Republic of Iraq
Ministry of Higher Education
and Scientific Research
University of Technology
Department of Production Engineering
and Metallurgy
Production Engineering

Mechanical Drawing (Assembly Drawing)

Second Stage

Asst. Prof. Dr. Shukry H. Aghdeab

Asst.Lec. Baqer Ayad Ahmed

Asst.Lec. Mohammed Sattar Jabbar

Eng. Emad Aziz Hamdi

2016 **1437**

INTRODUCTION

1.1Graphic language

1.1.1 General

A technical person can use the graphic language as powerful means of communication with others for conveying ideas on technical matters. However, for effective exchange of ideas with others, the engineer must have proficiency in (*i*) language, both written and oral, (*ii*) symbols associated with basic sciences and (*iii*) the graphic language. Engineering drawing is a suitable graphic language from which any trained person can visualize the required object. As an engineering drawing displays the exact picture of an object, it obviously conveys the same ideas to every trained eye. Irrespective of language barriers, the drawings can be effectively used in other countries, in addition to the country where they are prepared. Thus, the engineering drawing is the universal language of all engineers.

1.1.2 Importance of graphic language

The graphic language had its existence when it became necessary to build new structures and create new machines or the like, in addition to representing the existing ones. In the absence of graphic language, the ideas on technical matters have to be conveyed by speech or writing, both are unreliable and difficult to understand by the shop floor people for manufacturing. This method involves not only lot of time and labour, but also manufacturing errors. Without engineering drawing, it would have been impossible to produce objects such as aircrafts, automobiles, locomotives, etc., each requiring thousands of different components.

1.1.3 Need for correct drawing

The drawings prepared by any technical person must be clear, unmistakable in meaning and there should not be any scope for more than one interpretation, or else litigation may arise. In a number of dealings with contracts, the drawing is an official document and the success or failure of a structure depends on the clarity of details provided on the drawing. Thus, the drawings should not give any scope for misinterpretation even by accident. It would not have been possible to produce the machines and automobiles on a mass scale where a number of assemblies and sub-assemblies are involved, without clear, correct and accurate drawings. To achieve this, the technical person must gain a thorough knowledge of both the principles and conventional practice of draughting. If these are not achieved and or practiced, the drawings prepared by one may convey different meaning to others, causing unnecessary delays and expenses in production shops.

Hence, an engineer should posses good knowledge, not only in preparing a correct drawing but also to read the drawing correctly. The course content of this sketchbook is expected to meet these requirements. The study of machine part drawing mainly involves learning to sketch machine parts and to make working and assembly drawings. This involves a study of those conventions in drawings that are widely adopted in engineering practice.

1.2 Classification of Drawings

1.2.1 Machine drawing

It is pertaining to machine parts or components. It is presented through a number of orthographic views, so that the size and shape of the component is fully understood. Part drawings and assembly drawings belong to this classification. An example of a machine drawing is given in Fig. 1.1.

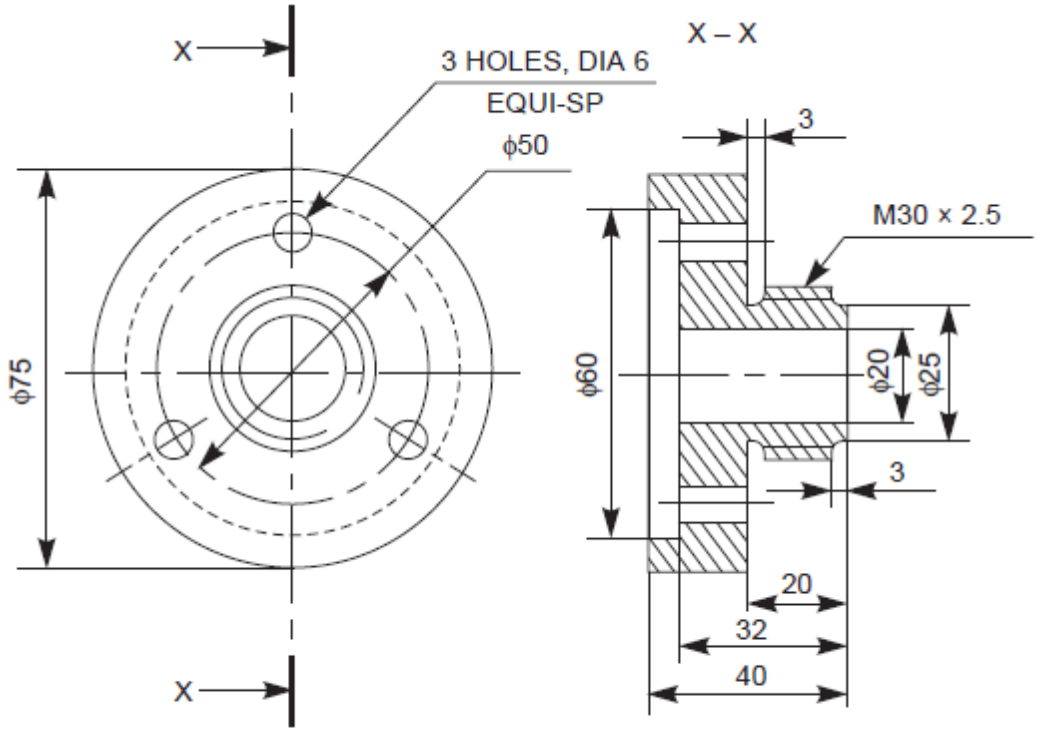


Fig. 1.1 Machine drawing.

1.2.2 Production drawing

A production drawing, also referred to as working drawing, should furnish all the dimensions, limits and special finishing processes such as heat treatment, honing, lapping, surface finish, etc., to guide the craftsman on the shop floor in producing the component. The title should also mention the material used for the product, number of parts required

for the assembled unit, etc. Since a craftsman will ordinarily make one component at a time, it is advisable to prepare the production drawing of each component on a separate sheet. However, in some cases the drawings of related components may be given on the same sheet. Fig. 1.2 represents an example of a production drawing.

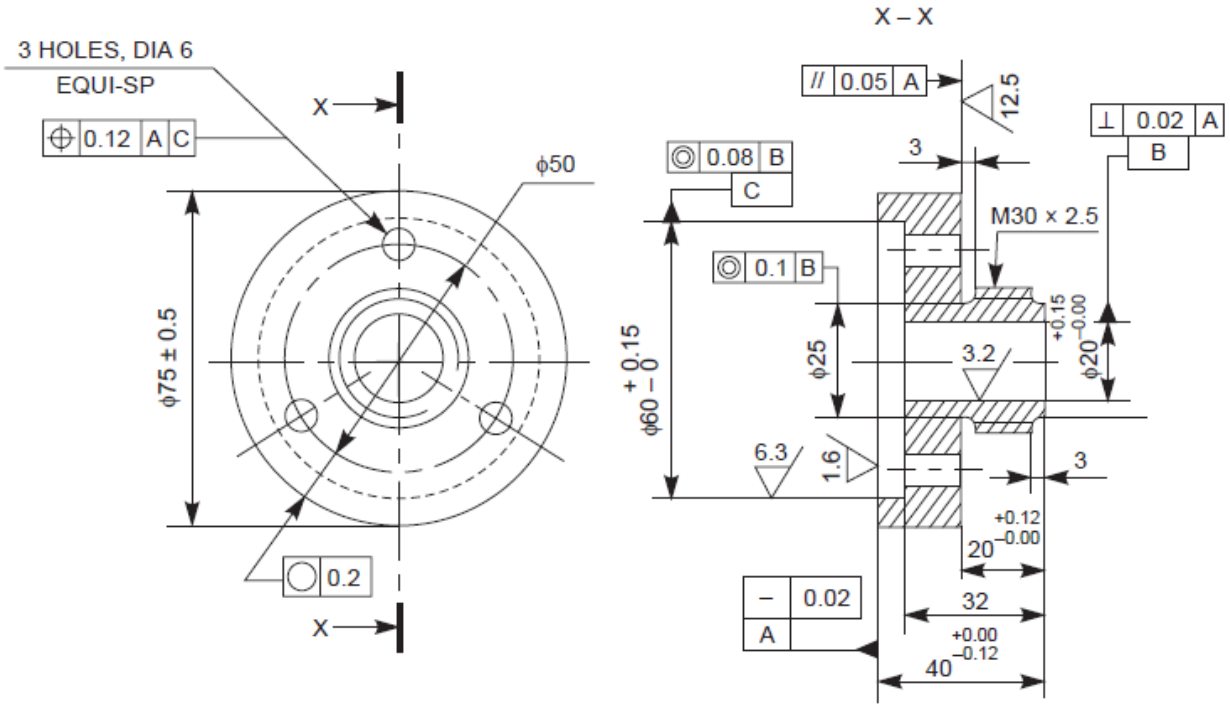
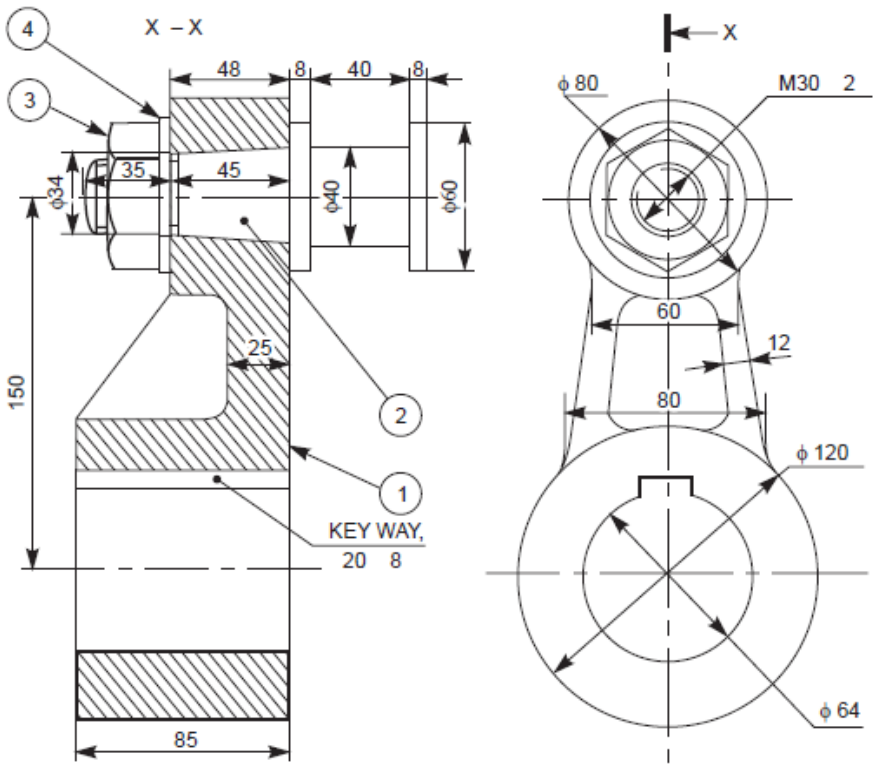


Fig. 1.2 Production drawing.

1.2.3 Assembly drawing

A drawing that shows the various parts of a machine in their correct working locations is an assembly drawing as shown in fig. 1.3There are several types of such drawings.



Parts List

Part No.	Name	Material	Qty
1	Crank	Forged Steel	1
2	Crank Pin	45C	1
3	Nut	MS	1
4	Washer	MS	1

Fig. 1.3 Assembly drawing.

1.2.3.1 Design Assembly Drawing

When a machine is designed, an assembly drawing or a design layout is first drawn to clearly visualise the performance, shape and clearances of various parts comprising the machine.

1.2.3.2 Detailed Assembly Drawing

It is usually made for simple machines, comprising of a relatively smaller number of simple parts. All the dimensions and information necessary for the construction of such parts and for the assembly of the

parts are given directly on the assembly drawing. Separate views of specific parts in enlargements, showing the fitting of parts together, may also be drawn in addition to the regular assembly drawing.

1.2.3.3 Sub- Assembly Drawing

Many assemblies such as an automobile, lathe, etc., are assembled with many pre-assembled components as well as individual parts. These pre-assembled units are known as sub-assemblies. A sub-assembly drawing is an assembly drawing of a group of related parts, that form a part in a more complicated machine. Examples of such drawings are: lathe tail-stock, diesel engine fuel pump, carburettor, etc.

1.2.3.4 Installation Assembly Drawing

On this drawing, the location and dimensions of few important parts and overall dimensions of the assembled unit are indicated. This drawing provides useful information for assembling the machine, as this drawing reveals all parts of a machine in their correct working position.

1.2.3.5 Assembly Drawings for catalogues

Special assembly drawings are prepared for company catalogues. These drawings show only the pertinent details and dimensions that would interest the potential buyer. Fig. 1.4 shows a typical catalogue drawing, showing the overall and principal dimensions.

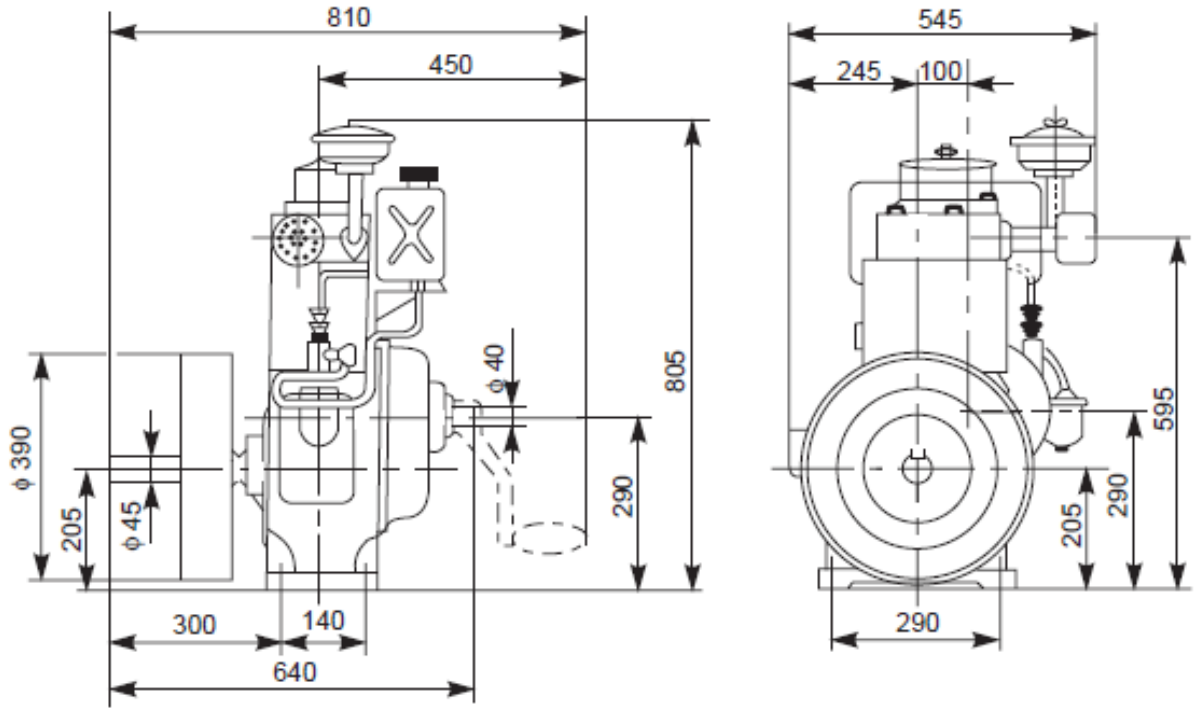
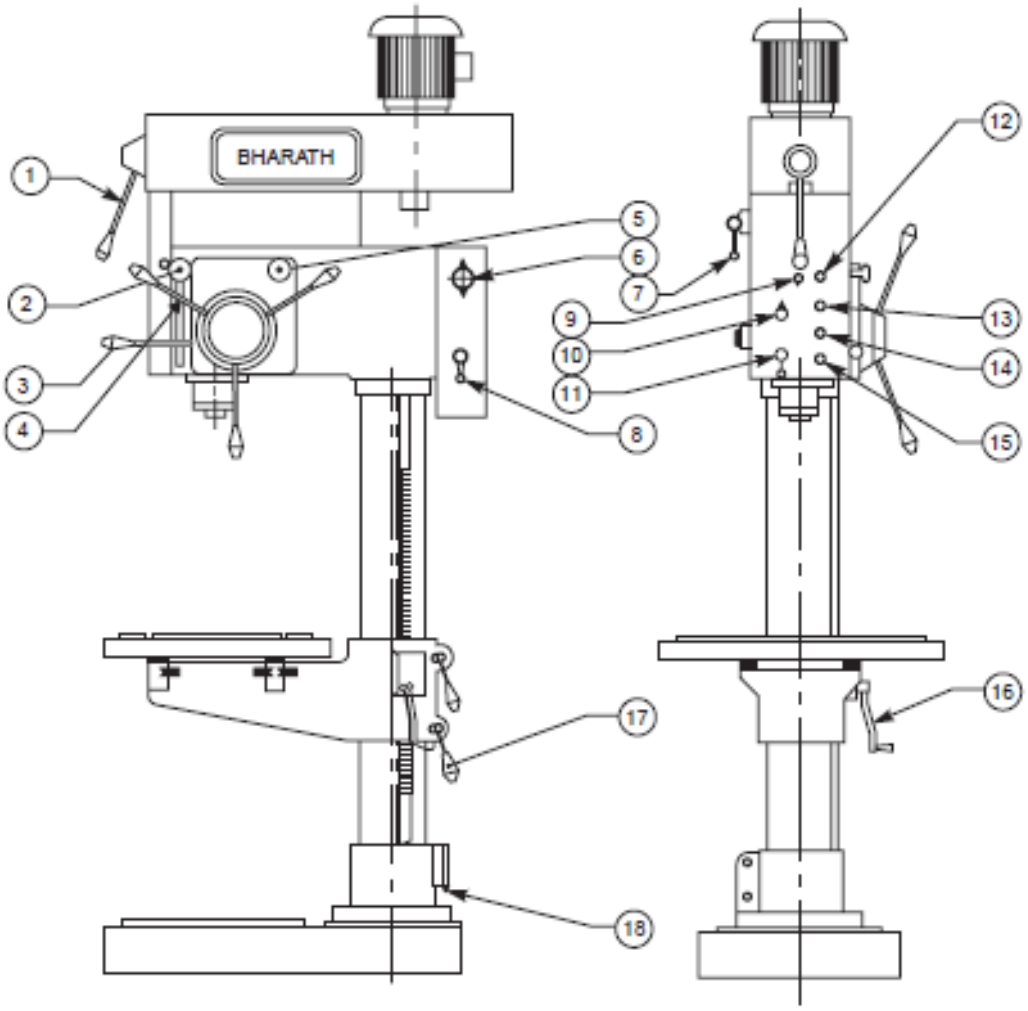


Fig. 1.4 Catalogue drawing.

