180



Locks plunger in position

1179



A stop should be provided to limit the unscrewing of the handle if the shaft is removed frequently.

Shaft Clamp

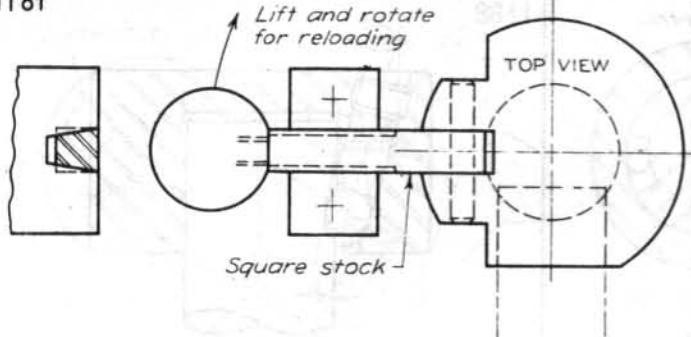
(Locking that Provides Lengthwise Adjustment but No Rotation)

Inserting the key of A in the slot locks the shaft at either end of its rotational movement.

Shaft Clamp

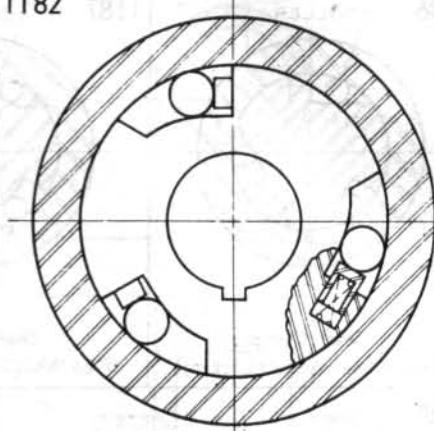
(Shaft Indexing)

1181

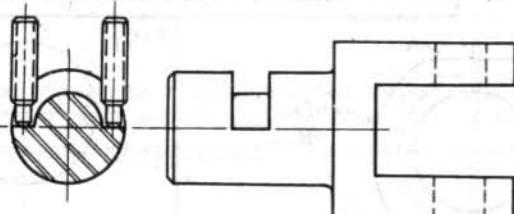


Shaft Clamp (Rotational Adjustment and Locking)

1182

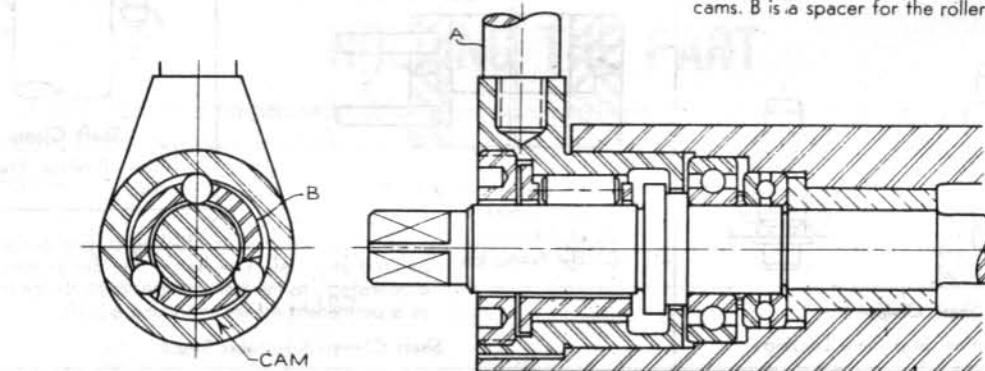
Shaft Clamp
(Free-Wheeling Shaft Locking)

1183



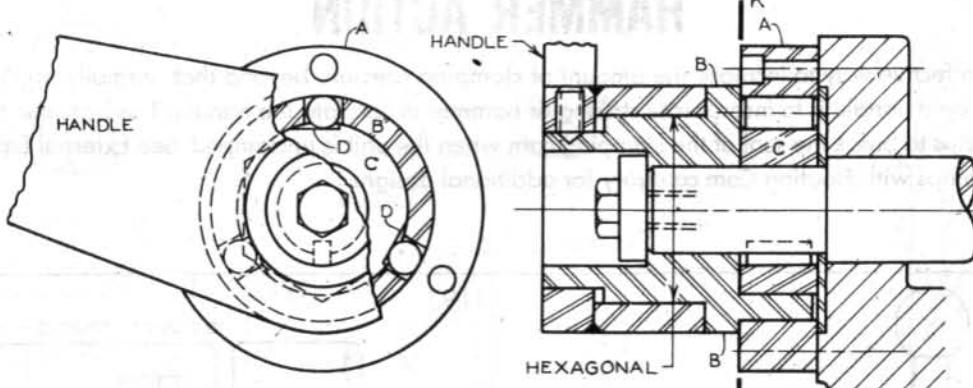
Shaft Clamp (Rotational Adjustment and Locking)

1184



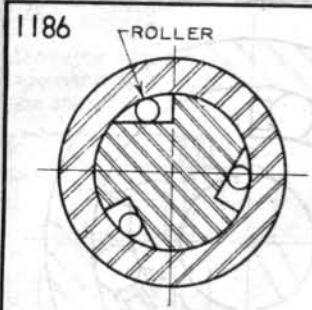
Shaft Clamp (Free-Wheeling Shaft Locking)

1185

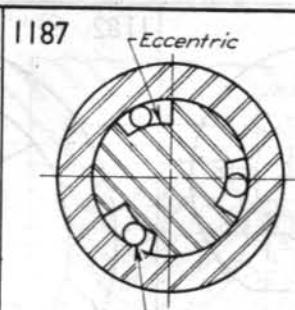


C, which contains the three cams D for the rollers, is keyed to the shaft. B, a spacer for the three rollers (see side view), has a hexagonal exterior which allows the handle to engage it. After the shaft and C have reached a stationary position, the handle is pushed down, causing B to move the three rollers. The rollers wedge between the three flat cams D and the bore of A, thereby locking the shaft.

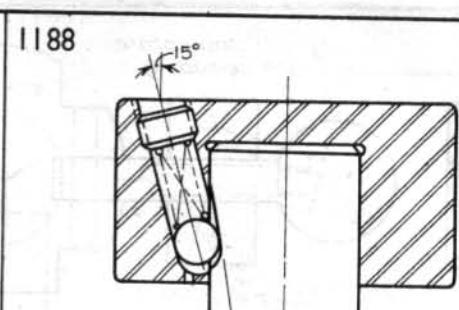
Shaft Clamp
(Free-Wheeling Shaft Locking)



1186
ROLLER
Shaft Clamp
(Free-Wheeling Shaft Locking)

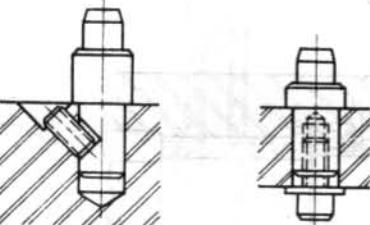
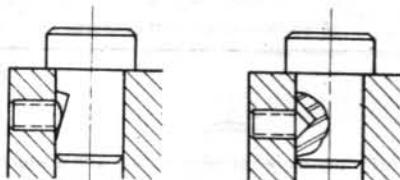


1187
Eccentric
ROLLER
Shaft Clamp
(Free-Wheeling Shaft Locking)



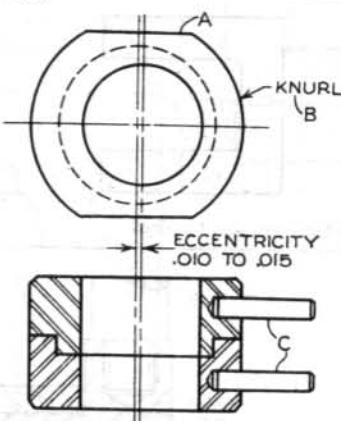
1188
15°
10
Shaft Clamp
(One - Position Stationary Locking)

1189

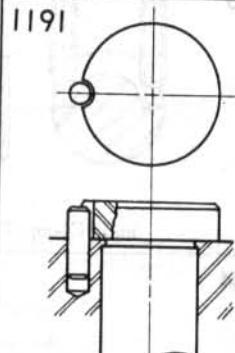


Shaft Clamp
(One - Position Stationary Locking)

1190



KNURL
A
ECCENTRICITY
.010 TO .015
C
Alternate locking methods
A. By wrench
B. By hand
C. By handles



1191
Shaft Clamp
(One - Position Stationary Locking)

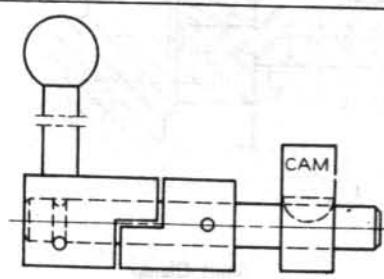
This quick adjusting and locking stop is designed to be used on a shaft. One-half of the design may be incorporated into the frame, allowing the device to serve as a permanent means of locking a shaft.

Shaft Clamp (Adjustable Stop)

HAMMER ACTION

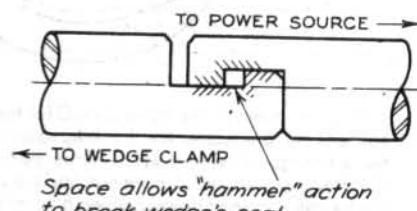
An effective way to increase the amount of clamping pressure beyond that normally applied to a cam by a handle is to incorporate striking or hammer action into the handle. This hammer action also helps to break the seal of the clamping cam when the unit is unclamped. See External Equalizing Clamps with Floating Cam category for additional designs.

1192



Hammer Action

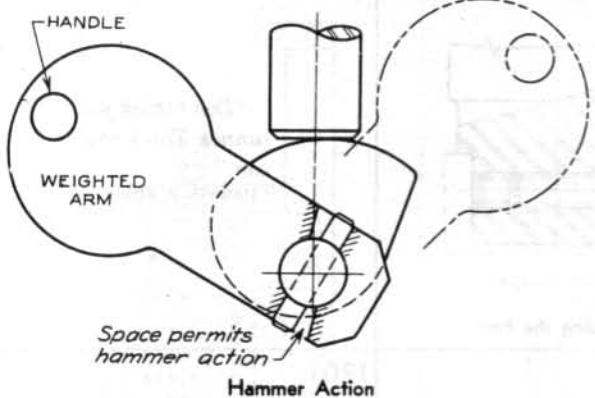
1193



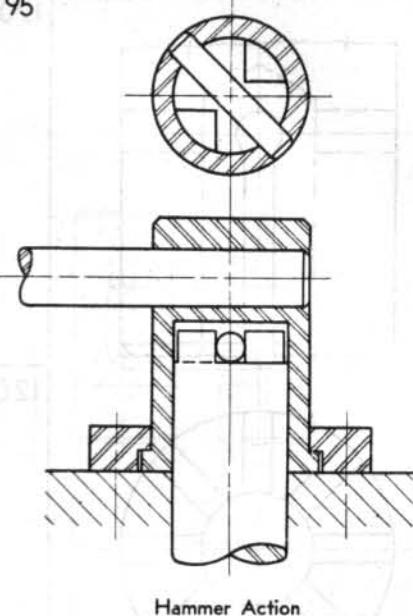
TO POWER SOURCE
TO WEDGE CLAMP
Space allows "hammer" action
to break wedge's seal.

Hammer Action

1194



1195

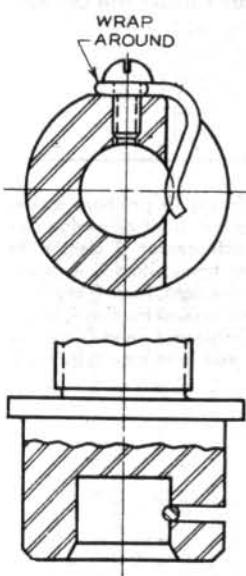


"New and stirring things are belittled, because if they are not belittled the humiliating question arises, 'Why then are you not taking part in them?'" H. G. WELLS

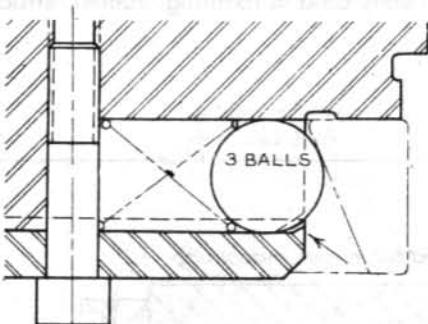
HOLDING THE PART

A part that must be pressed into another part or crimped or staked with another part should be placed in the position in which it will be held as it is assembled before the assembling operation begins.

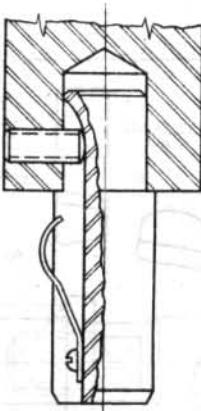
1196



1197

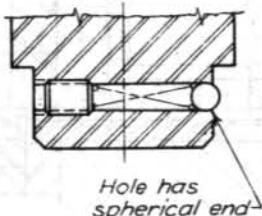


1198



Holding the Part

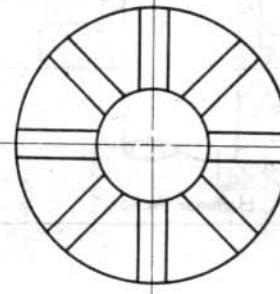
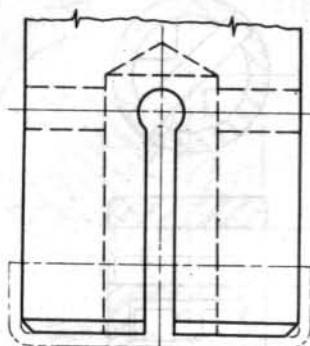
1199



Holding the Part

Holding the Part

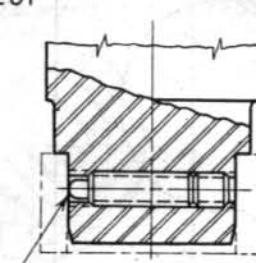
1200



Slots allow enough give
so the part will fit
tightly over the end.

Holding the Part

1201



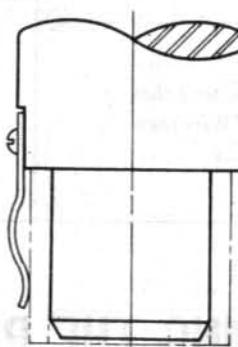
SPRING PLUNGER

Holding the Part

*"Don't think you
cannot. Think you
can."*

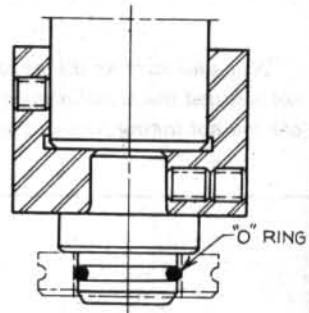
DARWIN P. KINGSLY

1202



Holding the Part

1203

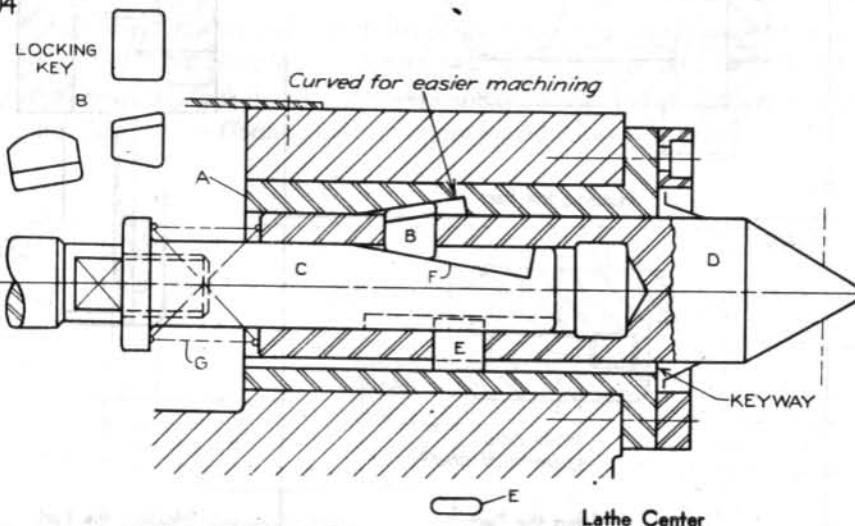


Holding the Part

Lathe Centers

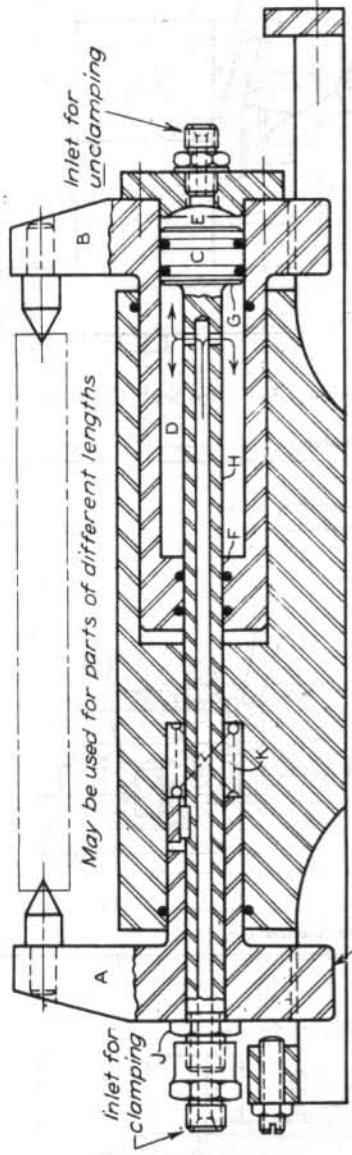
Lathe type centers are frequently used in fixturing. Built-in retracting devices retract the centers when necessary.

1204



Spring G positions locking key B in front of wedge cam F until center D clamps the part firmly. Then C is moved to the right, forcing key B upward against bushing A to lock D in place. C and D are prevented from turning by key E.

Lathe Center



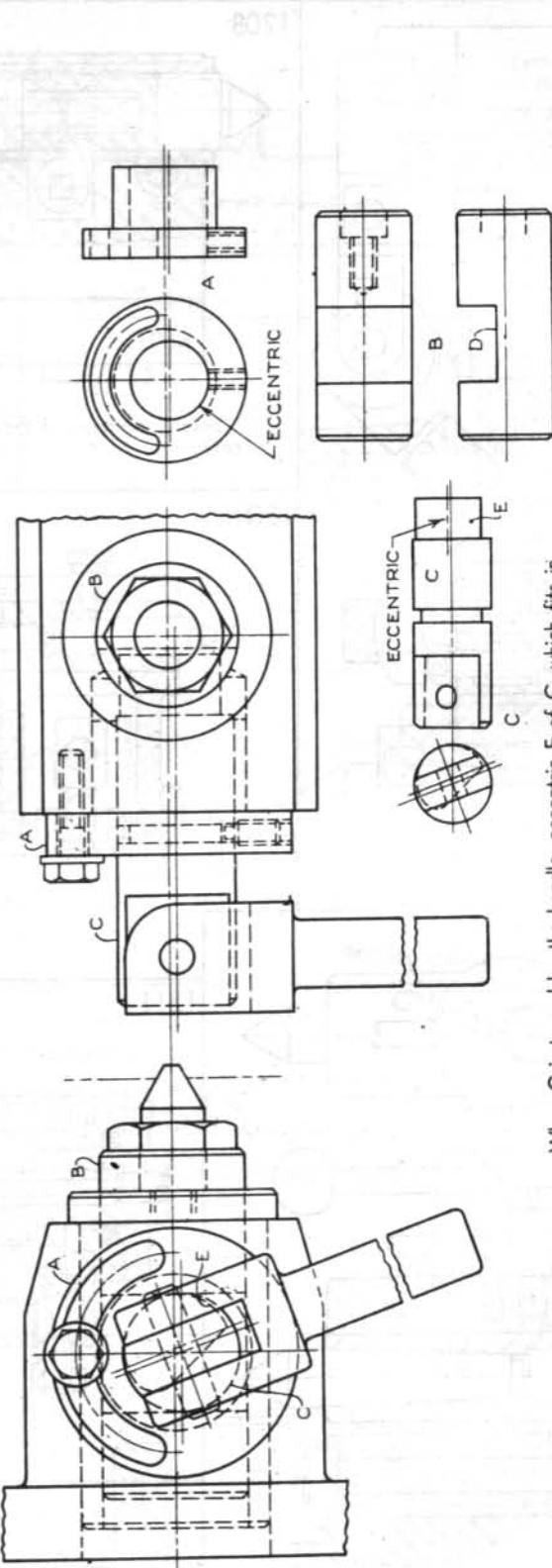
In the clamping operation, air enters chamber D of B as the arrows indicate. The pressure of the air against F of B moves B to the left; the air pressure also acts against G of piston C, moving the piston to the right. Nut J attaches stem H of piston C to A, enabling H to pull A to the right to clamp the part between the two centers.

During the unclamping action, air enters chamber E, moving piston C to the left and forcing B to the right. Spring K retracts A.

When it is necessary to accommodate a larger part, chamber D shortens and E lengthens.

1205

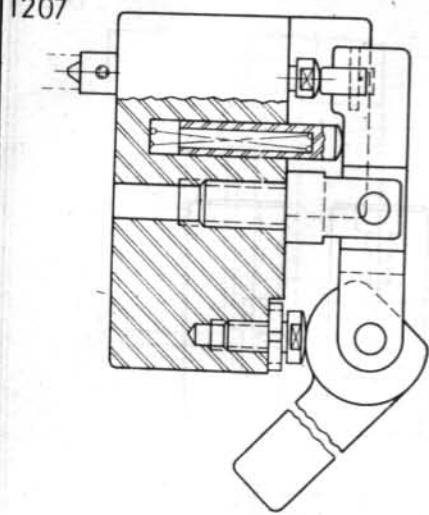
1206



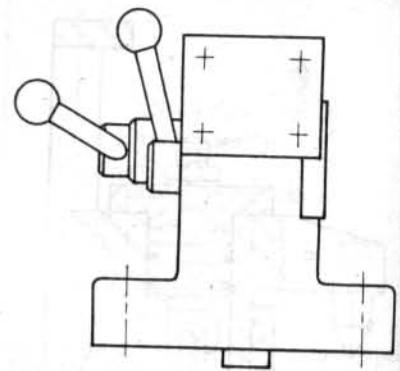
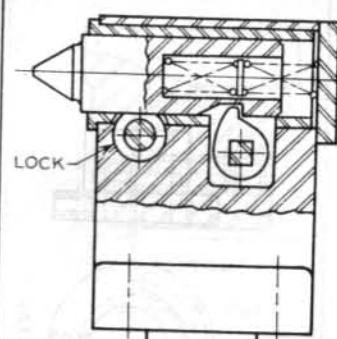
When C is turned by the handle, eccentric E of C, which fits in groove D of B (see details of B and C), moves B and the lathe center fastened to it. Adjustment of C by sleeve A, in which C rotates, ensures that eccentric E will be fully effective regardless of wear. However, if A is to adjust C, the bore for C must be eccentric (see detail of A). Rotating sleeve A counterclockwise increases the clamping force of eccentric E of C.

Lathe Center

1207



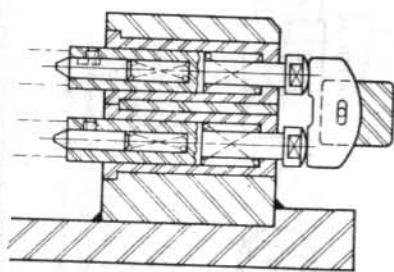
1208



Several examples of the split lock are included in the Shaft Clamping category.

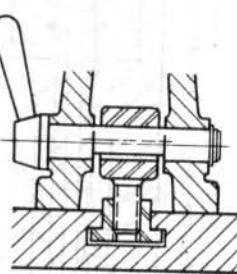
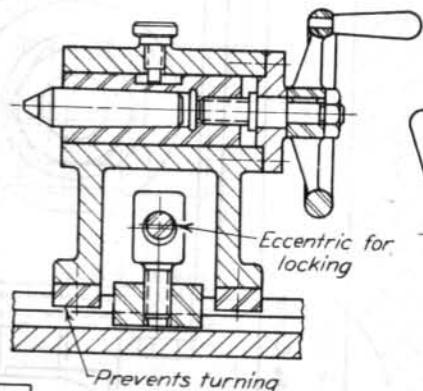
Lathe Center

1209



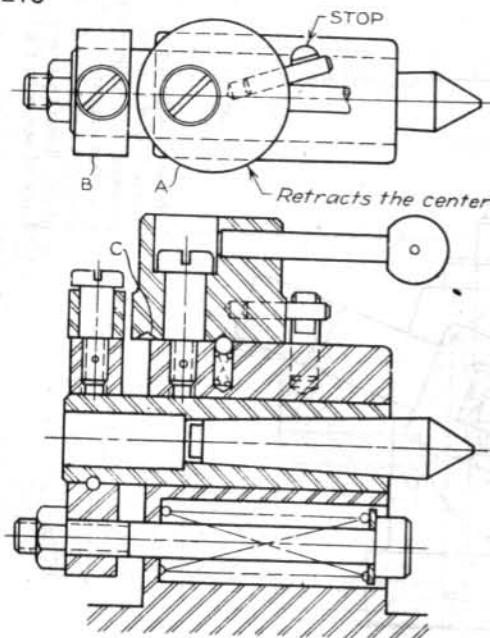
The double center is actuated by a cam and an equalizer.

Lathe Center



Prevents turning

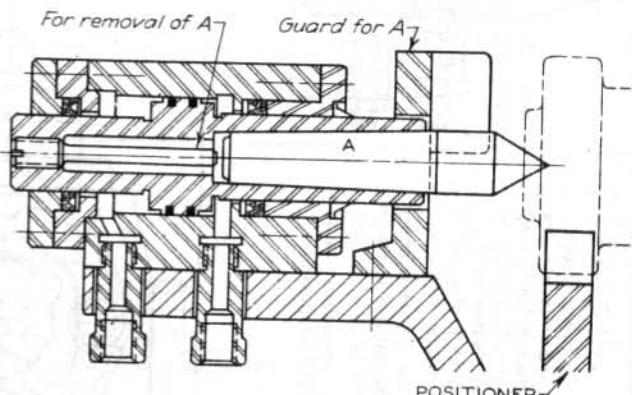
1210



Cam A operates against B to retract the spring-loaded center. The two detents keep cam A in position.

Lathe Center

1211

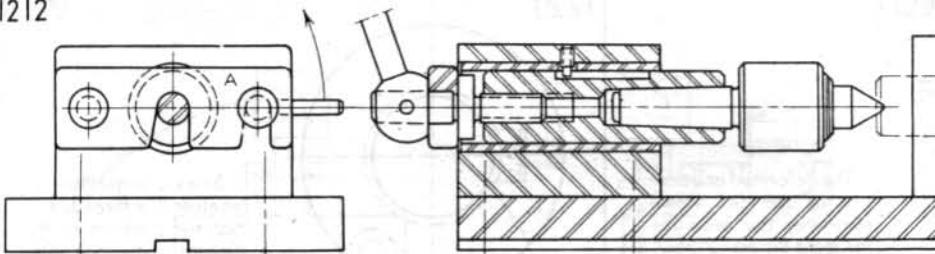


Lathe Center

"The man who never does more than he gets paid for seldom gets paid - for more than he does."

ELBERT HUBBARD

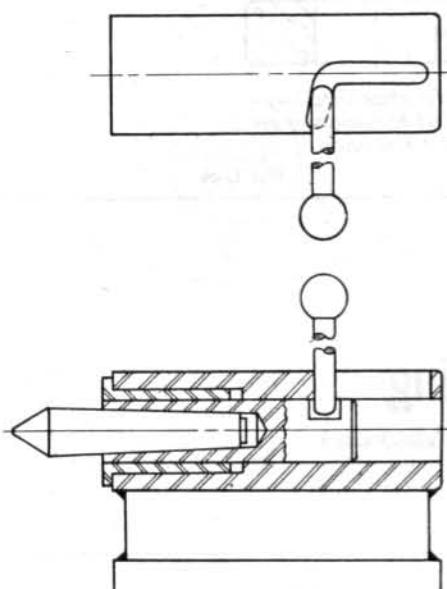
1212



Left-hand threads provide the clockwise movement of the handle required to move the center to the part. Swinging c-washer A serves as a quick release, retracting the center.

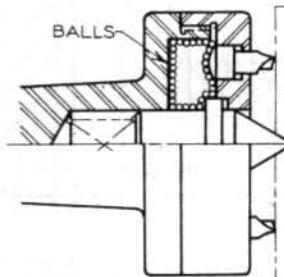
Lathe Center

1213



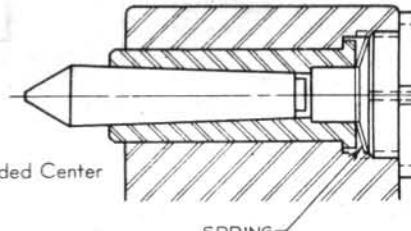
Lathe Center

1214



Lathe Center

1215



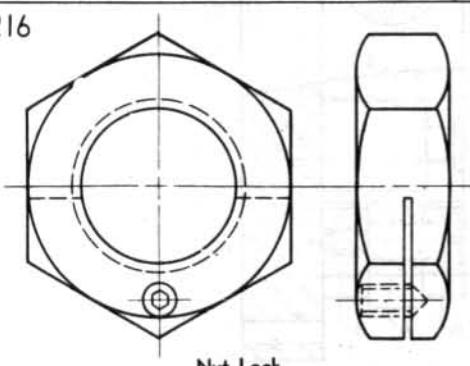
A Spring-Loaded Center

Lathe Center

NUT LOCKS

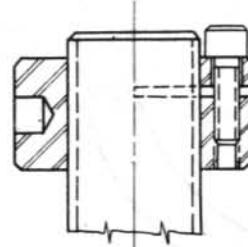
When it is inconvenient to use a second nut to lock a nut already in position, a nut with a built-in lock may be used.

1216



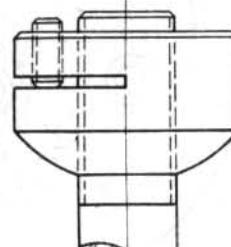
Nut Lock

1217



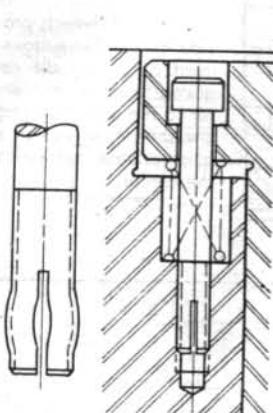
Nut Lock

1218



Nut Lock

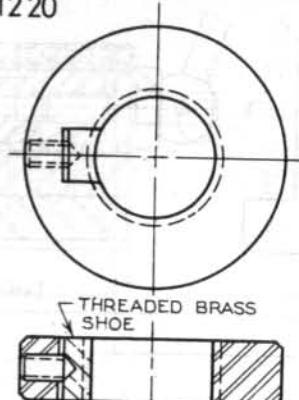
1219



Nut Lock

The deformed end portion of the cap screw eliminates the need for the more expensive shoulder bolt. A standard cap screw may easily be deformed.

1220



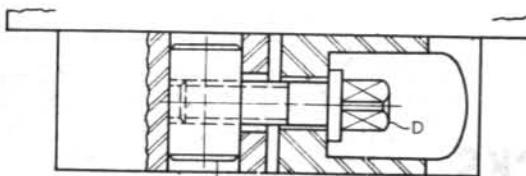
Press fit shoe into keyway, cut threads, then slide fit the shoe.

Nut Lock

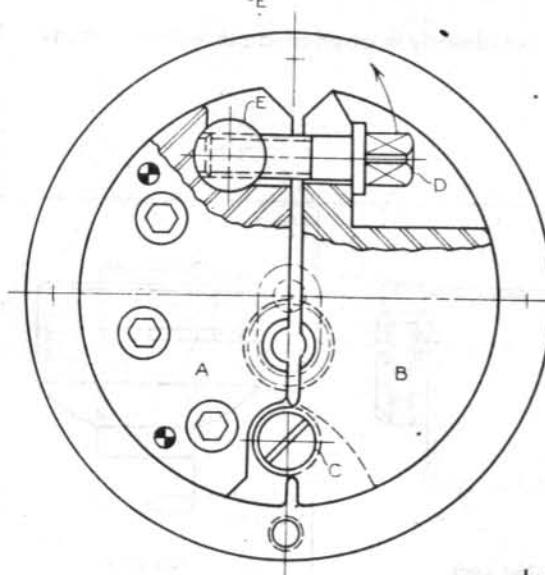
Brass, regardless of whether it is threaded or not, will conform to the threads of the bolt without damaging them.

Lathe Clamping

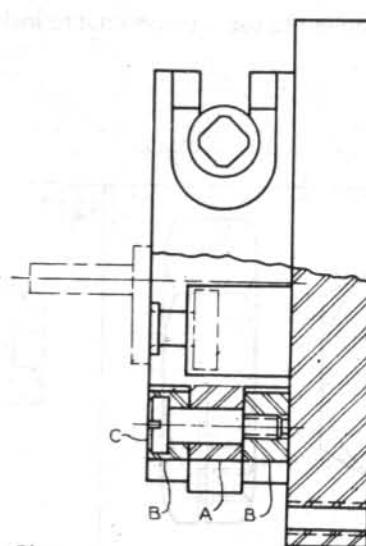
1221



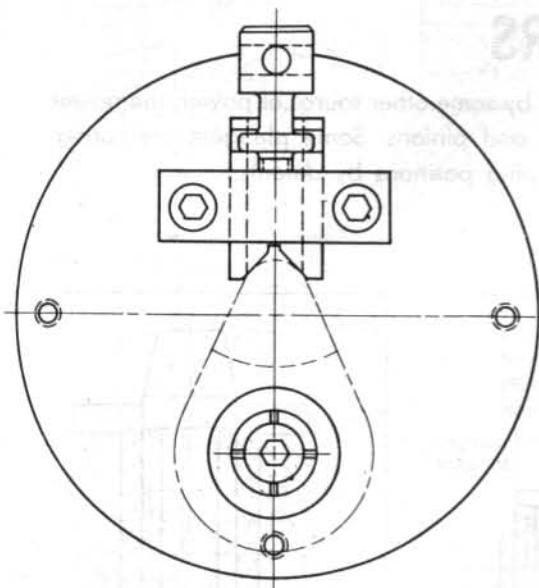
Rotating jaw B is pinned to stationary jaw A by shoulder bolt C through the tongue and groove connection. The cylindrical nut of clamp bolt D enables D to swing away from B.



Lathe Clamp

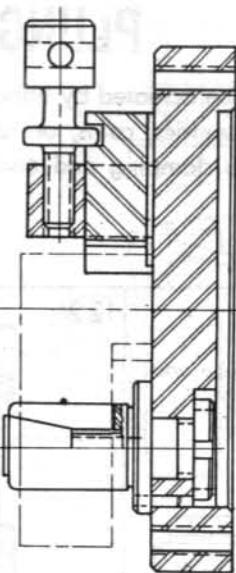


1222

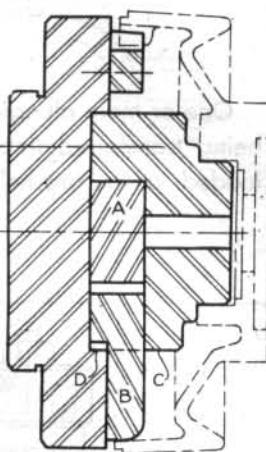


The collet and the vee block clamp the part.

Lathe Clamp



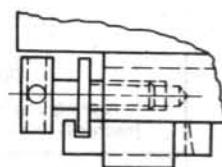
1223



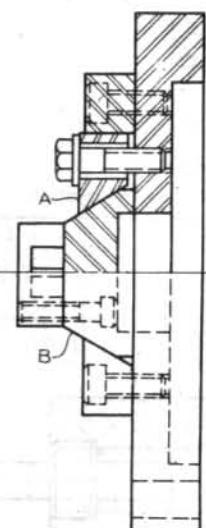
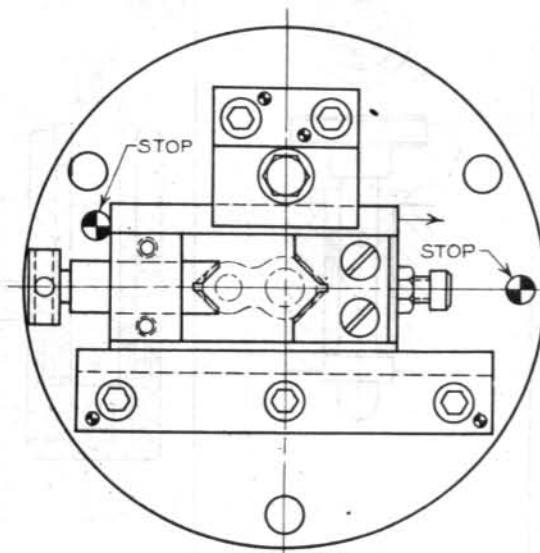
B is one of eight narrow fingers that slide in grooves of C. The extent to which fingers B retract is limited by round spacer A. Designed to prevent a thin part from vibrating, they are thrown outward by centrifugal force to contact the part. Note built-in stop D.

Lathe Clamp

1224



The stationary and the adjustable vee blocks clamp the part to dovetailed slide B. Wedge A clamps B in either of two positions which are controlled by the two dowel stops.

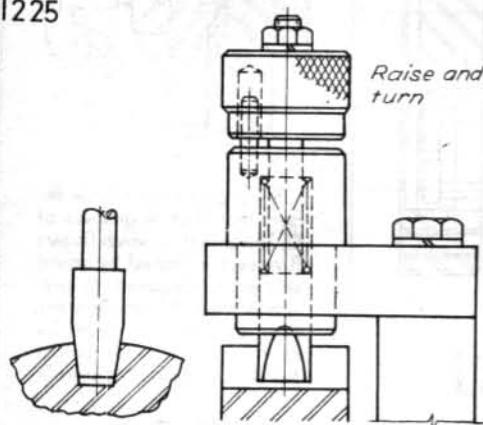


Lathe Clamp

PLUNGERS

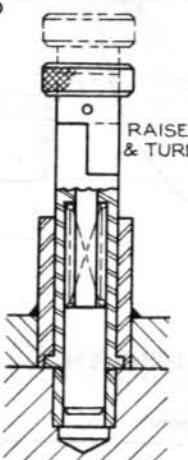
One or more plungers may be actuated by hand or by some other source of power, the power being transferred through eccentrics, cams, or racks and pinions. Some plungers are spring-loaded; others are held in the clamping and unclamping positions by detents.

1225



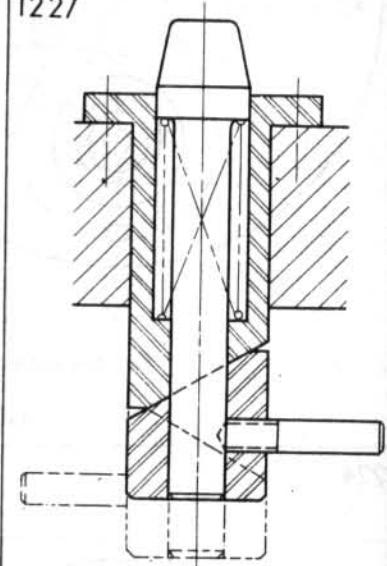
Plunger
(Spring-Loaded; Raise and Turn to Retract)

1226



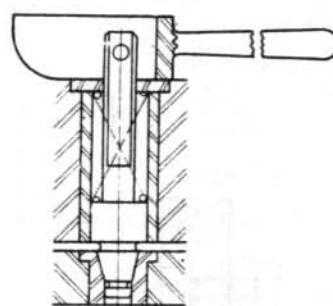
Plunger
(Spring-Loaded; Raise and Turn to Retract)

1227



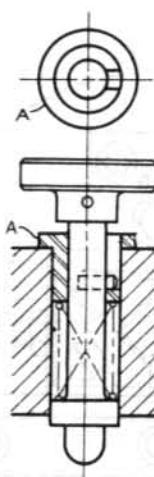
Plunger
(Spring-Loaded and Cam Retracted).

1228



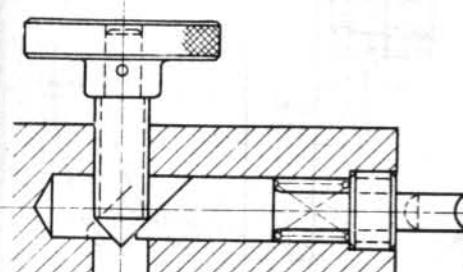
Plunger
(Spring-Loaded and Cam Retracted)

1229



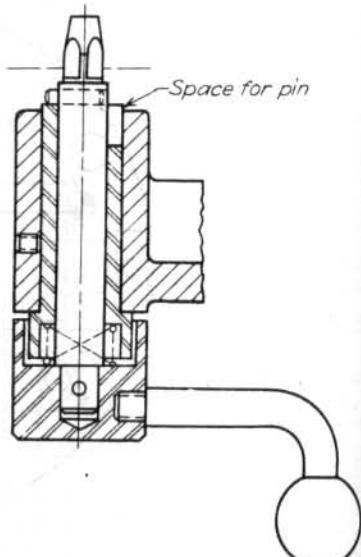
Plunger
(Spring-Loaded; Raise and Turn to Retract)

1231

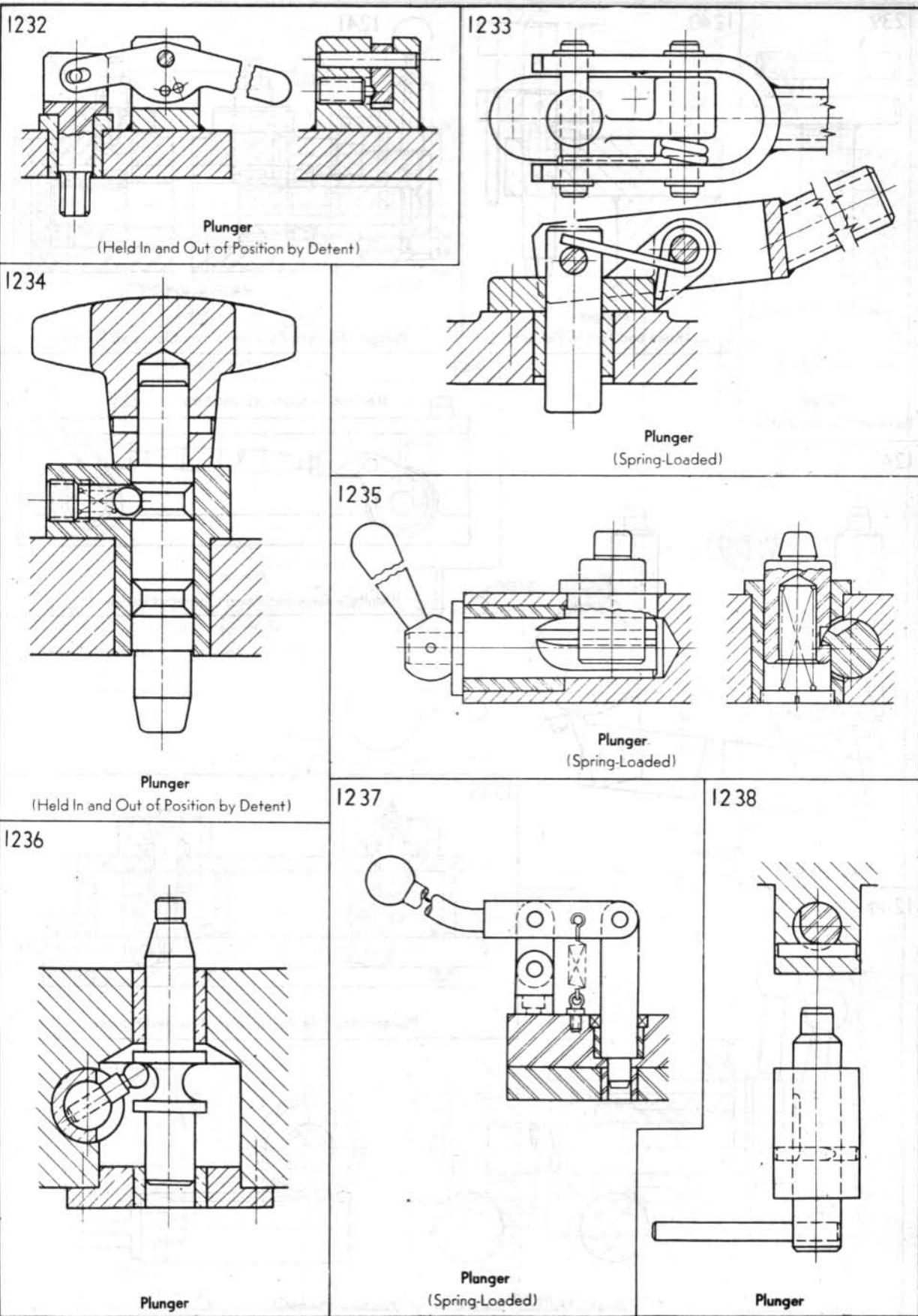


Plunger
(Spring Retracted)

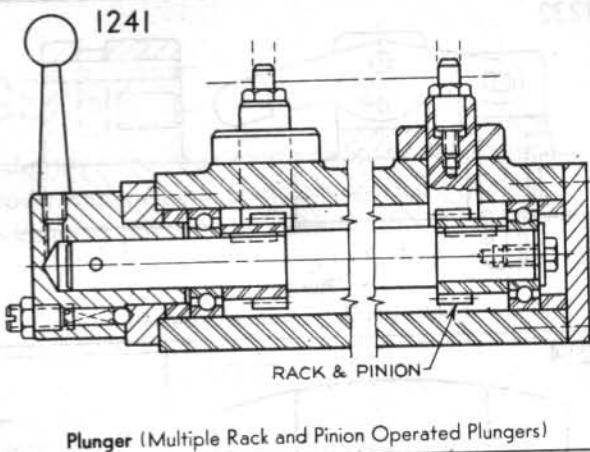
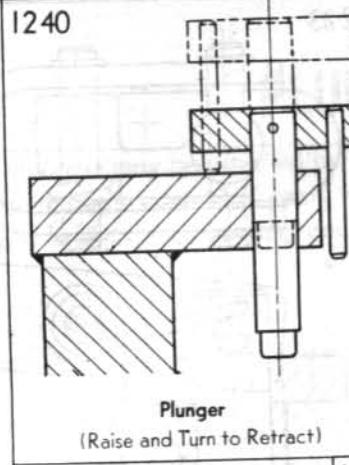
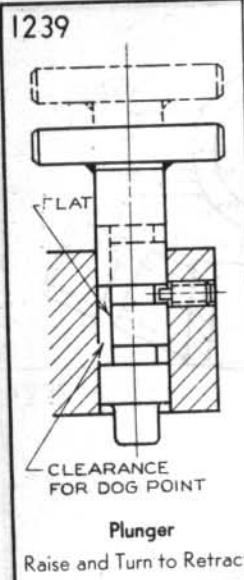
1230



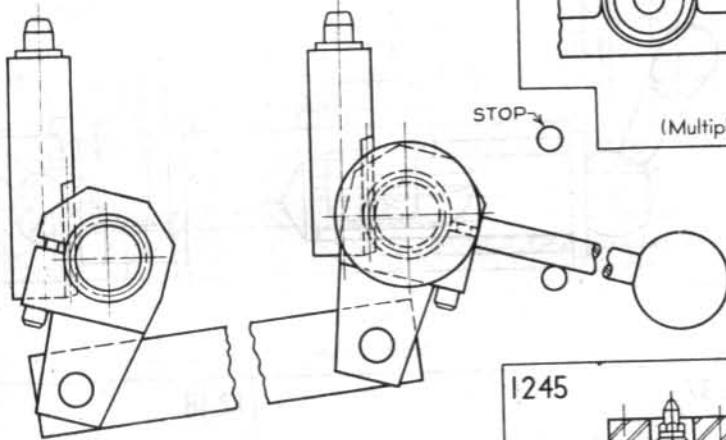
Plunger
(Spring Retracted)



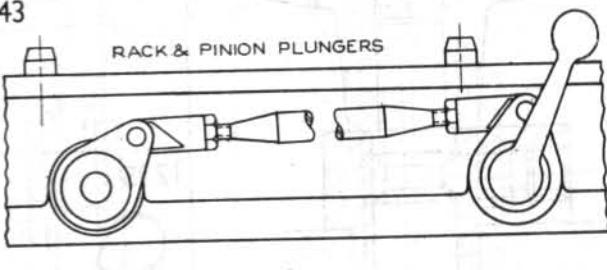
1239-1245



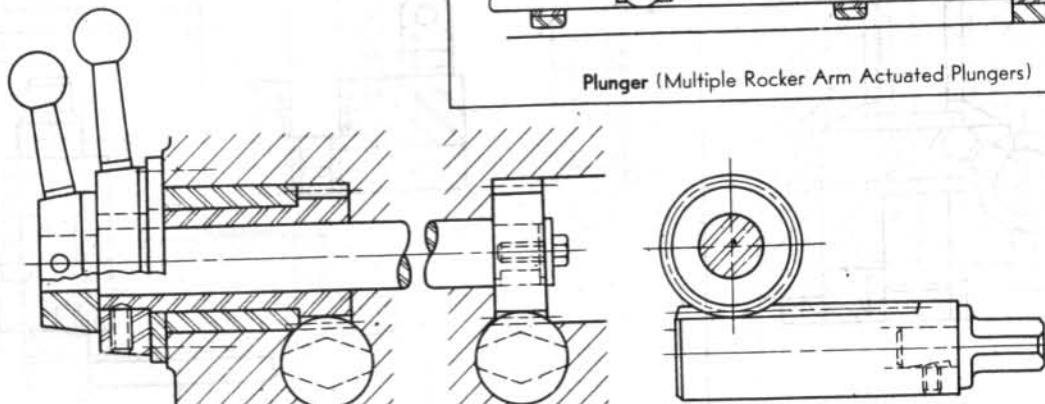
1242



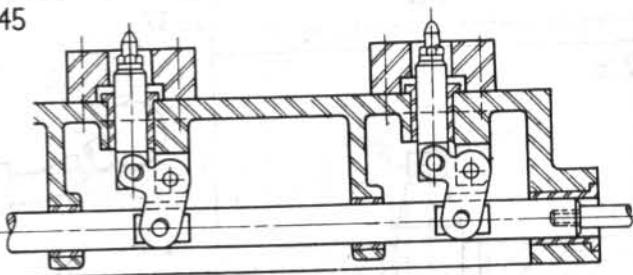
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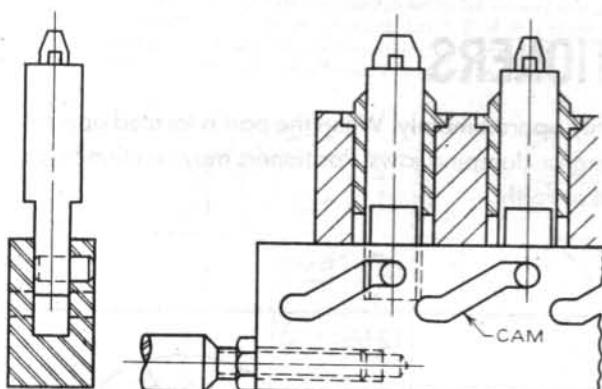
1244



1245

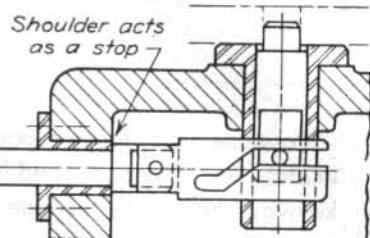


1246

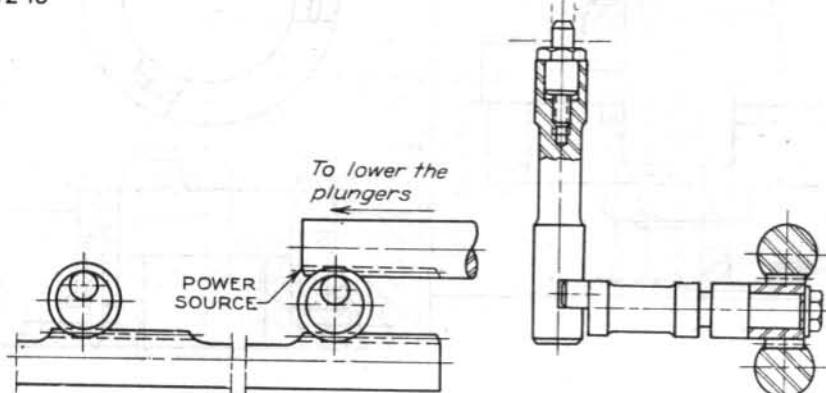


Plunger (Cam Actuated)

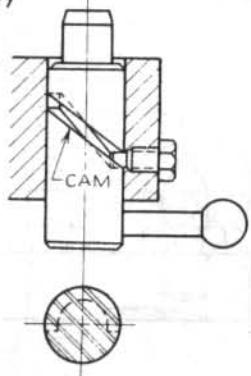
1247

Plunger
(Cam Actuated)

1248

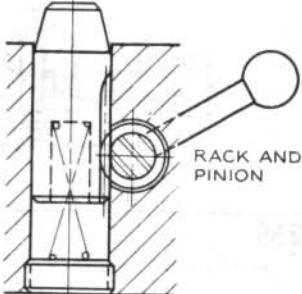
Plunger
(Multiple Eccentric Actuated Plungers)

1249



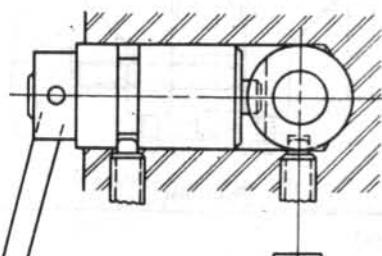
Plunger (Cam Actuated)

1250

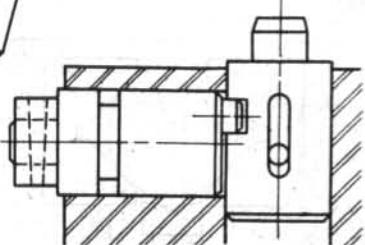


RACK AND PINION

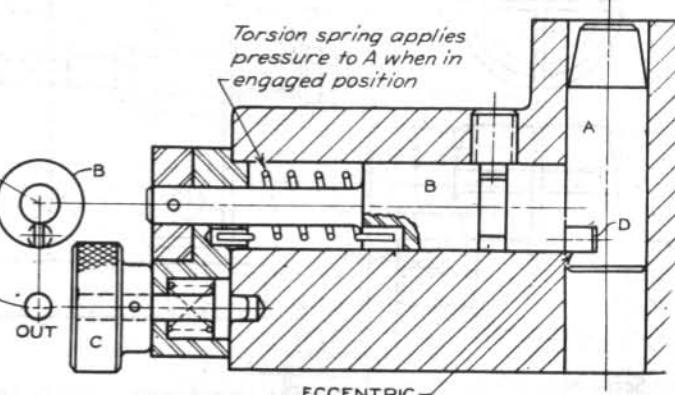
1251

Plunger
(Spring-Loaded Rack and Pinion)

1252

Plunger
(Eccentric Actuated)

Torsion spring applies pressure to A when in engaged position

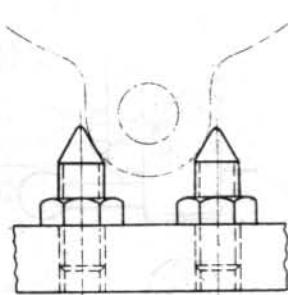


Plunger (Eccentric Actuated)

POSITIONERS

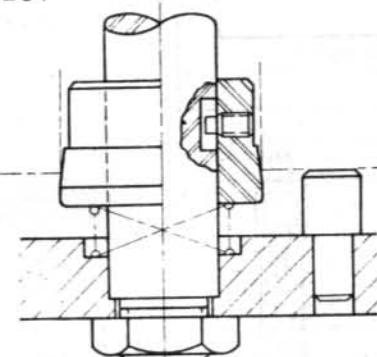
Positioners may locate a part accurately or only approximately. When the part is located approximately, it will be positioned further by centering or clamping jaws. Positioners may position holes, keyways, gear teeth, the exterior of a part, and so forth.

1253



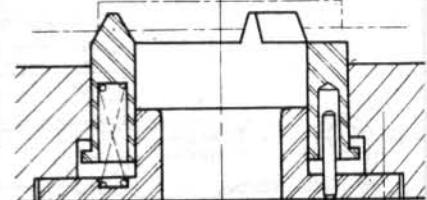
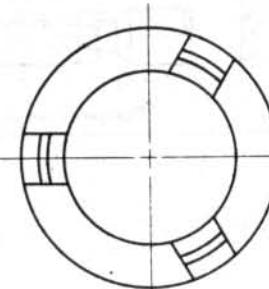
Positioner

1254



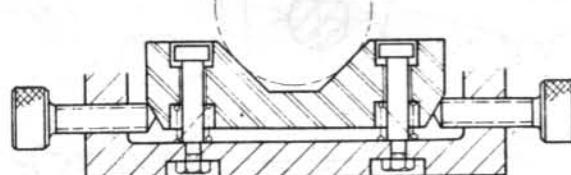
Positioner

1255



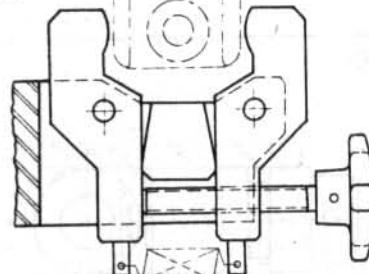
Positioner

1256



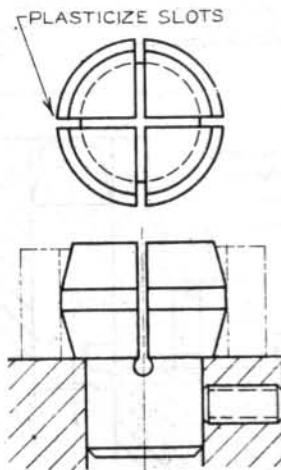
Positioner

1257



Positioner

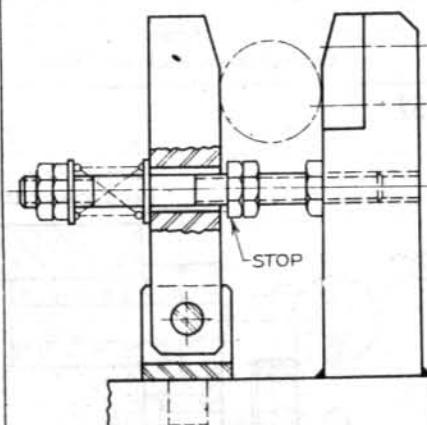
1258



Soft rubber or plastic material may be placed in the slots to keep out dirt and chips.

Positioner

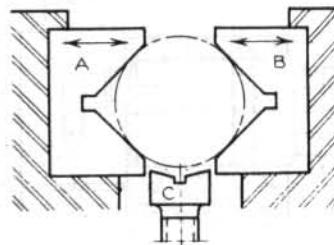
1259



This spring-loaded positioner has a stop. What would happen if there were no stop?

Positioner

1260

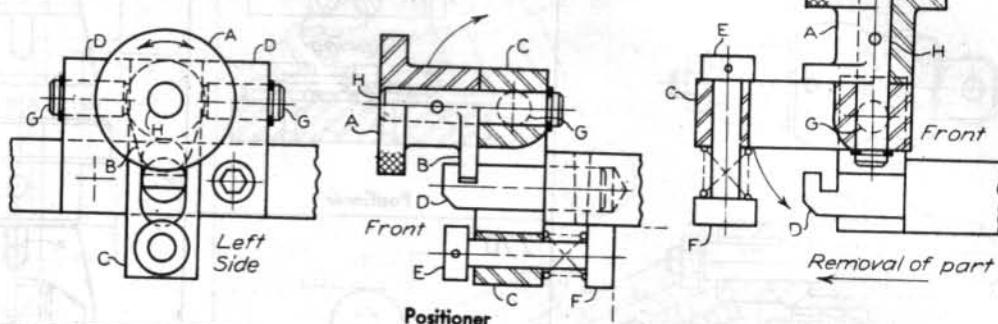


The part rests on positioner C until the vee blocks pick it up and clamp it.

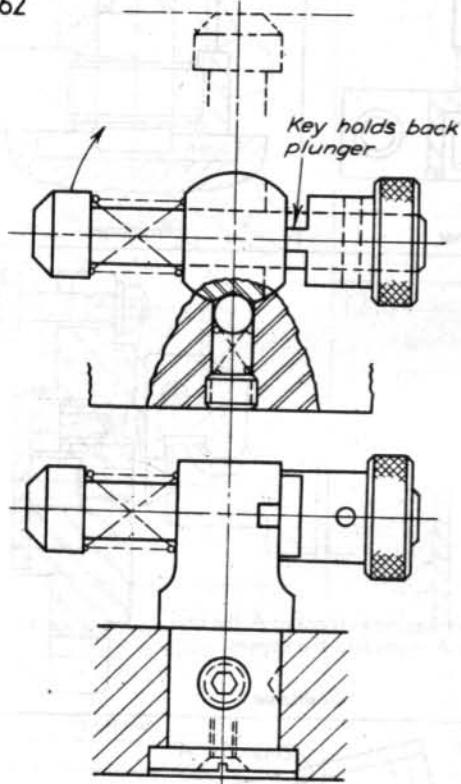
Positioner

1261

This design permits the positioner to be moved out of the way to facilitate removal of the part. As handle A is turned, catch B of A is disengaged from its notch in D. Then A and C, which are pinned together by H, may be rotated about pins G to the position shown on the right. Positioner F is spring-loaded.



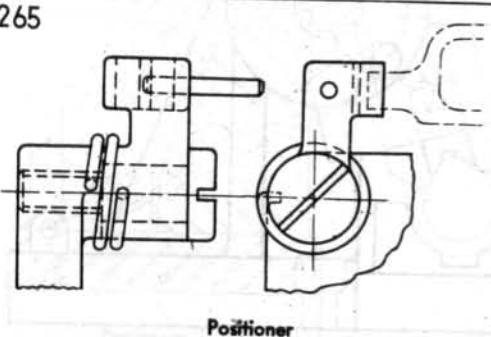
1262



The positioner may be rotated 90° out of position where it is held by a detent that also holds it when it is in position.

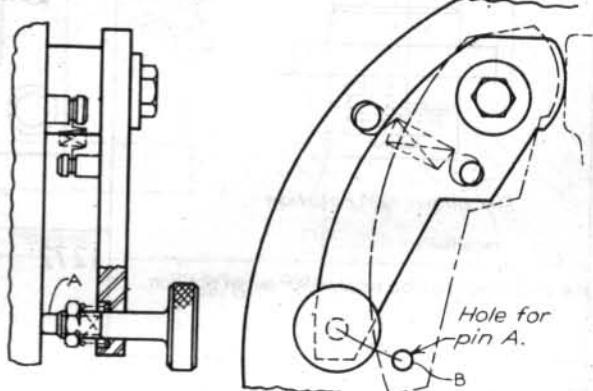
Positioner

1265



Positioner

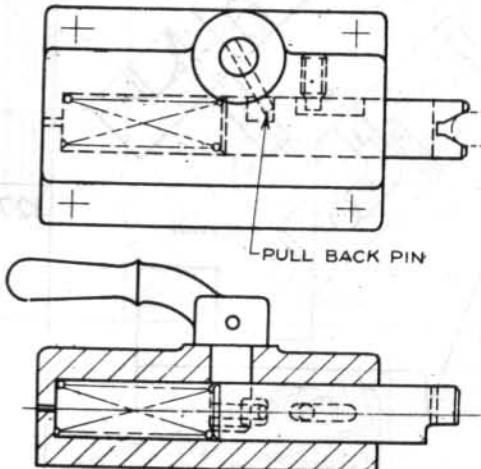
1263



Spring-loaded pin A drops in hole B in the frame until the positioner is needed.

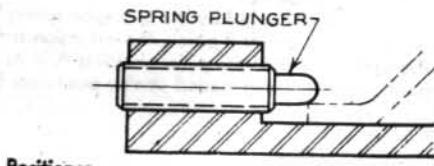
Positioner

1264



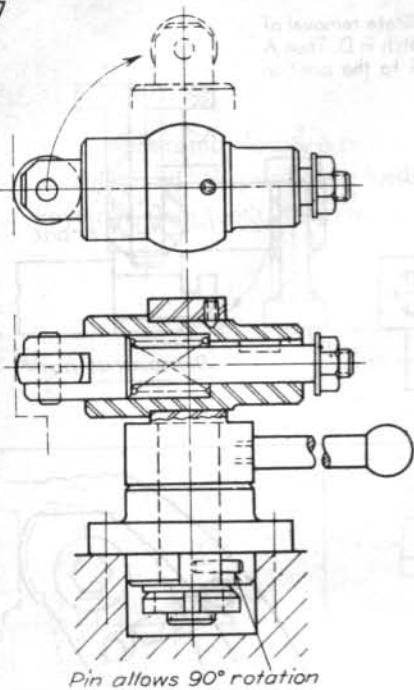
Positioner

1266

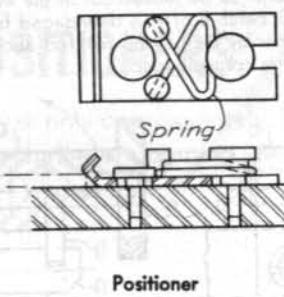


1267-1273

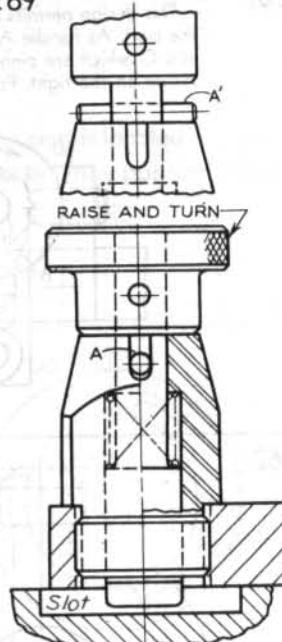
1267



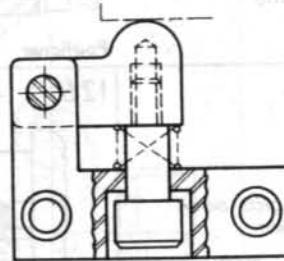
1268



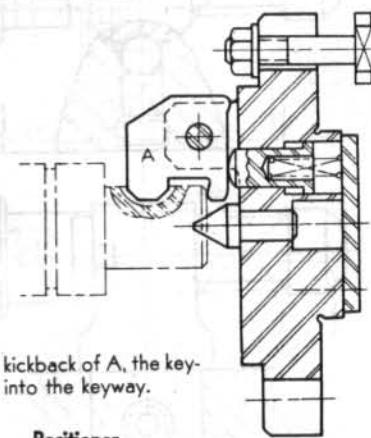
1269



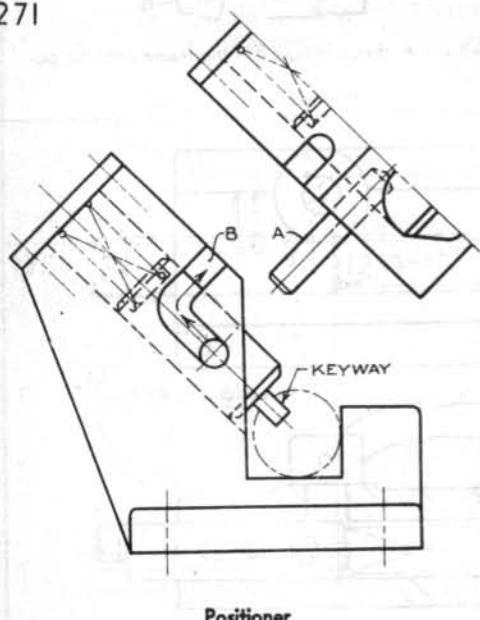
1270



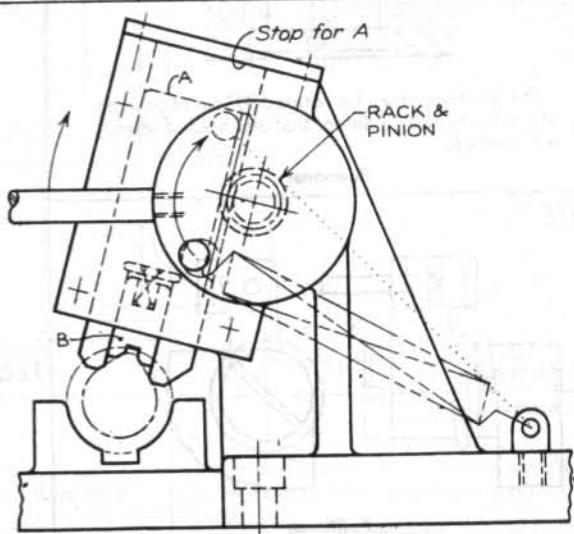
1272



1271



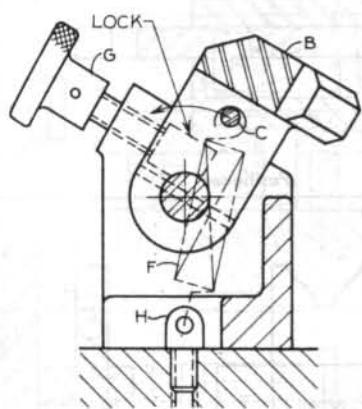
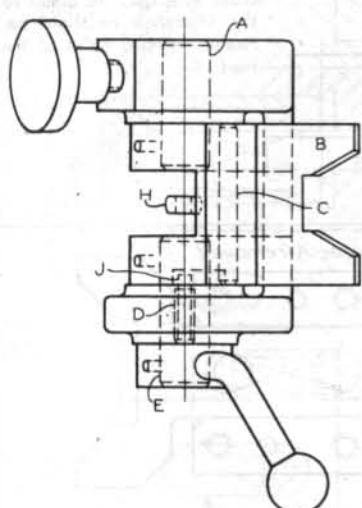
1273



Positioner A is spring-loaded by the extension spring. As A is retracted via the rack and pinion, the extension spring re-sways beyond the center of the pinion, holding A in its retracted position. Note spring-loaded smaller positioner B.

Positioner

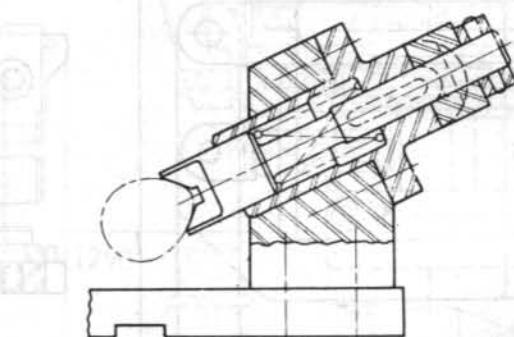
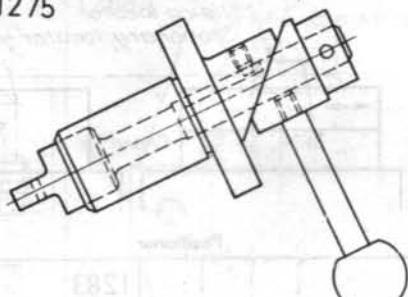
1274



Fitting in an arched groove in positioner B, set screw D limits the movement of B. Shafts E and A are pinned to B. Turning the handle actuates E to turn B. G locks shaft A, thereby locking B.