1.2.3.6 Assembly Drawings for instruction manuals

These drawings in the form of assembly drawings, are to be used when a machine, shipped away in assembled condition, is knocked down in order to check all the parts before reassembly and installation elsewhere. These drawings have each component numbered on the job. Fig.1.5 shows a typical example of such a drawing.



Speed change lever (1)

Depth adjusting knob (2)

Mech. Feed engagement lever (3)

Hand free lever (4)

Feed change knob (5)

Switch for tapping(6)

Gear shifting lever (7)

Main switch(8)

Lamp switch(9)

Selector switch (10)

Forward switch (11)

Pilot lamp (12)

Feed disengagement push button (13)

Start push button (14)

Emergency stop (15)

Elevating handle (16)

Clamping handle(17)

Supply inlet (18)

Fig. 1.5 Assembly drawing for instruction manuals.

1.2.3.7 Exploded Assembly Drawing

In some cases, exploded pictorial views are supplied to meet instruction manual requirements. These drawings generally find a place in the parts list section of a company instruction manual. Fig 1.6 shows drawings of this type which may be easily understood even by those with less experience in the reading of drawings; because in these exploded views, the parts are positioned in the sequence of assembly, but separated from each other.

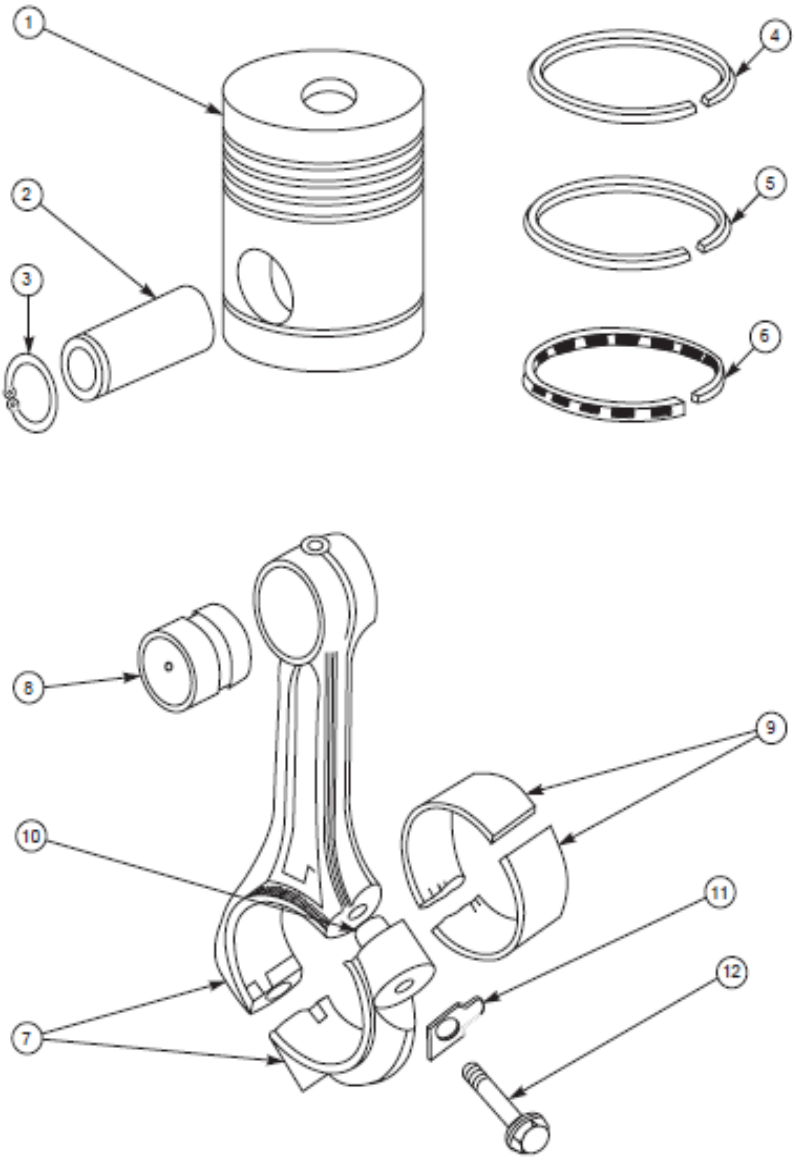
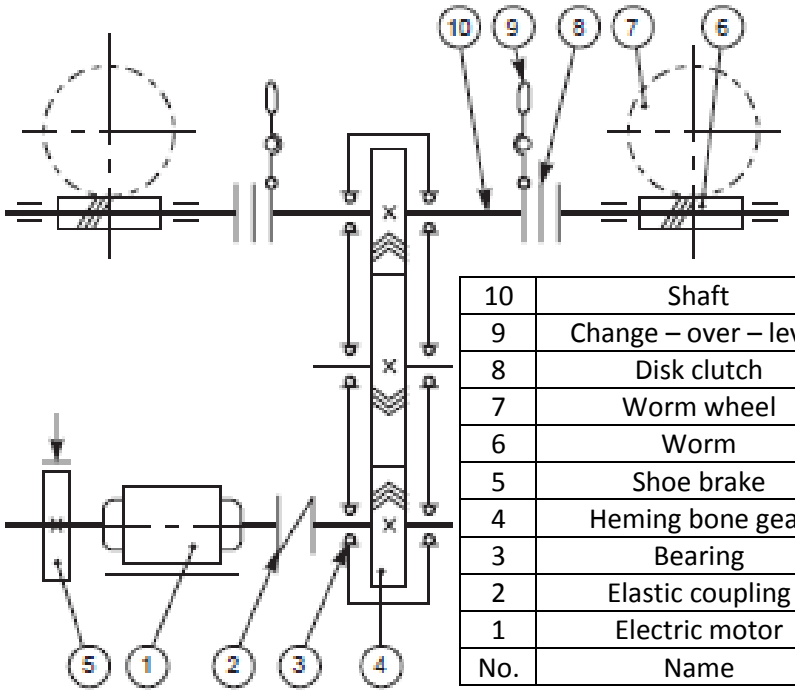


Fig. 1.6 Exploded assembly drawing.

1.2.3.8 Schematic Assembly Drawing

It is very difficult to understand the operating principles of complicated machinery, merely from the assembly drawings. Schematic representation of the unit facilitates easy understanding of its operating principle. It is a simplified illustration of the machine or of a system, replacing all the elements, by their respective conventional representations. Fig 1.7 shows the schematic representation of a gearing diagram.



No.	Name	Qty
10	Shaft	1
9	Change – over – lever	2
8	Disk clutch	2
7	Worm wheel	2
6	Worm	2
5	Shoe brake	2
4	Heming bone gear	3
3	Bearing	6
2	Elastic coupling	2
1	Electric motor	2

Fig. 1.7 Schematic assembly drawing.

1.2.3.9 Machine Shop Drawing

Rough castings and forgings are sent to the machine shop for finishing operation (Fig. 1.8). Since the machinist is not interested in the dimensions and information of the previous stages, a machine shop

drawing frequently gives only the information necessary for machining. Based on the same principle, one may have forge shop drawing, pattern shop drawing, sheet metal drawing, etc.

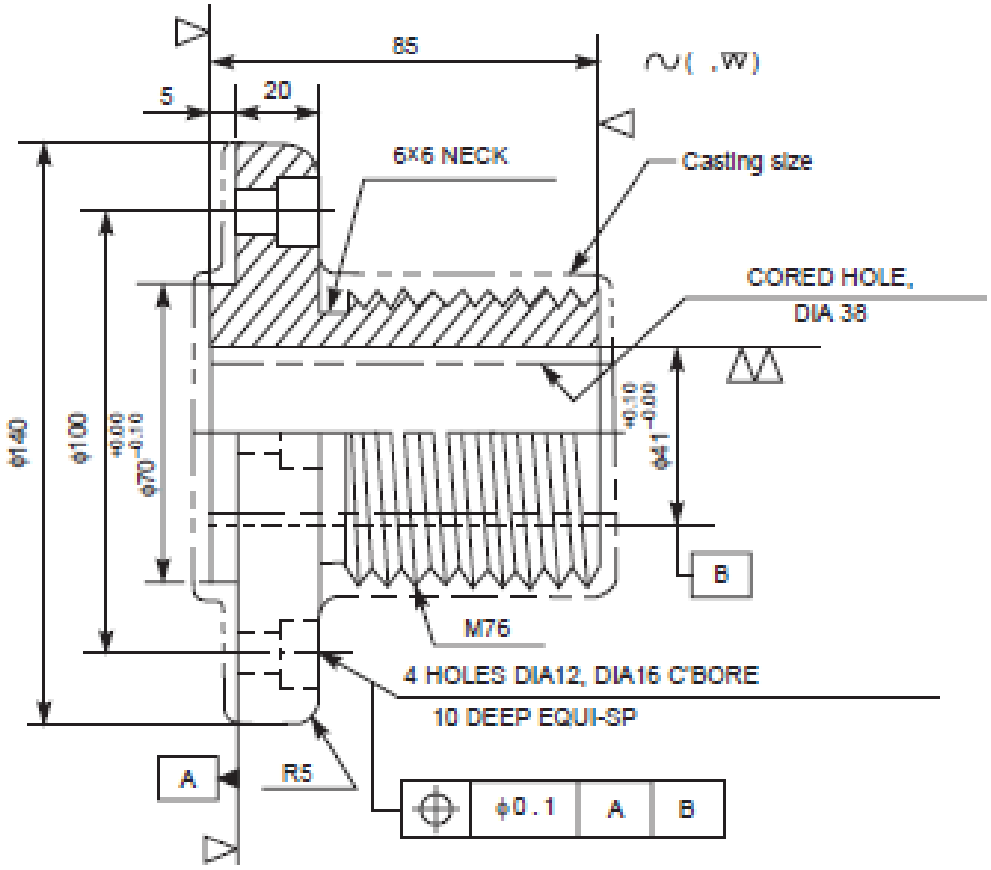


Fig. 1.8 Machine Shop drawing.

1.2.3.10 Patent Drawing

When new machines or devices are invented, patent drawings come into existence, to illustrate and explain the invention. These are pictorial drawings and must be self-explanatory. It is essential that the patent drawings are mechanically correct and include complete illustrations of every detail of the invention. However, they are not useful for production purposes. The salient features on the drawing are numbered for identification and complete description.

1.2.3.11 Symbols in Drawing

SYMBOL FOR:	ASME Y14.5M–1994	ISO	CAN/CSA–B78.2–M91
STRAIGHTNESS	—	—	—
FLATNESS	▱	▱	▱
CIRCULARITY	○	○	○
CYLINDRICITY	⌭	⌭	⌭
PROFILE OF A LINE	⌒	⌒	⌒
PROFILE OF A SURFACE	⌓	⌓	⌓
ALL AROUND–PROFILE	⌒○	⌒○	⌒○
ANGULARITY	∠	∠	∠
PERPENDICULARITY	⊥	⊥	⊥
PARALLELISM	//	//	//
POSITION	⌖	⌖	⌖
CONCENTRICITY/COAXIALITY	◎	◎	◎
SYMMETRY	⌯	⌯	⌯
CIRCULAR RUNOUT	*↗	↗	*↗
TOTAL RUNOUT	*⌰	⌰	*⌰
AT MAXIMUM MATERIAL CONDITION	Ⓜ	Ⓜ	Ⓜ
AT LEAST MATERIAL CONDITION	Ⓛ	Ⓛ	Ⓛ (PROPOSED)
REGARDLESS OF FEATURE SIZE	NONE	NONE	NONE
PROJECTED TOLERANCE ZONE	Ⓟ	Ⓟ	Ⓟ
DIAMETER	∅	∅	∅
BASIC DIMENSION	50	50	50
REFERENCE DIMENSION	(50)	(50)	(50)
DATUM FEATURE	*A	* OR *A	*A
DATUM TARGET	∅6 A1	∅6 A1	∅6 A1
TARGET POINT	×	×	×
DIMENSION ORIGIN	⌖→	⌖→	⌖→
FEATURE CONTROL FRAME	⌖ ∅0.5Ⓜ A B C	⌖ ∅0.5Ⓜ A B C	⌖ ∅0.5Ⓜ A B C
CONICAL TAPER	⌲	⌲	⌲
SLOPE	⌳	⌳	⌳
COUNTERBORE/SPOTFACE	⌴	⌴ (PROPOSED)	⌴
COUNTERSINK	⌵	⌵ (PROPOSED)	⌵
DEPTH/DEEP	↧	↧ (PROPOSED)	↧
SQUARE (SHAPE)	□	□	□
DIMENSION NOT TO SCALE	15	15	15
NUMBER OF TIMES/PLACES	8X	8X	8X
ARC LENGTH	105	105	105
RADIUS	R	R	R
SPHERICAL RADIUS	SR	SR	SR
SPHERICAL DIAMETER	S∅	S∅	S∅
BETWEEN	⟷	NONE	⟷ (PROPOSED)

1.3 Nut , Bolt and washer

1.3.1 Representation of external thread (Stud bolt)

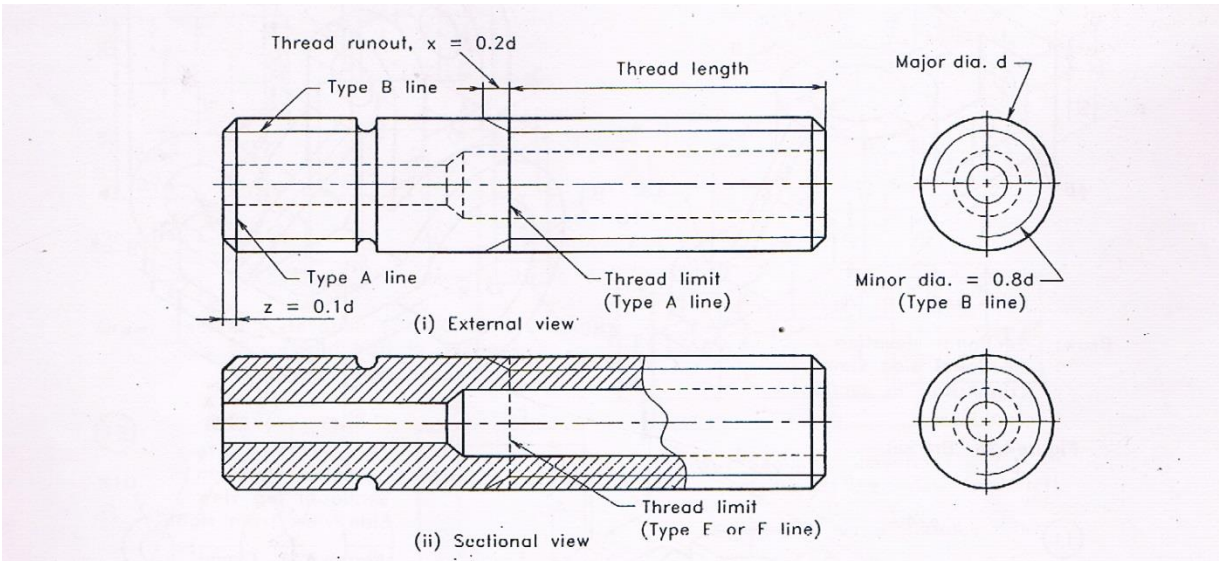


Fig. 1.9 Representation of external thread.