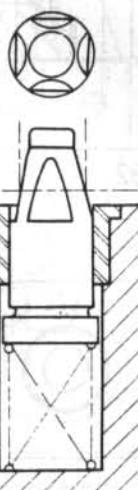
Positioner

1275



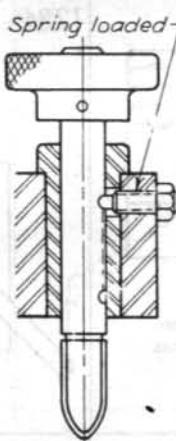
Positioner

1276



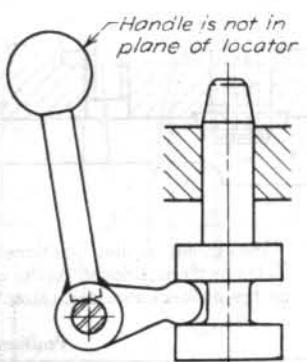
Positioner

1277



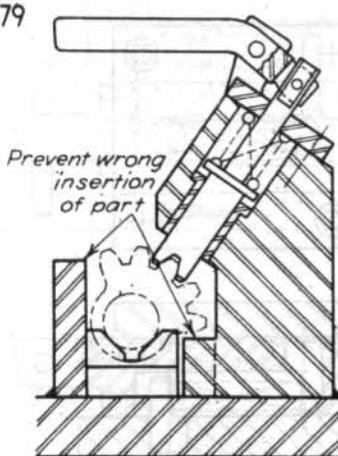
Positioner

1278



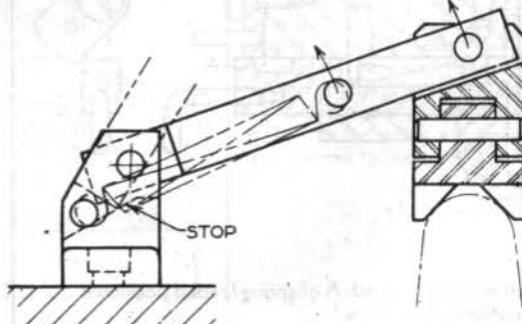
Positioner

1279



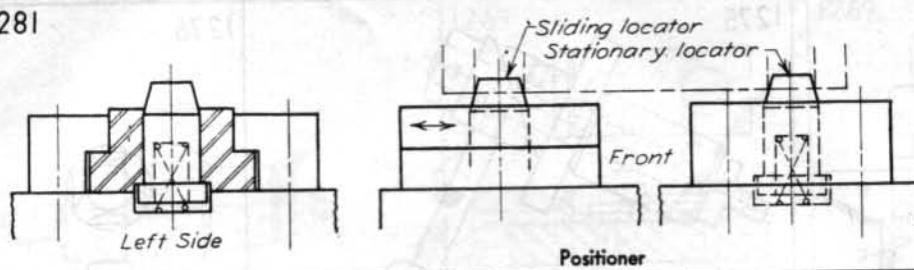
Positioner

1280



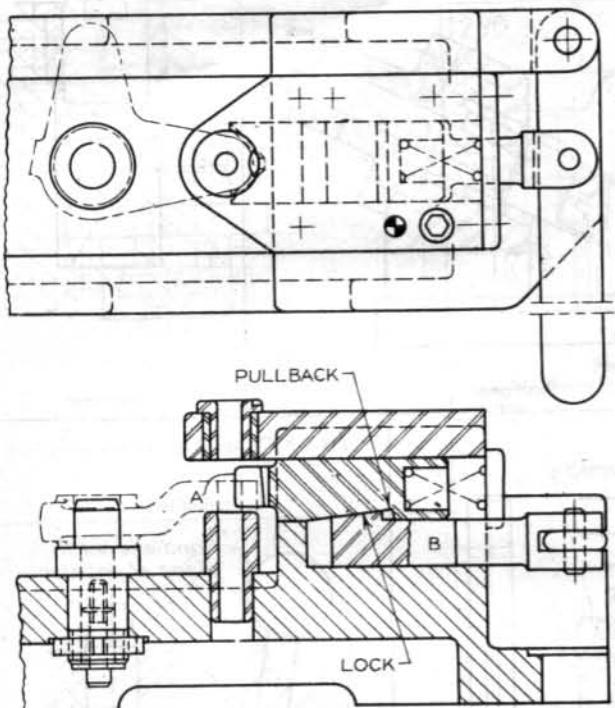
Positioner

1281



One of the two positioners slides in a T-slot to adjust to the tolerance variations between the two holes of the part.

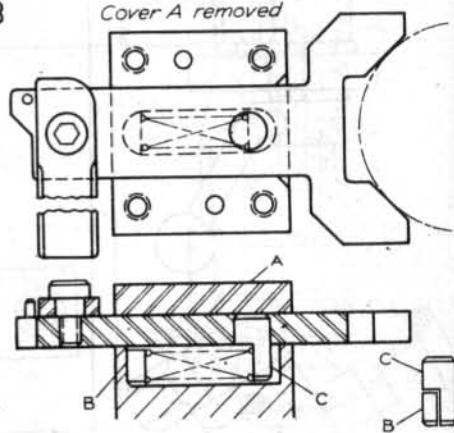
1282



The spring pushes positioner A to the part and cam B clamps the positioner. As the unit is unclamped, B catches on the pullback shoulder, retracting the positioner.

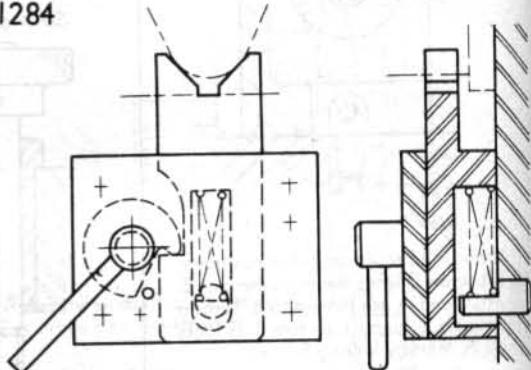
Positioner

1283



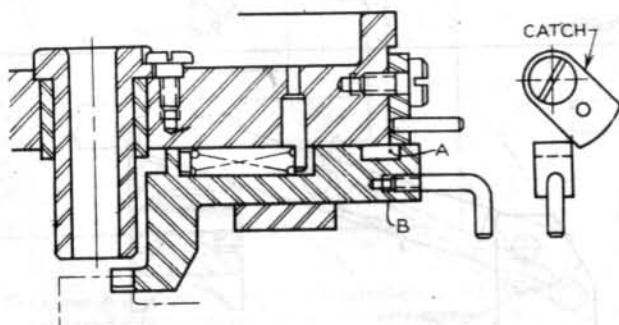
Positioner

1284



Positioner

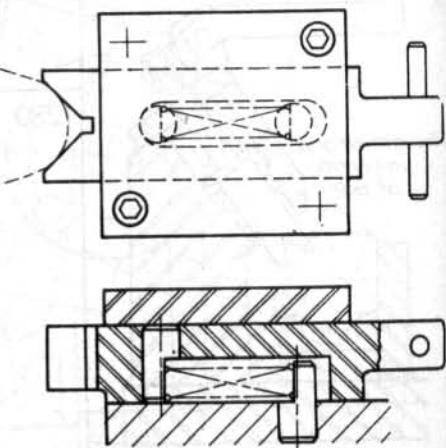
1285



The catch drops into notch A of spring-loaded positioner B as the positioner is retracted.

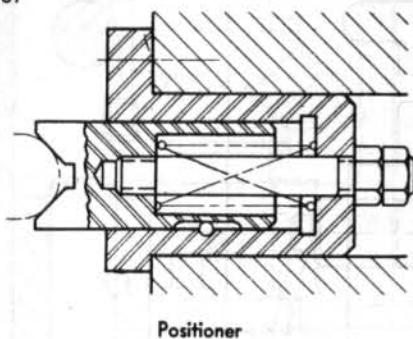
Positioner

1286

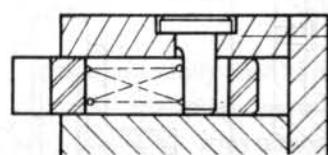
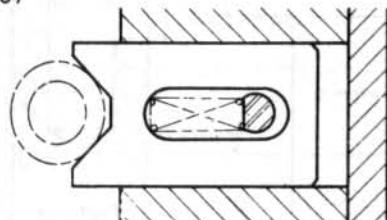


Positioner

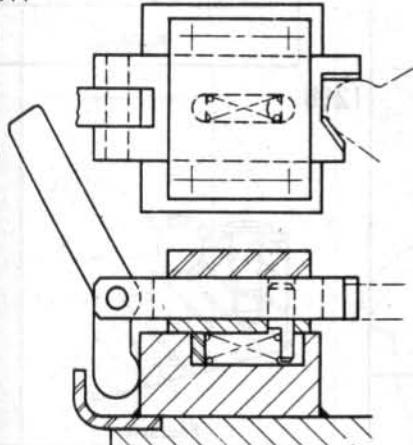
1287



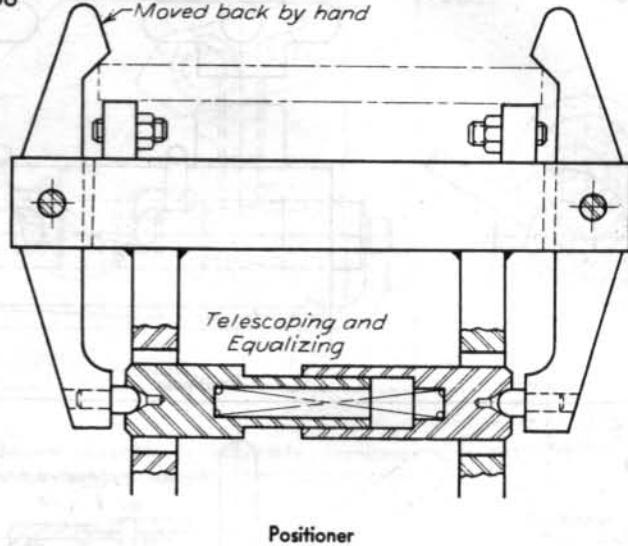
1289



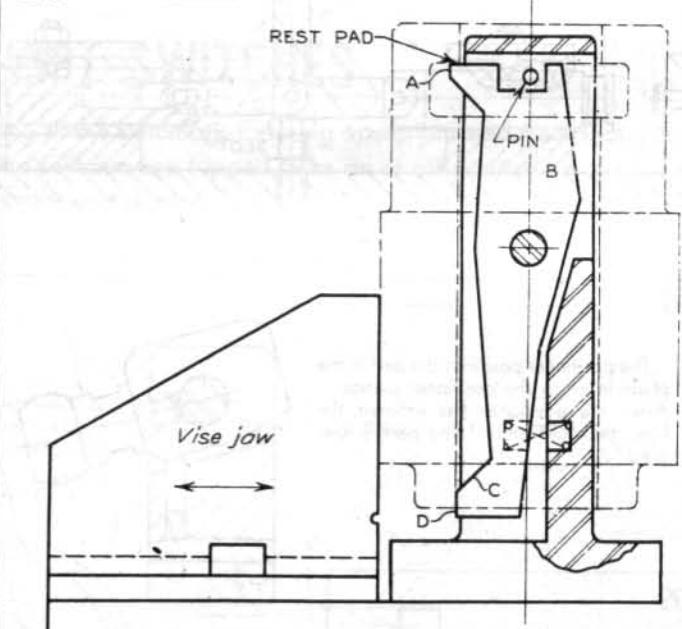
1291



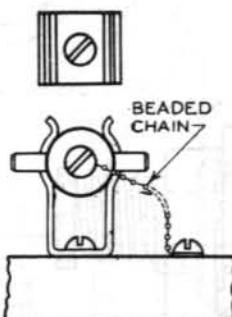
1288



1290



1292



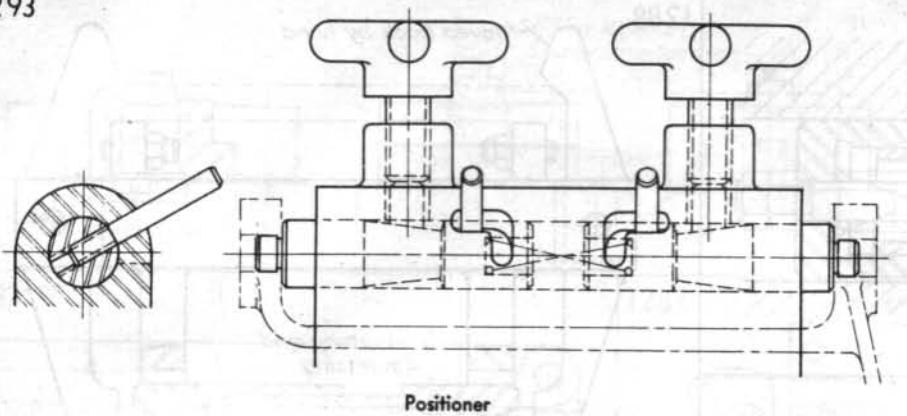
As the part is loaded, it strikes cam C and pushes the lower end of rocker arm B to the right, moving the upper end A into the recess of the part. When the part is raised in the unclamping operation, the lower end of B is moved to the left by the spring and the upper end A is moved to the right.

A clip is provided to store the locator pin when it is not being used.

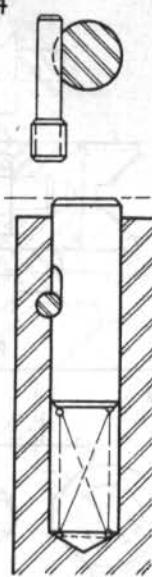
Positioner

Positioner

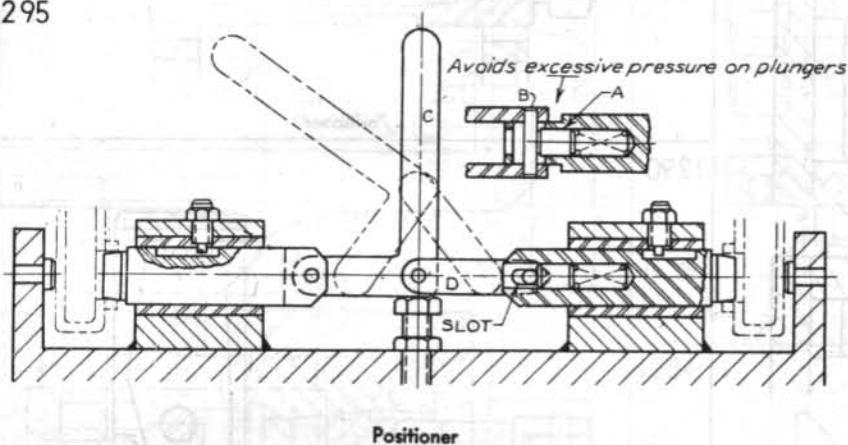
1293



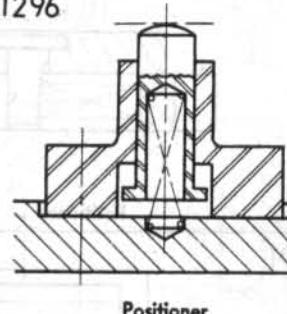
1294



1295

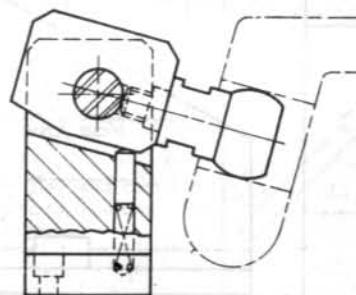


1296

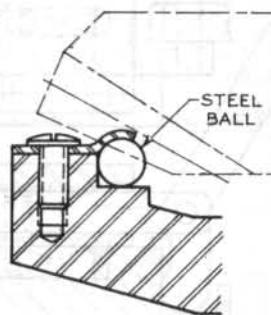


1297

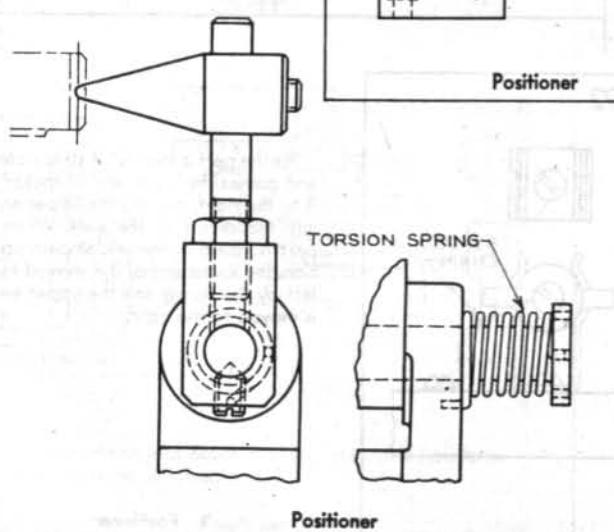
The positioner positions the part in the plane in which the positioner swings. After the positioner has entered the hole, the right end of the part is lowered.



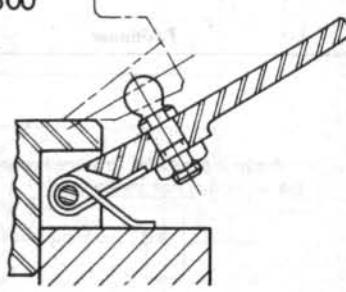
1298

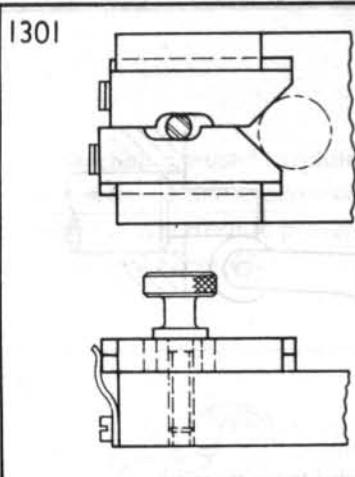


1299



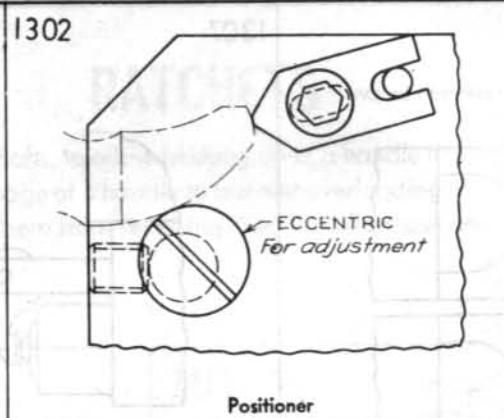
1300



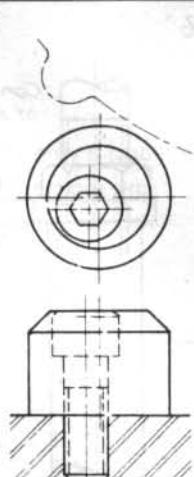


A lock is provided for this two-piece positioner.

Positioner



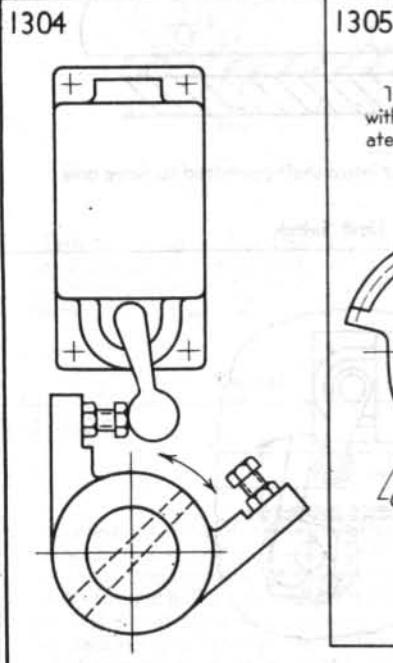
Several eccentrically adjustable positioners may be used to position the part approximately.



Positioner

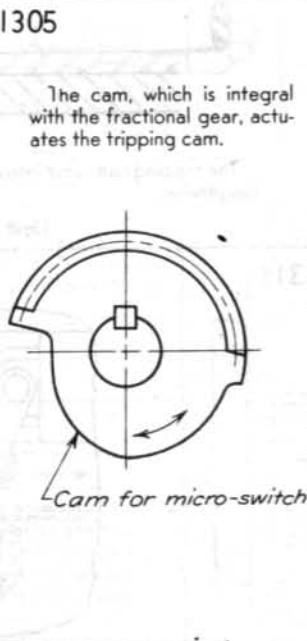
LIMIT SWITCHES

Switches usually control the timing of the automatic fixturing operations and the various clamping and unclamping operations. The switches are tripped to an on or off position by cams, extensions of shafts, or arms attached to shafts and clamps.

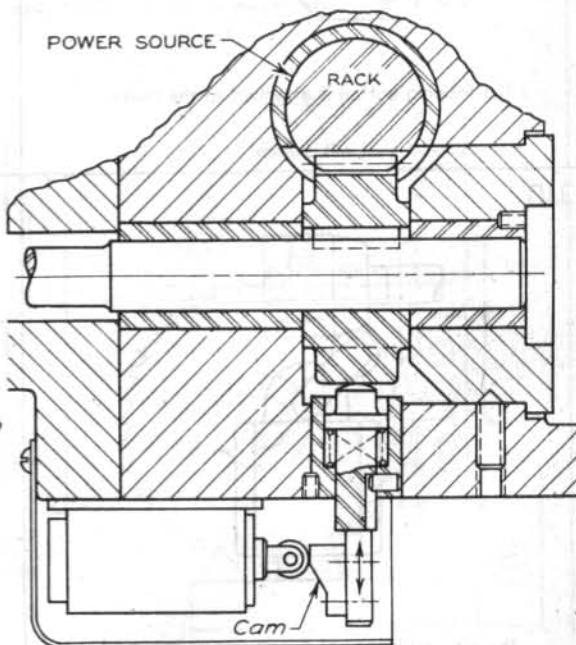


The shaft to which the tripping rocker arm is attached is permitted no lengthwise movement and only a limited amount of rotational movement.

Limit Switch



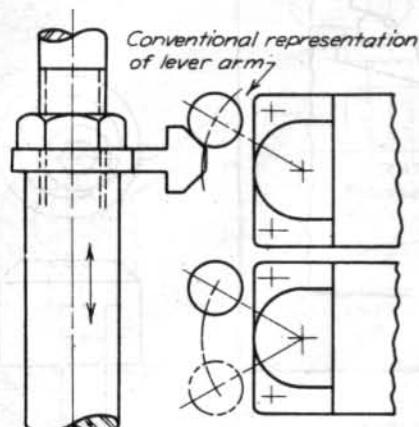
The cam, which is integral with the fractional gear, actuates the tripping cam.



Limit Switch

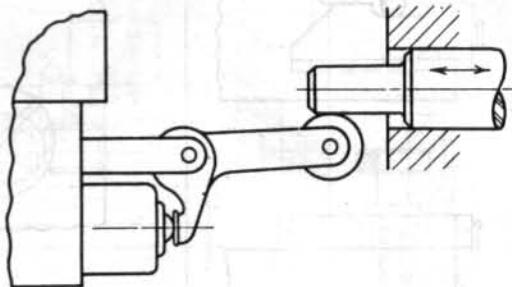
1306-1311

1306



Limit Switch

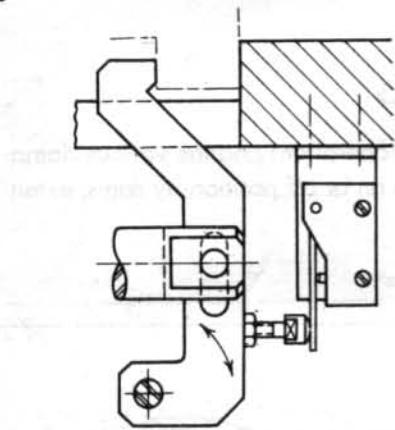
1307



The shaft is extended to trip the switch.

Limit Switch

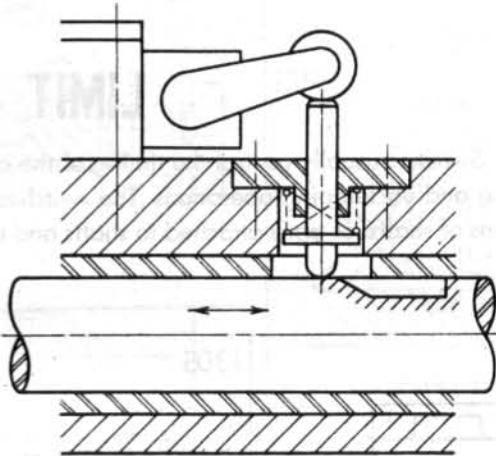
1308



The tripping button is attached to the clamp.

Limit Switch

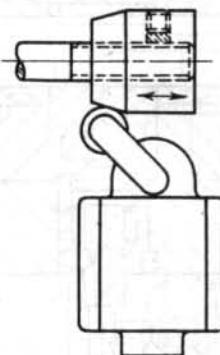
1309



The tripping cam is cut into a shaft permitted to move only lengthwise.

Limit Switch

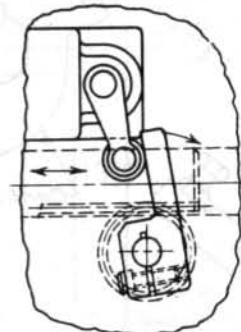
1310



The adjustable tripping nut is screwed onto a stud in the end of a shaft.

Limit Switch

1311



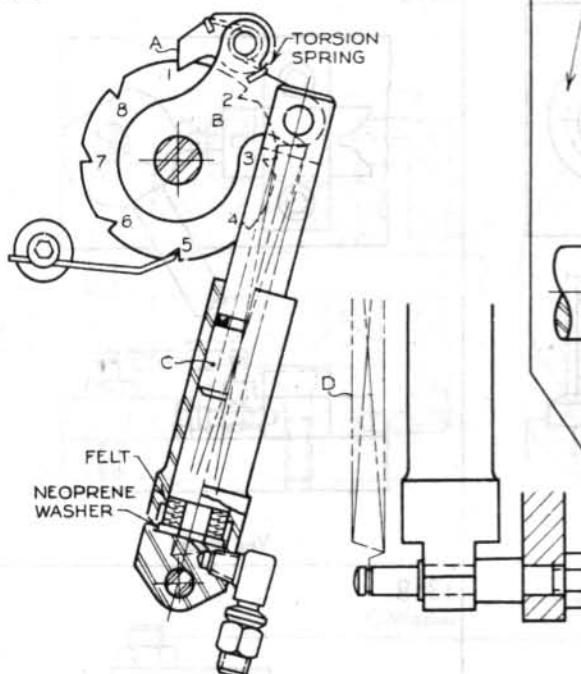
The tripping arm is clamped to the end of the pinion's shaft. This controls the rotation of the pinion and its shaft.

Limit Switch

RATCHETS

Ratchets are used to rotate shafts, to allow backing up of a handle designed to rotate only a fraction of a turn, and to allow slippage of a handle to prevent overloading. Frequently ratchets are provided with a catch to prevent them from reversing. See Miscellaneous and Indexing categories for additional examples.

1312



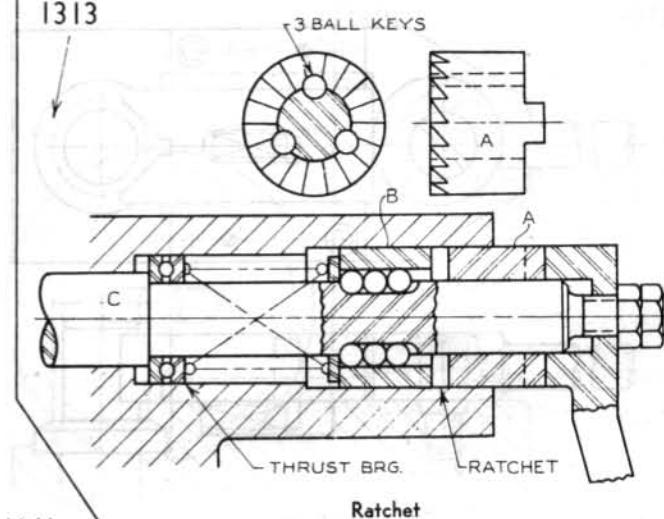
Extension spring D retracts piston C and rotates arm B until catch A drops into notch 2. Air pressure then raises piston C, rotating arm B and the ratchet.

Ratchet

1313 (Explanation)

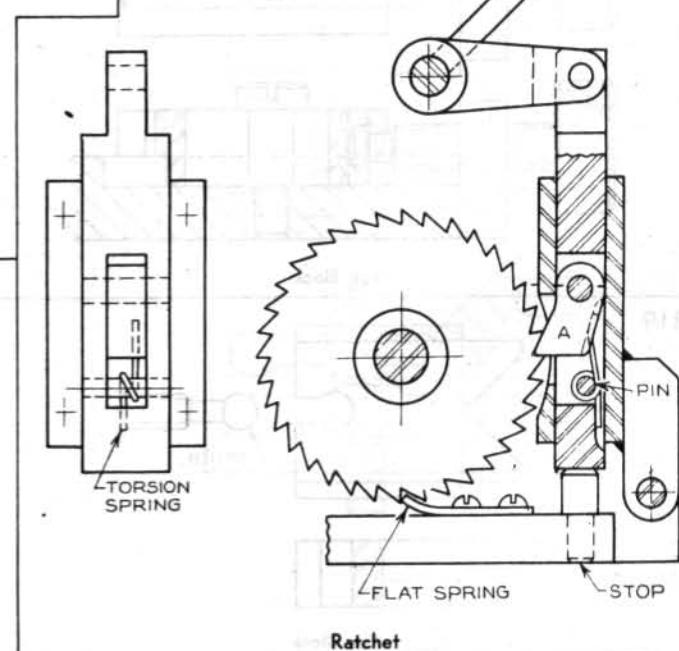
Continued turning of the handle after shaft C has reached the position in which it is stopped will cause slippage between the mating ratchet teeth of A and B. The spring in spring-loaded portion B of the ratchet allows B to move to the left. The balls not only serve as keys between B and C but permit B to move horizontally more easily than a square key would.

1313



1314

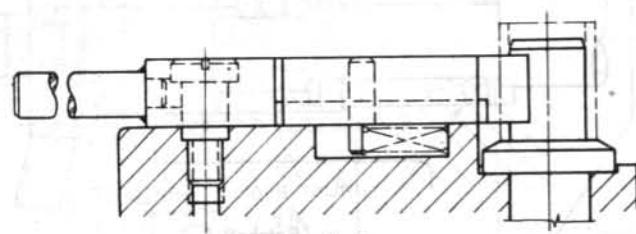
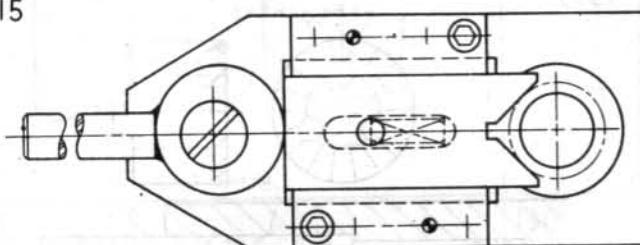
Raising the handle moves catch A up to the next tooth on the ratchet. Lowering the handle rotates the ratchet.



VEE BLOCKS

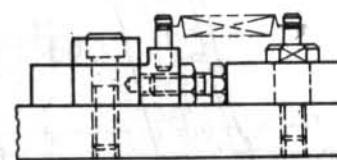
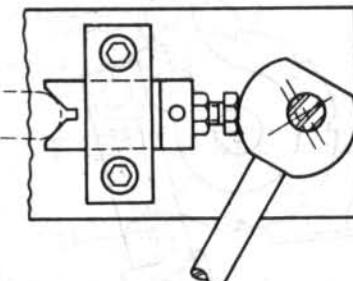
Vee blocks may be stationary or movable. When they are spring-loaded, they will retract automatically. In other instances they may be retracted by the clamping screw.

1315



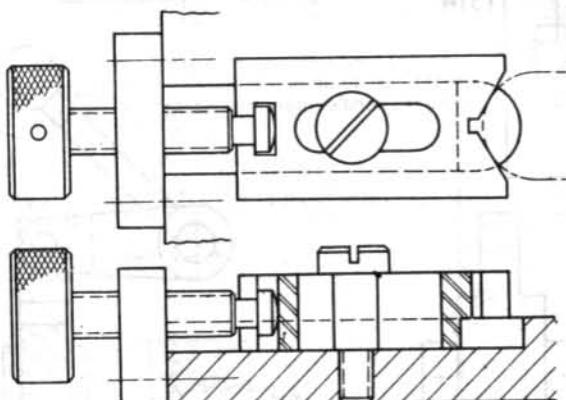
Vee Block

1316



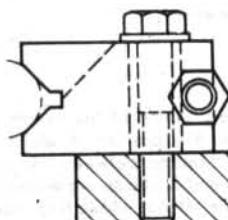
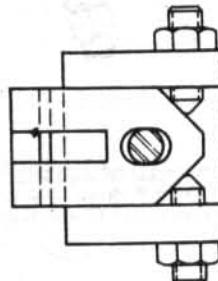
Vee Block

1317

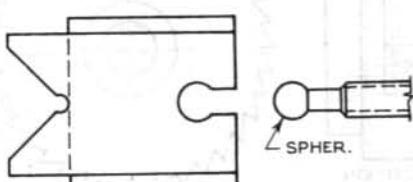


Vee Block

1318



1319



SPHER.



Vee Block

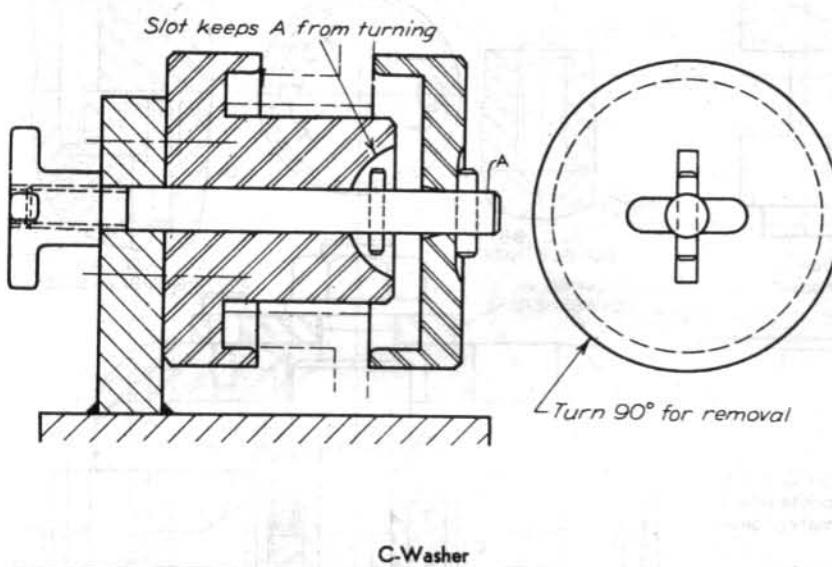
An Adjustable Stationary Vee Block

Vee Block

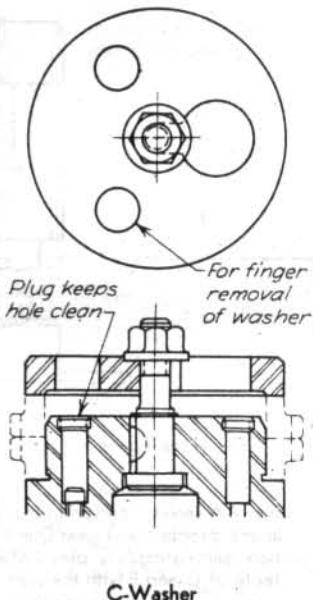
C-WASHERS

The c-washers illustrated are variations of the commercial type.

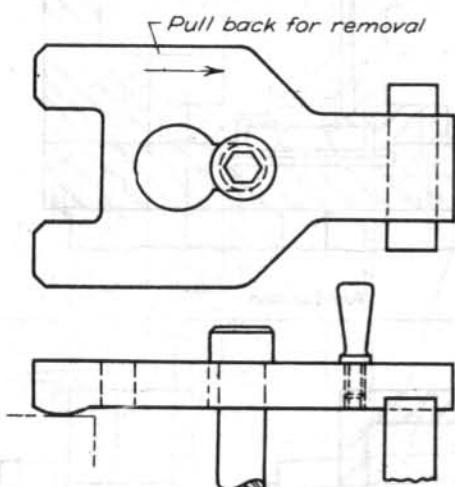
1320



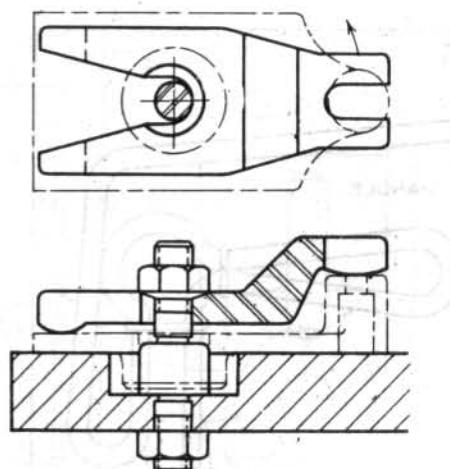
1321



1322

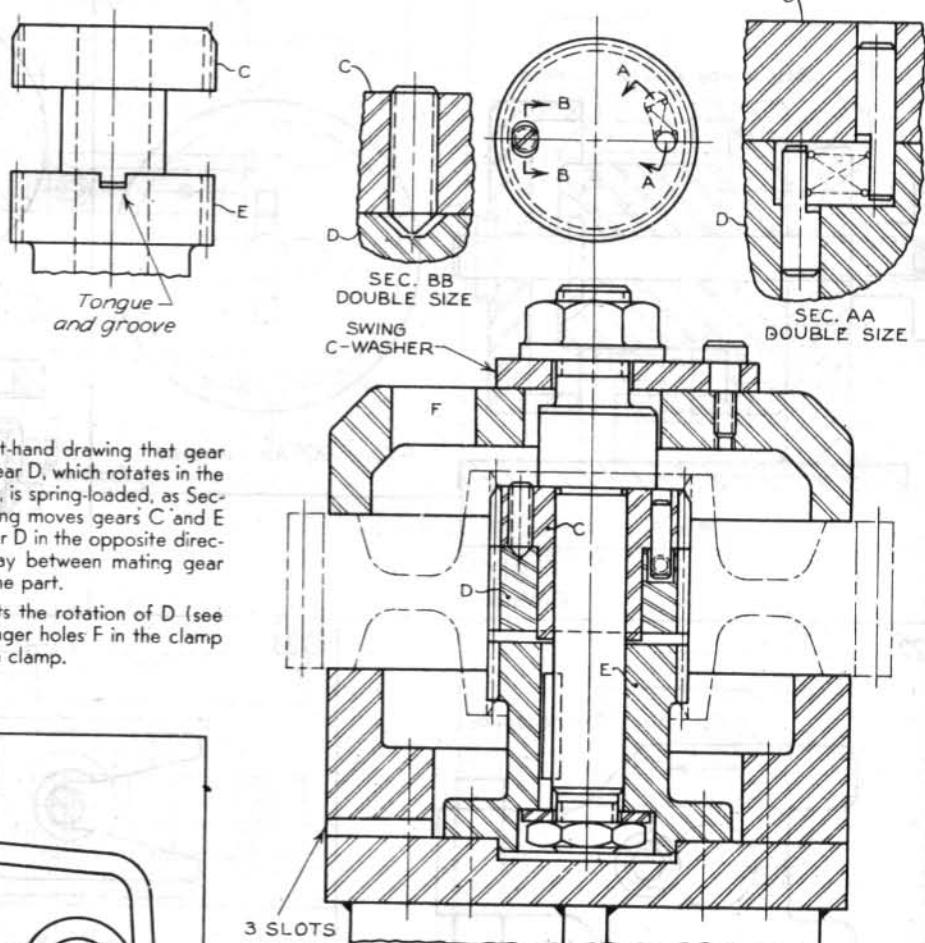


1323



MISCELLANEOUS

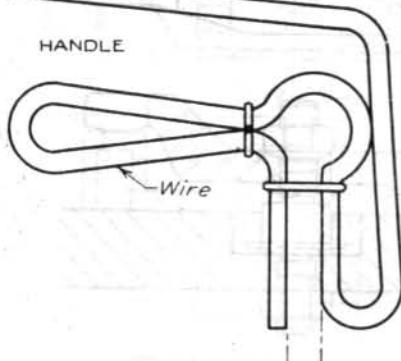
1324



Note in the upper left-hand drawing that gear C is keyed to gear E. Gear D, which rotates in the space between C and E, is spring-loaded, as Section AA shows. The spring moves gears C and E in one direction and gear D in the opposite direction, eliminating any play between mating gear teeth of C and E with the part.

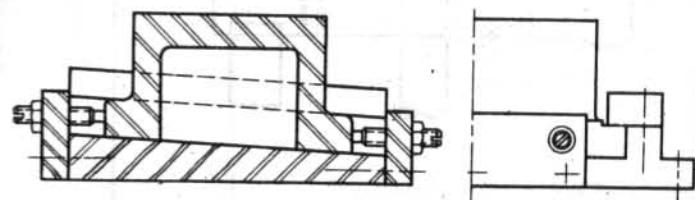
A set screw in C limits the rotation of D (see Section BB). The two finger holes F in the clamp facilitate removal of the clamp.

1325



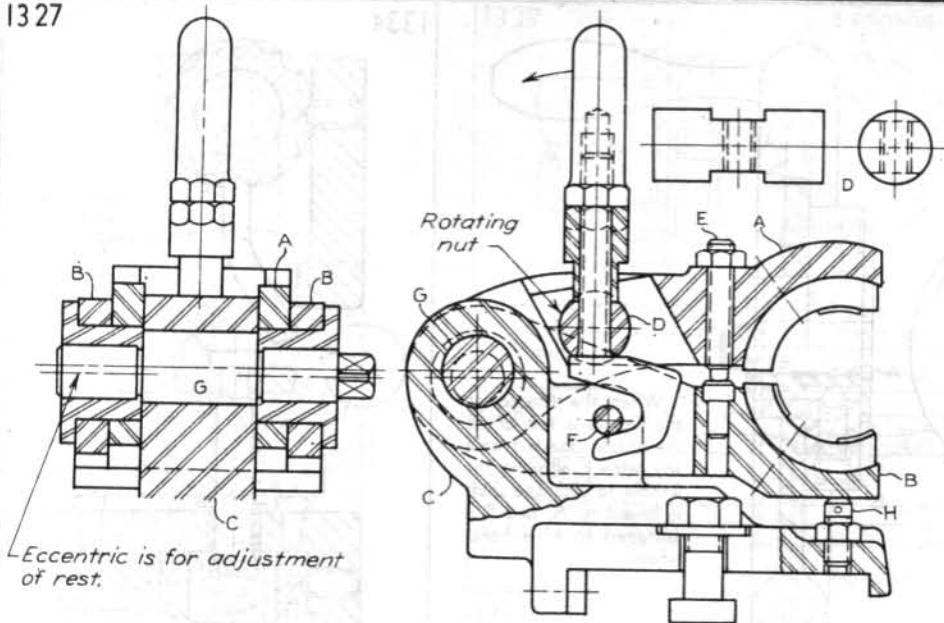
Holder

1326



Adjustable-Height Base

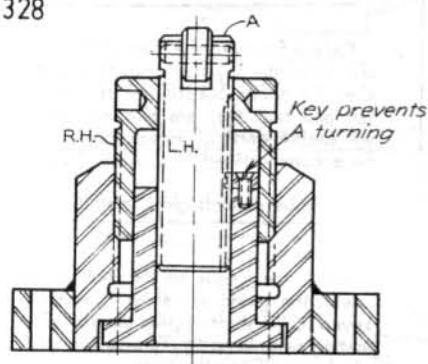
1327



After the handle has been swung to the left and it has cleared F, it raises jaw A. Eccentric shaft G may be adjusted to move jaws A and B horizontally as H adjusts their vertical position. Adjustable stop E prevents clamping action. A steady rest holds a part in position; it does not clamp the part.

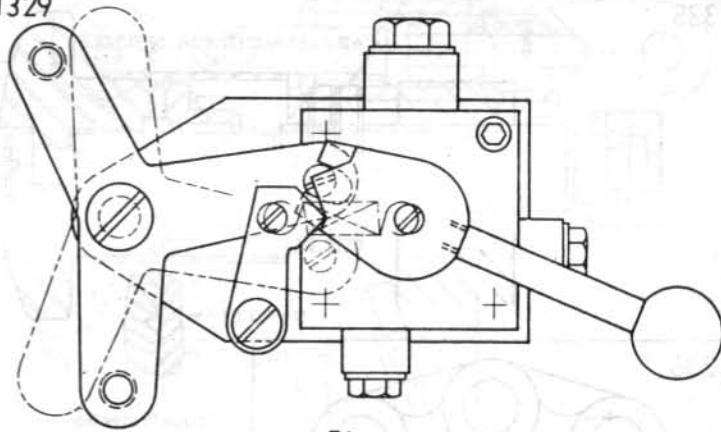
Steady Rest

1328



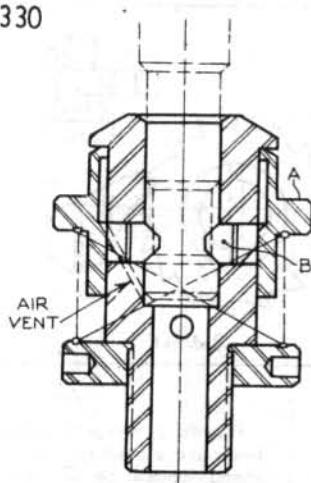
Steady Rest

1329



Tripper

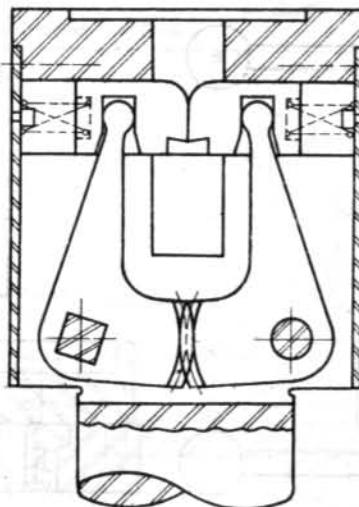
1330



Pushing A down enables the three jaws B to retract, allowing the broach to be removed.

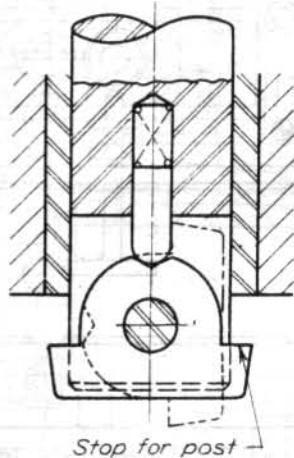
Broach Puller

1331



Broach Puller

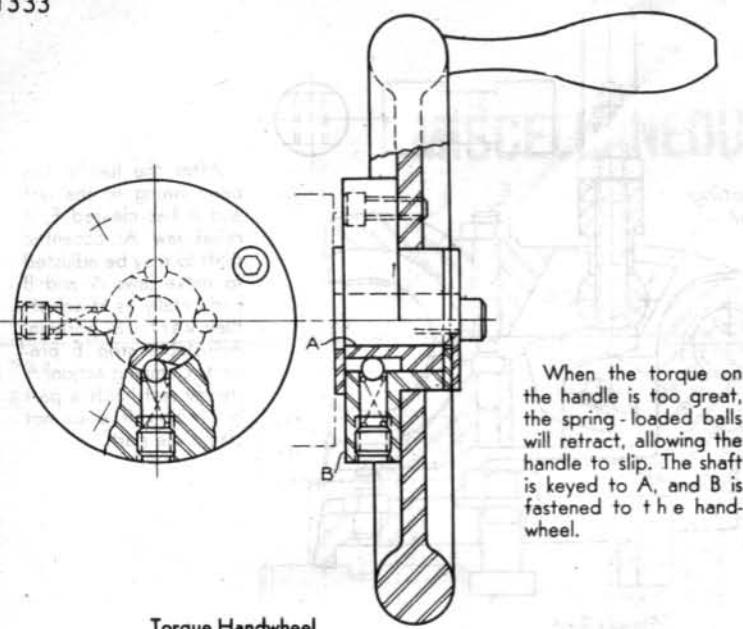
1332



Clamp Post Stop

1333-1337

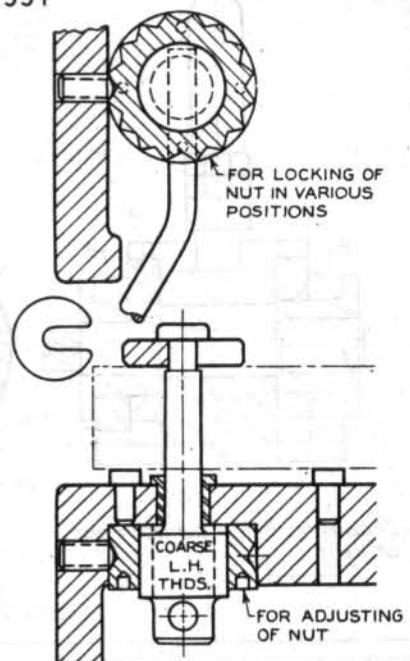
1333



Torque Handwheel

When the torque on the handle is too great, the spring-loaded balls will retract, allowing the handle to slip. The shaft is keyed to A, and B is fastened to the handwheel.

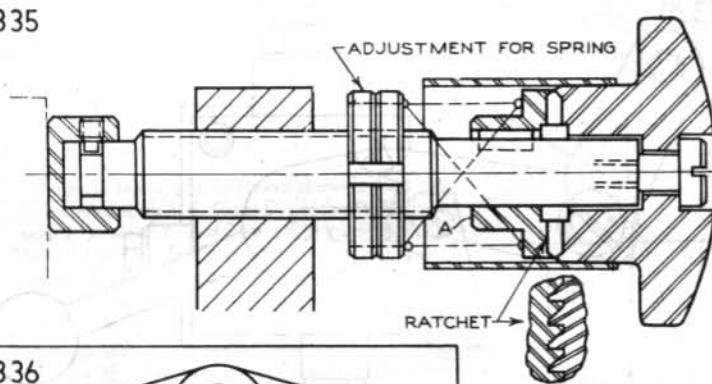
1334



FOR LOCKING OF NUT IN VARIOUS POSITIONS

FOR ADJUSTING OF NUT

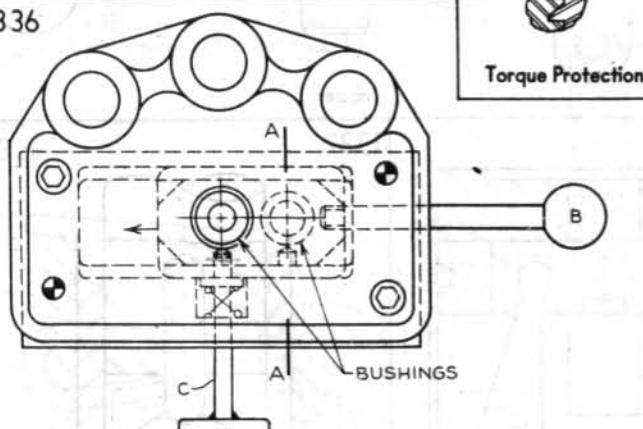
1335



Adjustable-Height Clamp Post

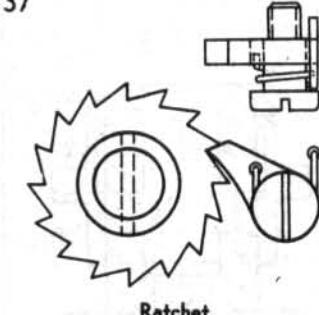
Only a fraction of a turn of the handle allows the adjustable nut to actuate clamping action. Substitution of a longer nut and bolt that are also adjustable will enable parts of varying heights to be accommodated.

1336

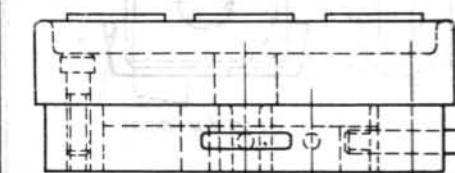


Torque Protection

1337

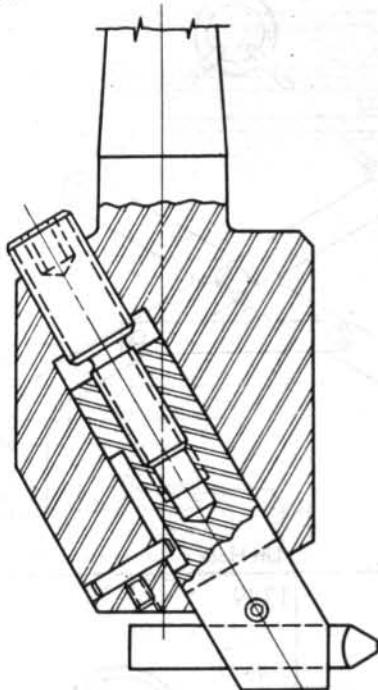


Handle B moves the two bushings in and out of position; spring-loaded pin C holds them in position.



Bushing Mover

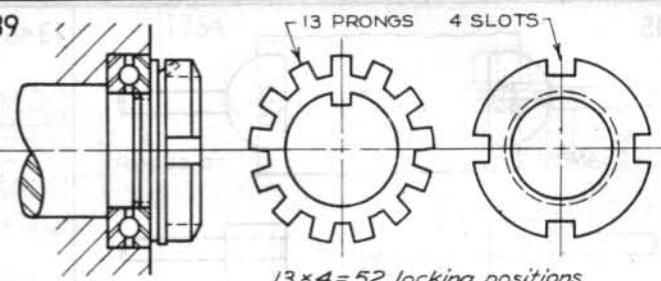
1338



Difference of the two pitches creates a very fine adjustment

Micro Adjustment

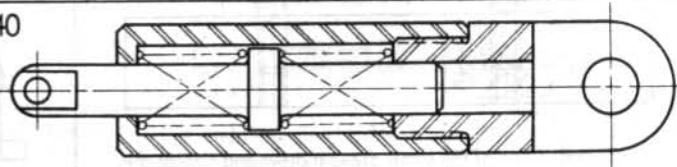
1339



Any combination of a number of slots and prongs that allows only one prong to match one slot will provide a maximum number of locking positions.

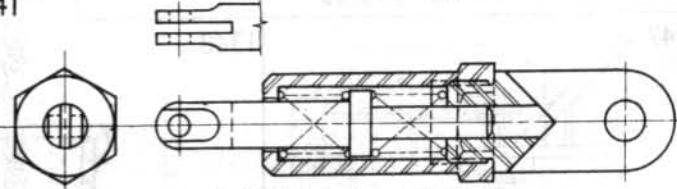
Micro Adjustment

1340



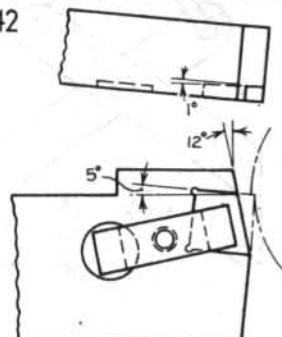
Push-Pull Spring-Loaded Link

1341



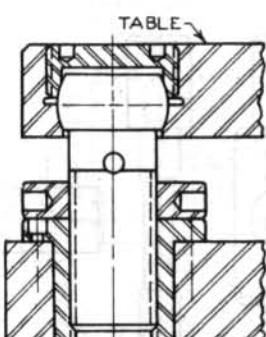
Push-Pull Spring-Loaded Link

1342



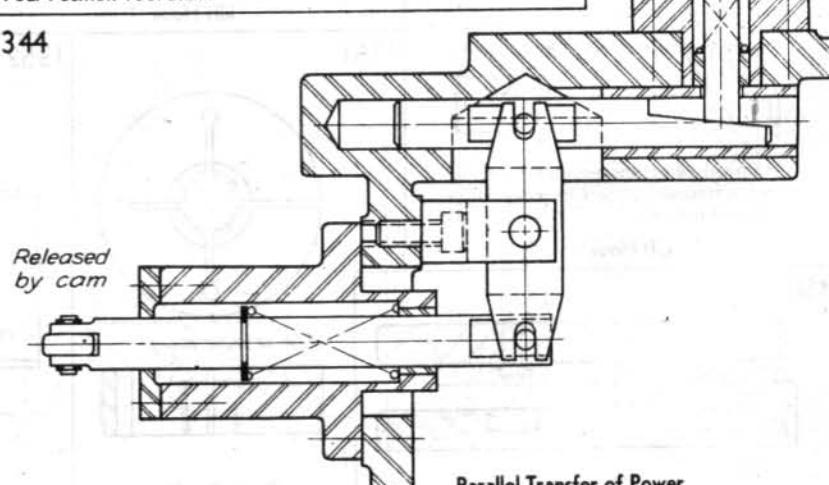
Four-Position Tool Blank

1343



Adjustable Table Leg

1344

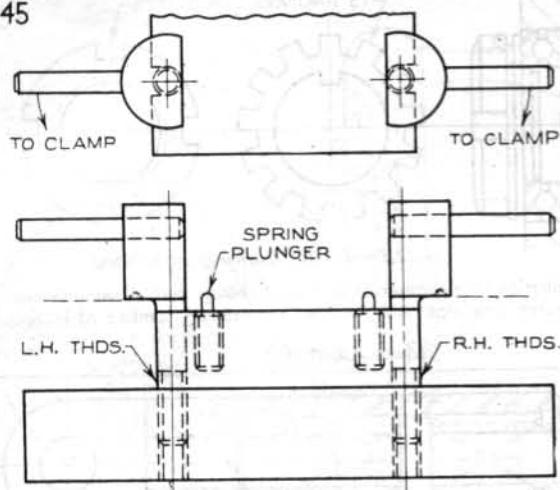


Released by cam

Parallel Transfer of Power

1345-1352

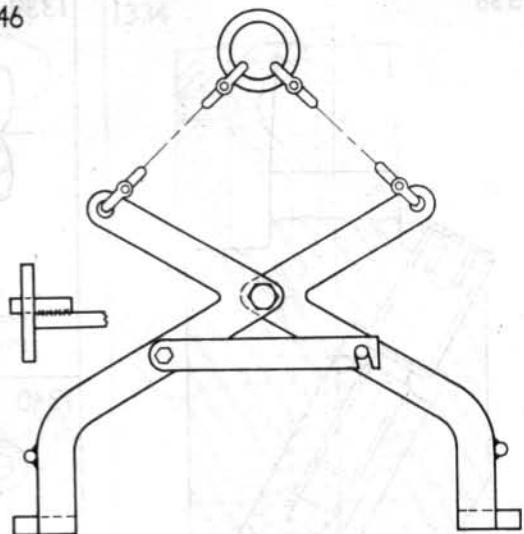
1345



A one-half turn of the screw draws it down and clamps the part. The spring plunger detent holds the clamp in retracted position.

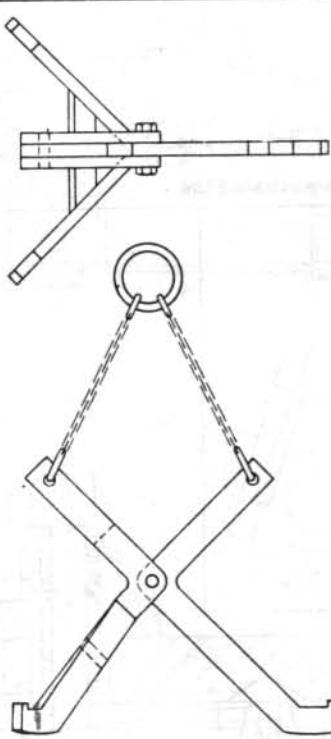
Half-Turn Screw

1346



Lift Hook

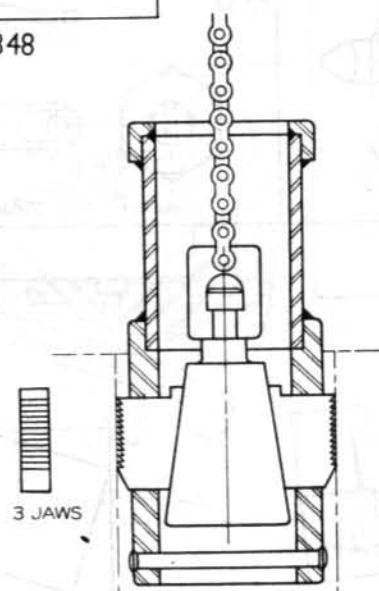
1347



An overhead crane equipped with lift hooks is frequently used to move large parts and fixtures.

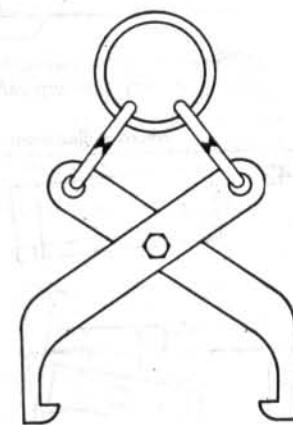
Lift Hook

1348



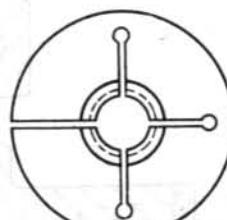
Lift Hook

1349



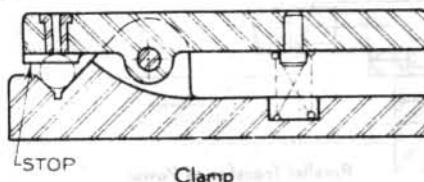
Lift Hook

1351



For a pipe plug

1350

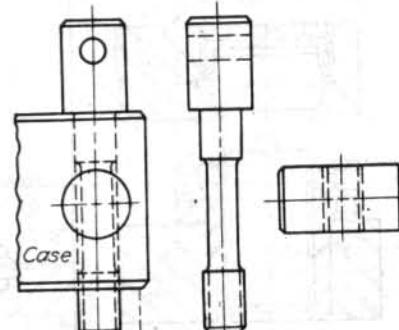


STOP

Clamp

Expanding Plug

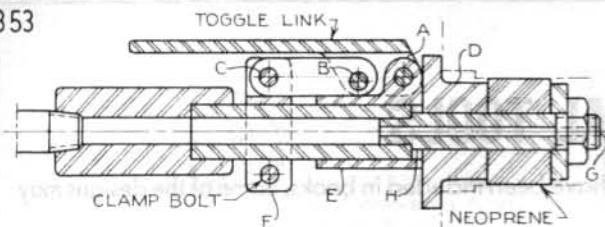
1352



Case

Retaining Screw in Place

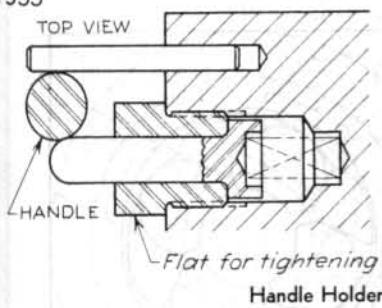
1353



With E pressing against D, the toggle linkage draws on H and squeezes the neoprene, forcing it to expand and clamp the bore. F is adjustable. The air or water used in the test for leaks enters through G.

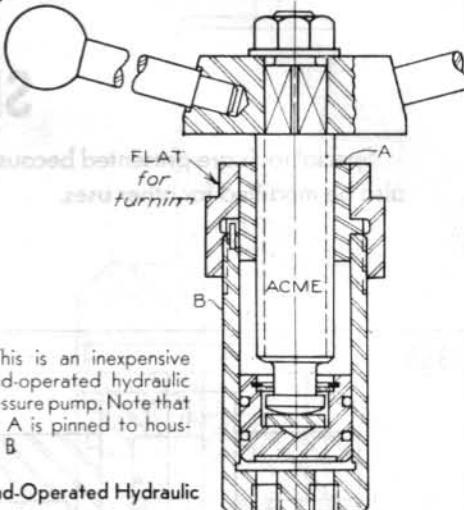
Leak Test Plug

1355



In this design the handle is held in a raised position.

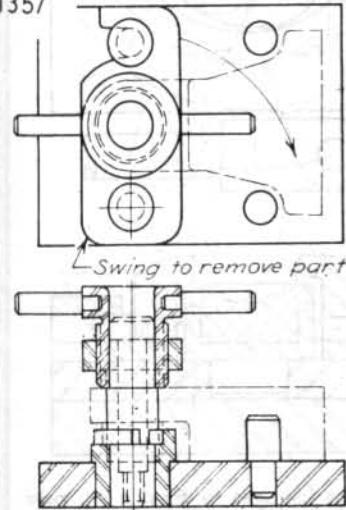
1354



This is an inexpensive hand-operated hydraulic pressure pump. Note that nut A is pinned to housing B.

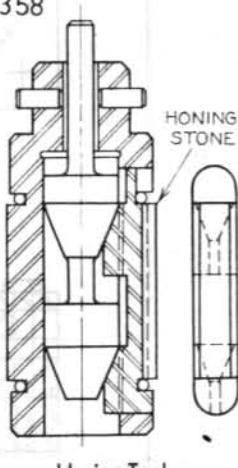
Hand-Operated Hydraulic Pressure Pump

1357



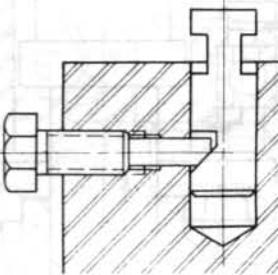
Bushing Clamp

1358



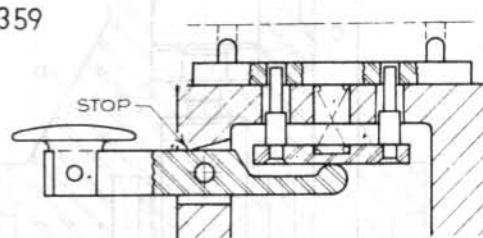
Honing Tool

1356



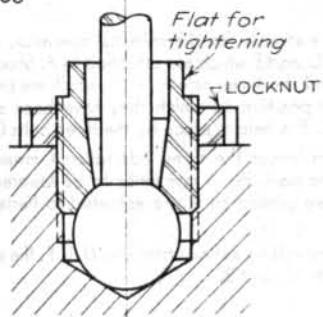
Clamp Bolt.

1359



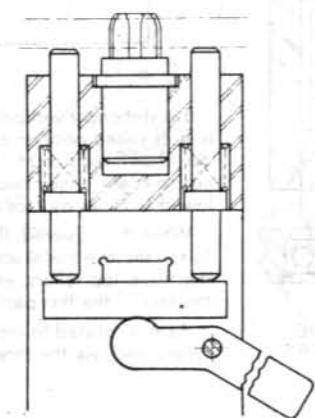
Part Knock-Out Device

1360



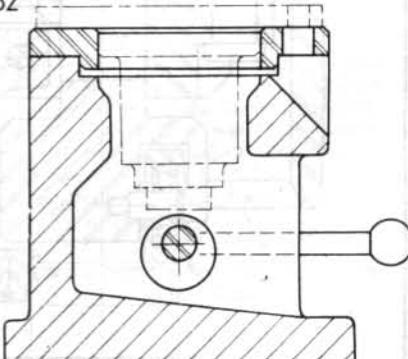
Floating End

1361



Part Knock-Out Device

1362



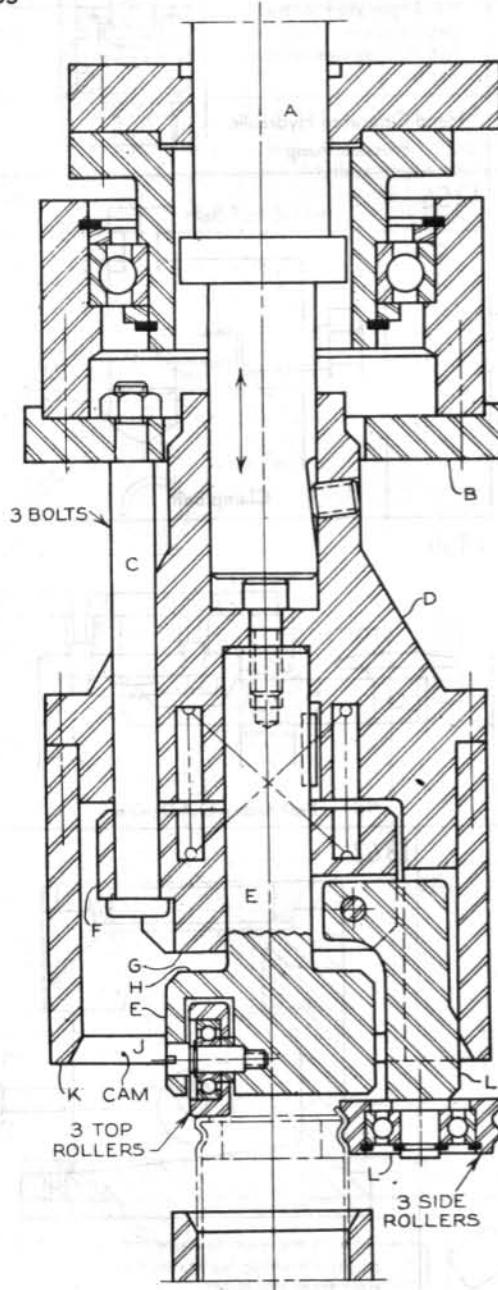
Using the cam to raise the part out of its positioning hole facilitates the removal of the part from the hole.

Part Knock-Out Device

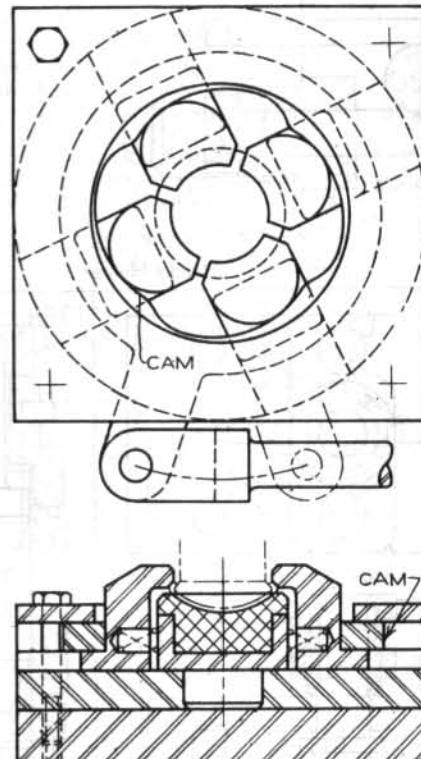
SPECIAL TOOLS

Special tools are presented because so few have been included in books. Some of the designs may also be modified for other uses.

1363



1364



Four cams force four jaws to crimp a thin metal part over the end of a rod.

Crimping Tool

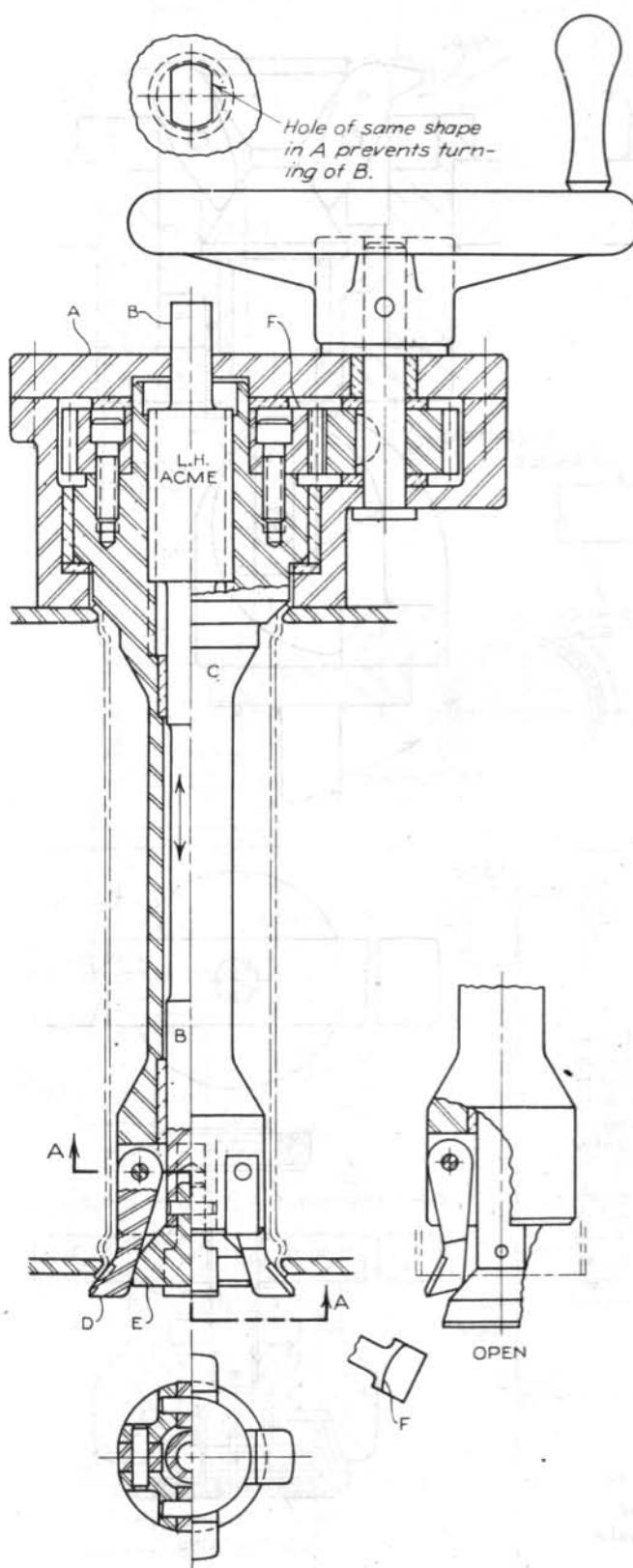
B is stationary vertically. In readiness for the spinning operation, A is in its raised position as are D and E which are attached to A. Shoulder G of F rests on H of E, and the three side rollers L, which are pinned to F, are in their swung-out position to which they have been allowed to move by cam J of K. F is held in place by the three bolts C.