1.3.2 Representation of internal thread

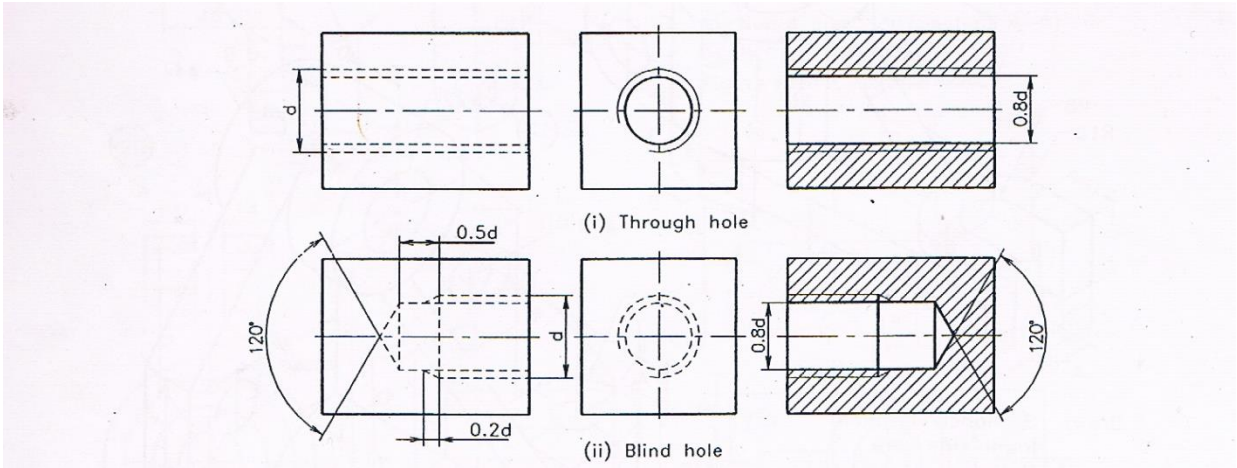


Fig. 1.10 Representation of internal thread.

1.3.3 Terminology of bolt and nut

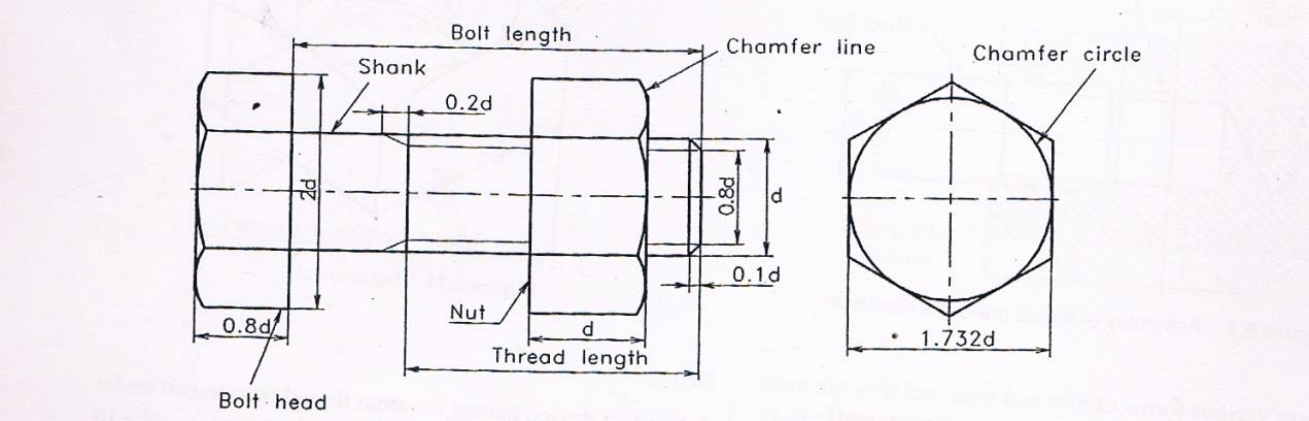


Fig. 1.11 Terminology of bolt and nut.

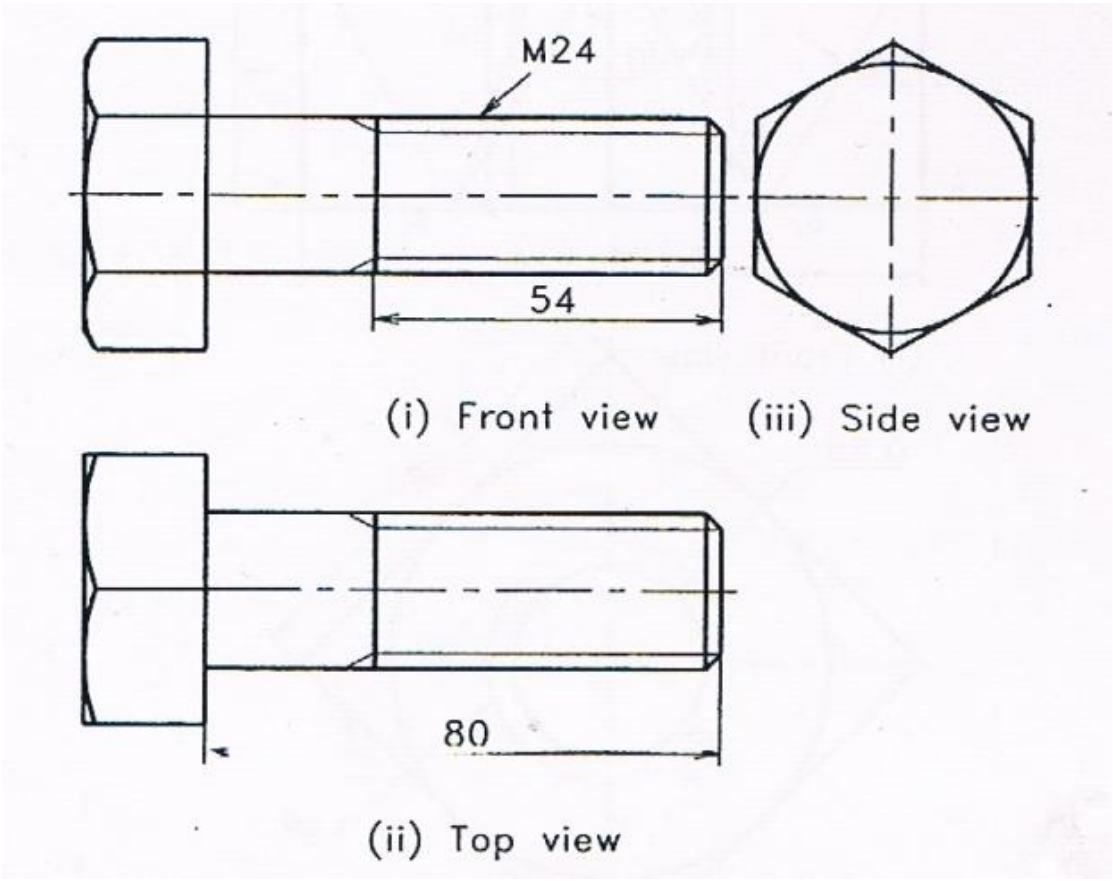


Fig. 1.12 Hexagonal headed bolt

1.3.4 Hexagonal nut (method of drawing)

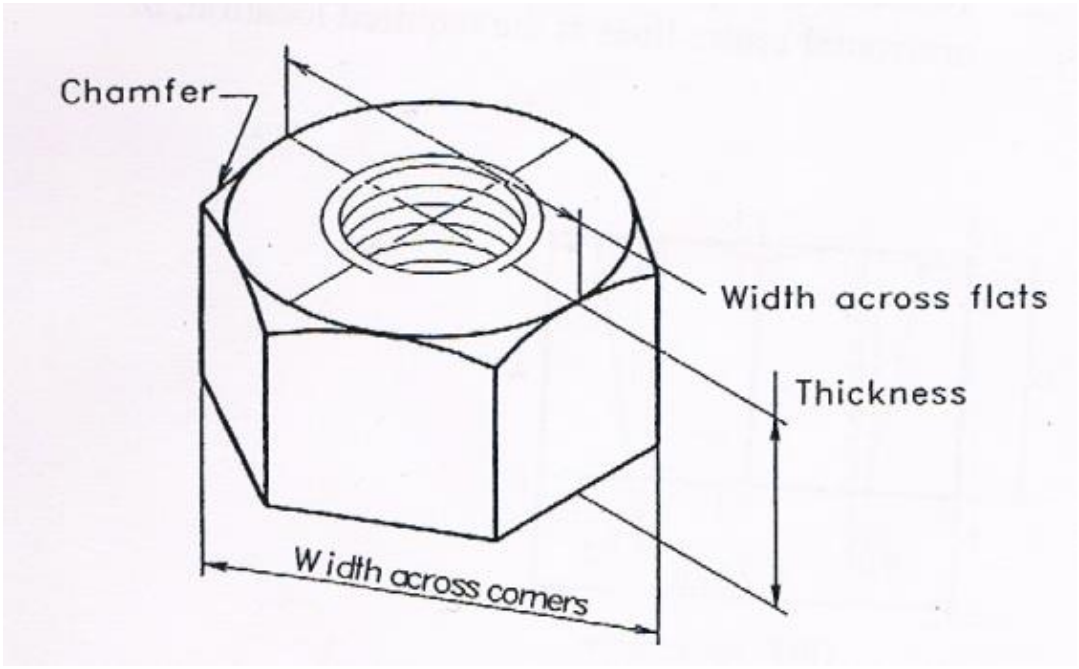


Fig. 1.13 Hexagonal nut

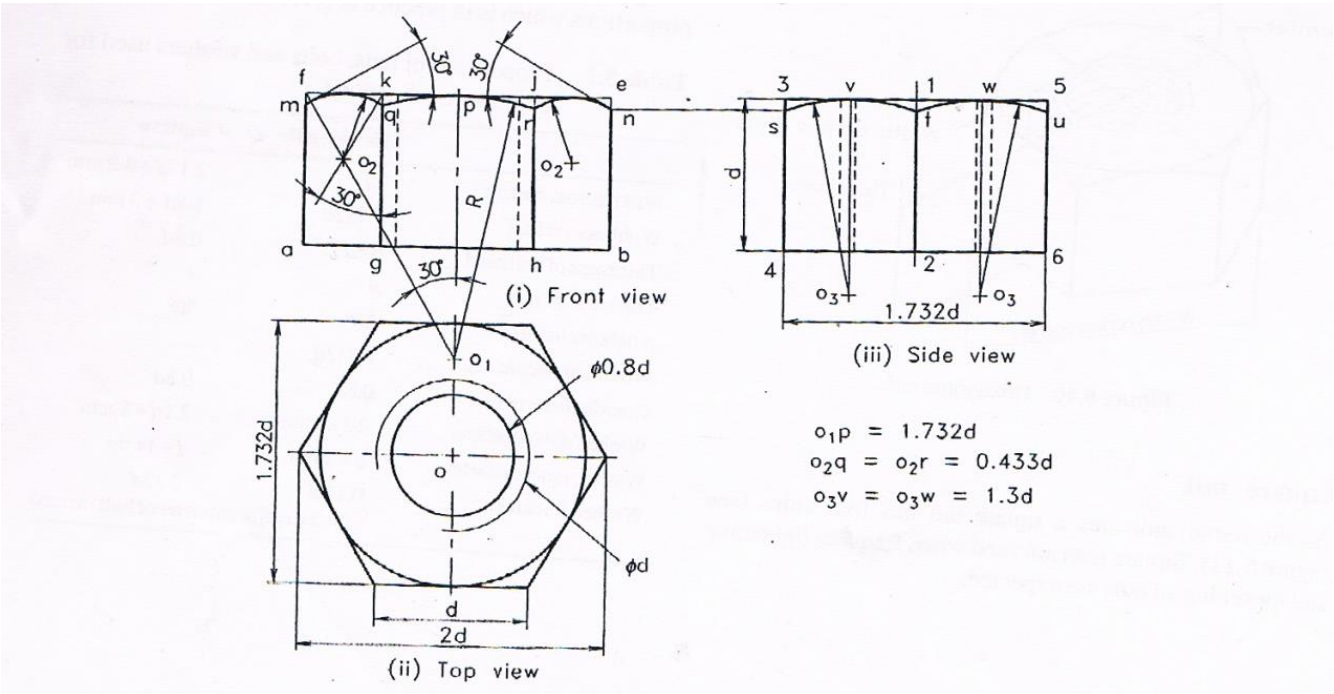


Fig. 1.14 Hexagonal nut method of drawing

1.3.5 Proportion of nuts and bolts

TABLE Proportions of nuts, bolts and washers used for engineering drawings.

	Hexagonal	Square
Width across corners	$2d$	$2.12d + 4.2$ mm
Width across flats	$1.732d$	$1.5d + 3$ mm
Thickness of bolt head	$0.8d$	$0.8d$
Thickness of nut	d	d
Angle of chamfer	30°	30°
Front chamfer arc rad.	$1.732d$	—
Core diameter of bolt	$0.8d$	$0.8d$
Washer, outer diameter	$2d + 3$ mm	$2.1d + 8$ mm
Washer, inner diameter	$d + 1$ mm	$d + 1$ mm
Washer, thickness	$0.12\,d$	$0.12d$

(d = the major diameter of bolt in mm)