When A is lowered, the cam forces the three side rollers L inward to roll the thin metal about the part. As A continues to be lowered, the three top rollers, which are pinned to E, are actuated to flatten the end of the thin part.

As A is rotated to create the rolling action, it rotates D, E, F, the six rollers, and, via the three bolts C, unit B.

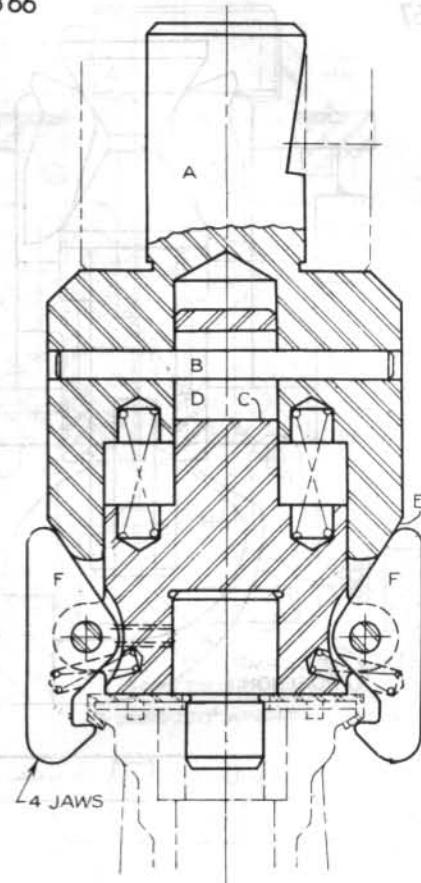
Spinner

1365



Swaging Tool

1366



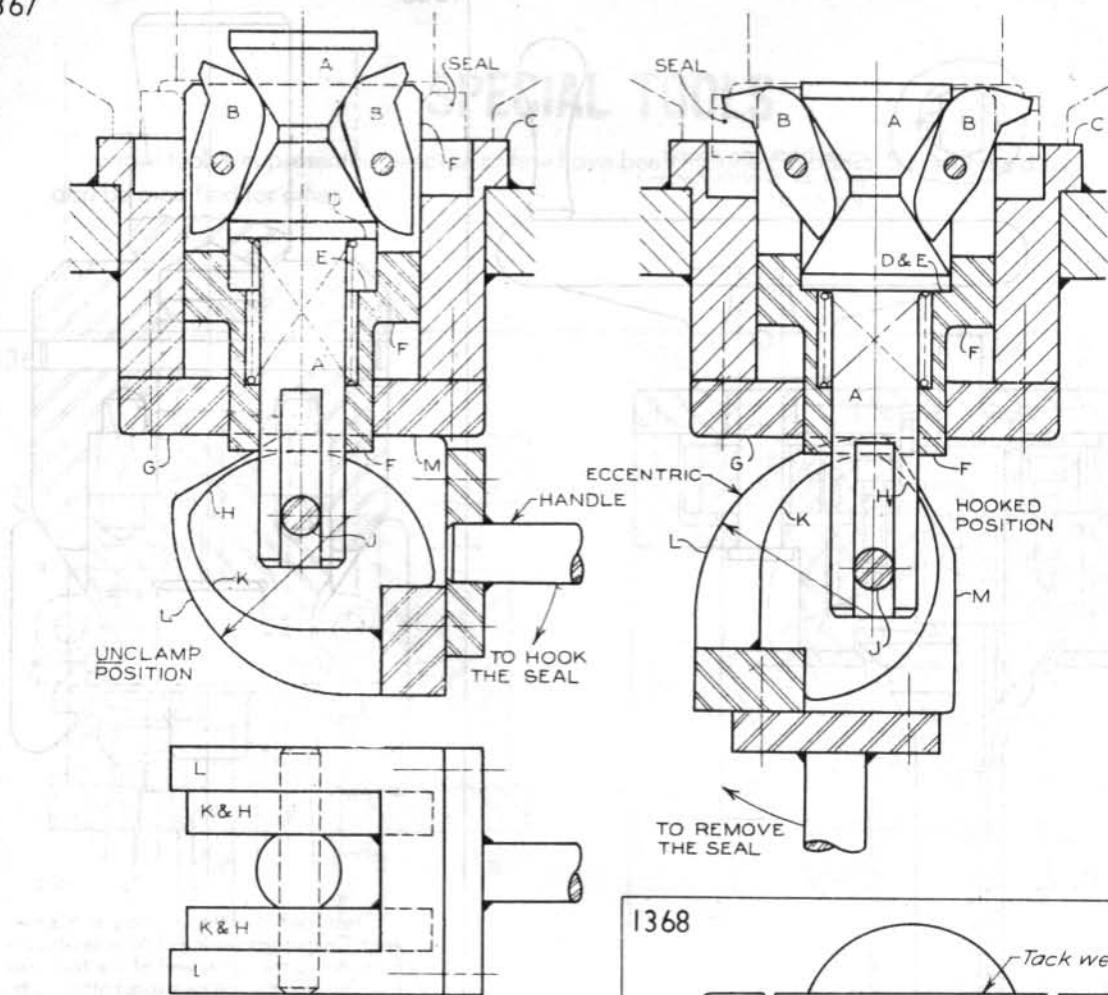
C rests on top of the assembly as A is lowered. Continued lowering of A causes its cam E to spread the upper end of the four jaws F which crimp the thin part about other parts. Slot D in A and pin B control the movement of A. What would happen if B and D were omitted?

Crimping Tool

The handle rotates a pinion that turns gear F, which is cap screwed to C. As the handle is turned clockwise, screw B and expander E, which is attached to B, are raised, thereby spreading the four jaws D to swage the thin metal. Since jaws D are pinned to housing C, the jaws move around the thin metal part when C is rotated by gear F.

Note the curved jaw contact surface F. It produces a smooth swaged surface on the part.

1367



In the unclamped position, spreader A causes jaws B to retract, allowing the seal to be placed about F until the housing rests against shoulder C. When the handle is turned to hook the seal as indicated, cam H forces spreader A to spread jaws B to hook the seal as shown in the drawing on the right. As cam H pulls A down, it causes shoulder D of A to contact shoulder E of F.

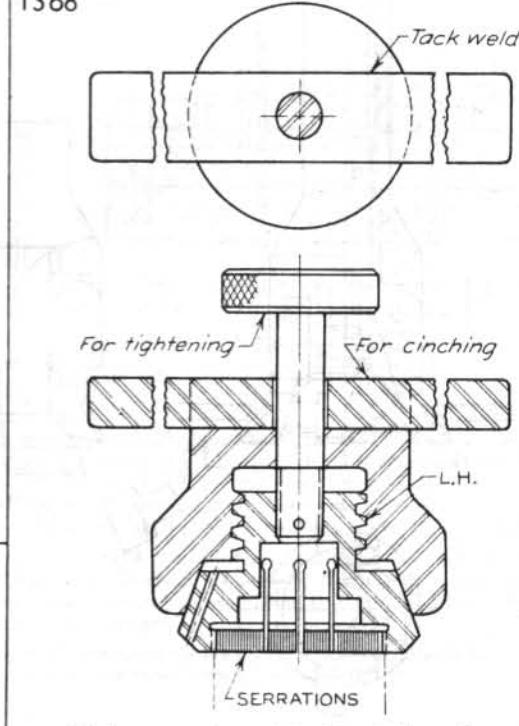
To remove the seal, the handle is turned further as indicated, actuating cam L to press against G and to pull A down further. Shoulder D of A presses against E of F and forces F downward, thereby causing jaws B, which are attached to F, to remove the seal. Surface K, which is concentric with pin J, holds A and F together as cam L initiates the action to remove the seal.

Oil Seal Removing Tool

"When you hear that somebody has been discovered, you can put it down as a fact that he discovered himself years ago—since which time he has been working, toiling, and striving to make himself worthy of being discovered."

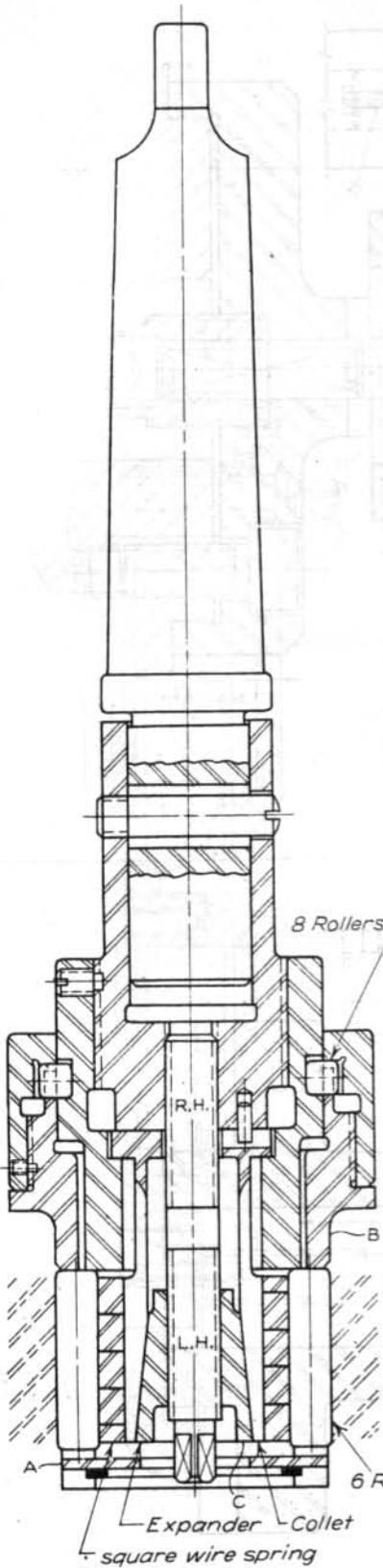
JAMES WHITCOMB RILEY

1368



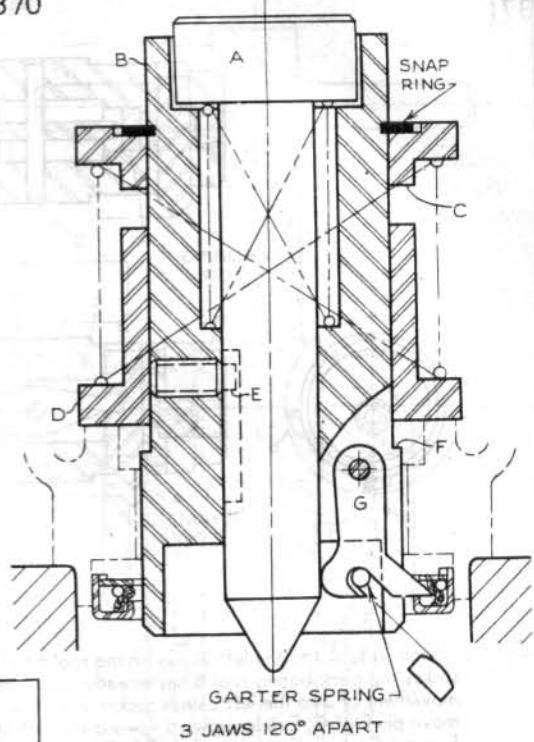
Wrench

1369



Burnishing Tool

1370



After the removing tool has been inserted into the part and D has been brought to rest on a shoulder of the part, shaft A is forced down, spreading the three jaws G which engage the oil seal. Then as A is pushed down still further, it forces down B and jaws G, which are pinned to B, enabling the jaws to remove the oil seal.

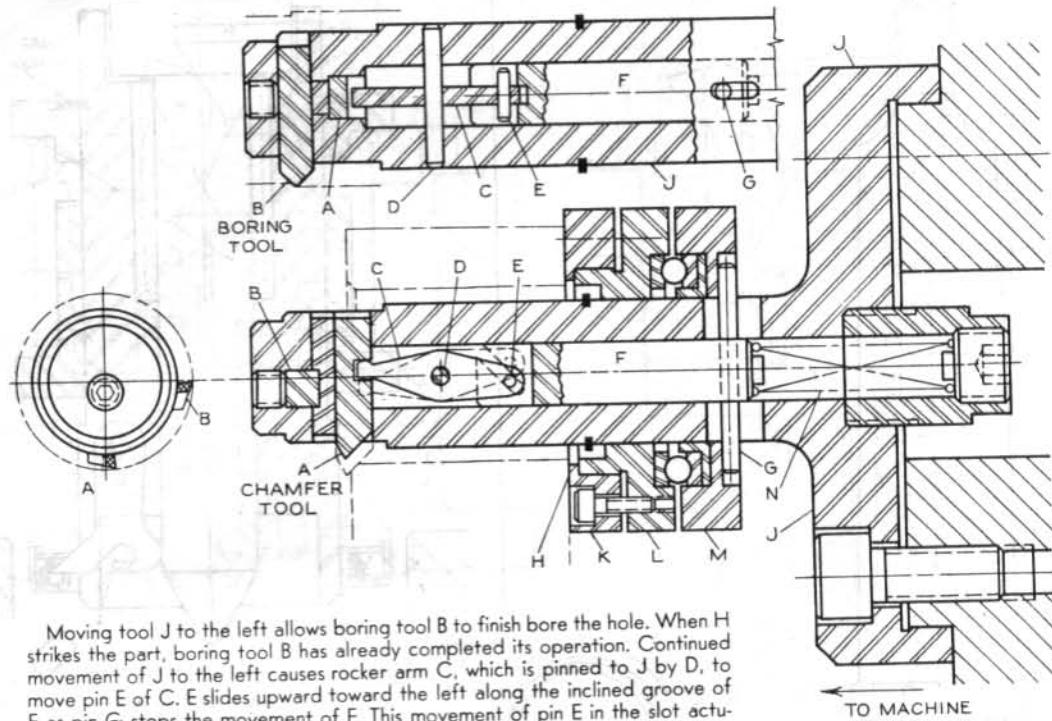
Set screw E limits the movement of A; shoulders C and F limit the movement of D. Determine why E and the shoulders are necessary.

Oil Seal Removing Tool

As the screw is turned clockwise, expander C forces the collet to expand the spring, thereby forcing the six rollers against the bore of the part. As the tool is rotated, the rollers burnish the surface. The square spring is coiled without any space between its coils.

"Some men give up their designs when they have almost reached the goal; while others, on the contrary, obtain a victory by exerting, at the last moment, more vigorous efforts than before." POLYBIUS

1371



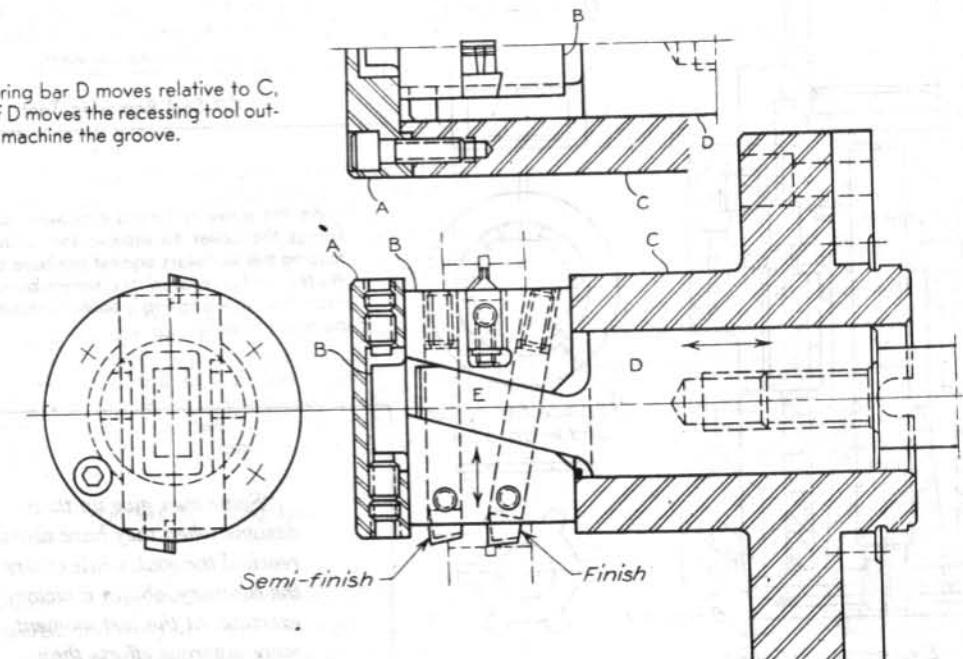
Moving tool J to the left allows boring tool B to finish bore the hole. When H strikes the part, boring tool B has already completed its operation. Continued movement of J to the left causes rocker arm C, which is pinned to J by D, to move pin E of C. E slides upward toward the left along the inclined groove of F as pin G stops the movement of F. This movement of pin E in the slot actuates chamfer tool A.

The pressure of spring N on F and its pin G keeps K, L, and M together. The snap ring limits the movement of K, L, and M to the left when chamfer tool A is retracted.

Chamfer and Boring Tool

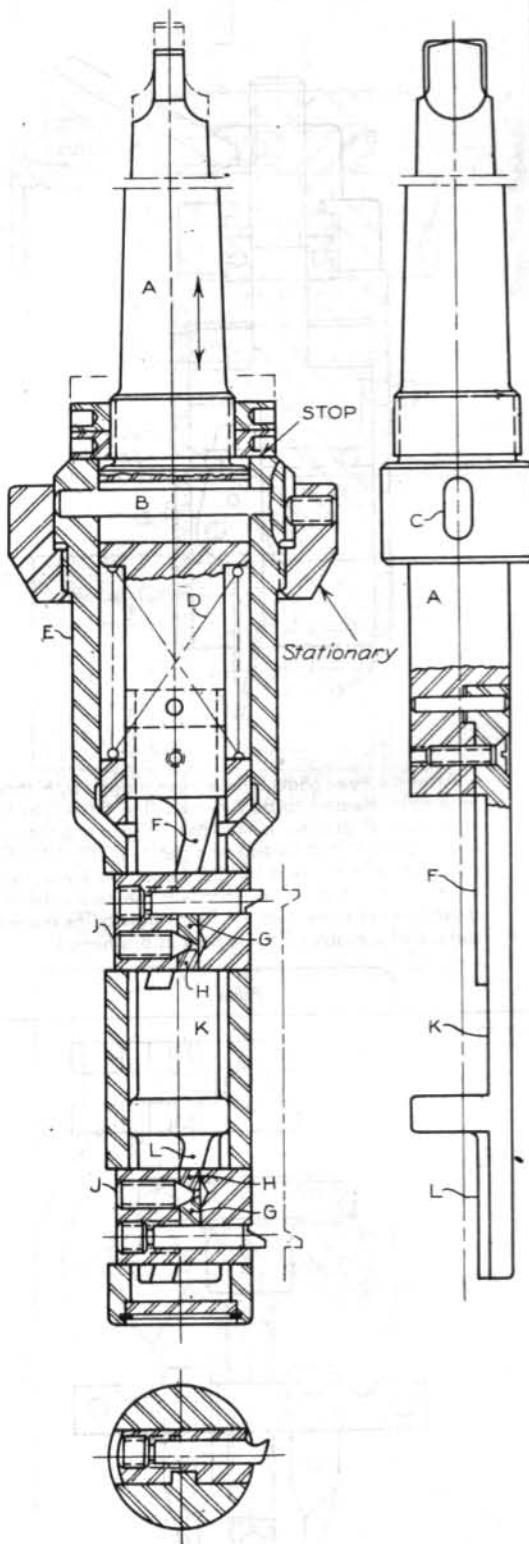
1372

As boring bar D moves relative to C, cam E of D moves the recessing tool outward to machine the groove.



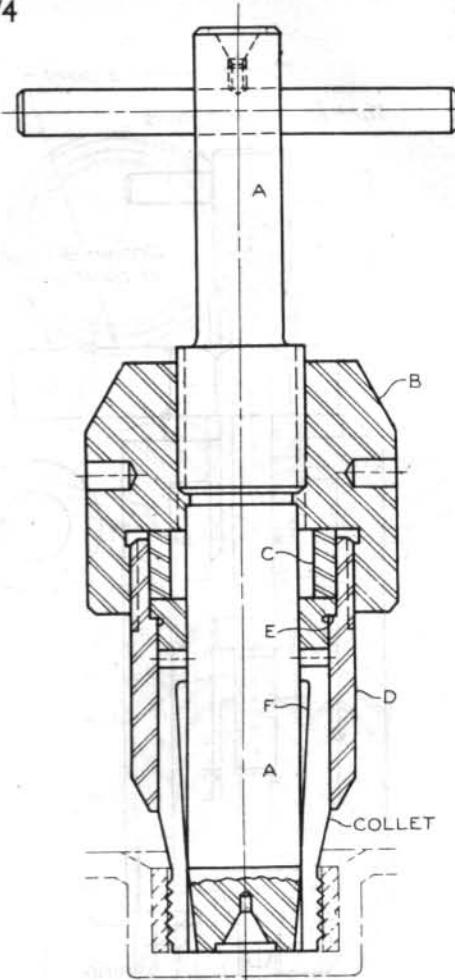
Recessing and Boring Tool

1373



Recessing Tool

1374



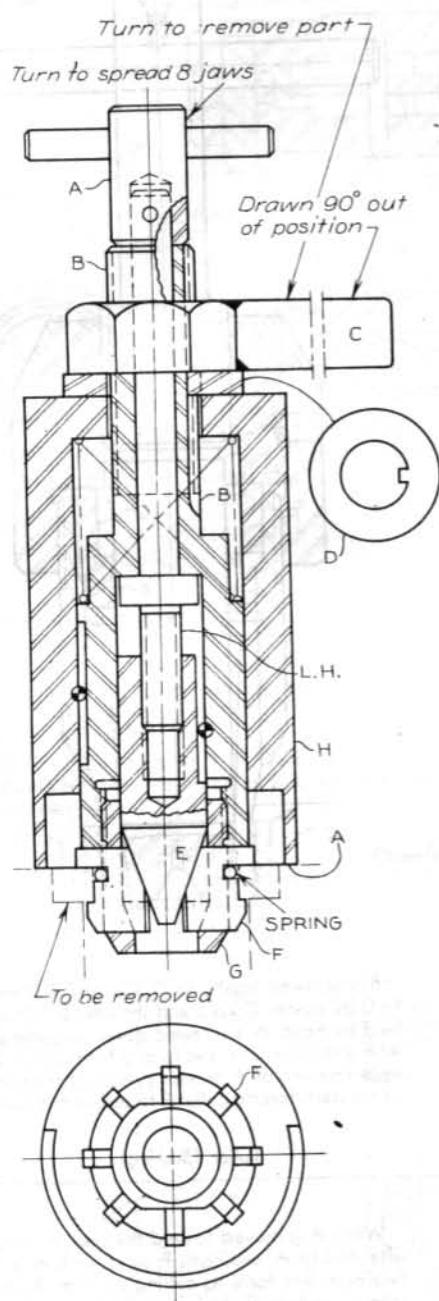
B is screwed tightly to D. Collet F is clamped to D by spacer C via B and shoulder E. While B is held by hand, A is screwed down, spreading collet F and causing its jaws to grip the bushing. Continued turning of A presses A against the bottom of the part, forcing collet F to pull up the bushing.

Puller (Bushing)

When A is moved toward the part, K, which is attached to A, and cams F and L of K move the two recessing tools to cutting position. Screws J spread wedges G and H to bind the recessing tools in their grooves. Spring D aids in the retraction of K and the recessing tools. Pin B in housing E functions in groove C of A; it prevents K from rotating.

"Dissatisfaction with existing designs coupled with determination to improve them has produced many inventions."
C. WALTER LOHR

1375

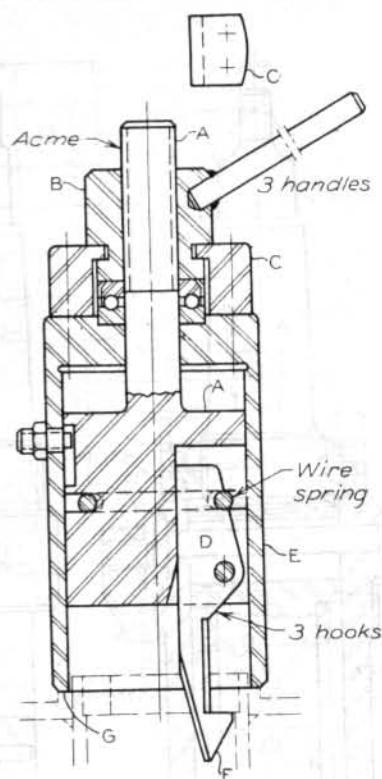


When A is turned, spreader E spreads the eight jaws F, allowing them to hook the underside of the part to be removed. The eight jaws fit in slots in G which is screwed to B. Shoulder A of housing H rests on the unit from which the part is to be removed. Turning handle C raises B, G, jaws F, and the part. Note the use of dowels to prevent B and E from turning.

Puller

The adjustable puller is designed to remove two sizes of parts.

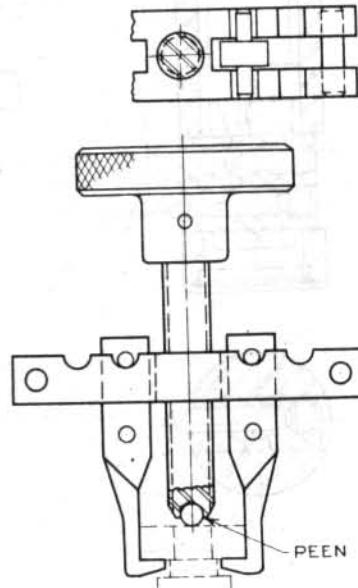
1376



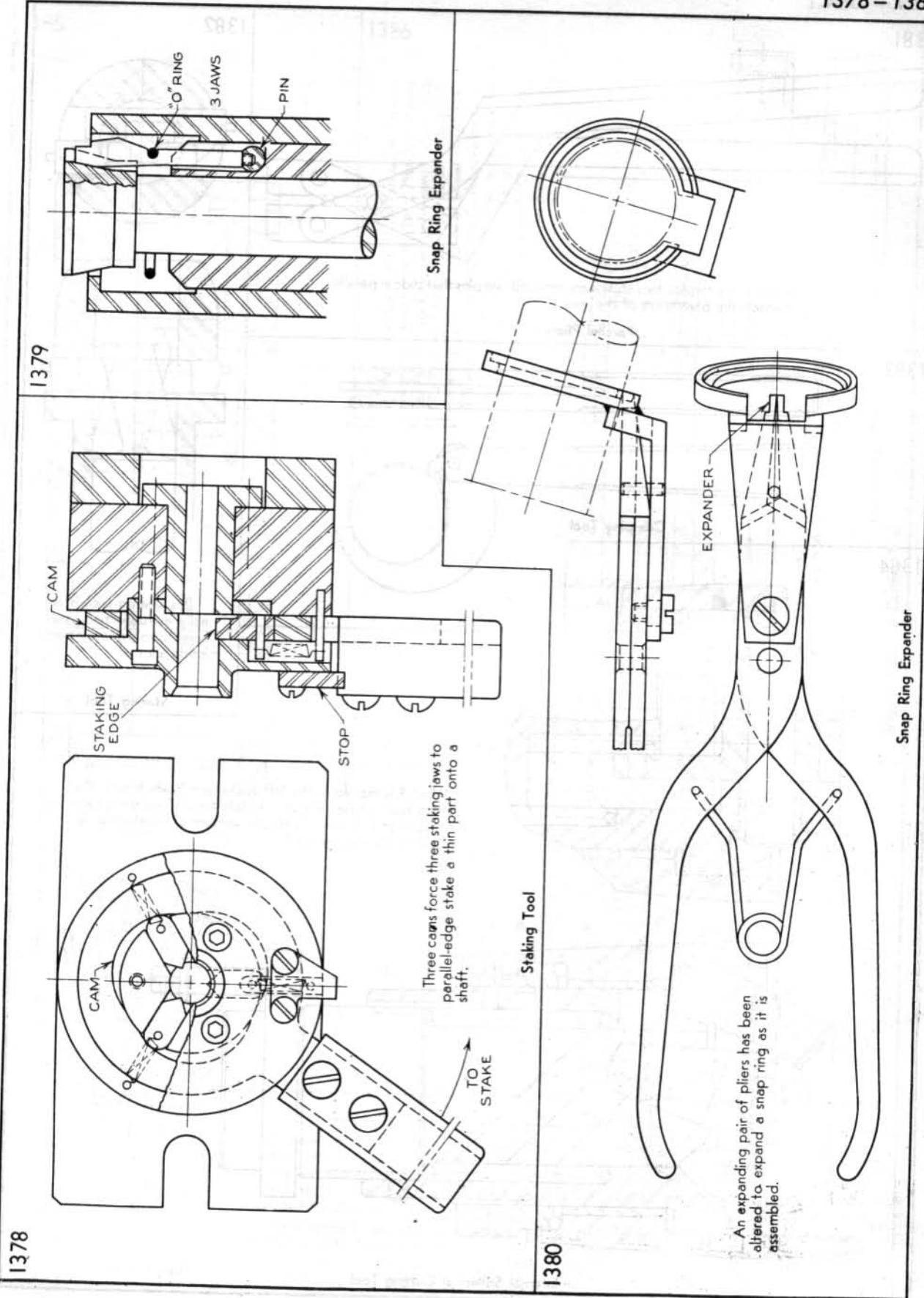
After the three hooks D have been tripped by F, they hook onto the part to be removed. The three jaws fit in grooves A and are pinned to it. A snap ring (round wire) spring is used instead of a garter spring. With G of E resting on the part, nut B is turned clockwise, raising A and the three hooks along with the part to be removed. A set screw keeps A from rotating. The knurled surface of E enables E to be held as B is turned.

Puller

1377

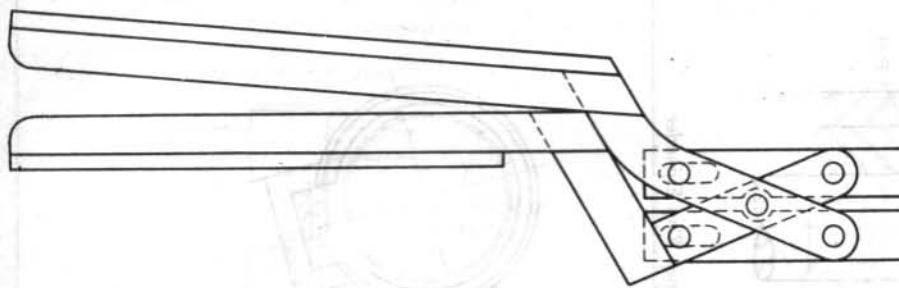


Puller



1381-1384

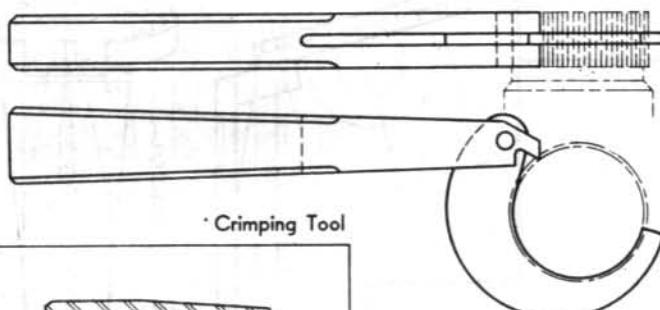
1381



The parallel pliers require two stationary pins and two pins that slide in parallel slots to maintain the parallelism of the jaws.

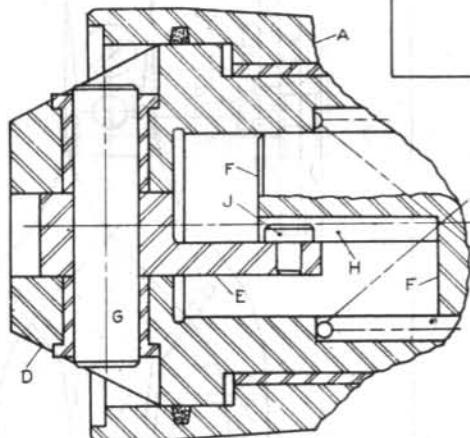
Parallel Pliers

1383



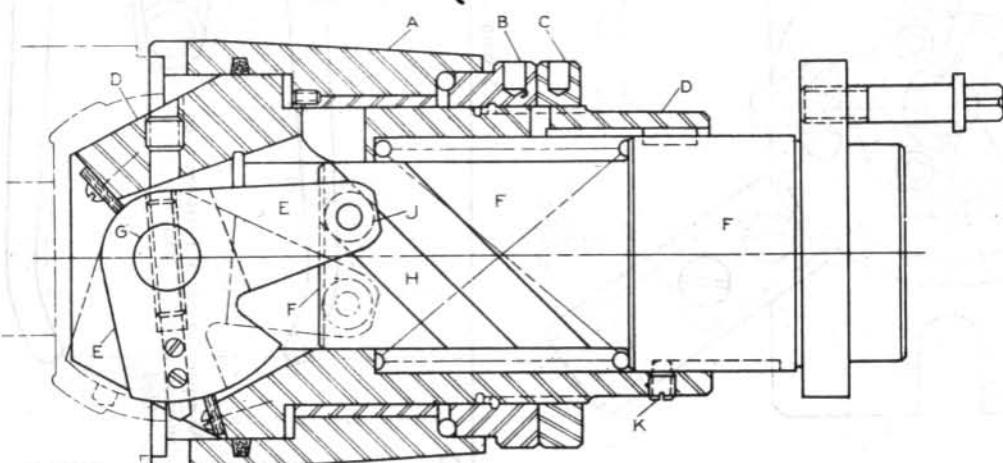
Crimping Tool

1384



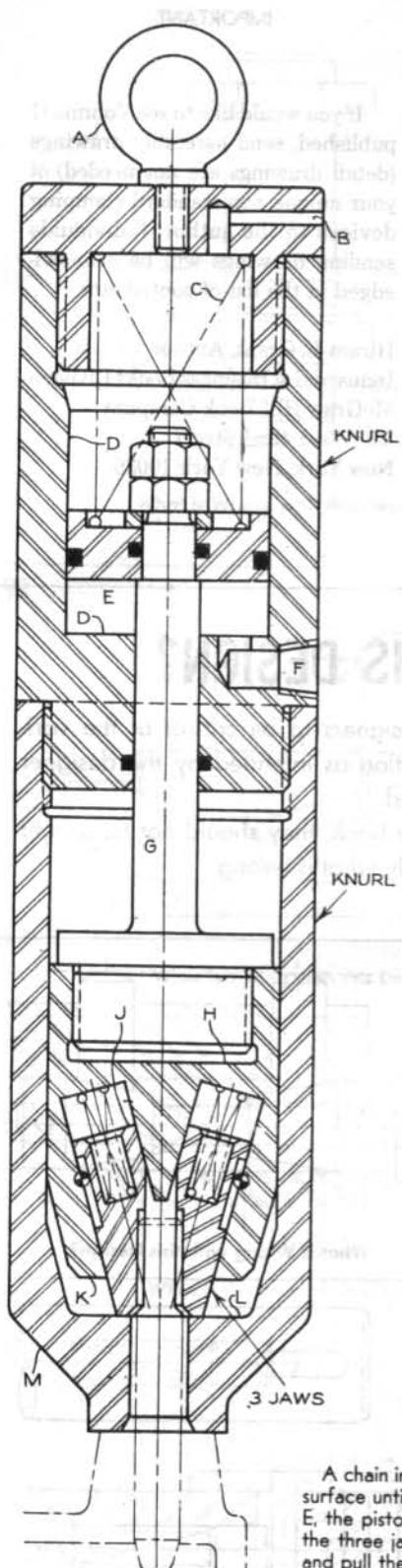
This staking tool internally extrudes two small holes to hold one thin part inside another.

Staking Tool



Internal Spherical Cutting Tool

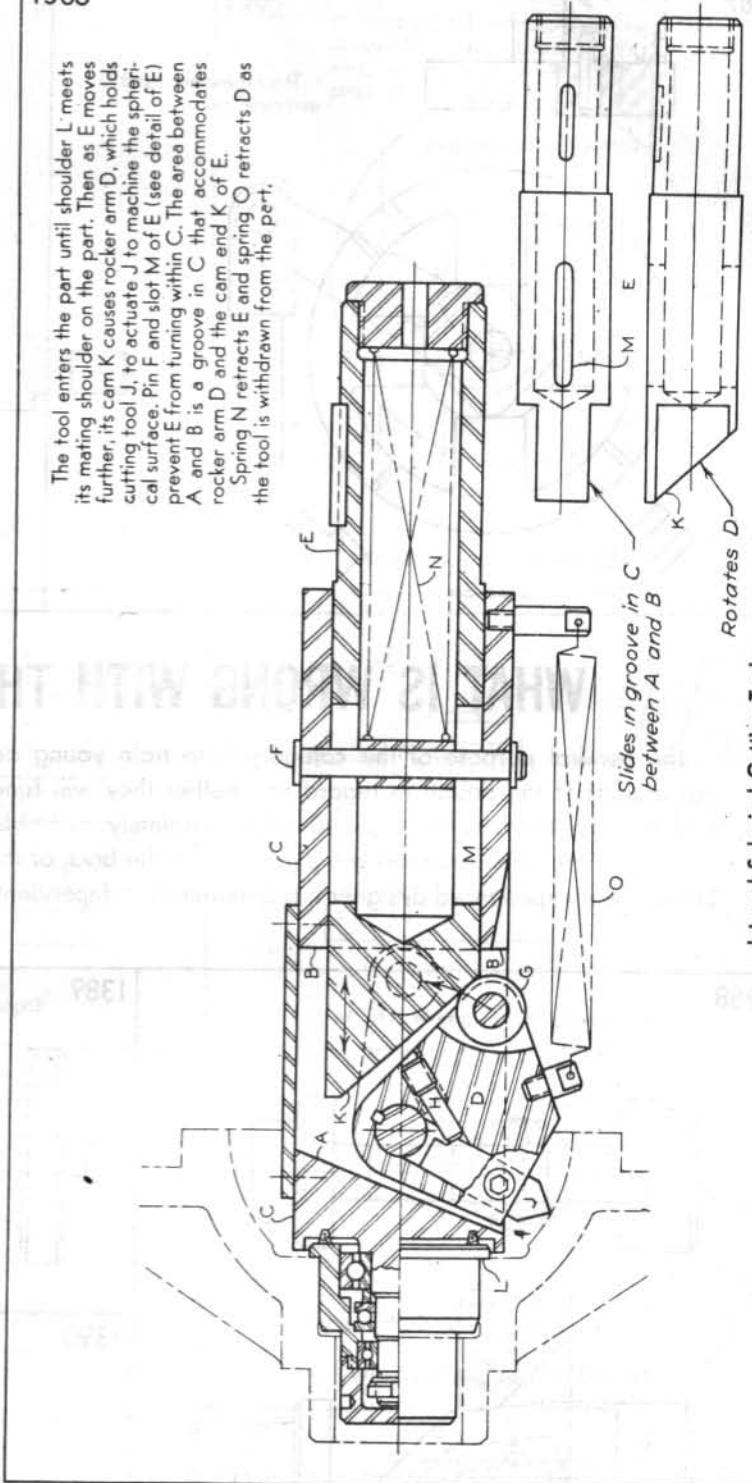
1385



Puller (Stud)

1386

The tool enters the part until shoulder L meets its mating shoulder on the part. Then as E moves further, its cam K causes rocker arm D, which holds cutting tool J, to actuate J to machine the spherical surface. Pin F and slot M of E (see detail of E) prevent E from turning within C. The area between A and B is a groove in C that accommodates rocker arm D and the cam end K of E. Spring N retracts E and spring O retracts D as the tool is withdrawn from the part.

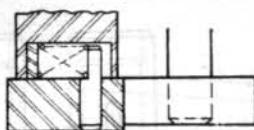


Internal Spherical Cutting Tool

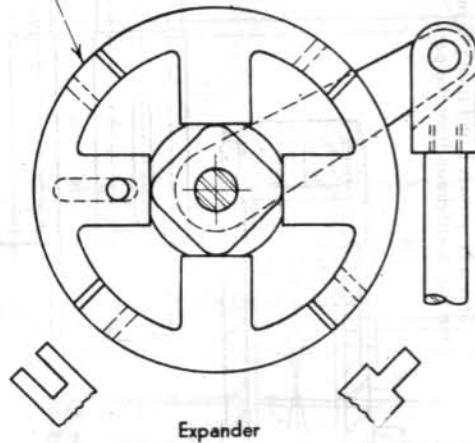
A chain inserted through A holds the tool above the working area. M rests on the indicated surface until the stud is clamped and pulled out. When air is admitted through F into chamber E, the piston is forced upward. The piston pulls up G and H, which is attached to G, allowing the three jaws J to grip the stud. As the piston continues to rise, the jaws grip more tightly and pull the stud up.

In the action to unclamp the removed stud, spring C forces G, H, and the piston down until surface K of H strikes surface L of M, causing the three jaws to retract upward and outward in H and release their grip on the stud. Note airvent B.

1387



TONGUE AND GROOVE



This expander is used to assemble parts.

IMPORTANT

If you would like to see Volume II published, send assembly drawings (detail drawings are not needed) of your unique non-standard clamping devices to the author. Individuals sending drawings will be acknowledged in the list of contributors.

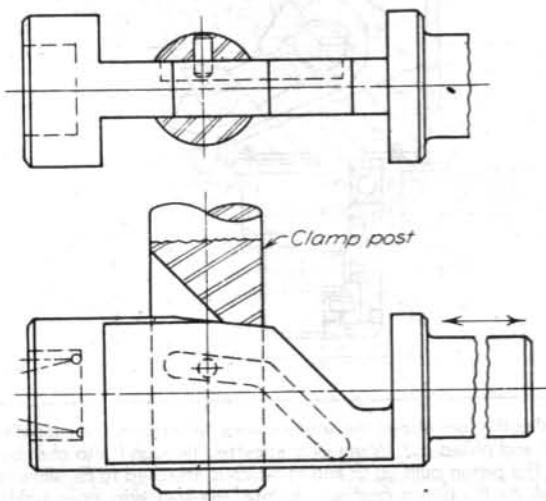
Hiram E. Grant, Author
Industrial & Business Books Division
McGraw-Hill Book Company
330 West 42nd Street
New York, New York 10036

WHAT IS WRONG WITH THIS DESIGN?

The general purpose of this category is to train young designers to be critical of the various aspects of the design in regard to whether they will function as intended by the designer and whether the fixture can actually be completely assembled.

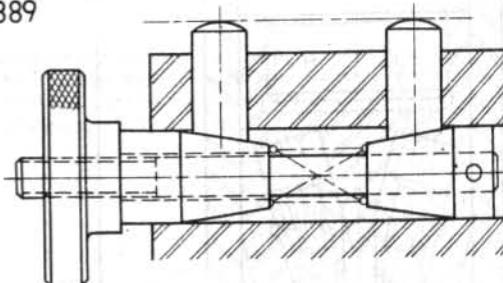
Although the discrepancies are explained at the back of the book, they should not be sought before the inexperienced designer has determined independently what is wrong

1388



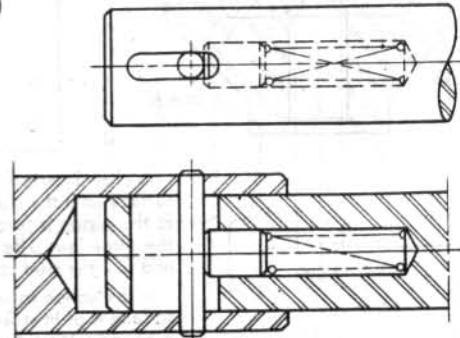
What is Wrong with this Design?

1389



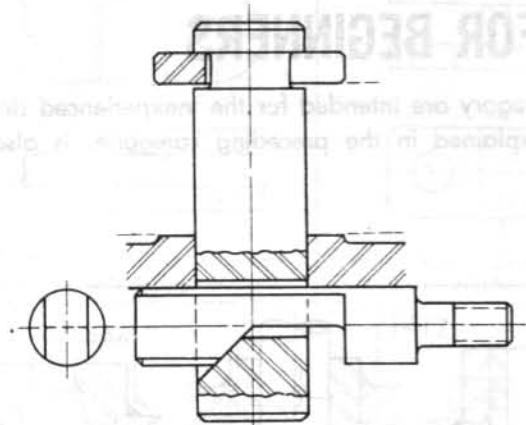
What is Wrong with this Design?

1390



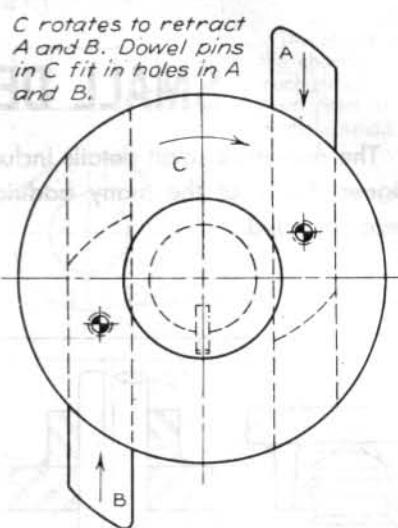
What is Wrong with this Design?

1391



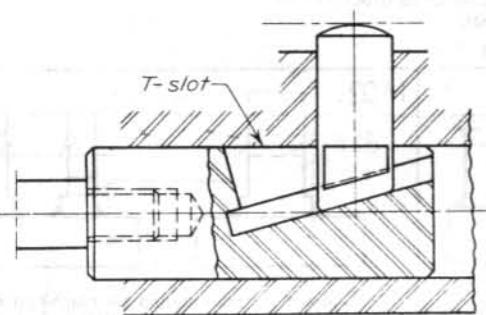
What is Wrong with this Design?

1392



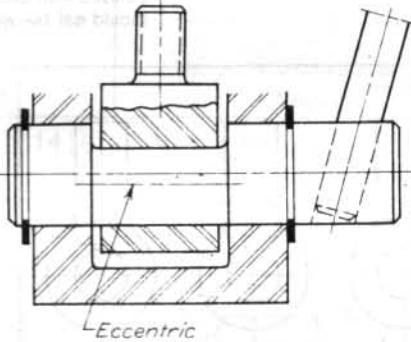
What is Wrong with this Design?

1393



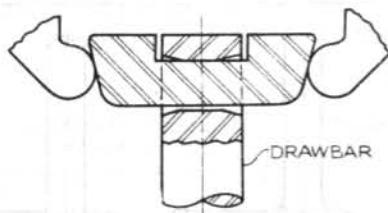
What is Wrong with this Design?

1394



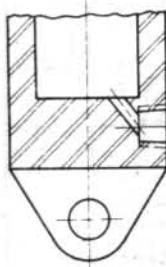
What is Wrong with this Design?

1395



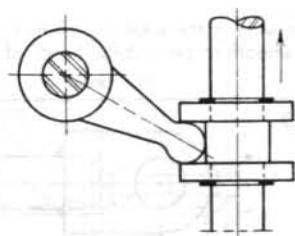
What is Wrong with this Design?

1396



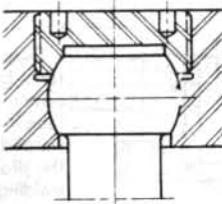
What is Wrong with this Design?

1397



What is Wrong with this Design?

1398

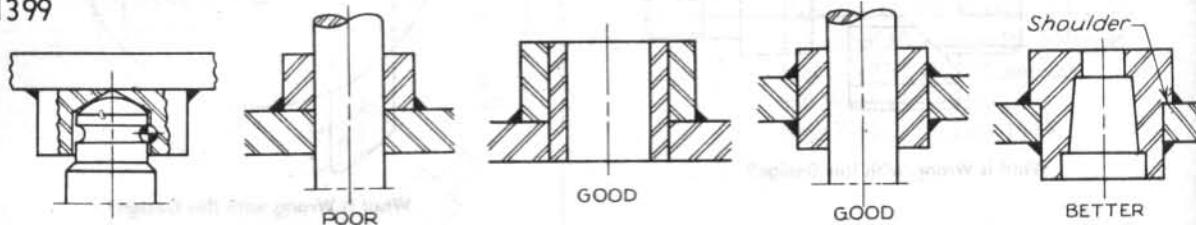


What is Wrong with this Design?

SMALL DETAILS FOR BEGINNERS

The numerous small details included in this category are intended for the inexperienced designer. Study of the many additional details explained in the preceding categories is also recommended.

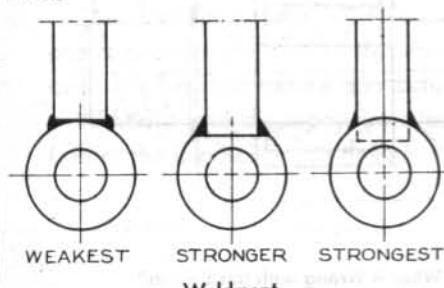
1399



The design at the extreme left is satisfactory but should be used with caution. The poor design is not satisfactory and should not be used for a moving shaft.

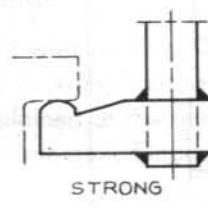
Weldment

1400



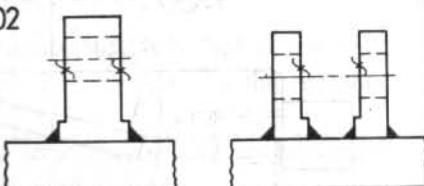
Weldment

1401



Weldment

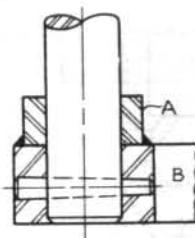
1402



Contact surfaces should be machined regardless of the material specified. Although plate stock appears to be smooth, it too should be machined. The control over the location of the welded components is usually limited.

Weldment

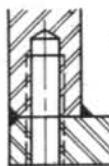
1403



Sleeve A has been added to increase the stability of the taper-pinned base of the shaft.

Weldment

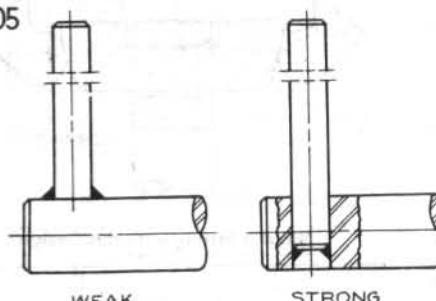
1404



The practice of tapping into two weldment members should be used with caution.

Weldment

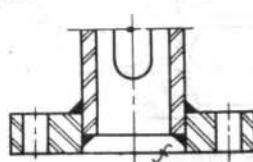
1405



The weld in the weak design must be ground or filed smooth to protect the hands of the operator.

Weldment

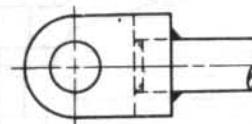
1406



Because a weld is harder than the material being welded, it is not possible to obtain a smooth overall machined surface if a portion of the surface has been welded. Recessed welding eliminates this problem. In the illustration, recessed welding is provided for the tubing.

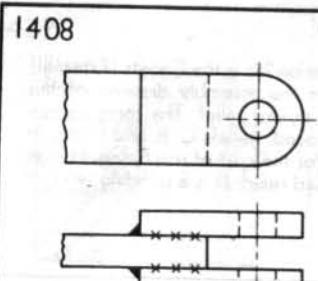
Weldment

1407

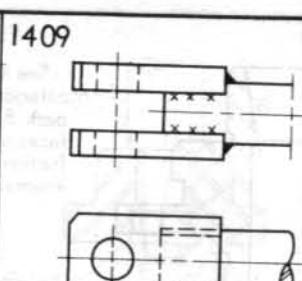


A Satisfactory Clevis Weldment

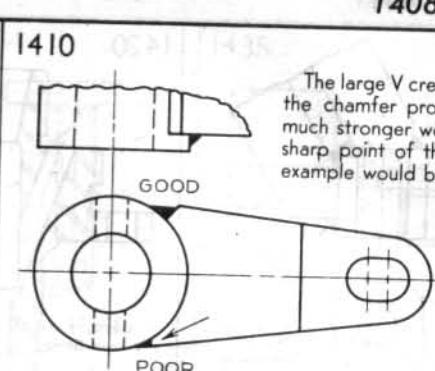
Weldment



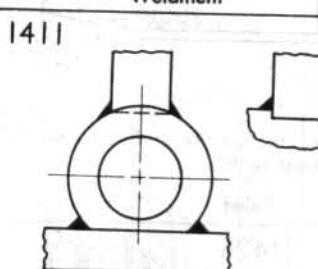
A Satisfactory Clevis Weldment Weldment



A Satisfactory Clevis Weldment Weldment

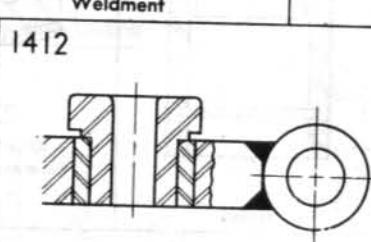


The large V created by the chamfer provides a much stronger weld. The sharp point of the poor example would burn.



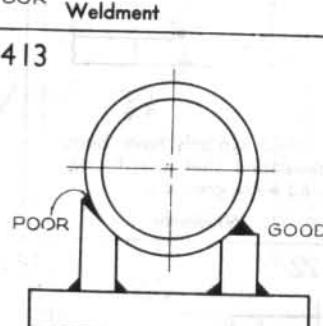
The narrow V welds are not satisfactory. The larger V welds created by the flats on the cylinder are much stronger.

Weldment



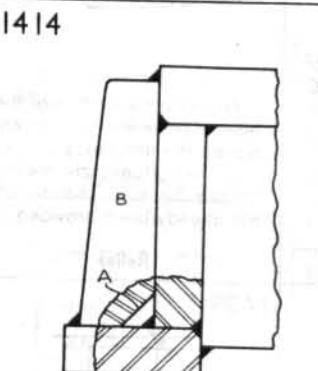
The chamfers increase the size of the Vs, creating a stronger weld.

Weldment



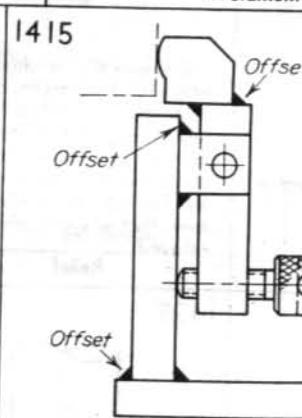
Narrow Vs produce weak welds.

Weldment



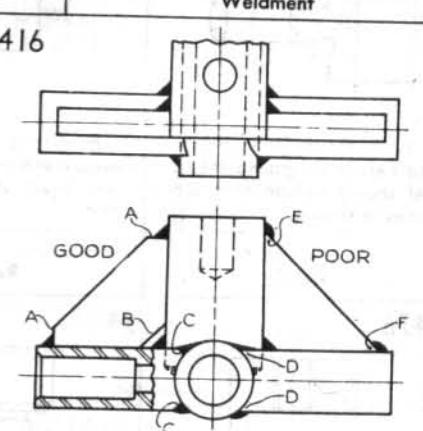
Part B is welded after the other welds are completed. Chamfer A permits a continuous weld in the corner.

Weldment



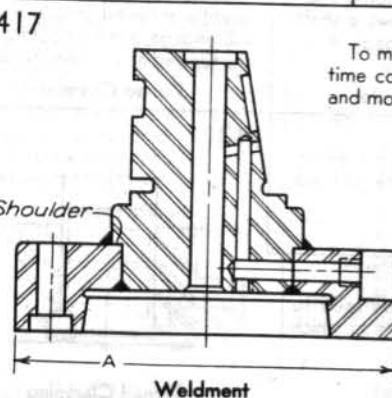
Offset welds are less expensive than flush V welds, which involve the cost of chamfering.

Weldment



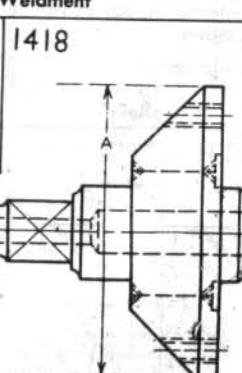
The sharp points of D, E, and F burn and create weak welds. Cutoffs A and C provide stronger welds. B permits a contiguous weld in the corner.

Weldment



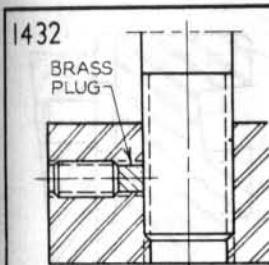
To machine this part from stock of diameter A would be time consuming. Welding the two components saves time and money. Note the use of the shoulder for alignment.

Specifying a weldment in this design will permit a less expensive material to be used for the larger piece and will reduce the amount of time required to machine the part.

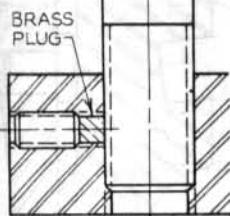


Weldment

<p>1419</p> <p>Weldment</p>	<p>1420</p> <p>Relief</p>	<p>1421</p> <p>Relief</p>
<p>1422</p> <p>Relief</p>	<p>1423</p> <p>Relief</p>	<p>1424</p> <p>Relief</p>
<p>1426</p> <p>Relief</p>	<p>1427</p> <p>Relief</p>	<p>1428</p> <p>Thread Chamfer</p>
<p>1430</p> <p>Cylindrical Rotating Nut</p>	<p>1431</p> <p>Thread Clamping</p>	<p>1429</p> <p>CHFR.</p>

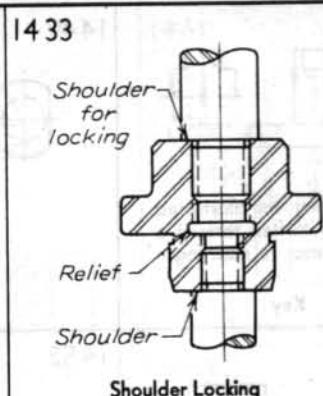


1432

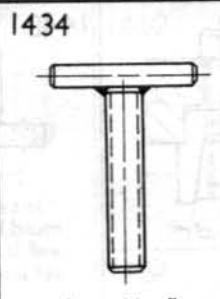


A brass plug will not damage the screw it holds because the plug shapes itself to the threads.

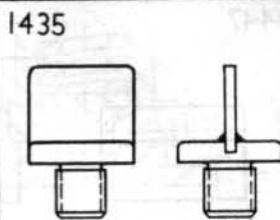
Thread Clamping



1433



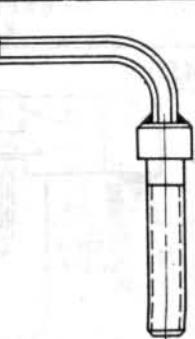
1434



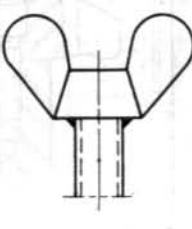
1435

Screw Handle

1439

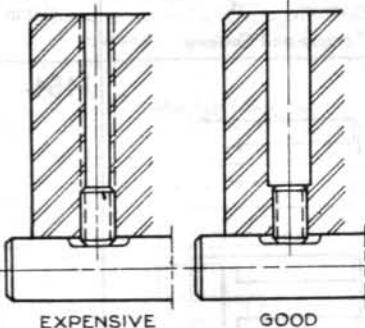


1438



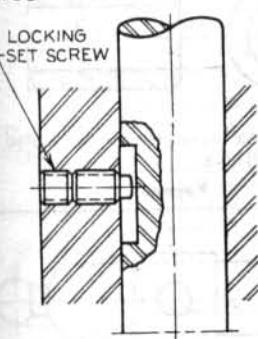
Screw Handle

1440

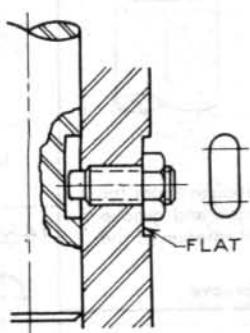


GOOD

1436



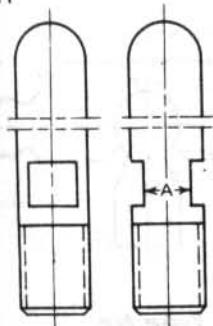
1437



The adjustable and locking set screw fits in an endmilled slot of the shaft to control its lengthwise movement. A flat for the nut must be provided because of the cylindrical surface.

Set Screws

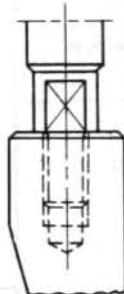
1441



Flats are cut on shafts and some special screws to tighten or adjust them. Measurement A should be based on standard end wrench sizes, that is, the distance across the flats of standard bolts and nuts.

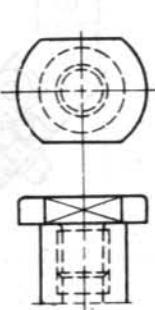
Turning of Rod

1442

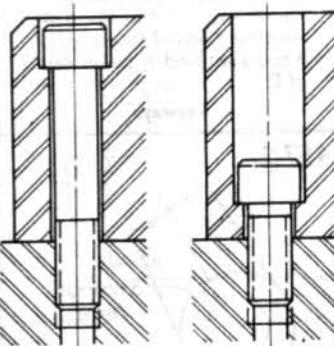


Turning of Rod

1443



1444



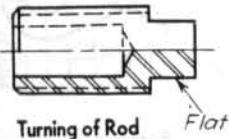
POOR

GOOD

A long shank cap screw is not as effective as a short one.

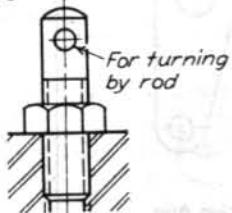
Cap Screws

1445



Turning of Rod Flat

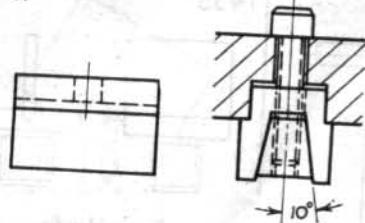
1446



Turning of Rod

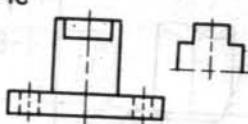
Turning of Rod

1447



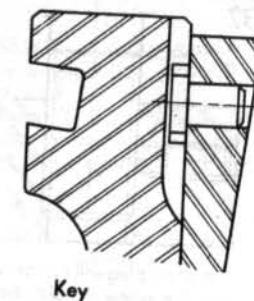
This is a clampable key.
Key

1448



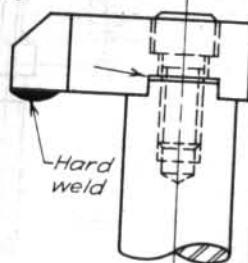
Inserting the illustrated round key with flats through a wall is superior to inserting a set screw.

1449



Key

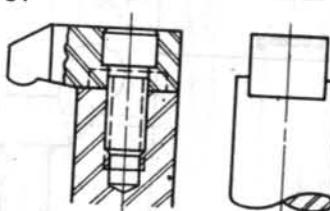
1450



Note the welded button and the clearance of the tongue and groove.

Tongue and Groove

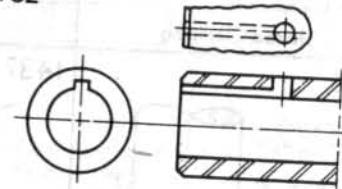
1451



When there is not enough room for two cap screws, a tongue and groove may be used to prevent rotation of the clamp.

Tongue and Groove

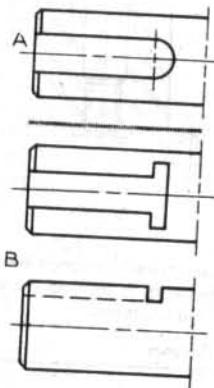
1452



An internal keyway may be terminated by a drilled hole.

Keyway

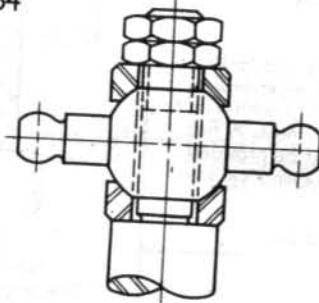
1453



A rectangular key placed in the keyway of A could bind at the closed end of the keyway; it could not bind in the keyway of B.

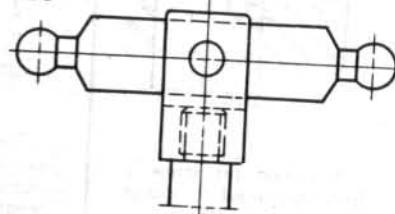
Keyways

1454



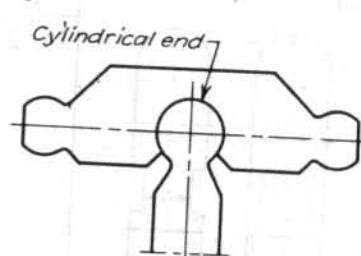
An Adjustable Spherical Rocker Arm
Rocker Arm

1455



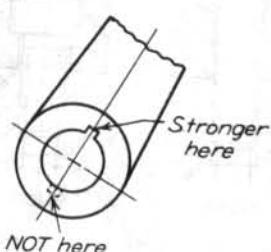
Rocker Arm

1456



Rocker Arm

1457

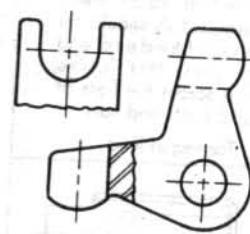


Keyway

An Adjustable Rocker Arm

Rocker Arm

1459



Rocker Arm

1460



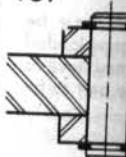
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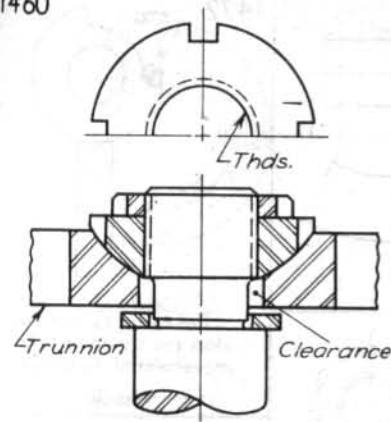


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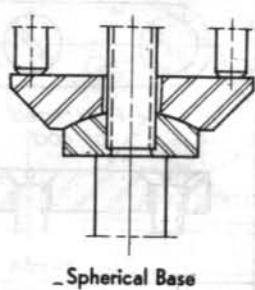
1460



Care should be taken to provide clearance to allow the trunnion to equalize. Note the use of the locknut.

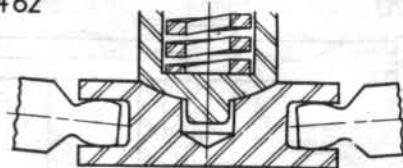
Spherical Base

1461



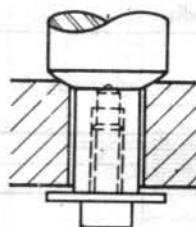
1462

1462

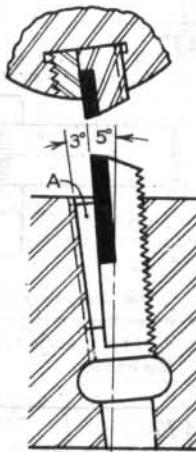


Spherical Base

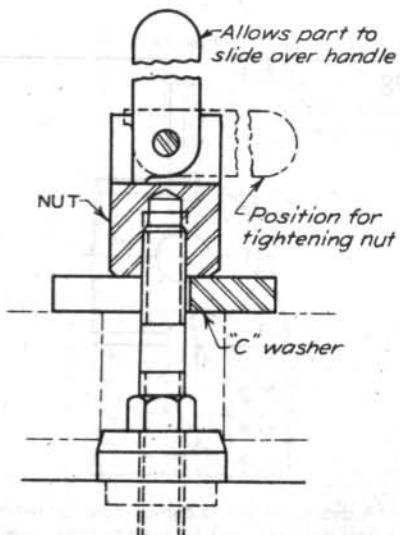
1464



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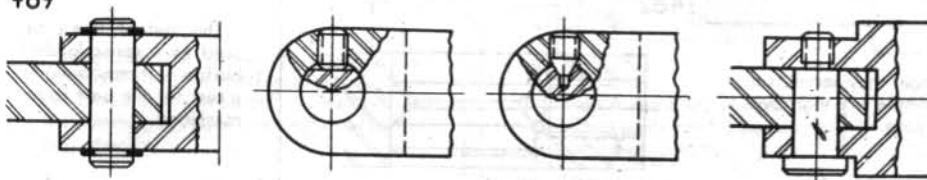


1468



Handle

469

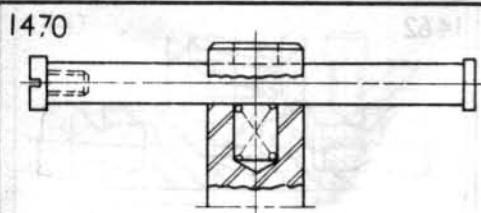


Four methods of fastening clevis pins are shown.

Clevis Pin Fastening

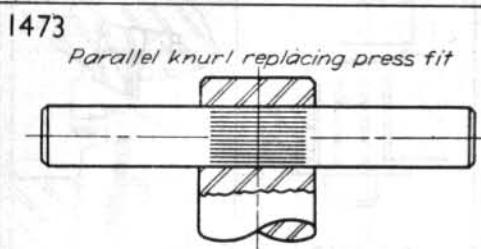
Socket Joints

The cylindrical ends of the rocker arm provide large areas of surface contact as they fit in their mating cylindrical holes located in A and B (see detail of the holes). When seven of the eight segments are pushed together, the combined sawcut spaces will provide enough space to allow the eighth segment to be inserted. Note the reliefs for the ground holes for A and B.



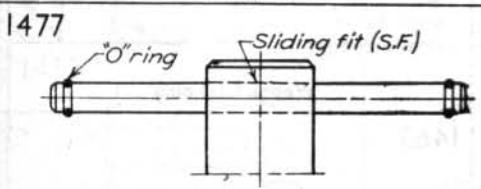
Pressure created by the spring will hold the handle in any desired position.

Handle

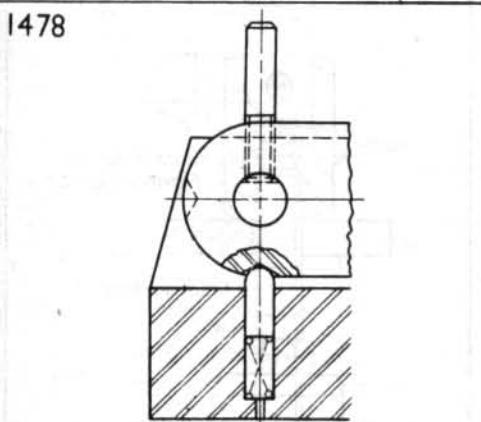


The illustrated parallel-knurled handle eliminates the scoring created by a press fit. A sliding fit is specified for the remaining portions of the handle.