1.3.6 Square nut (method of drawing)

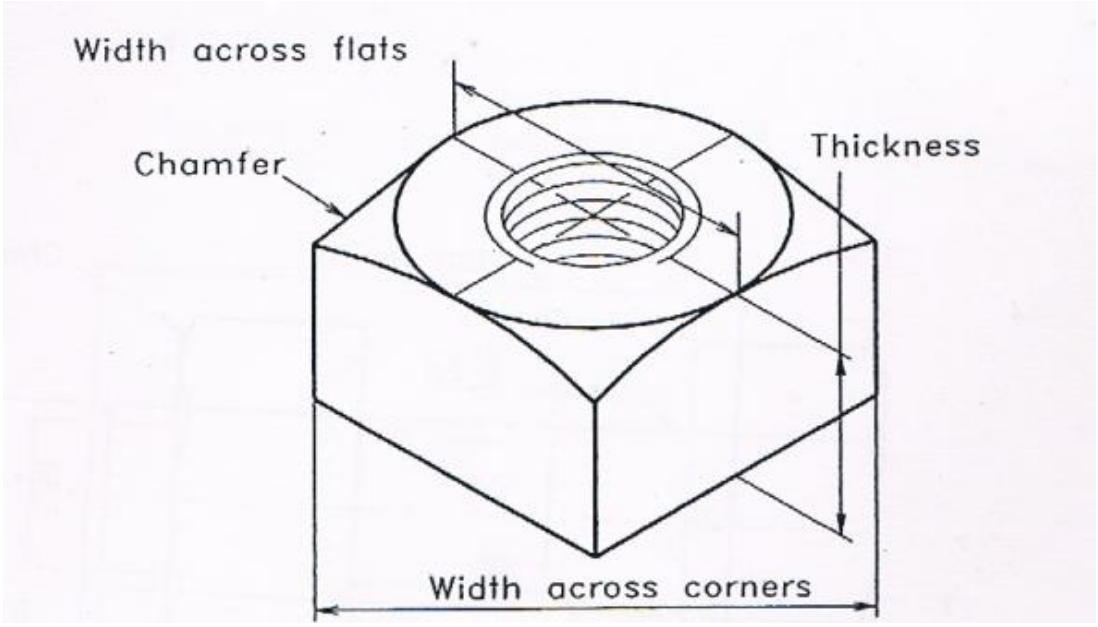


Fig. 1.15 Square nut

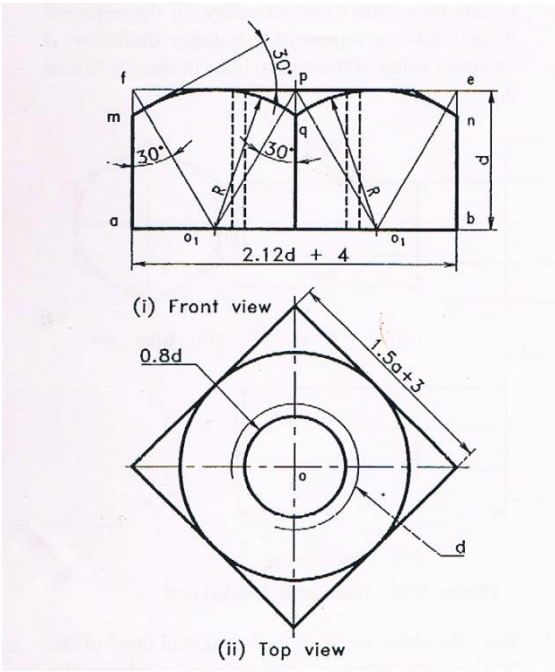


Fig. 1.16 Square nut method of drawing

1.3.7 Stud bolt

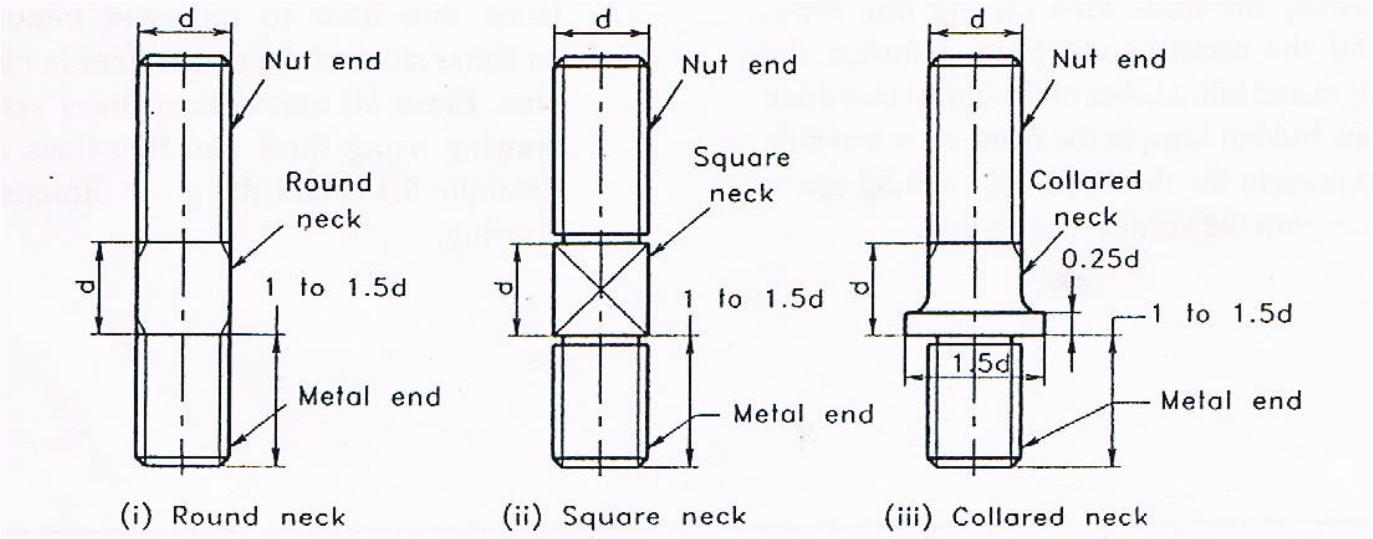


Fig. 1.17 Stud bolt

1.3.8 Special form of bolts:

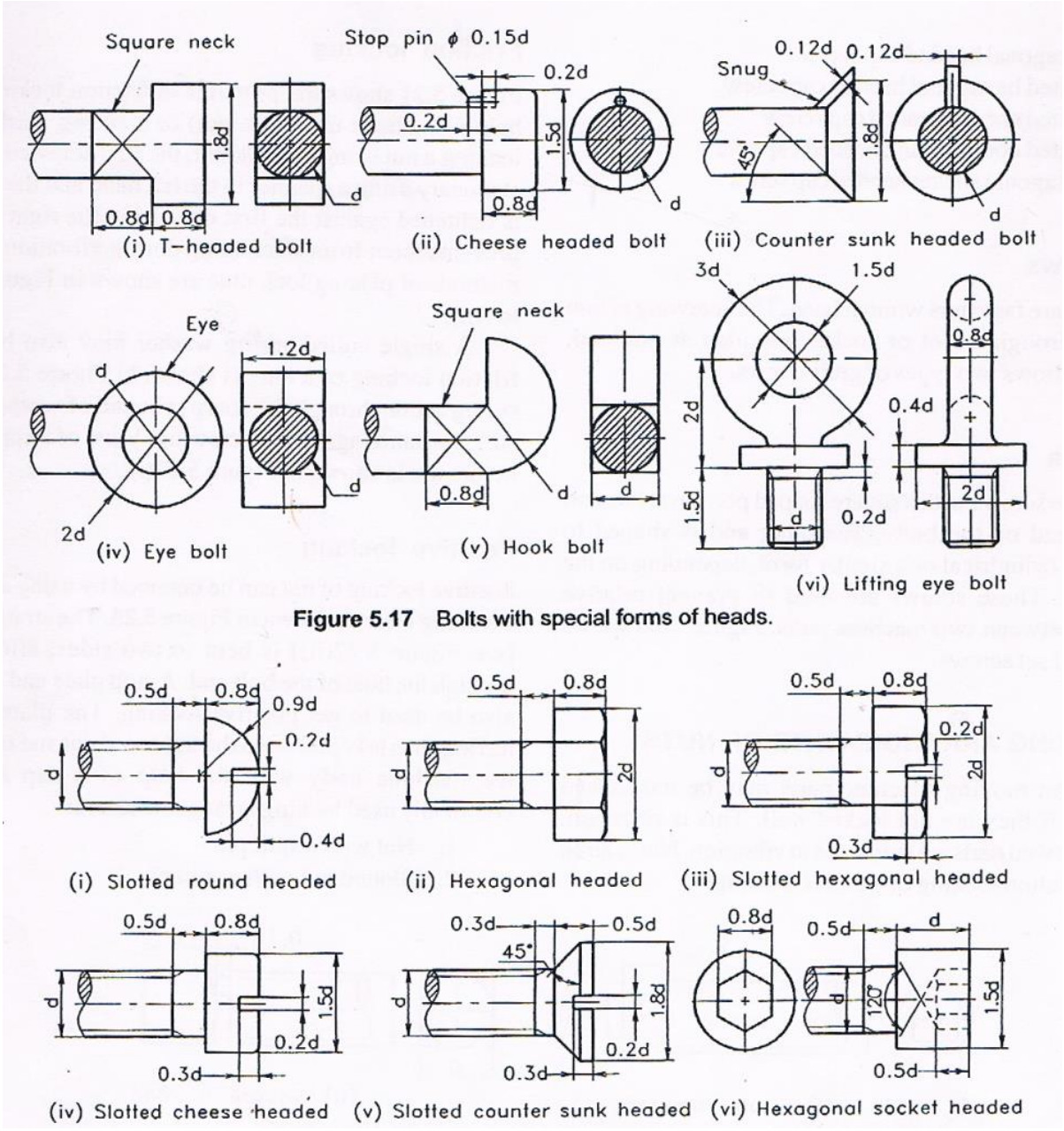


Figure 5.17 Bolts with special forms of heads.

Fig. 1.18 Special form of bolts

1.3.9 Locking arrangements of nuts

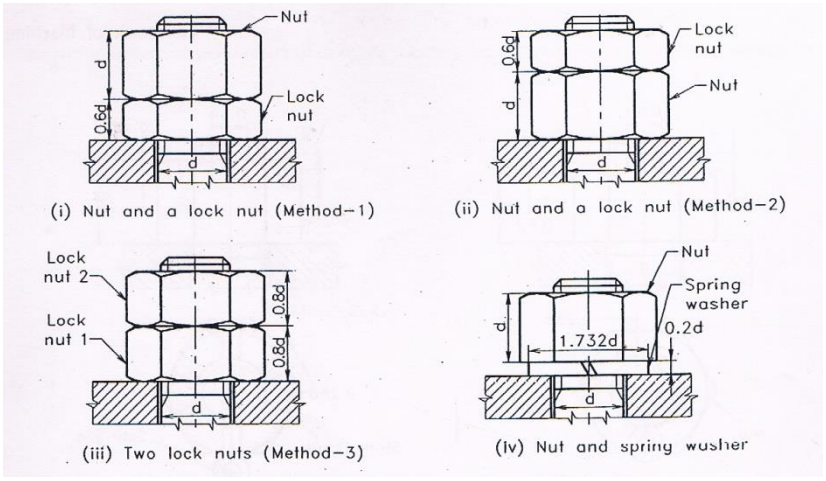


Fig. 1.19 Locking of a nut (friction locking)

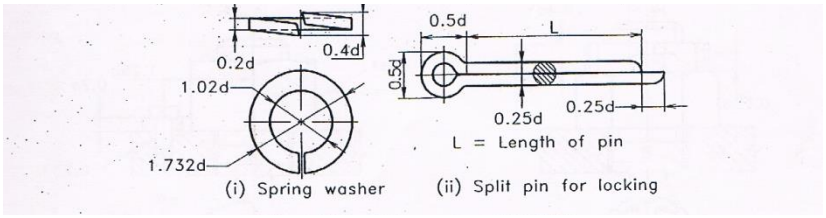


Fig. 1.20 Spring washer and split pin

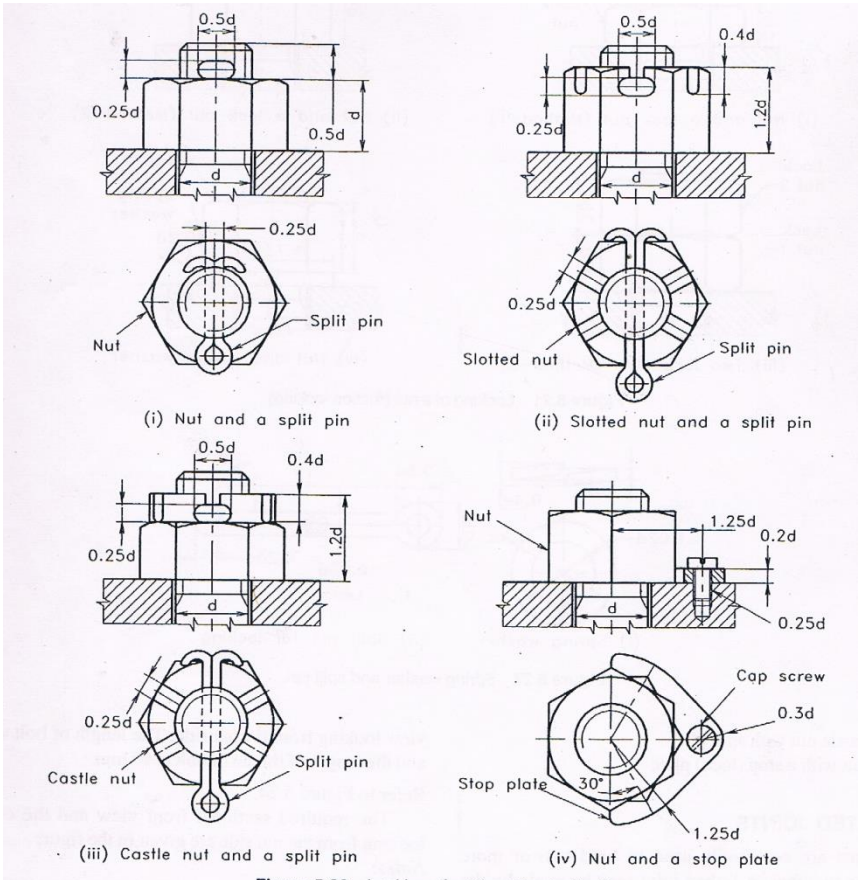


Fig. 1.21 Locking of a nut (positive locking)

Examples:

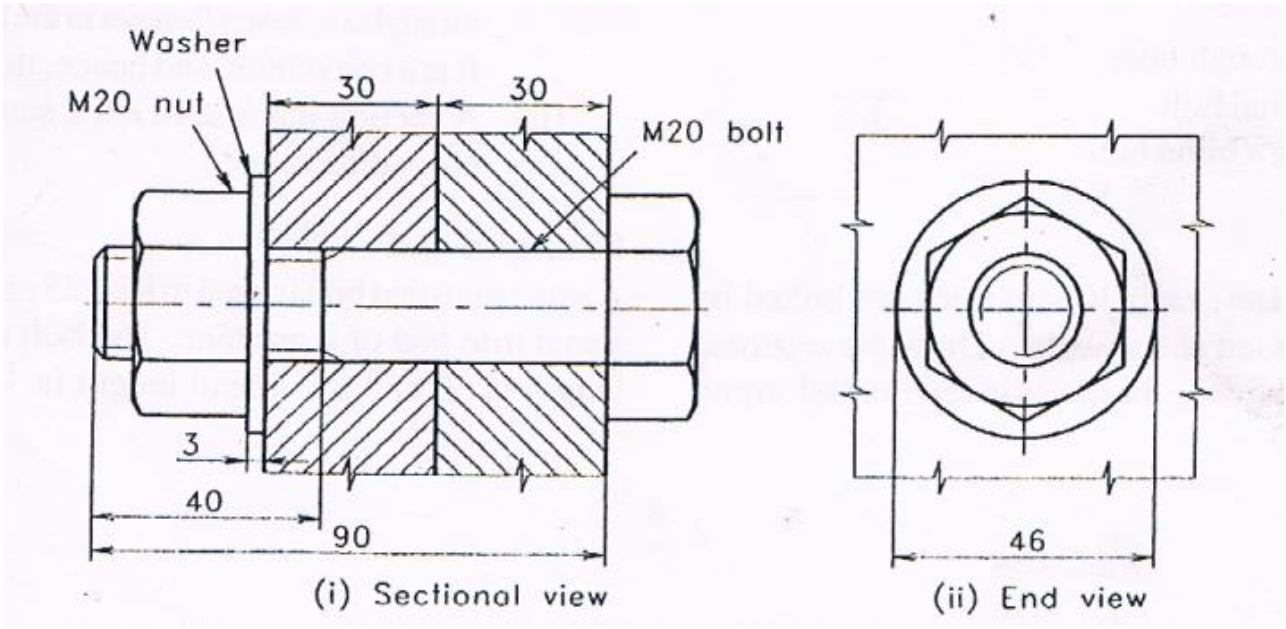


Fig. 1.22 Assembly of hexagonal bolt, nut and a washer

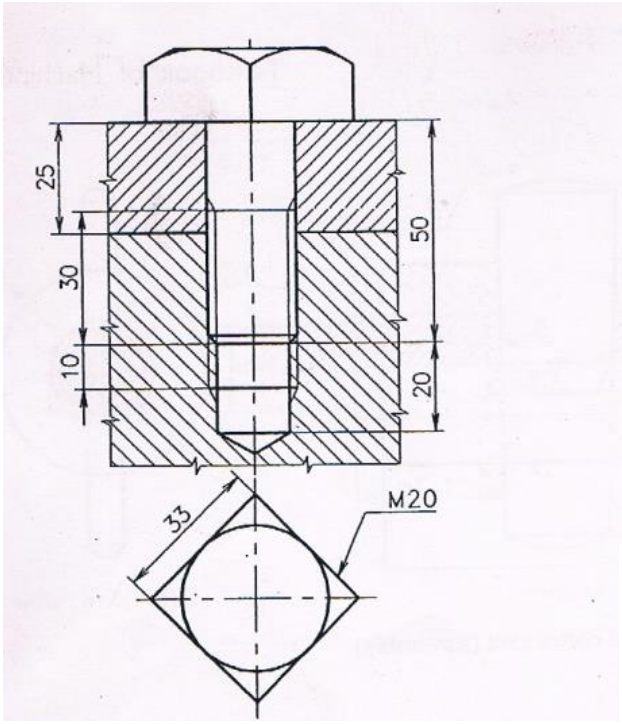


Fig. 1.23 Square headed bolt

In blind hole

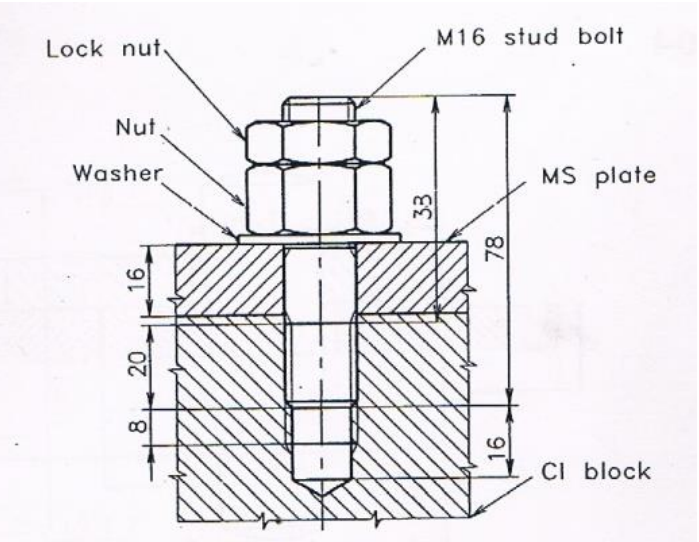


Fig. 1.24 Stud bolt

In blind hole

1.4 Exercises

Assemble the following parts and Draw full sectional view of the assembly for the following:

1.4.1 C-clamp

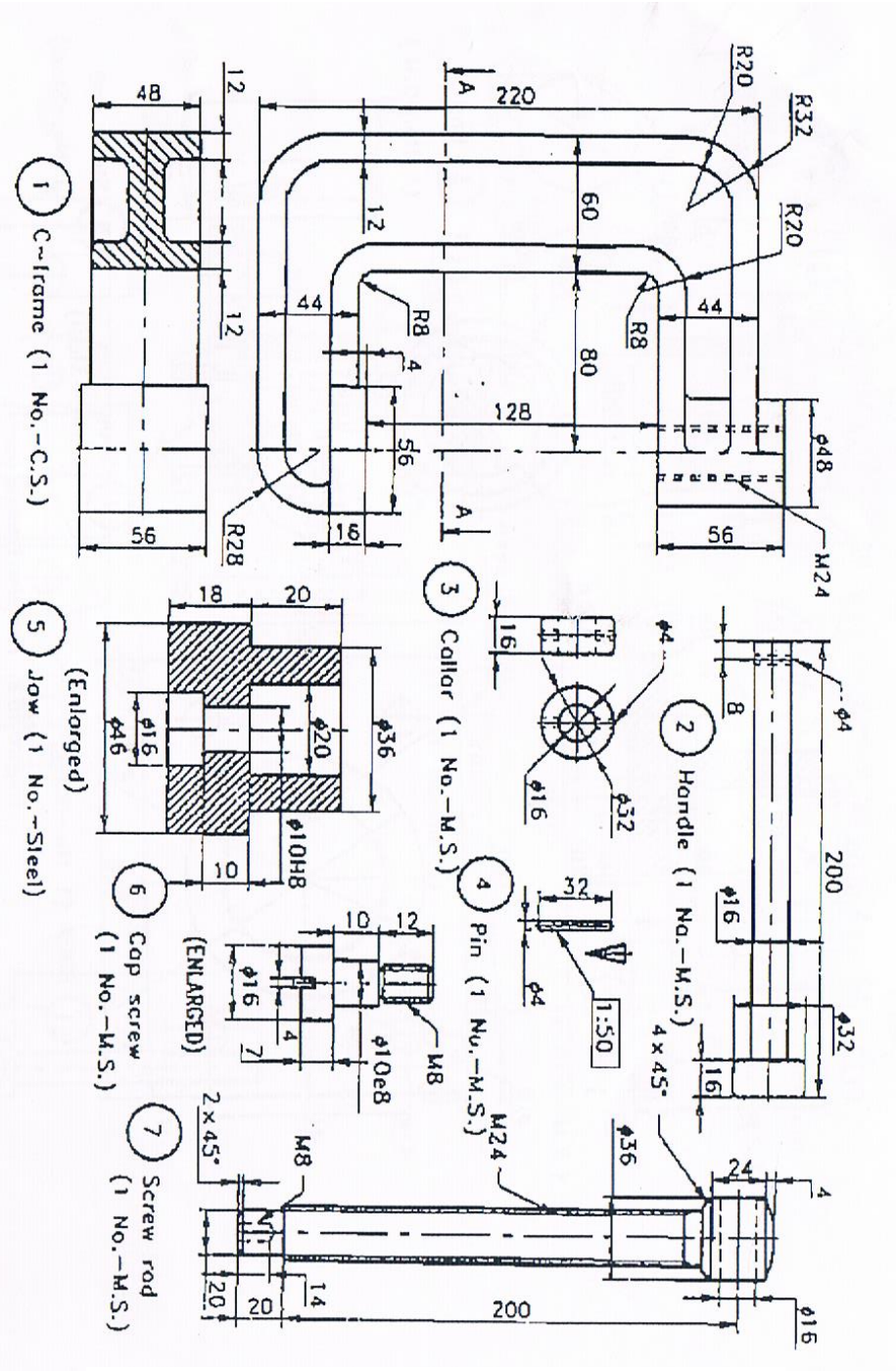


Fig. 1.25 C-clamp parts.

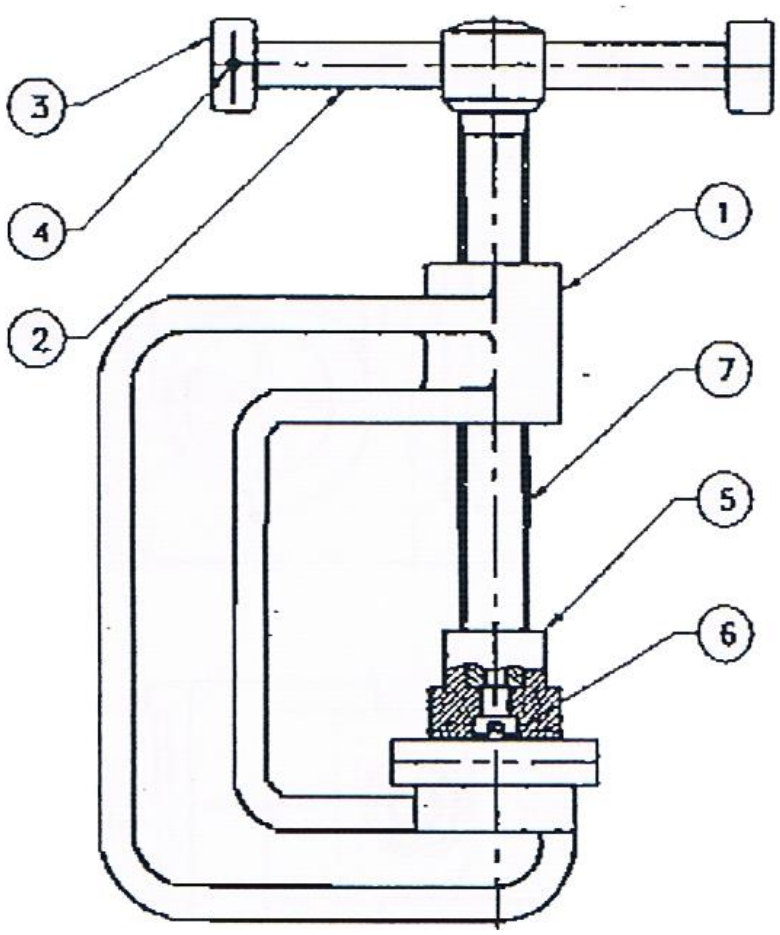


Fig. 1.26 C-clamp assembly.

7	Screw rode	M.S.		1
6	Cap screw	M.S.		1
5	Jaw	Steel		1
4	Pin	M.S.		1
3	Collar	M.S.		1
2	Handle	M.S.		1
1	C-frame	C.S.		1
No.	Name of part	Material	Notes	Q

1.4.2 Machine vice

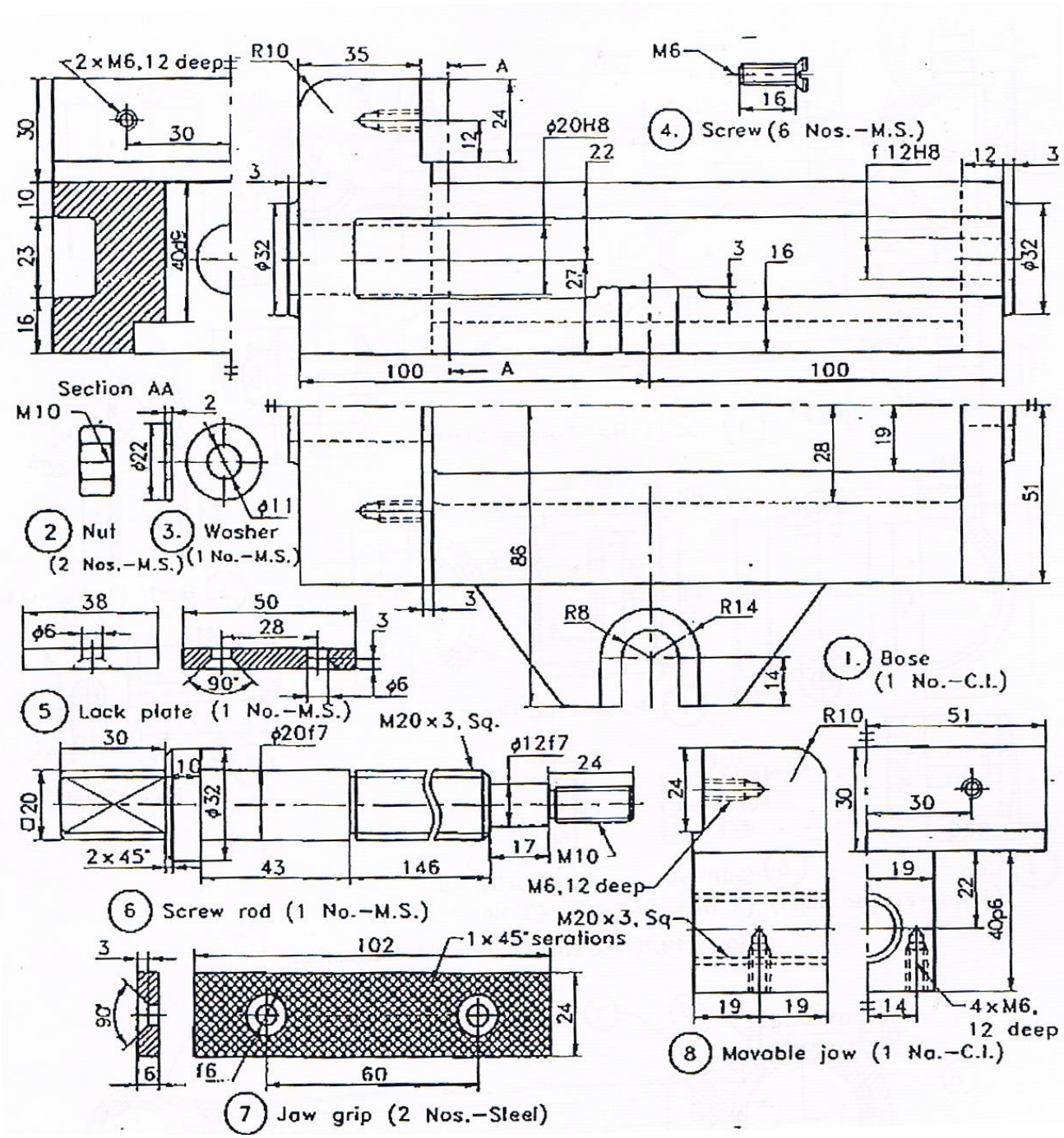


Fig. 1.27 Machine vice (parts).

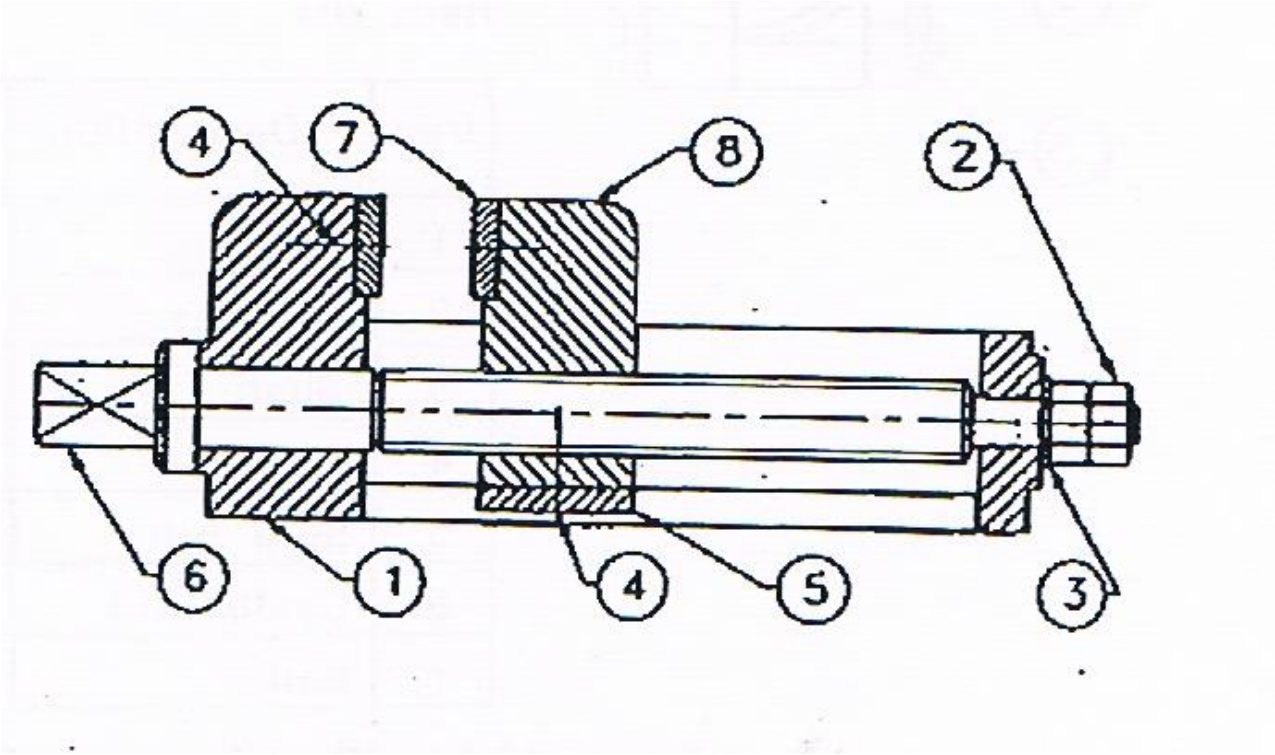


Fig. 1.28 Machine vice (assembly).

8	Movable Jaw	C.I.		1
7	Jaw grip	Steel		2
6	Screw rod	M.S.		1
5	Lock plate	M.S.		1
4	Screw	M.S.		6
3	Washer	M.S.		1
2	Nut	M.S.		2
1	Base	C.I.		1
No.	Name of part	Material	Notes	Q

1.3.3 IC engine connecting rode

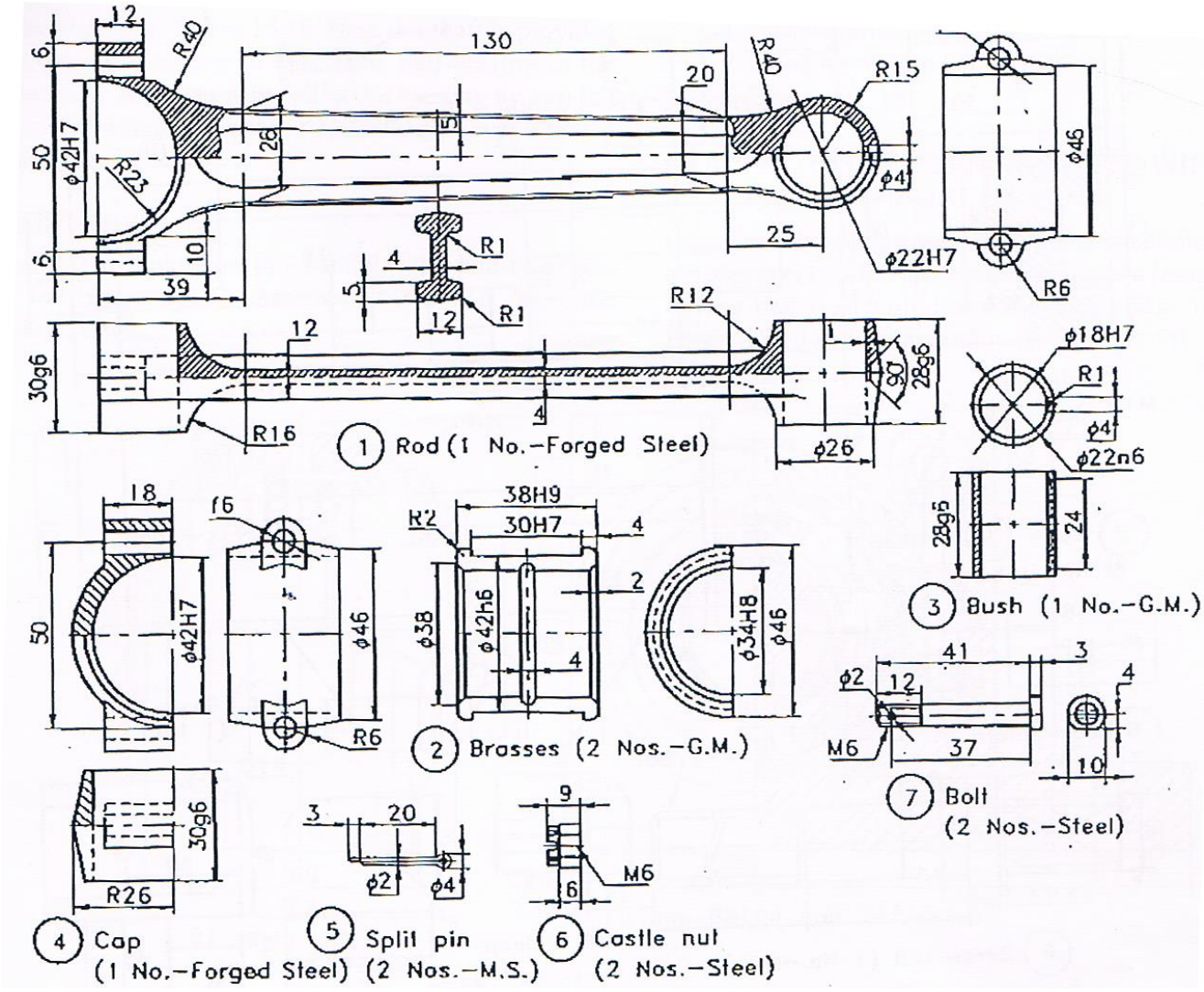


Fig. 1.28 IC engine connecting rode (parts).

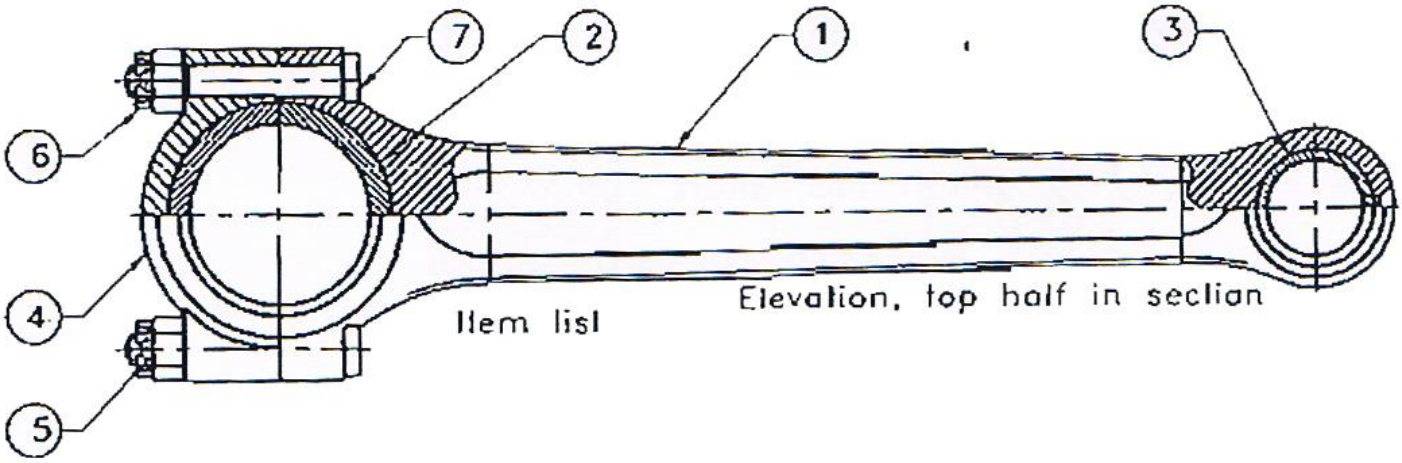


Fig. 1.29 IC engine connecting rode (assembly).