Handle



Handle

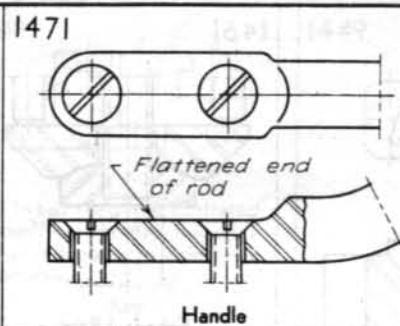


A detent pin and a conical hole (sometimes called a dimple) may be used to hold a part in any one of a number of selected positions to which the part may be moved. In this design there are only two positions. Frequently the part is a handle.

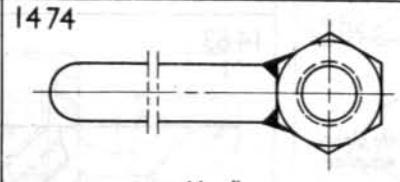
Detent

A commercial spring plunger may serve as a detent. The plunger and a dimple or a v-groove are used to hold a part in place.

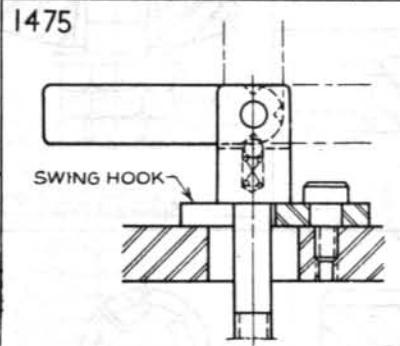
Detent



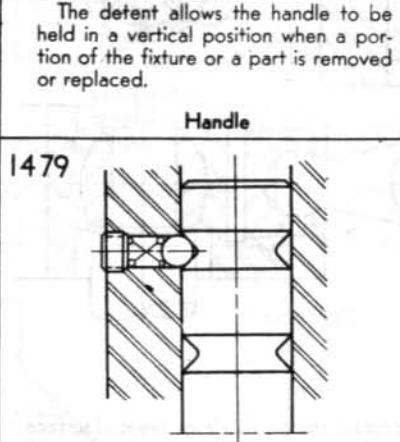
Handle



Handle



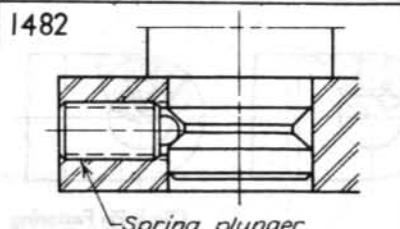
Handle



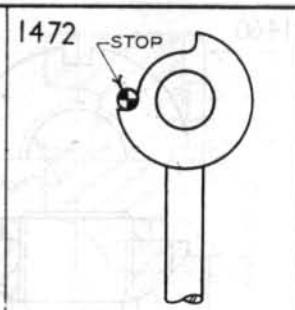
Handle

A shaft may be held by a detent and a v-groove in any one of a number of desired positions to which it may move.

Detent

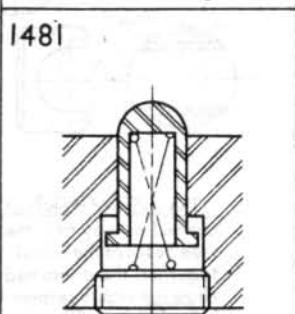
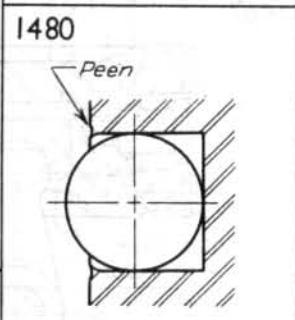
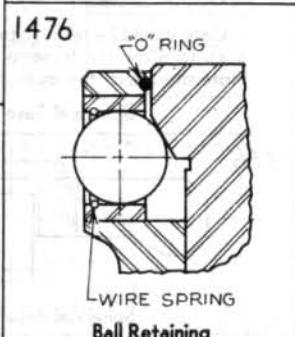


Spring plunger



The recess and the stop pin control the movement of the handle.

Handle



This detent may be used as a spring-loaded button or it may serve as a rest for the part to be machined.

Detent



The Note to me

1486

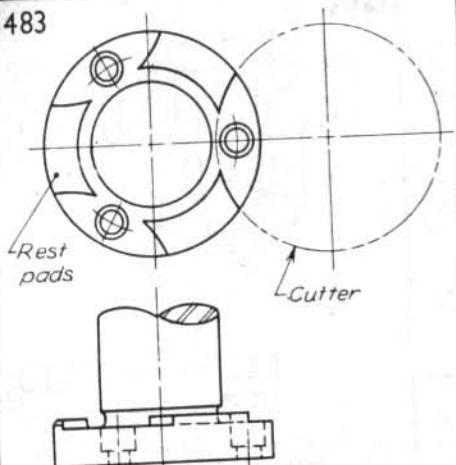
1489

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The shaft and the rest pads are ground. Note the rounded relief and the milling cutter machined reliefs for the pads.

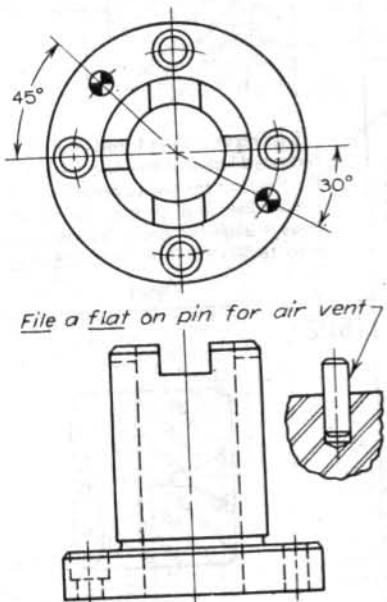
Rest Pad

1486



Rest Pad

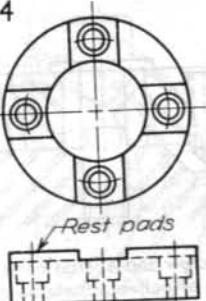
1489



Unsymmetrical doweling prevents parts from being reassembled incorrectly. Dowels are drilled and reamed only in assembly after the mating parts have been adjusted to function smoothly.

Dowels

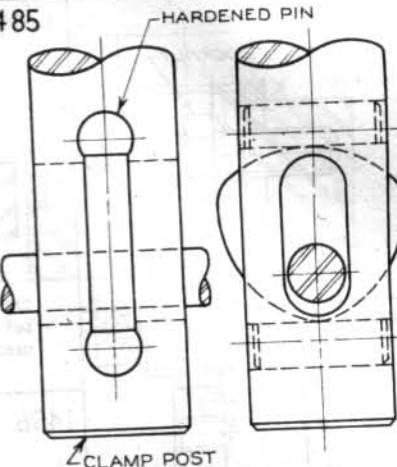
1484



Rest pads are usually hardened and ground and small in size. The reliefs between the pads provide space for chips and dirt as the parts are wrung onto the pads.

Rest Pad

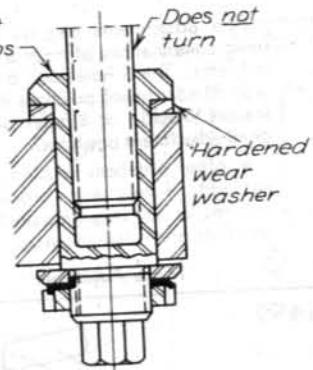
1485



Hardened wear pins with flats may be press fitted in holes in a shaft (or elsewhere) to reduce wear.

Hardened Wear Pad

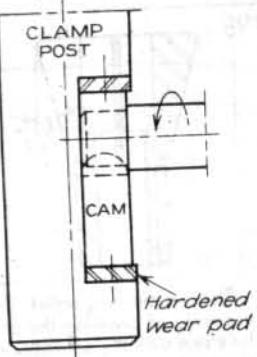
1487



When the area of surface contact is small, the resultant wear can be considerable. Hardened surfaces and wear washers will reduce the wear.

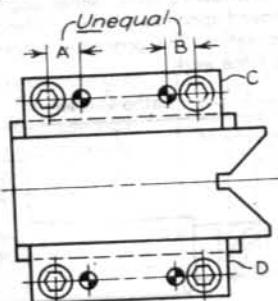
Hardened Wear Pad

1488



Hardened Wear Pad

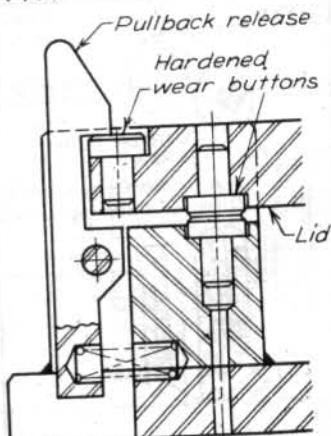
1490



When A and B are unequal, these two parts cannot be reassembled incorrectly.

Dowels

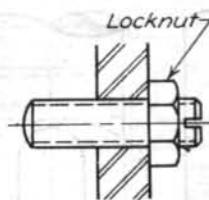
1491



The wear created by striking surfaces can be reduced by hardened wear buttons.

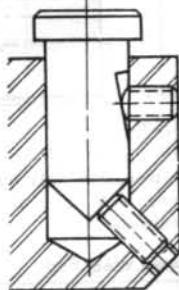
Hardened Wear Pad

1492



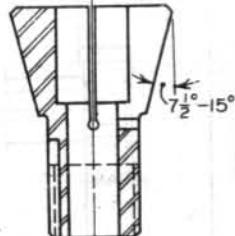
Adjustable Stop

1495



Adjustable Stop

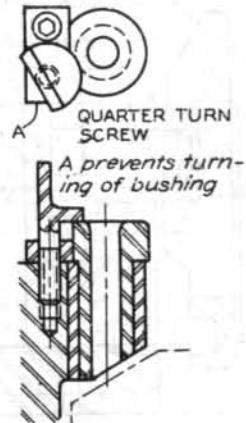
1498



This is a pinching collet. The necessity of breaking the collet's seal with the squeezer of the collet increases as the angle of the cone becomes smaller.

Collet

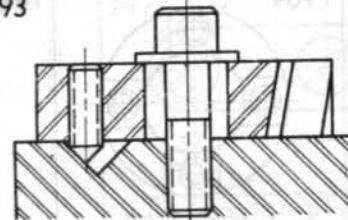
1500



A fraction of a turn of the set screw clamps the bushing. Note that A prevents the bushing from turning.

Quarter-Turn Screw

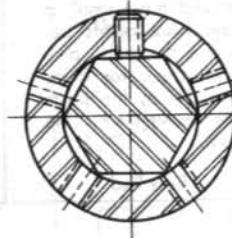
1493



A set screw and a large conical hole create an effective adjustable stop. A set screw and a nut are also frequently used as a stop.

Adjustable Stop

1496

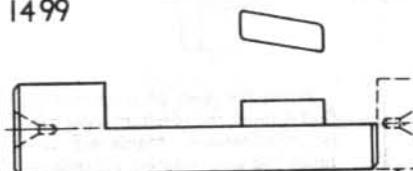


Fine adjustments can be made by using combinations of holes and flats as indicated. The 5 holes and 6 flats provide 30 adjustment positions in the illustration. Would 4 or 8 holes provide 24 or 48 adjustment positions?

In other situations requiring fine adjustments, holes, slots, grooves, flats, notches, or pins may be paired as holes and flats are in this instance.

Micro Adjustment

1499

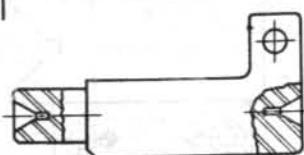


Remove after grinding

The shaft illustrated may be ground if an additional piece of metal is provided for the lathe center and then removed upon completion of the grinding operation. This procedure also applies to lathe work.

Lathe Center

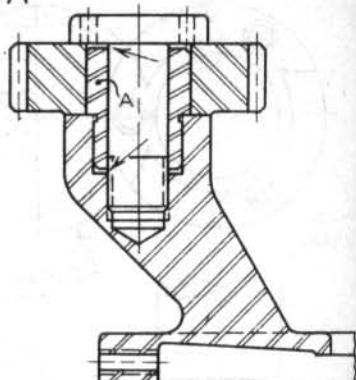
1501



When it is necessary to machine only a portion of a non-circular part to a cylindrical shape, the part may be turned on a lathe if the lathe centers are included.

Lathe Center

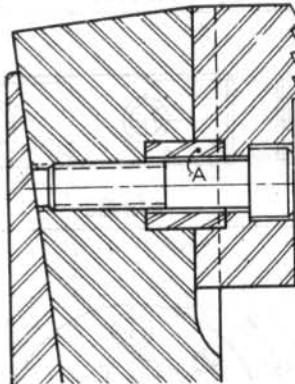
1494



The screw does not take the thrust of the clamping action; the thrust is absorbed by bushing A. Note the indicated clearances.

Thrust

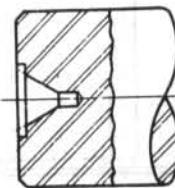
1497



Bushing A is snug fitted into the counterbored holes of the two parts to take the thrust of the jaw's operation. The cap screw does not absorb the thrust nor does it align the parts. Its sole purpose is to fasten the two parts together.

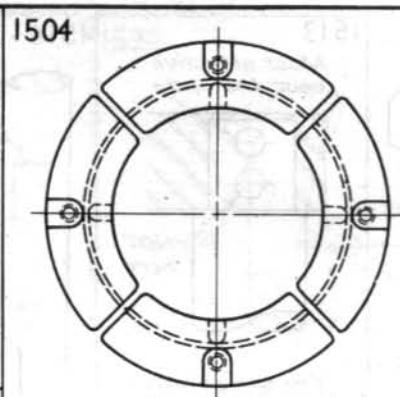
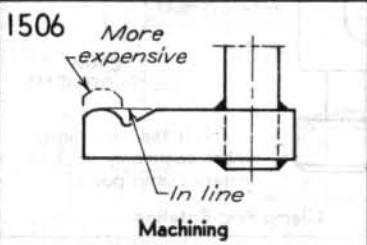
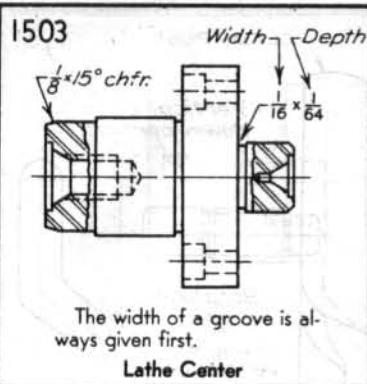
Thrust

1502

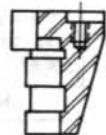


The counterbore prevents the lathe center from becoming burred or nicked, for a burred center would create inaccuracies in the machining process. The counterbore must be large enough to clear the lathe center.

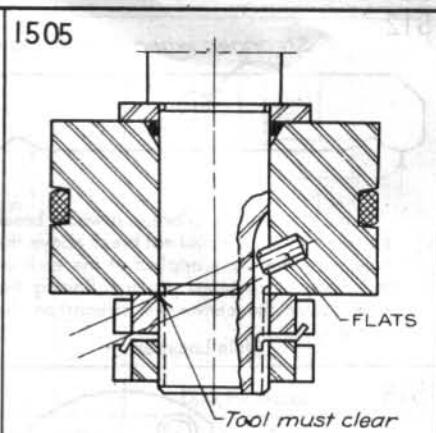
Lathe Center



Frequently several identical parts are machined as one and then sawed apart. In some instances a shim is added to fill in the saw cut.

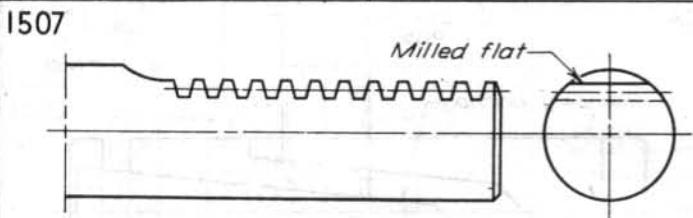


Multiple Parts



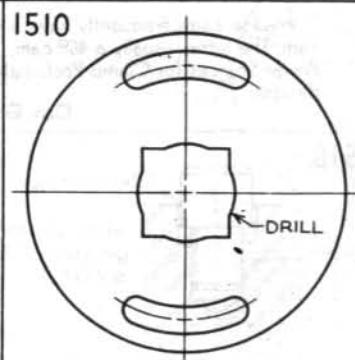
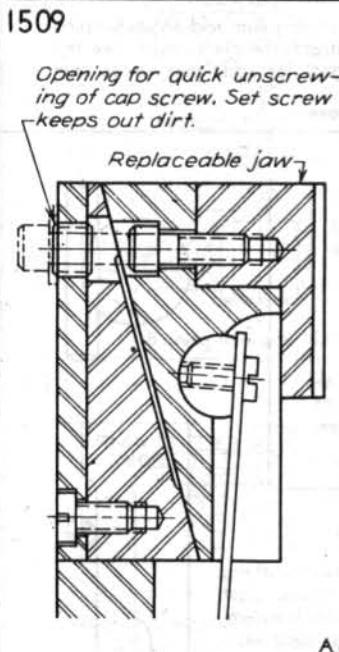
Thought should be given to the space needed for the cutting tools used in certain machining operations. In this operation the drill must clear the edge of the hole.

Machining



In fixture design, a rack is frequently machined on a shaft. Before the rack is cut, a flat is usually milled to increase the length of the teeth.

Machining a Rack on a Shaft

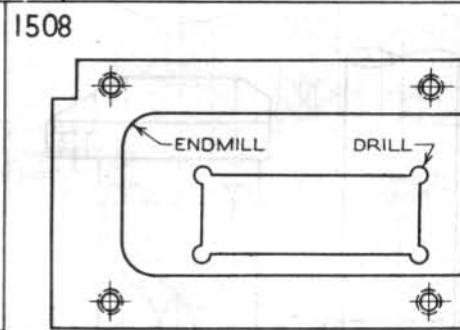


A drilled hole may be enlarged into a square hole. The remaining portions of the drilled hole may serve as friction-reducing reliefs. Note the circular endmilled slots that are used for rotational adjustment:

Slots and Holes

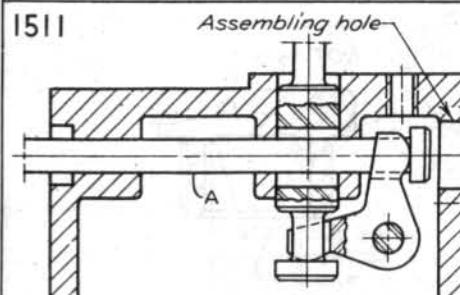
A cap screw and a washer are inserted into a threaded hole to hold the jaw in place as it is ground. Usually there are three jaws. All are replaceable, enabling the chuck in which they are used to accommodate other parts.

Assembling Hole



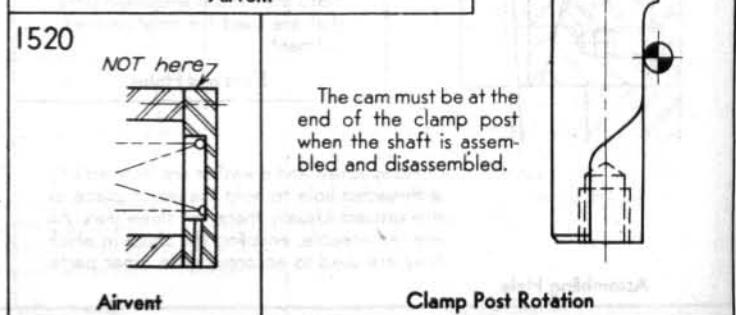
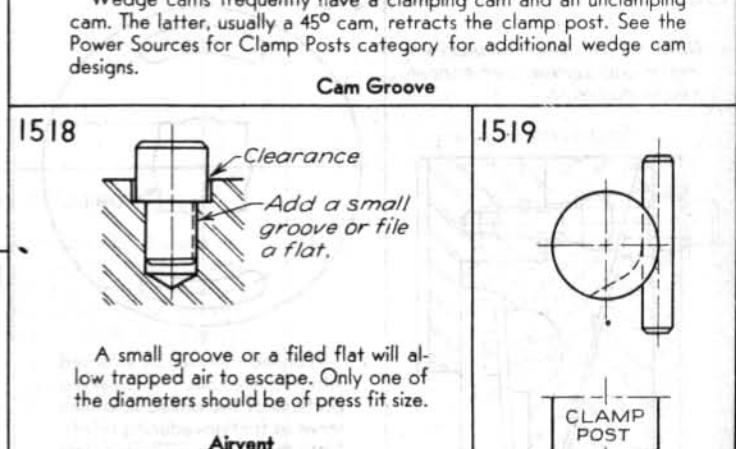
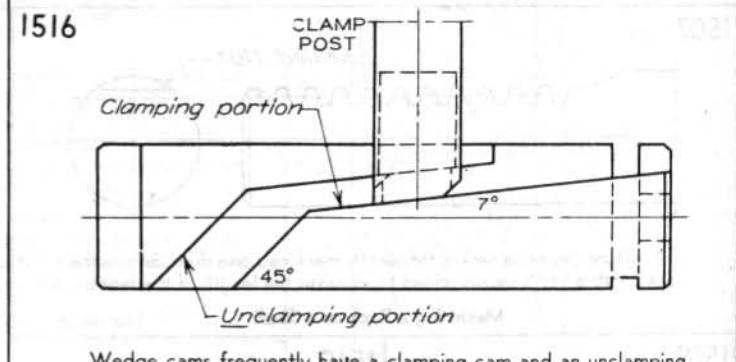
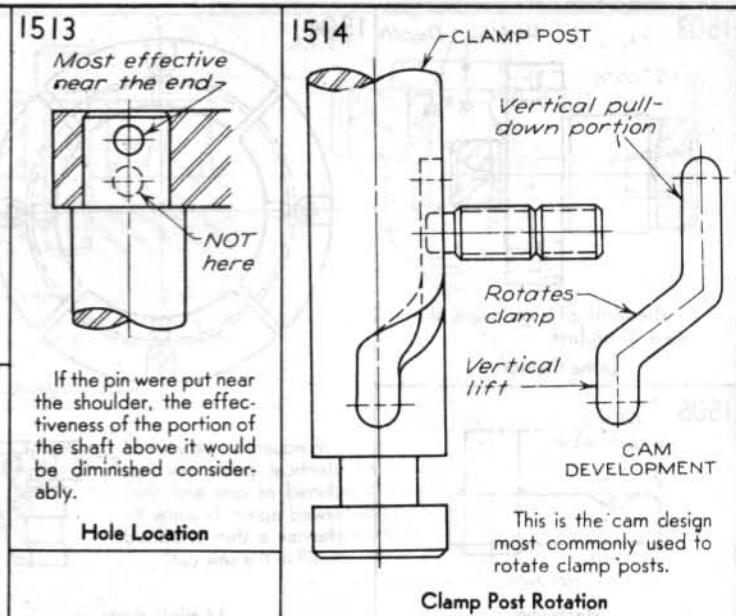
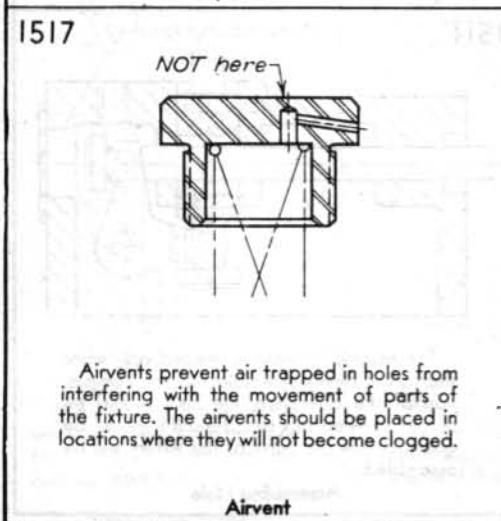
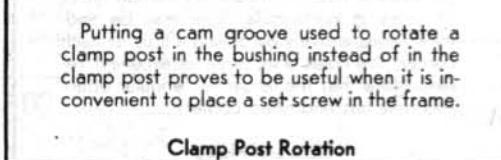
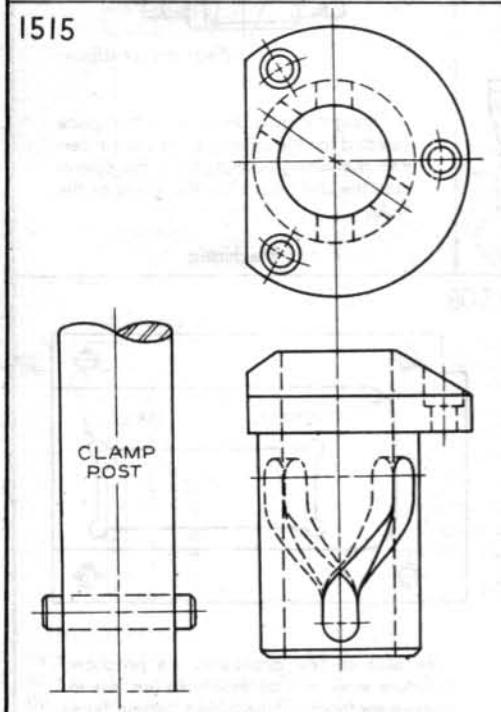
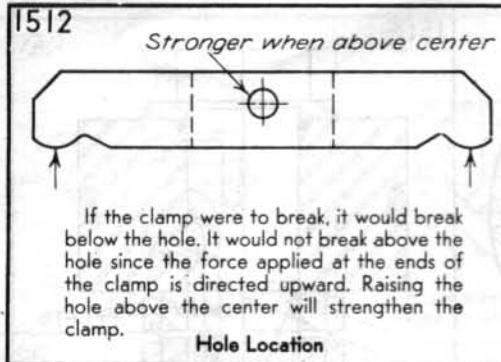
Because so few duplicates are produced in fixture work, it is necessary to use less expensive methods of machining certain types of holes. A rectangular hole may be endmilled inexpensively by drilling a hole at each corner; the holes also serve as excellent reliefs. Note that the larger rectangular open-end hole has endmilled corners.

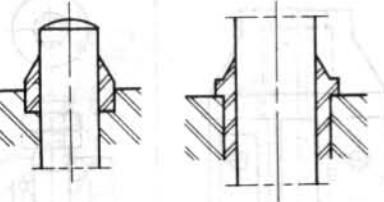
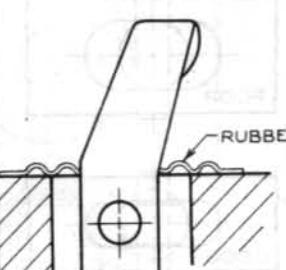
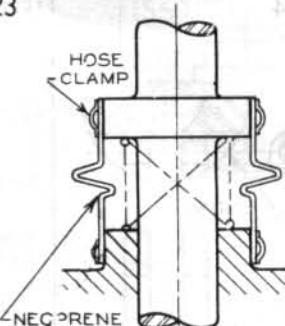
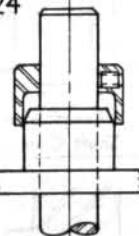
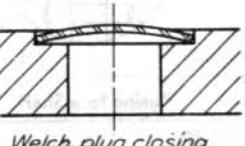
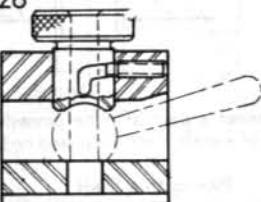
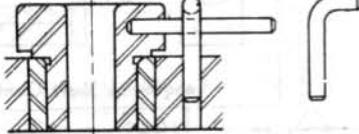
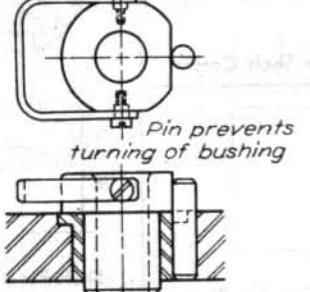
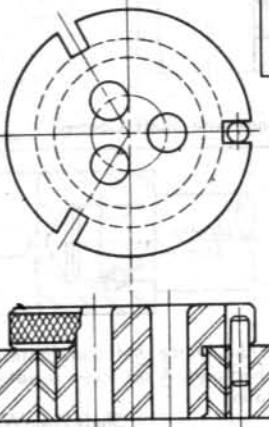
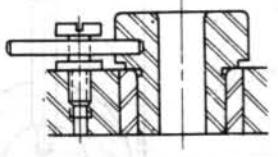
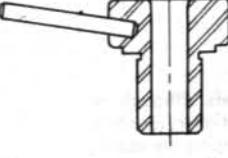
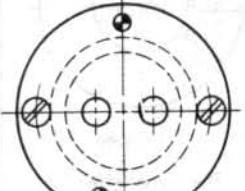
Slots and Holes



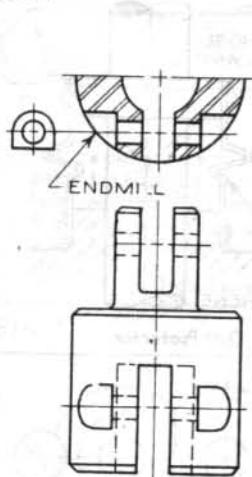
The assembling hole is needed only while shaft A is being assembled. Upon completion of the operation, the hole should be closed to keep out dirt. Thought should be given to how the parts of the fixture will be assembled.

Assembling Hole



 <p>Although sharp-edged bushings are usually used to keep out dirt, some designers prefer to specify a .005 flat.</p> <p>Dust Protector</p>	 <p>Dust Protector</p>	 <p>Dust Protector</p>
 <p>Dust Protector</p>	 <p><i>Welch plug closing of end of a hole</i></p> <p>Dust Protector</p>	 <p>The part is centered by the bushing which conforms to the spherical shape of the part. Note that the action of the cam tightens the bushing against the part.</p> <p>Bushing Clamp</p>
 <p>Bushing Removal Handle</p>	 <p><i>Pin prevents turning of bushing</i></p> <p>Bushing Removal Handle</p>	 <p>The rotating drill bushing with indexed slots is used with a pin to eliminate drill bushing interference.</p> <p>Bushing</p>
 <p>Bushing Removal Handle</p>	 <p>Bushing Removal Handle</p>	 <p>When holes are drilled close together, drill bushing interference results. It may be eliminated by replacing the bushing with a larger two-hole bushing. The lower end of the two-hole bushing should lie fairly close to the part and conform reasonably well to its shape.</p> <p>Bushing</p>

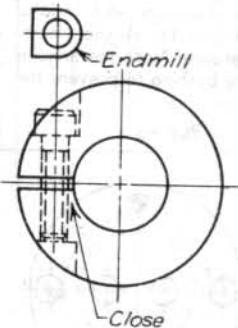
1534



Drilling into the side of a shaft is not easy nor is it accurately located unless special precautions are taken. A flat is end-milled before the drilling operation begins.

Pinning to a Shaft

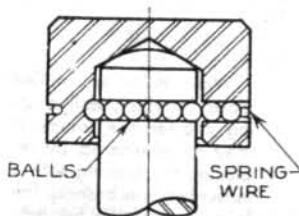
1538



The most effective clamping action is produced when the cap screw is very close to the bore.

Clamping to a Shaft

1544

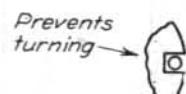


The balls allow the shaft to rotate although the end of the shaft remains in a stationary position, firmly pressed against the part being clamped.

Shaft Free-Wheeling

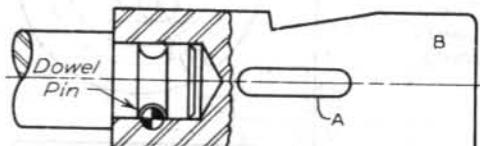
1545

Although the pin prevents the shaft from turning, it allows the shaft to be disengaged easily.



Shaft Locking

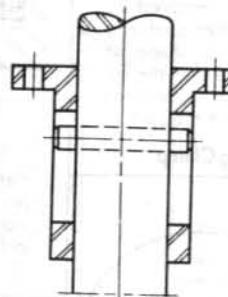
1542



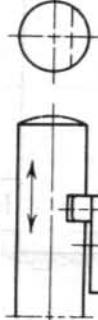
Although the shaft can rotate freely, it can move the attached part. A set screw in slot A of the part keeps B from rotating.

Shaft Free-Wheeling

1539

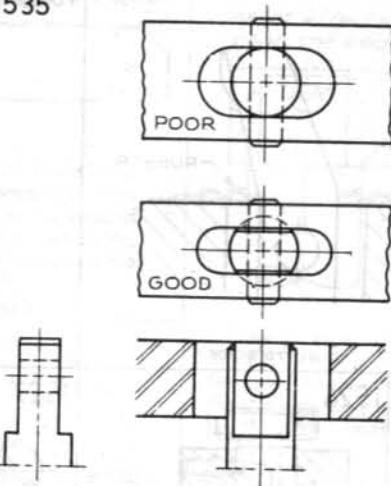


Lengthwise Shaft Control



Lengthwise Shaft Control

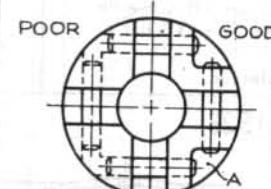
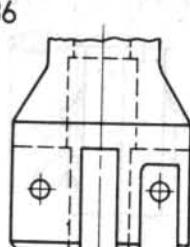
1535



Whenever a part is to be pinned to the end of a shaft, flats are milled on the shaft.