7	Bolt	Steel		2
6	Castle nut	Steel		2
5	Split pin	M.S.		2
4	Cap	F. Steel		1
3	Bush	G.M.		1
2	Brasses	G.M.		2
1	Rod	F. Steel		1
No.	Name of part	Material	Notes	Q

1.3.4 Wheel

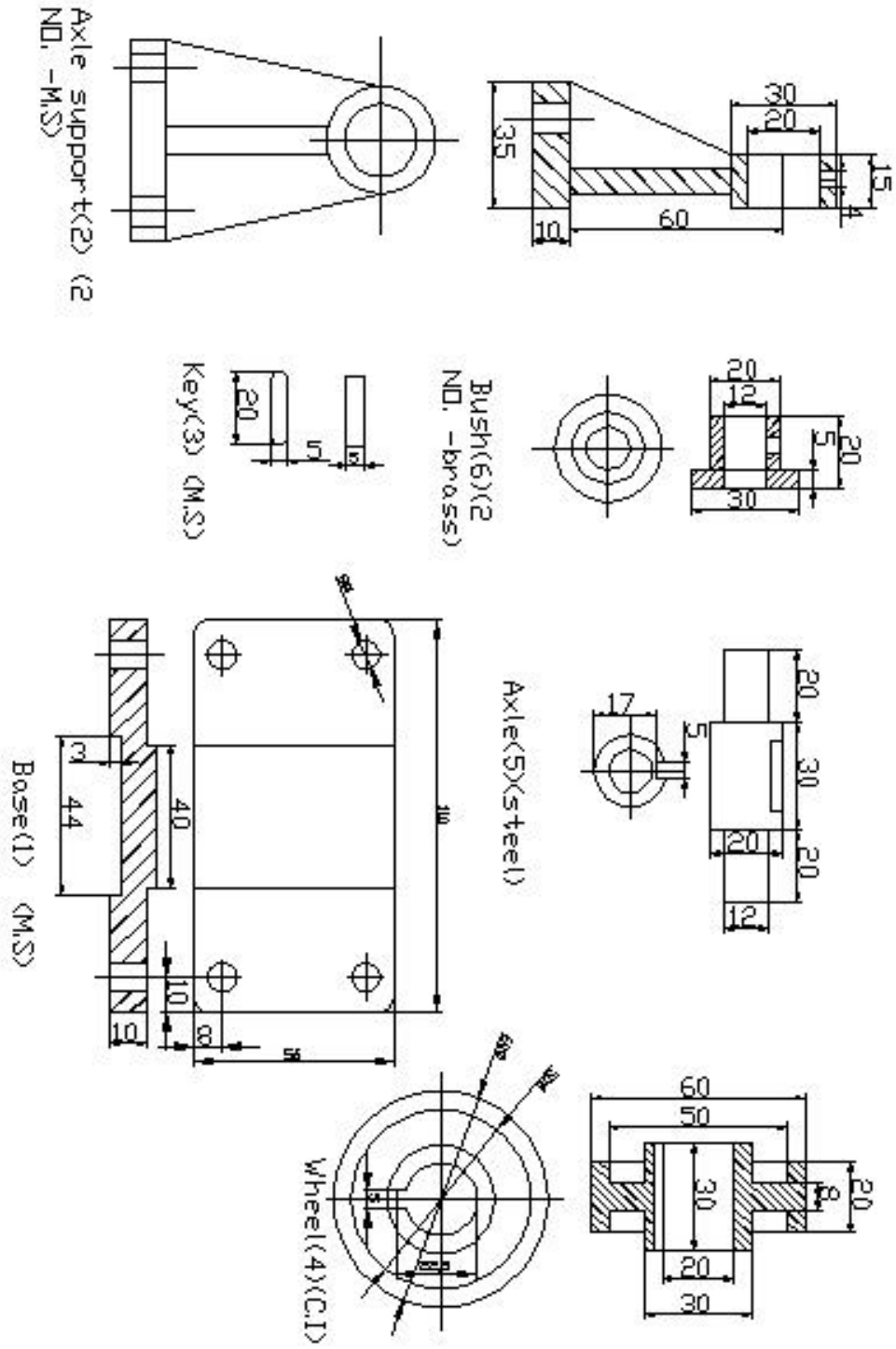


Fig. 1.30 Wheel (parts).

1.4.5 Screw lack

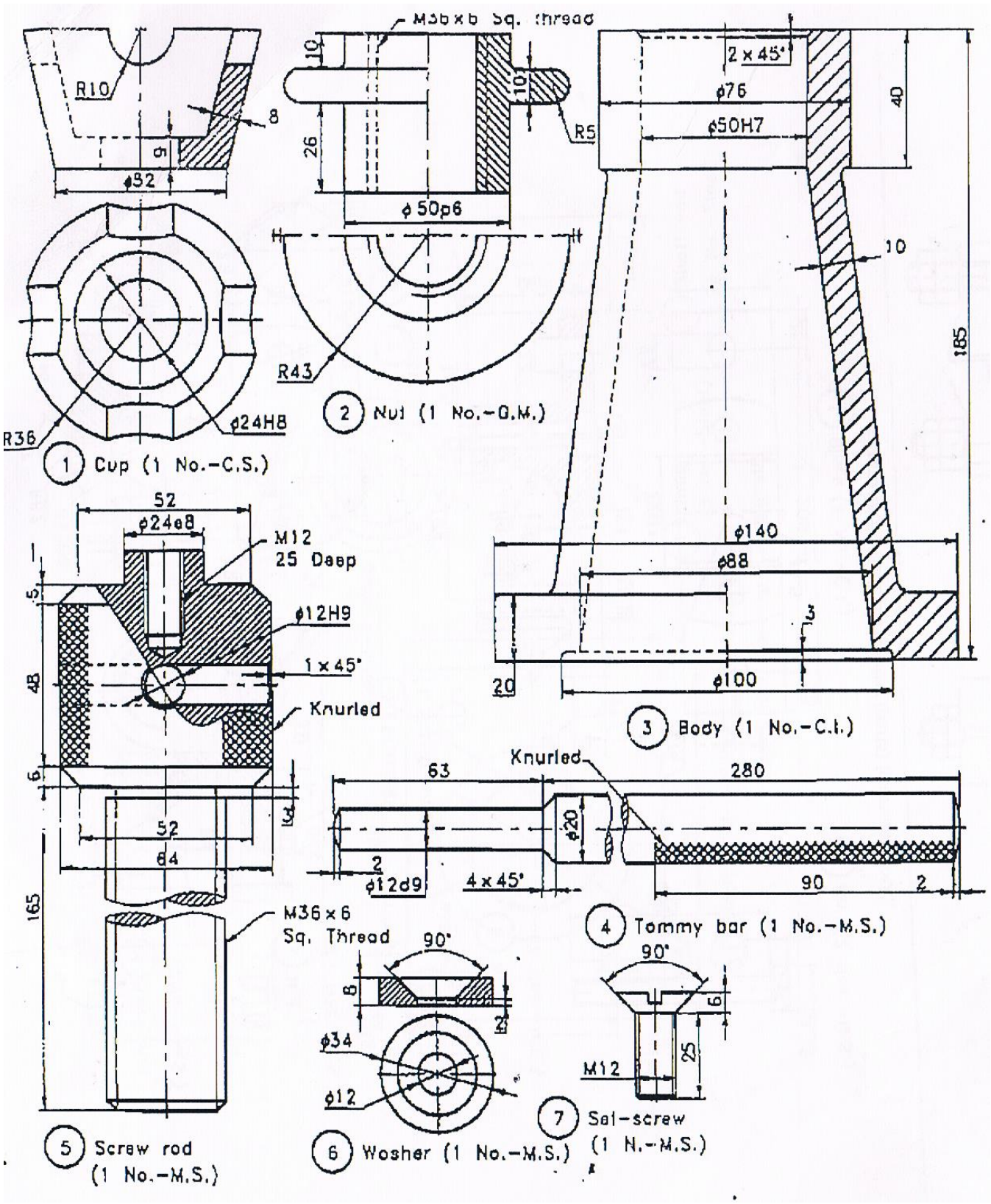


Fig. 1.31 Screw lack (parts).

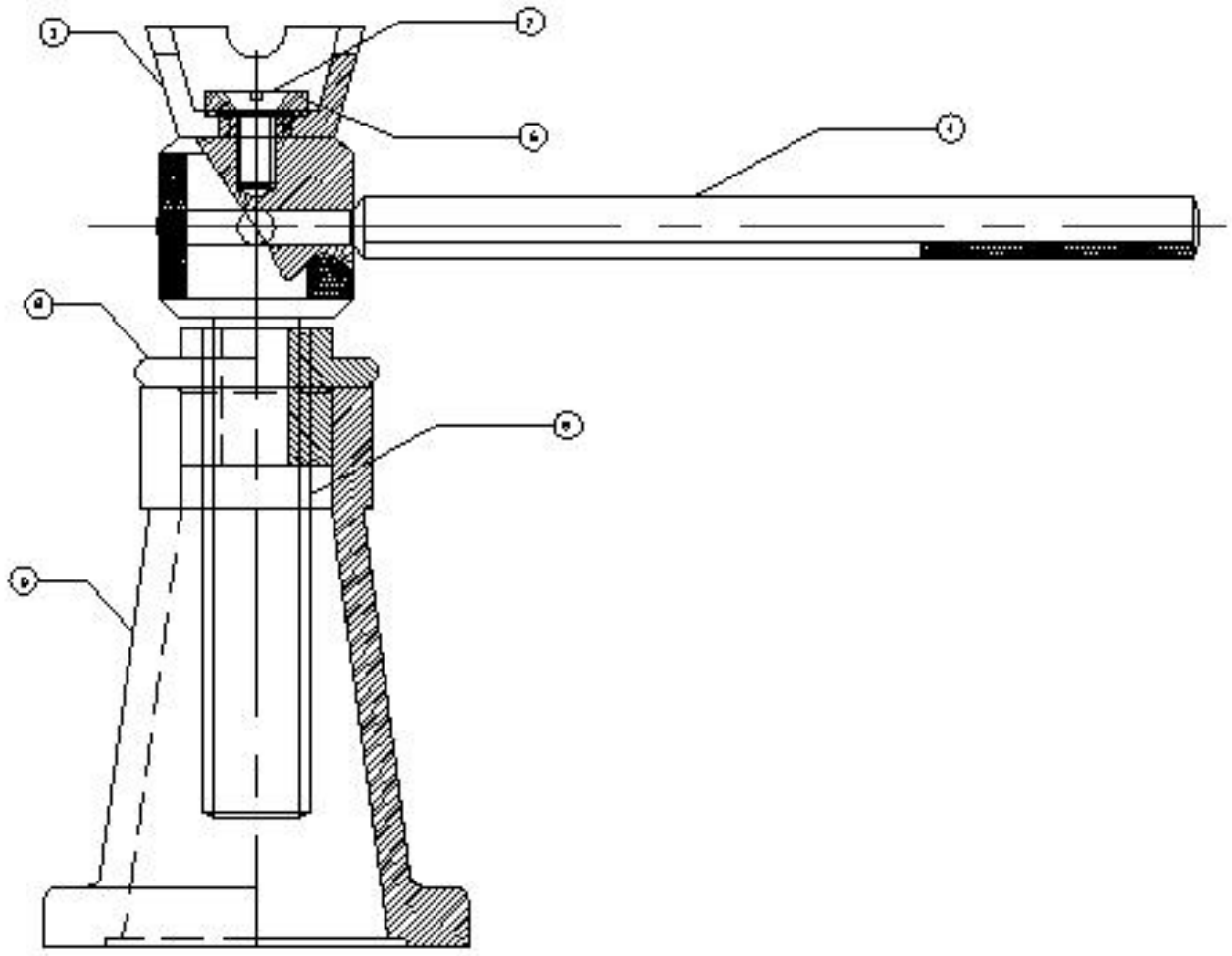


Fig. 1.32 Screw lack (assembly).

7	Set screw	M.S.		1
6	Washer	M.S.		1
5	Screw rod	M.S.		1
4	Tommy bar	M.S.		1
3	Body	C.I		1
2	Nut	G.M		1
1	Cup	C.S		1
No.	Name of part	Material	Notes	Q

1.4.6 Pedestal bearing

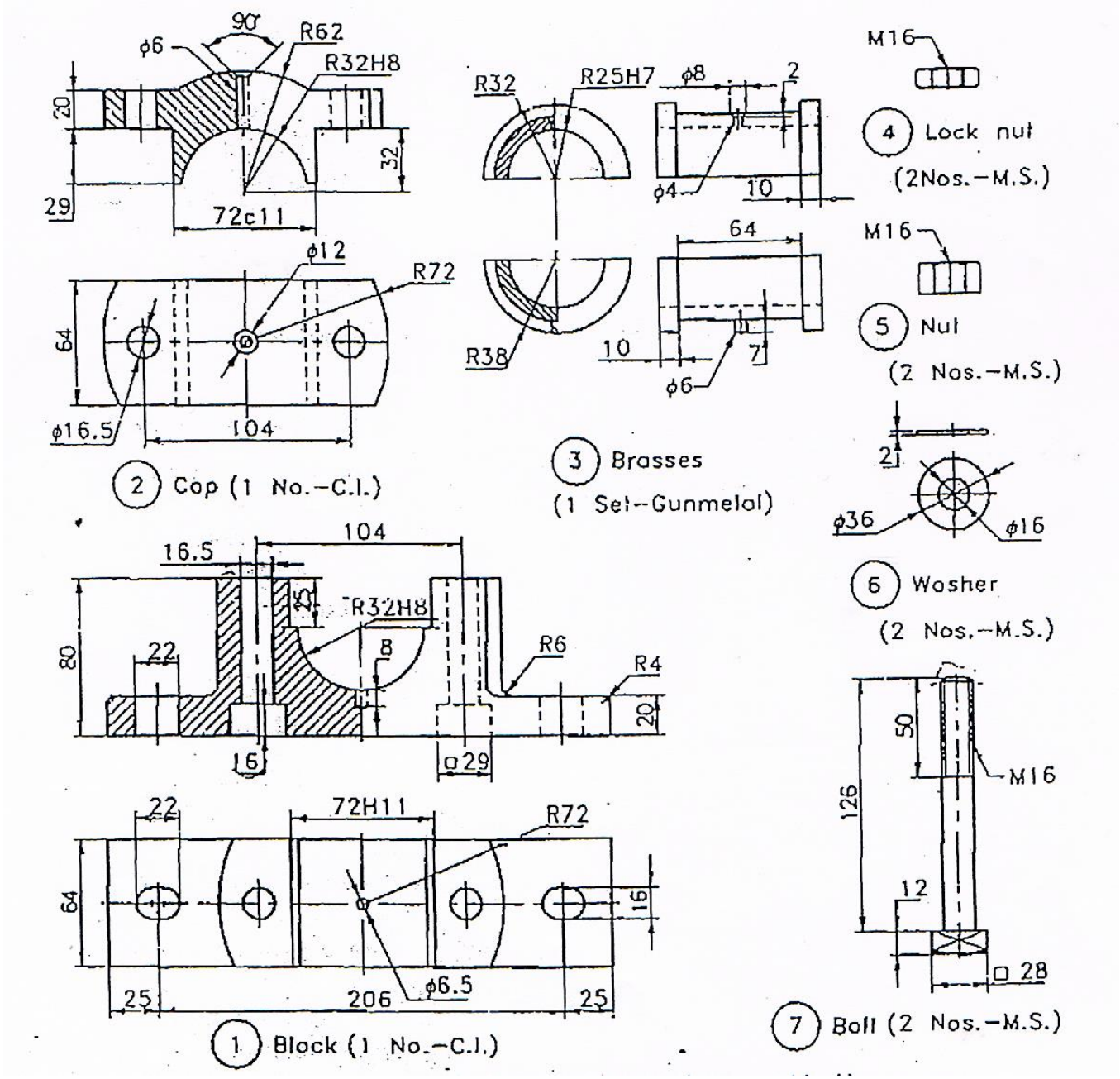


Fig. 1.33 Pedestal bearing (parts).

1.4.7 Knuckle joint

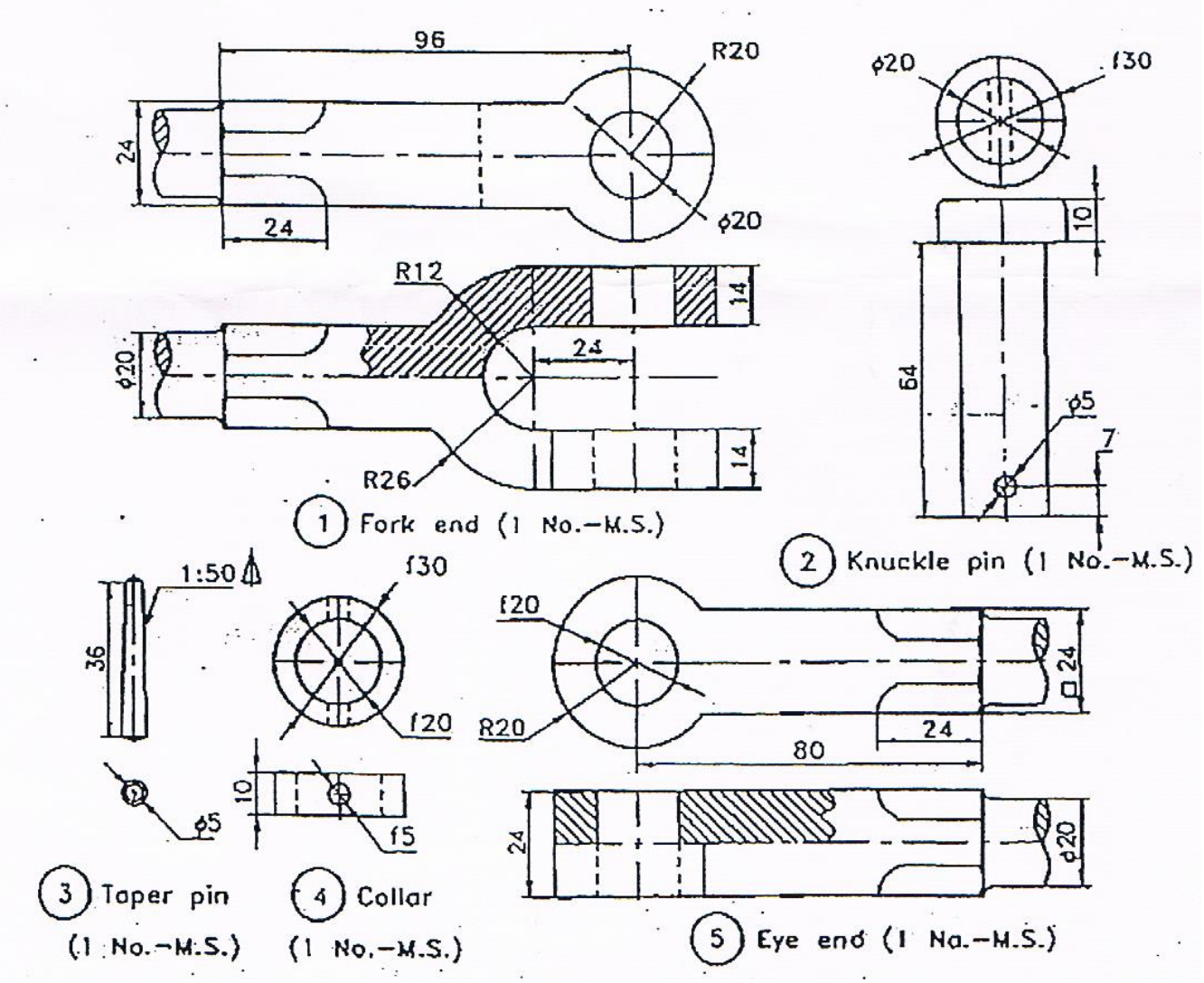


Fig. 1.34 Knuckle joint (parts).

1.4.8 Coupling

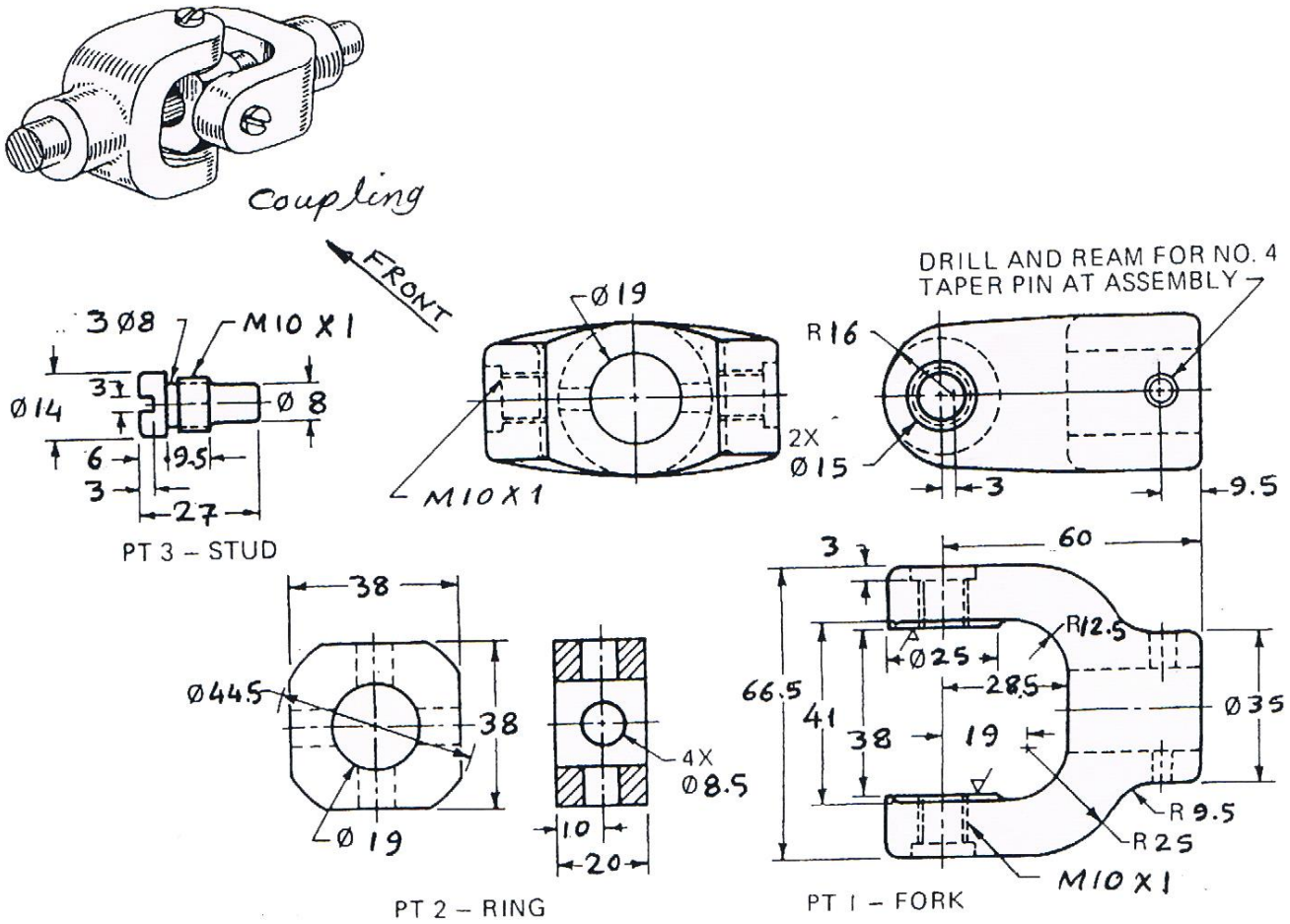


Fig. 1.35 Coupling (parts).

1.4.9 Flexible Coupling

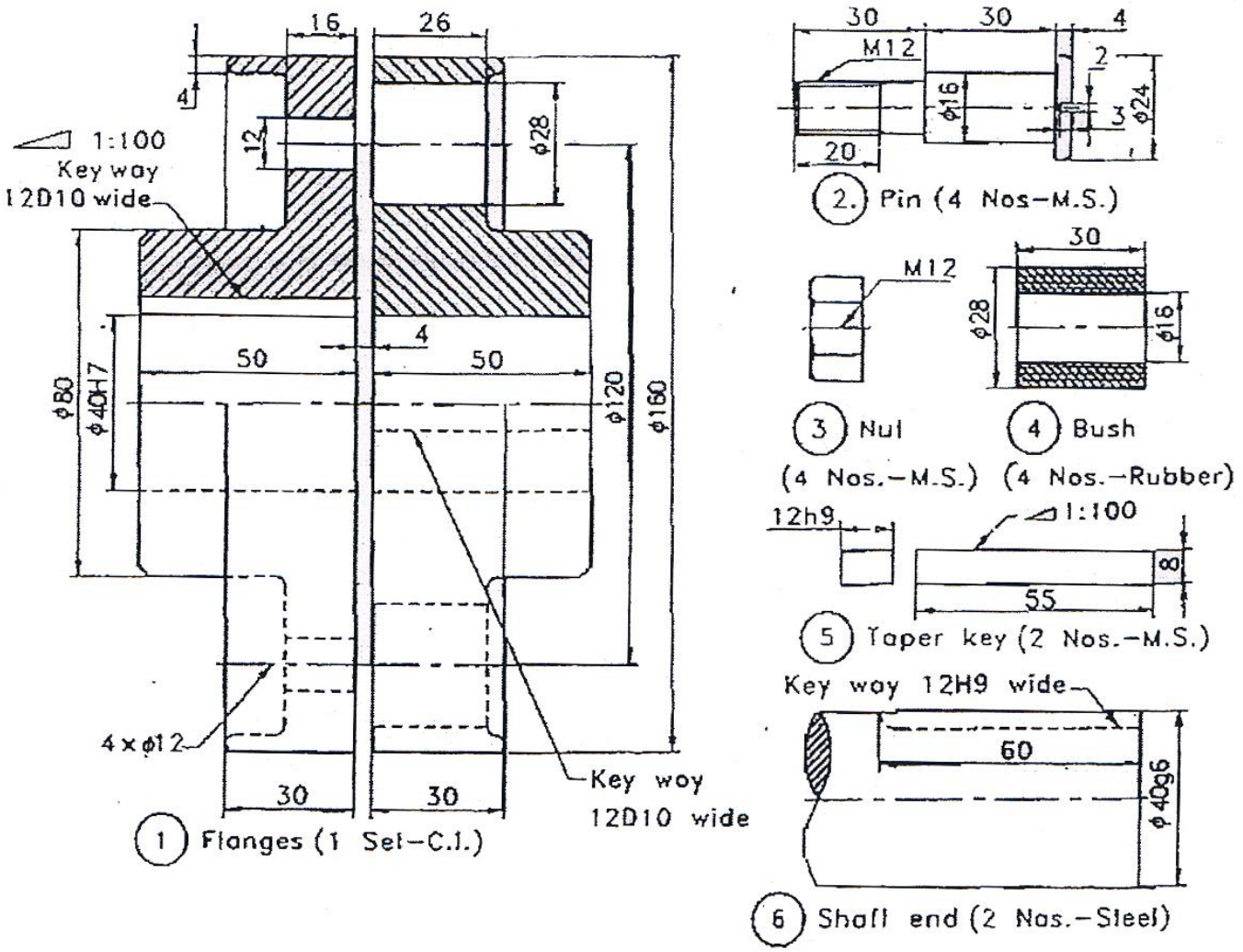


Fig. 1.36 Flexible Coupling (parts).

1.4.10 Adjustable shaft support

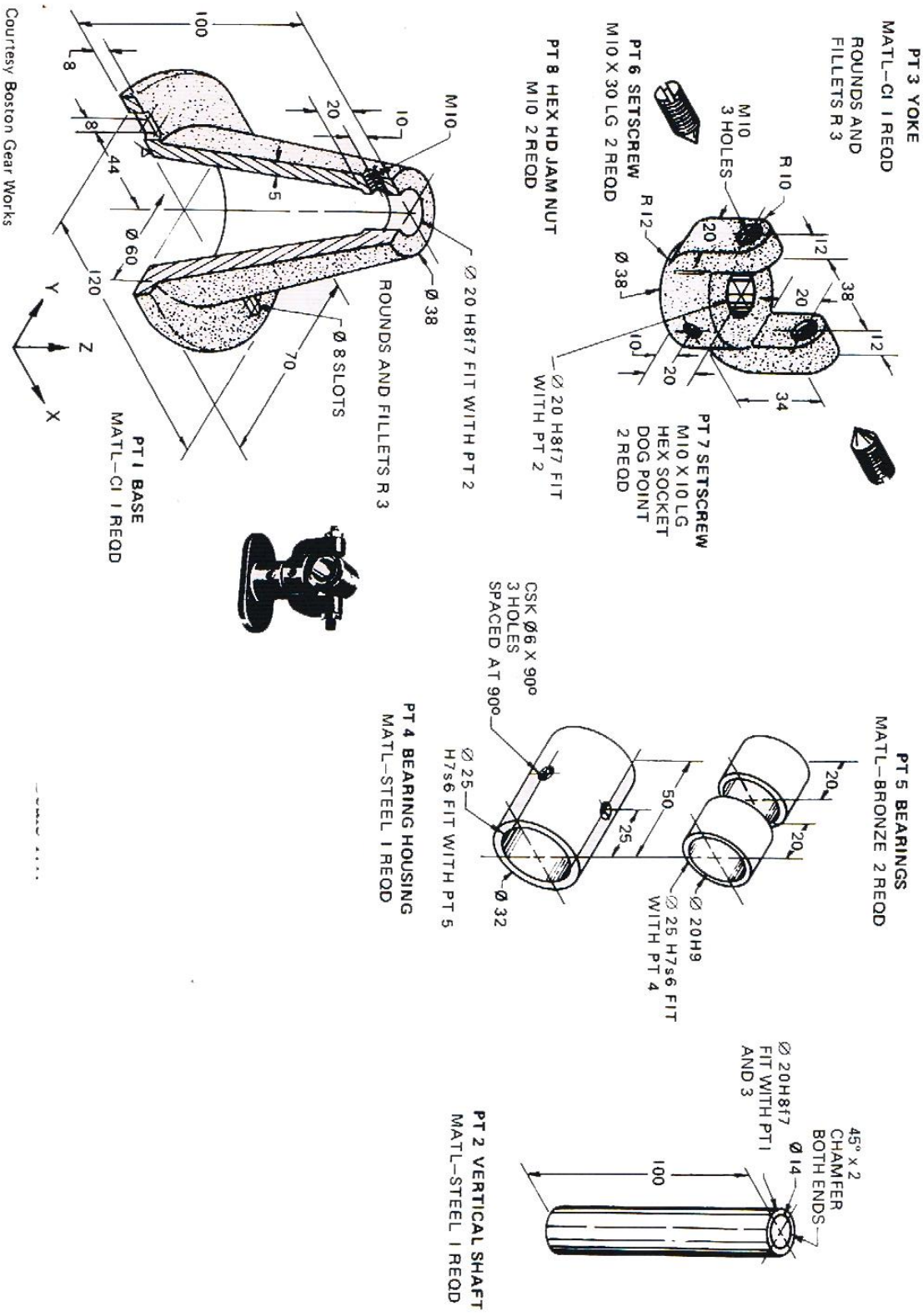


Fig. 1.37 Adjustable shaft support (parts).