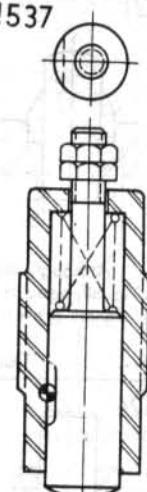
Pinning to a Shaft

1536



Pinning to a Shaft

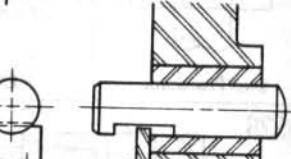
1537



Lengthwise Shaft Control

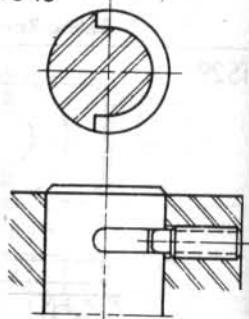
1540

1541



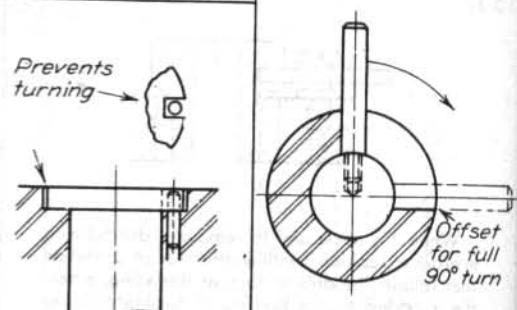
Lengthwise Shaft Control

1543

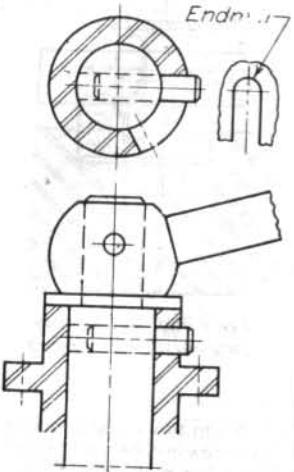
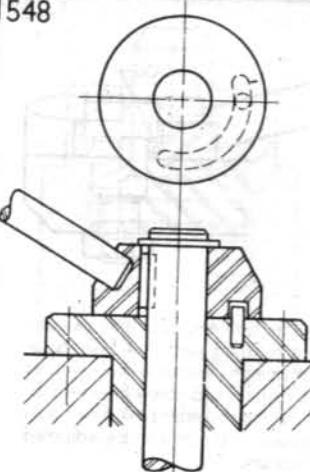
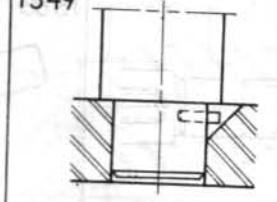
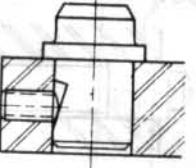
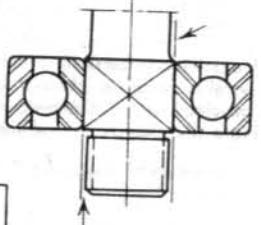
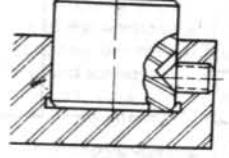
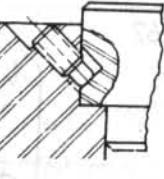
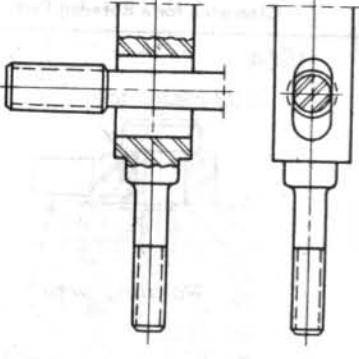
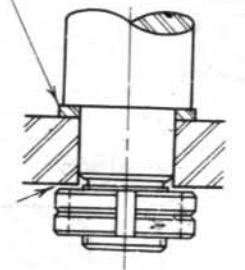
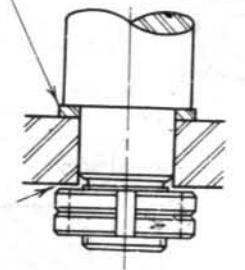
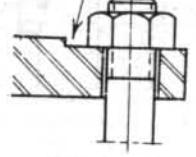
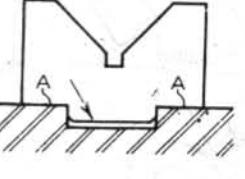


Shaft Rotation Control

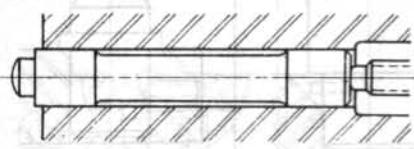
1546



Shaft Rotation Control

<p>1547</p>  <p>Frequently the rotation of a shaft must be limited to only a fraction of a turn. Note how the endmilled slot is created.</p> <p>Shaft Rotation Control</p>	<p>1548</p>  <p>Shaft Rotation Control</p>	<p>1549</p>  <p>Although the pin prevents the shaft from turning, it allows the shaft to be disengaged easily.</p> <p>Shaft Locking</p>	<p>1547-1558</p> <p>1550</p>  <p>Shaft Locking</p>
<p>1551</p>  <p>Shaft Locking</p>	<p>1552</p>  <p>Shaft Locking</p>	<p>1553</p>  <p>An angular set screw is used to lock a shaft when it is impractical to use a set screw perpendicular to the shaft.</p> <p>Shaft Locking</p>	
<p>1554</p>  <p>Occasionally it is necessary to pass a shaft through another shaft by means of an endmilled slot. See Illustration 496 in the Combination Clamping category for the assembly of which this illustration is a part.</p> <p>Shaft Through a Shaft</p>	<p>1555</p>  <p>The clearance permits a limited portion of the shaft to be decimal sized and prevents the press fit of the bearing from damaging the threads.</p> <p>Clearance</p>	<p>1556</p>  <p>Hardened wear pad</p> <p>Shaft Locking</p>	<p>1557</p>  <p>Specifying two lock nuts in this design allows the nuts to be adjusted to prevent the shaft from being locked to the frame.</p> <p>Clearance</p>
			<p>1558</p>  <p>When the height of the tongue is specified to be identical to the depth of the groove, machining tolerances may prevent surfaces A from touching the mating surfaces. It is necessary to dimension to create a clearance as shown.</p> <p>Clearance</p>

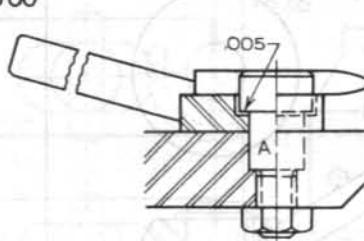
1559



Relieving the central portion of a long shaft in a hole reduces the friction and provides a chamber for grease.

Clearance

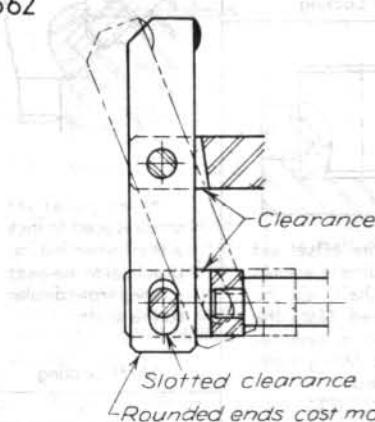
1560



A shoulder bolt and a nut may be used to hold a rotating part if a few thousandths of an inch clearance is allowed as shown. A regular cap screw may be substituted for the shoulder bolt if two nuts are provided. The nuts can be adjusted as wear occurs.

Clearance for a Rotating Part

1562

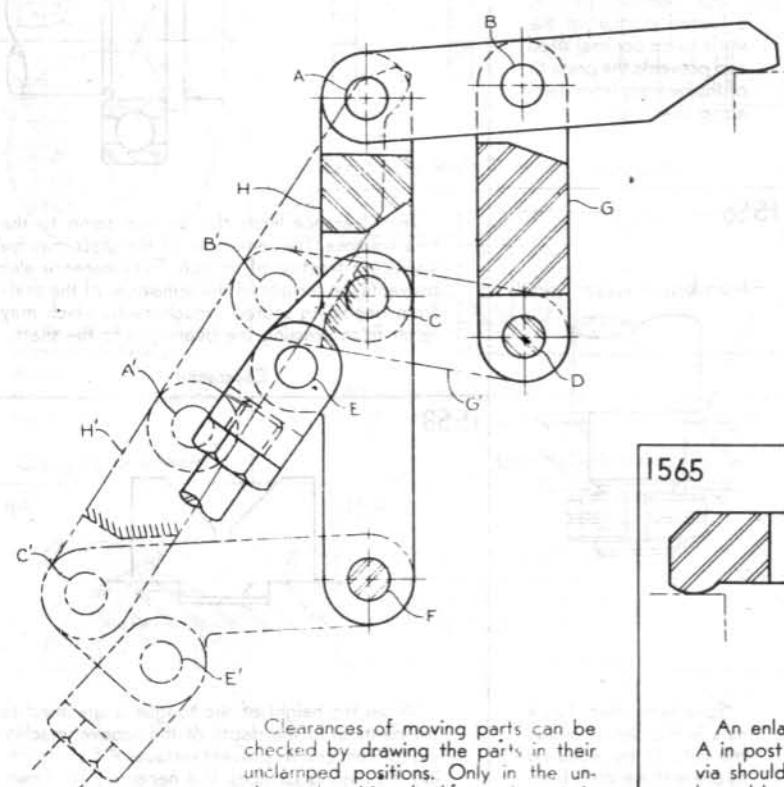


Slotted clearance
Rounded ends cost more

Clearance Checking

When the power source shaft remains in a horizontal position, an oblong slot must be provided in the clamp to retract it. Note the clearances and their size.

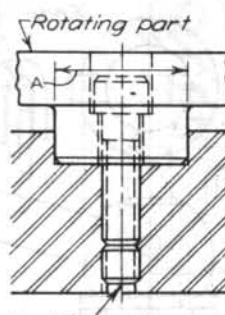
1563



Clearances of moving parts can be checked by drawing the parts in their unclamped positions. Only in the unclamped position do the angular cuts in links H and G appear to be necessary.

Clearance Checking

1561

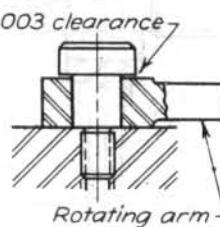


Locking set screw prevents clamping

A cap screw and a locking set screw may be used to hold a rotating part if they are adjusted to provide the clearance required to allow the part to rotate. The clearance is not shown below the head in this illustration. The thrust is absorbed by diameter A of the rotating part in the counterbored hole. It is not absorbed by the diameter of the cap screw.

Clearance for a Rotating Part

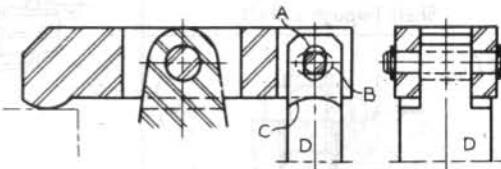
1564



A rotating part may be held by a rigidly clamped shoulder bolt if a few thousandths of an inch clearance is allowed as shown.

Clearance for a Rotating Part

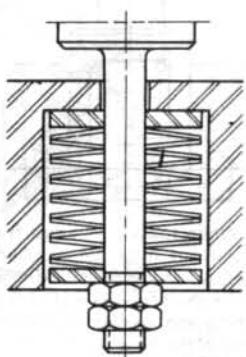
1565



An enlarged hole may be substituted for slot A in post D since the clamping force is applied via shoulders C and not via the pin, but an enlarged hole should not be substituted for slot B because the slot is needed to retract the clamp.

Clearance Checking

1566

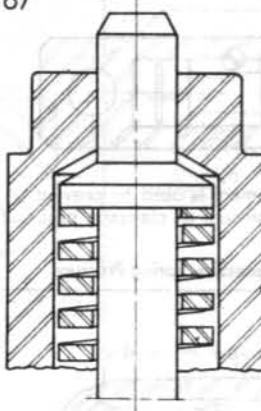


Belleville washer springs are used when the load on the spring is heavy and only a small amount of compression is required.

Slotted washer springs are more flexible than plain Belleville washer springs. They should be used only when it is necessary to maintain constant pressure.

Belleville Washer Spring

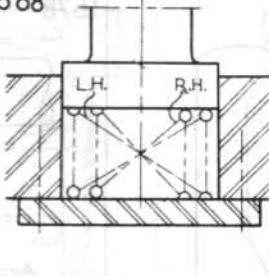
1567



The limited amount of radial and lengthwise space necessitates winding the wire "on the flat" as shown. If the amount of radial space were reduced further, it would not be possible to wind a rectangular wire spring "on edge" without extending the lengthwise space considerably.

Rectangular Wire Spring

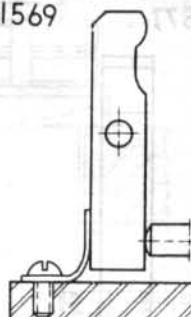
1568



Nested springs (two or more inside each other) produce the maximum amount of energy in the minimum amount of space. In a two-spring system, the outer spring absorbs two-thirds of the workload and the inner spring one-third. Opposite wound springs are used to prevent coils of adjacent springs from intermeshing.

Nesting of Springs

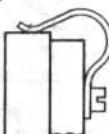
1569



Flat springs are made of flat stock. They take many shapes and forms.

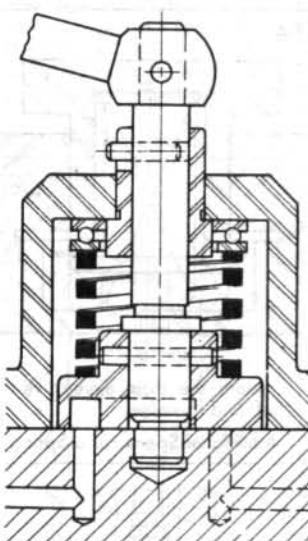
Flat Spring

573



Flat Spring

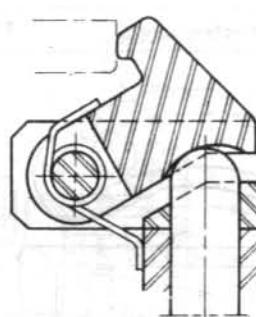
1570



Springs that are not made of round wire should be used only when the amount of space available does not permit the use of round wire springs. Because square wire has a larger cross section than round wire, a shorter free length square wire spring will produce results equal to that produced by a longer free length round wire spring.

Square Wire Spring

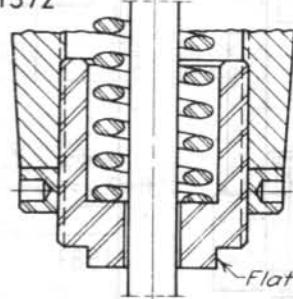
1571



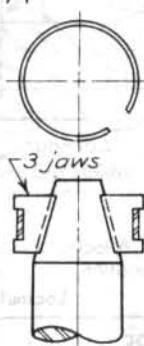
This torsion spring is designed to unwind when it is deflected. A well-designed torsion spring winds when it is deflected.

Torsion Spring

1572



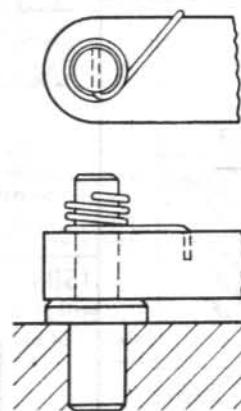
1574



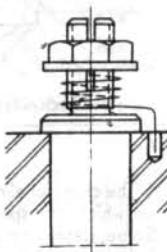
Use of elliptical wire springs applies in the same way use of rectangular wire springs does.

Elliptical Wire Spring

1575



1576



Snap ring springs are made of round, square, or rectangular stock.

Snap Ring Spring

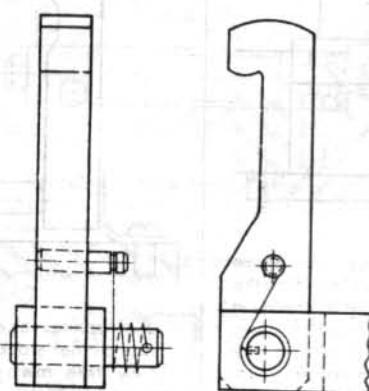
The coils of a torsion spring should wind when the spring is deflected. This action tends to increase the number of coils.

Torsion Spring

One end of the spring is held in the slot. A locknut should be added to prevent vibration from causing the nut to move.

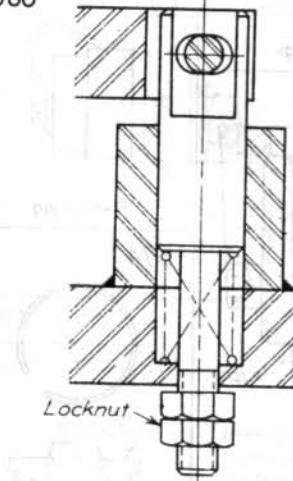
Torsion Spring

1577



Torsion Spring

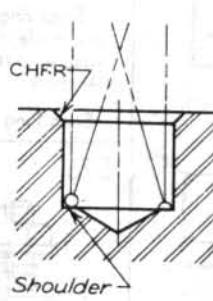
1580



A locknut keeps the controlling nut in position.

Locknuts for a Spring

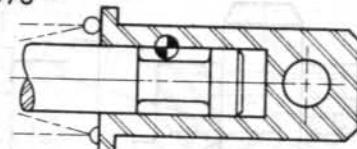
1585



The chamfer eliminates the sharp edge on which the spring coils could catch. Some designers specify that a drilled hole be endmilled to create a shoulder for the spring.

Additional Space for a Spring

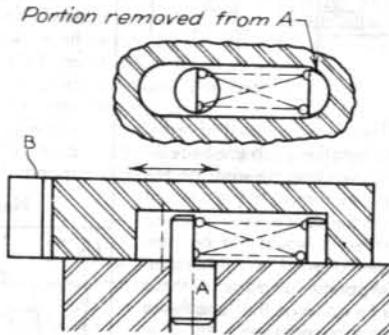
1578



This arrangement is used to prevent an excessive amount of clamping pressure.

Avoiding Excessive Spring Pressure

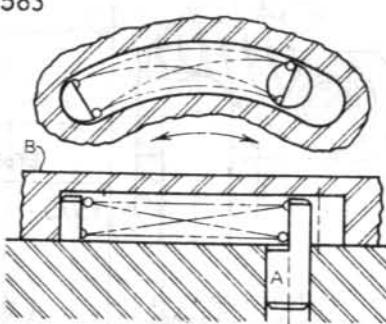
1581



The spring fits in an endmilled slot of moving part B and functions against stationary pin A in the frame.

Retracting Spring

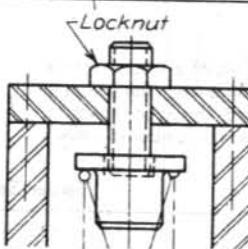
1583



The spring will function satisfactorily in the curved endmilled slot to accommodate rotating part B.

Retracting Spring

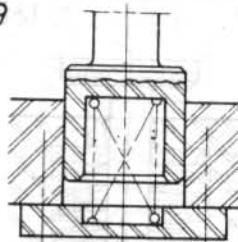
1586



Note the use of the locknut and the recess in the base of the spring for the point of the screw.

Adjusting a Spring

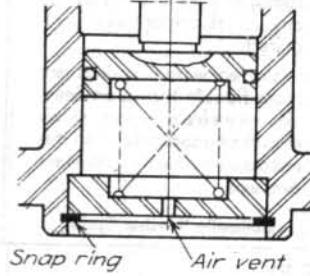
1579



When space is needed for the spring, it can be supplied by providing an endmilled hole in the shaft for one end of the spring and another endmilled hole in the base for the other end of the spring.

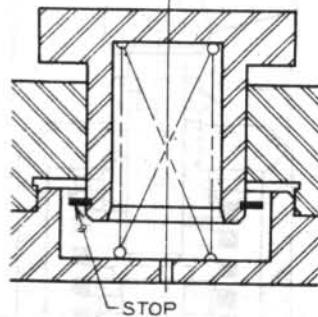
Additional Space for a Spring

1582



Additional Space for a Spring

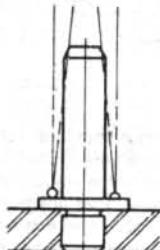
1584



Note the stop, airvent, relief, and chamfers.

Additional Space for a Spring

1587



When long springs are used, it is advisable to add a guide to the base of the spring. The guide may be used as a stop to limit the amount of compression of the spring.

Spring Guiding Stem

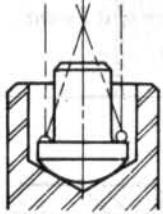
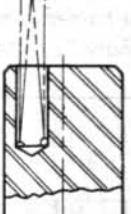
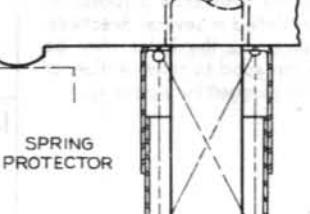
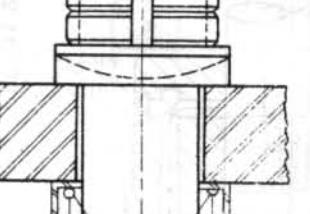
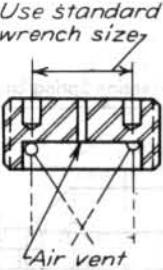
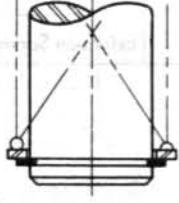
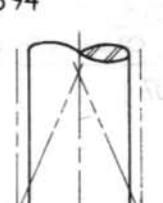
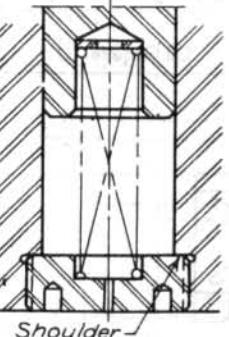
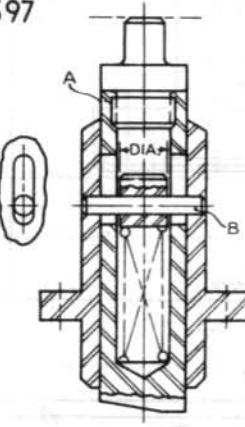
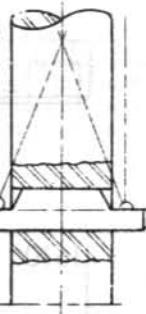
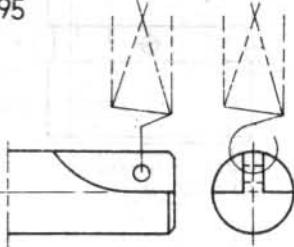
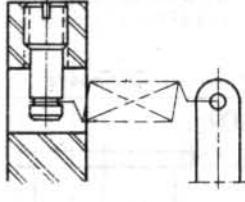
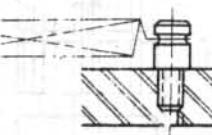
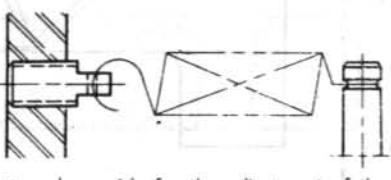
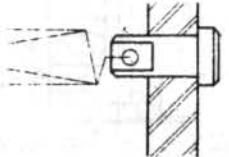
1588

1592

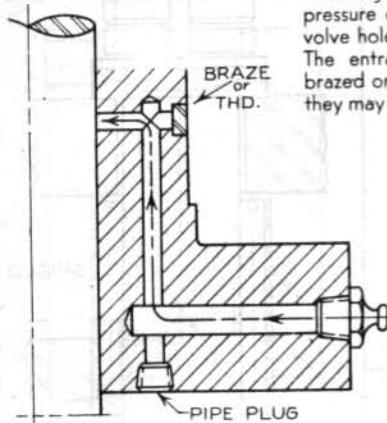
A lock and from may види the are pre

1595

No washers are used. The spring is within the hole. The sharp edge could

<p>1588</p>  <p>Spring Guiding Stem</p>	<p>1589</p>  <p>Offsetting a Spring</p>	<p>1590</p>  <p>SPRING PROTECTOR</p>	<p>1591</p>  <p>SHIELD</p>
<p>1592</p>  <p>Use standard wrench size</p> <p>Air vent</p>	<p>1593</p> 	<p>1594</p>  <p>Sometimes one base of a spring is attached to a shaft and the other is located at the bottom of a counter-bored hole.</p> <p>Spring Base Attached to a Shaft</p>	<p>Spring Shield</p> <p>Spring shields prevent chips and dirt from interfering with the compression of the spring.</p> <p>Spring Shield</p>
<p>Nut for a Spring</p> <p>1596</p>  <p>Shoulder</p>	<p>1597</p>  <p>A</p> <p>B</p> <p>DIA</p>	<p>1598</p>  <p>Spring Base Attached to a Shaft</p>	<p>1595</p>  <p>Extension Spring End Holder</p>
<p>Nut for a Spring</p> <p>1599</p>  <p>Extension Spring End Holder</p> <p>Not all designers specify a washer at the bottom of a drilled hole for the spring. The spring's sidewise movement within the bore is controlled by the hole in the shaft and the hole in the nut. The chamfer of the drilled hole eliminates the sharp edge on which the spring could catch.</p> <p>Spring Base Attached to a Shaft</p>	<p>1600</p>  <p>Extension Spring End Holder</p> <p>1601</p>  <p>The threads provide for the adjustment of the amount of tension of the spring.</p> <p>Extension Spring End Holder</p>	<p>1602</p>  <p>Extension Spring End Holder</p>	

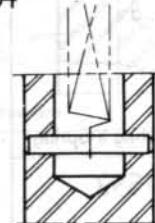
1603



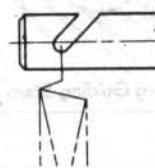
Passageways provided for air or oil pressure or for lubrication purposes involve holes drilled in several directions. The entrances to the holes may be brazed or threaded to retain a plug, or they may be plugged by pipe plugs

*"I am a great believer in Luck.
The harder I work the more of it I seem
to have."* COLEMAN COX

1604



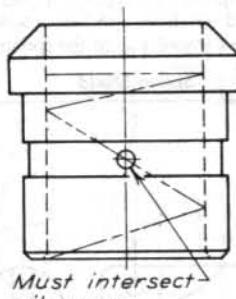
1605



Extension Spring End Holder

Extension Spring End Holder

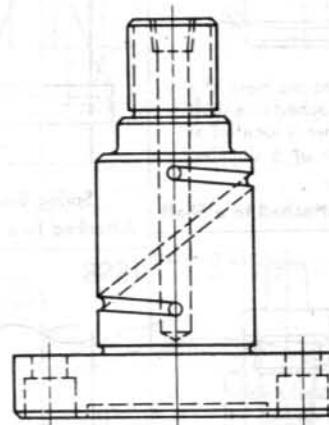
1606



The conventional representation of an oil groove is shown.
Note the runout at the lower end of the oil groove.

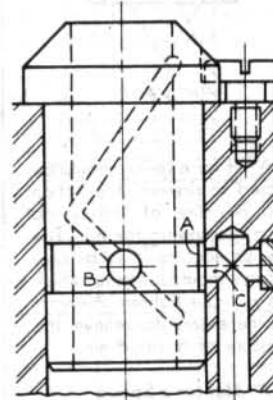
Oil Groove

1607



Oil Groove

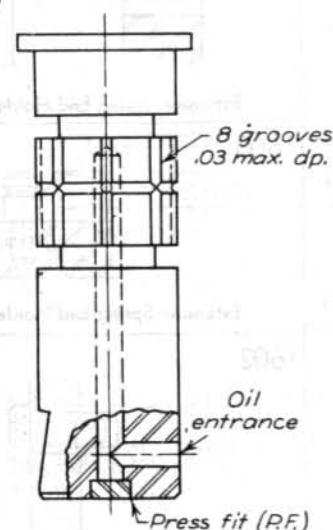
1608



Providing recess A eliminates the need to align B and C.

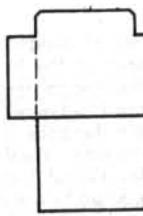
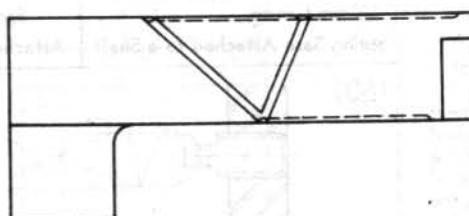
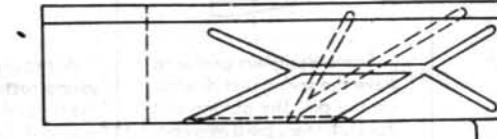
Oil Groove

1609



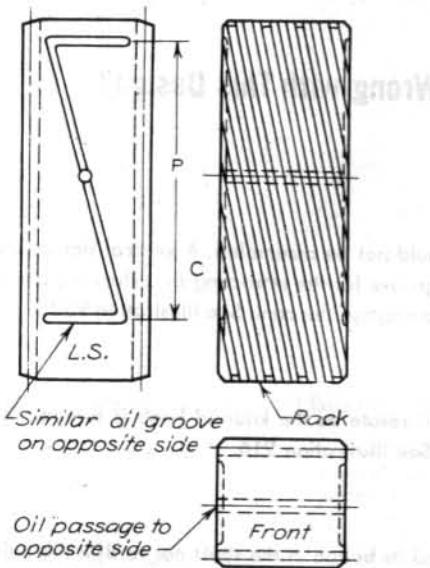
Oil Grooves

1610



Oil Grooves

1611

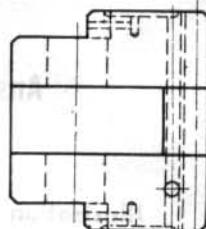


This drawing is detail C of Illustration 104. The measurement of pitch P of the oil groove should be slightly less than the measurement of the distance C moves horizontally.

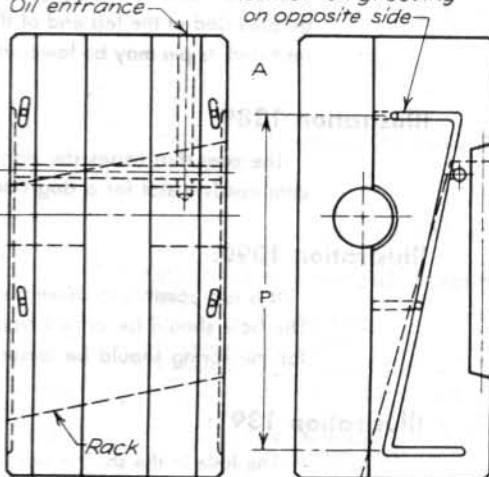
Oil Grooves

1612

This drawing is detail C of Illustration 104. The part functions vertically.

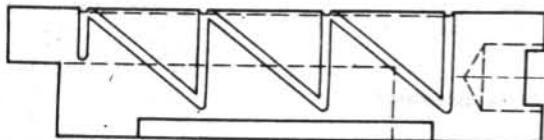
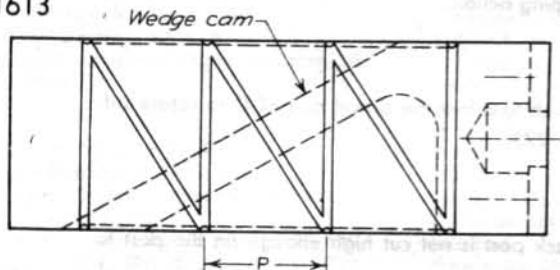


Similar oil grooving on opposite side



Oil Grooves

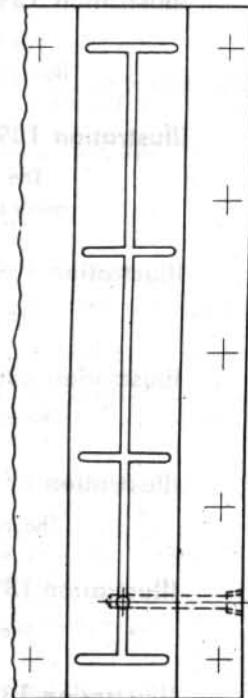
1613



The measurement of pitch P of the oil grooves should be less than the measurement of the distance the part moves.

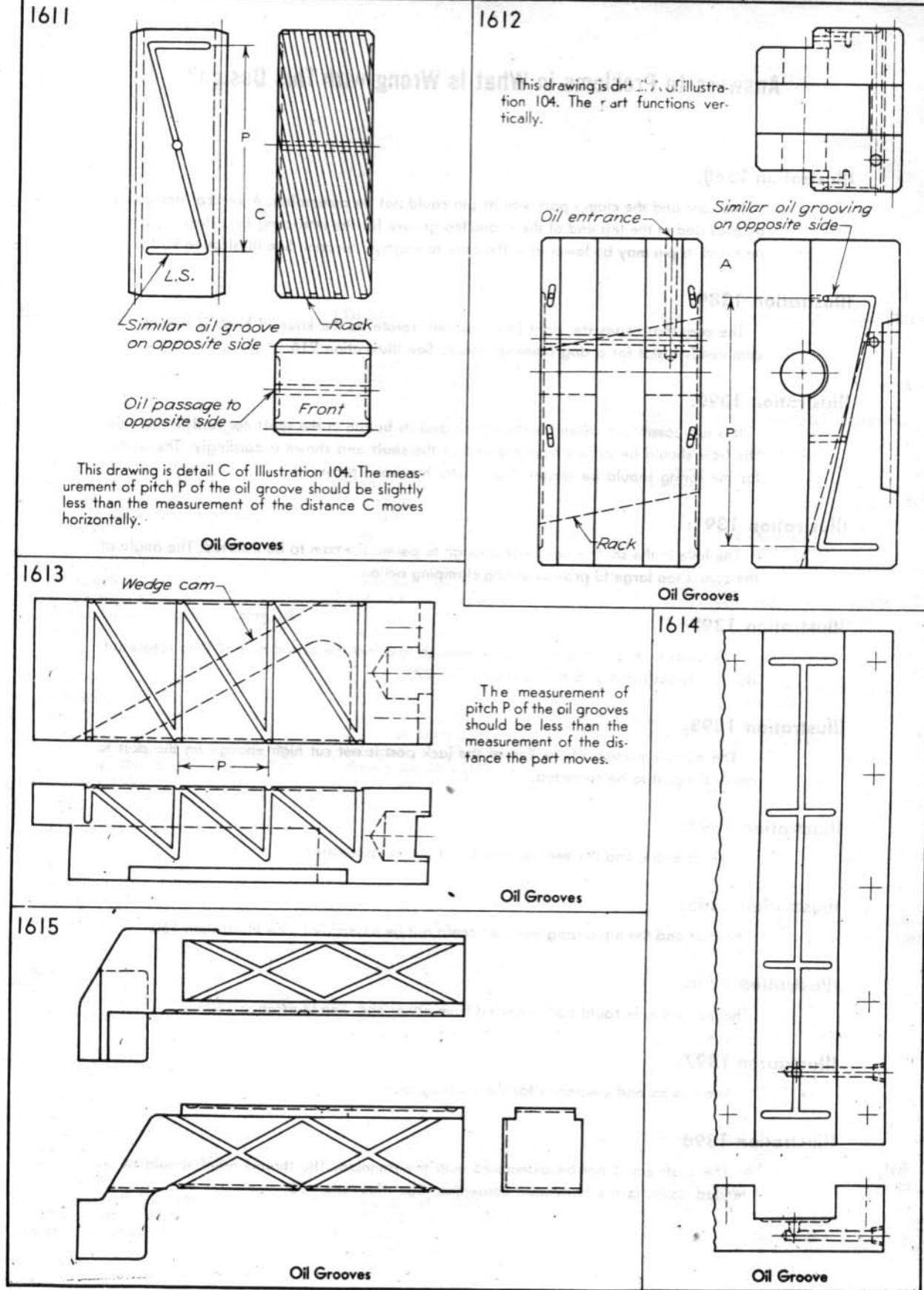
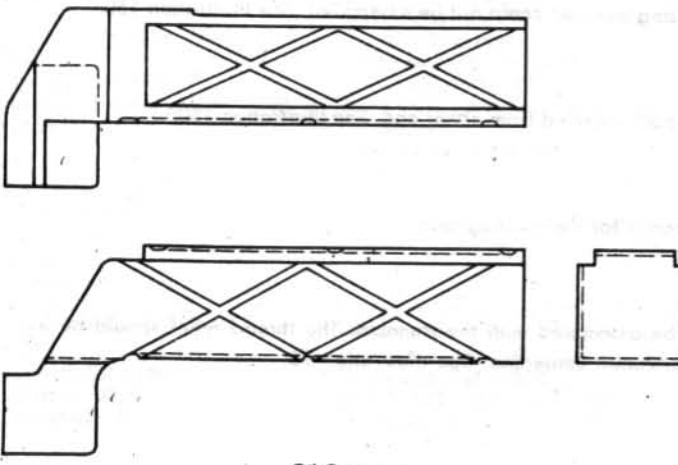
Oil Grooves

1614



Oil Groove

1615



Answers to Problems in What Is Wrong with This Design?

Illustration 1388:

The cam and the clamp post with its pin could not be assembled. A vertical slot should be provided at the left end of the endmilled groove for the retracting pin. Then the clamp post and its pin may be lowered in the bore to engage the cam. See Illustration 950.

Illustration 1389:

The cam that raises the right jack post will rotate as the knurled knob is turned. This cam needs a slot for a dog point set screw. See Illustration 916.

Illustration 1390:

It is not possible to assemble the spring and its button in the shaft nor to drill the hole. The hole should be drilled from the end of the shaft and shown accordingly. The button for the spring should be longer. No airvent has been provided.

Illustration 1391:

The hole in the shaft is not large enough to permit the cam to be inserted. The angle of the cam is too large to provide strong clamping action.

Illustration 1392:

The holes in A and B are not large enough to allow the dowel pins of C to rotate sufficiently to retract A and B. See Illustration 225.

Illustration 1393:

The narrow portion of the Tee of the jack post is not cut high enough on the post to allow the post to be retracted.

Illustration 1394:

The eccentric and the vertical post could not be assembled.

Illustration 1395:

The post and the equalizing trunnion could not be assembled. See Illustration 150.

Illustration 1396:

The inclined hole could not be drilled from either end. See Illustration 1505.

Illustration 1397:

There is no end clearance for the rotating arm.

Illustration 1398:

The shaft could not be assembled with the trunnion. The thread relief should be extended down to the horizontal centerline. See Illustration 93.

Internal clamp, two-position, 268 to 276
 Internal collet (*see* Collet, internal)

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Two dire

Undermea

Vacuum
Vee block

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