1.4.11 Bench vise

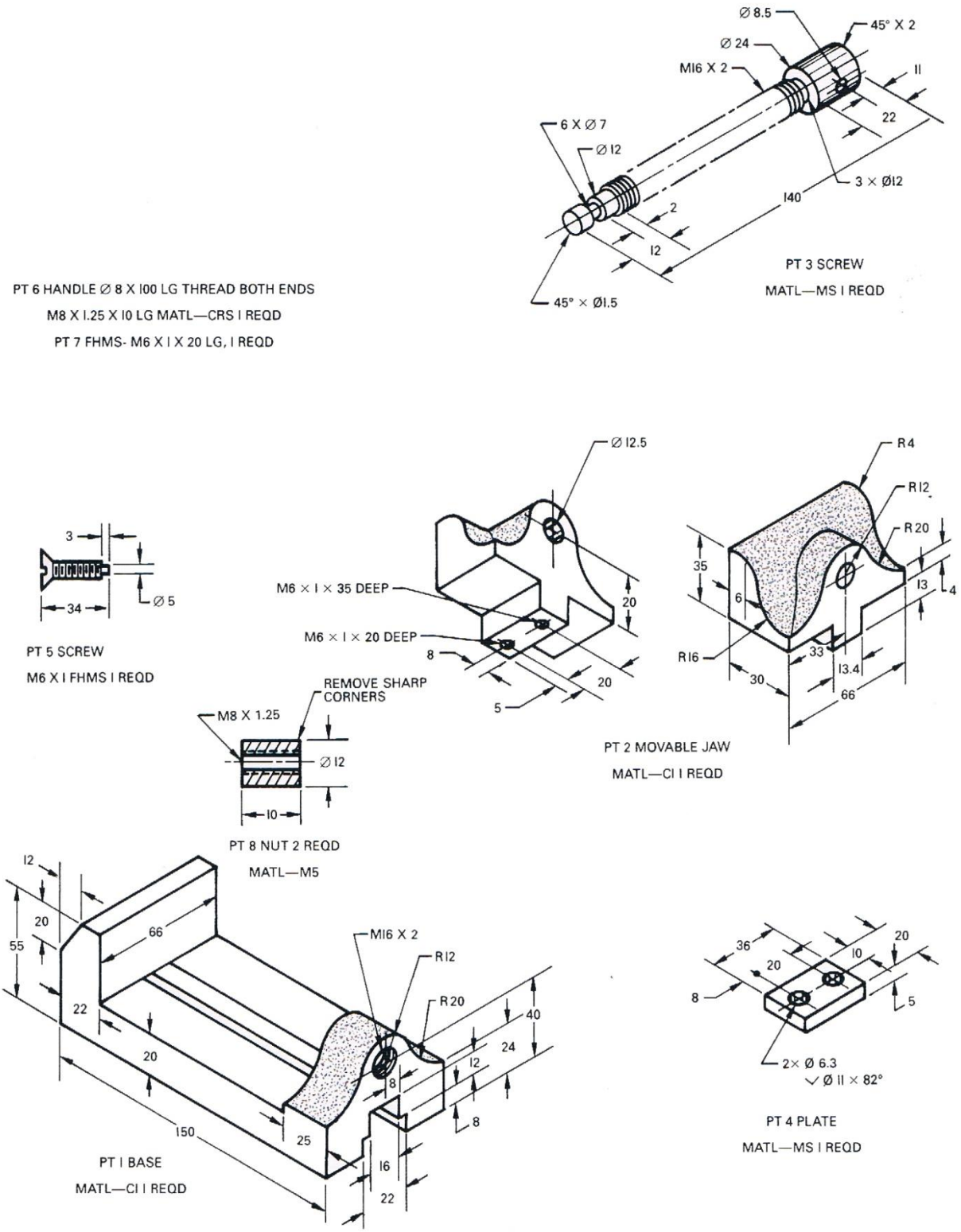
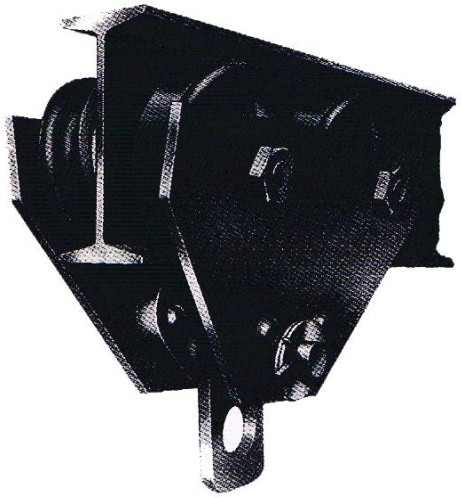
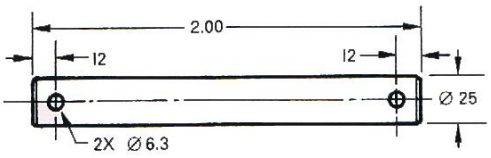


Fig. 1.38 Bench vise (parts).

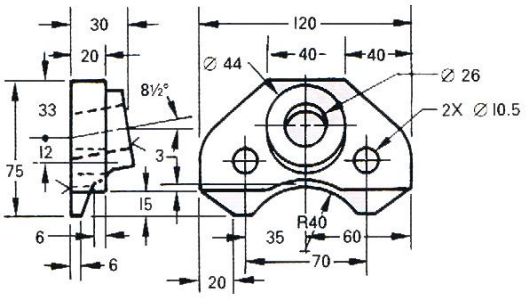
1.4.12 Trolley



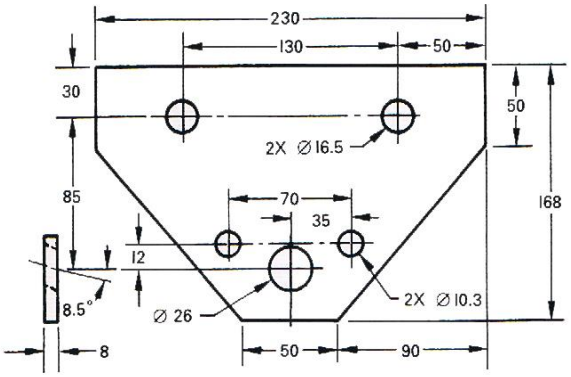
PT 8 ADJUSTING WASHER 26 ID × 44 OD × 4 THK
12 REQD, MATL—STL
PT 9 RIVET, BUTTON HEAD, Ø10 × 60 LG, 4 REQD
PT 10 WASHER 26 ID × 65 OD × 3 THK, 4 REQD
PT 11 LOCKNUT M16 × 2, 4 REQD
PREVAILING TORQUE INSERT-TYPE
PT 12 COTTER PIN Ø6 × 40 LG, 6 REQD



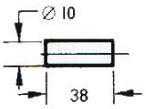
PT 3 AXLE 1 REQD MATL—CRS



PT 2 GUIDE 2 REQD MATL—CI

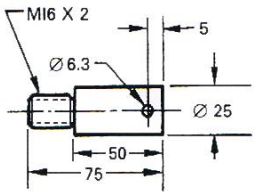


PT 1 SIDE PLATE 2 REQD MATL—MST

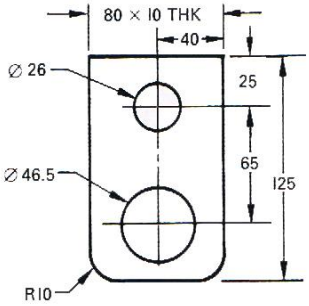


PT 5 ROLLER BEARING

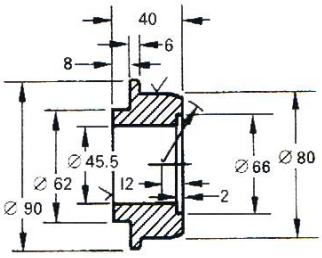
44 REQD MATL—CRS
CASE HARDEN!



PT 7 AXLE 4 REQD MAT—CRS



PT 4 HOOK 1 REQD MATL—MST



PT 6 WHEEL 4 REQD MAT—CI

Fig. 1.39 Trolley (parts).

1.4.13 Caster

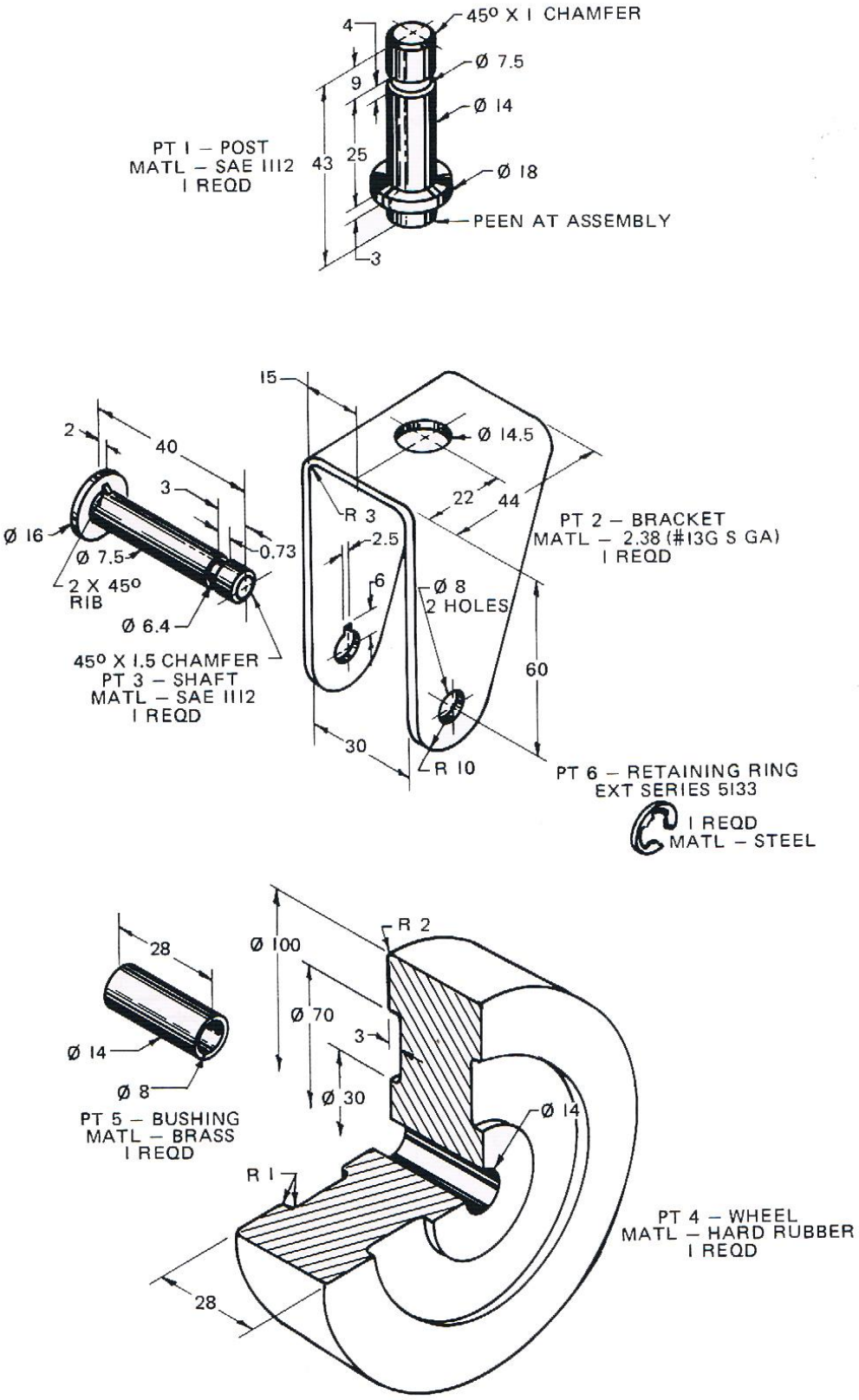


Fig. 1.40 Caster (parts).

1.4.14 Pipe cutter

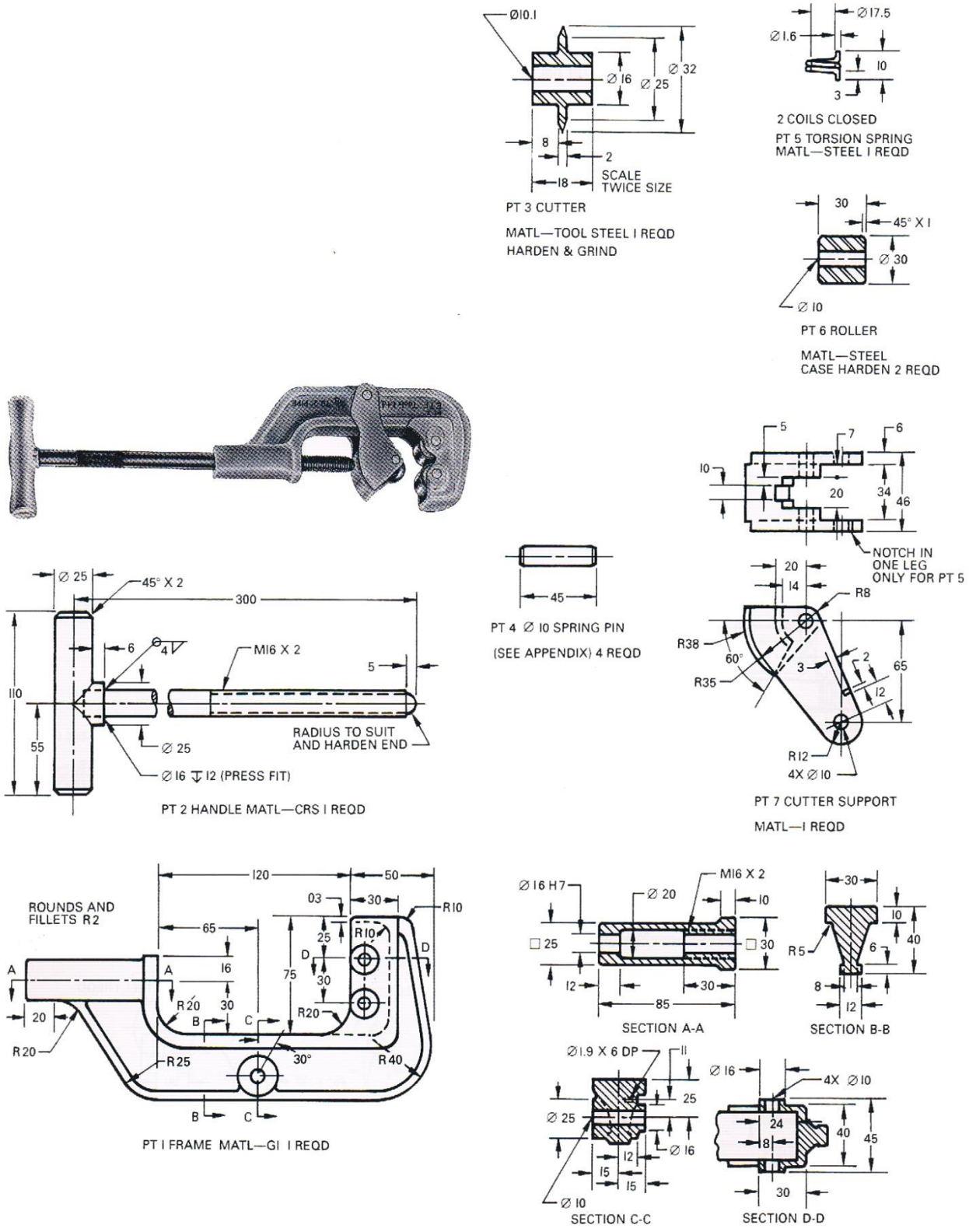


Fig. 1.41 Pipe cutter (parts).

1.4.15 Parallel clamps

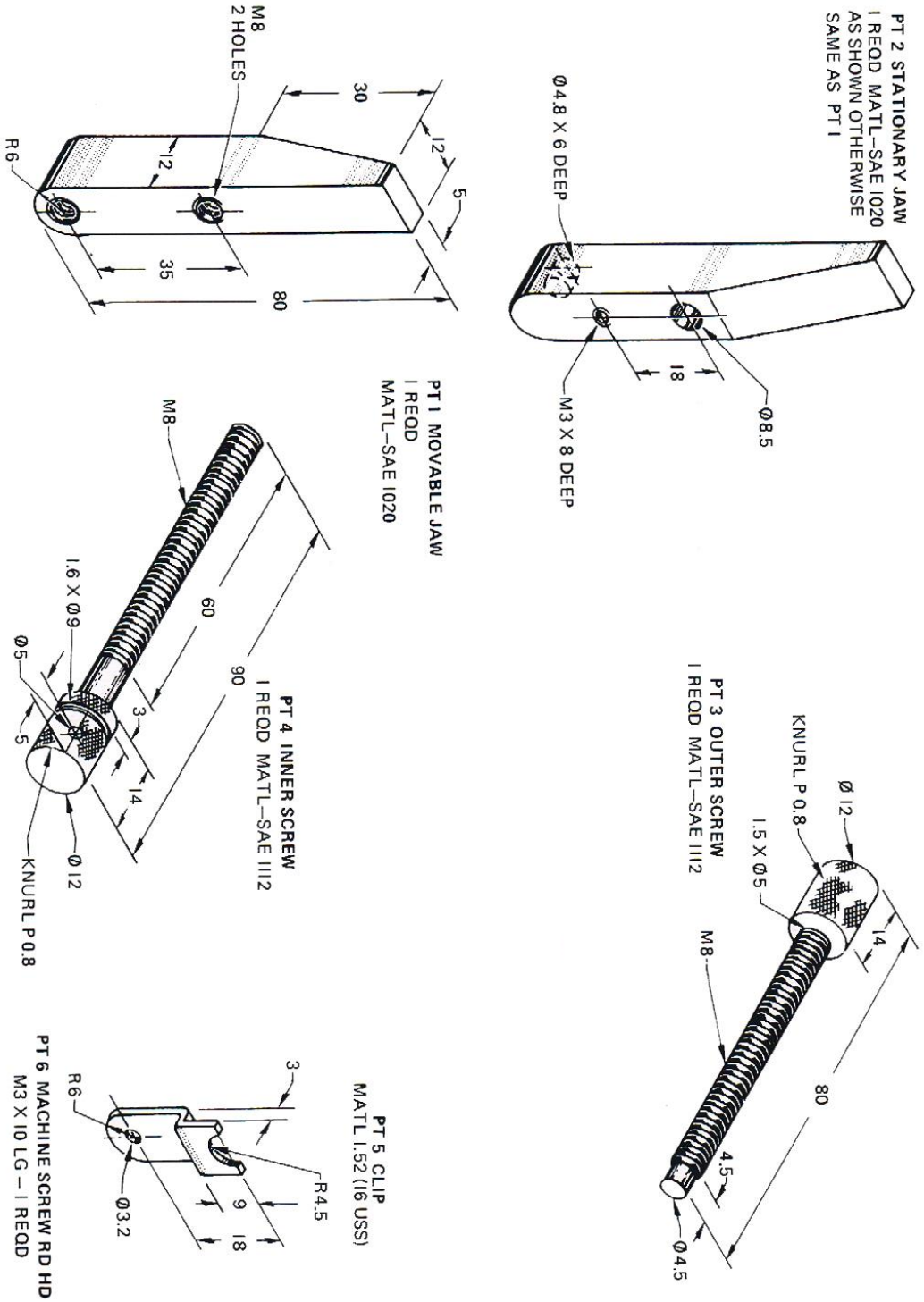


Fig. 1.42 Parallel clamps (parts).

1.4.16 Die sets

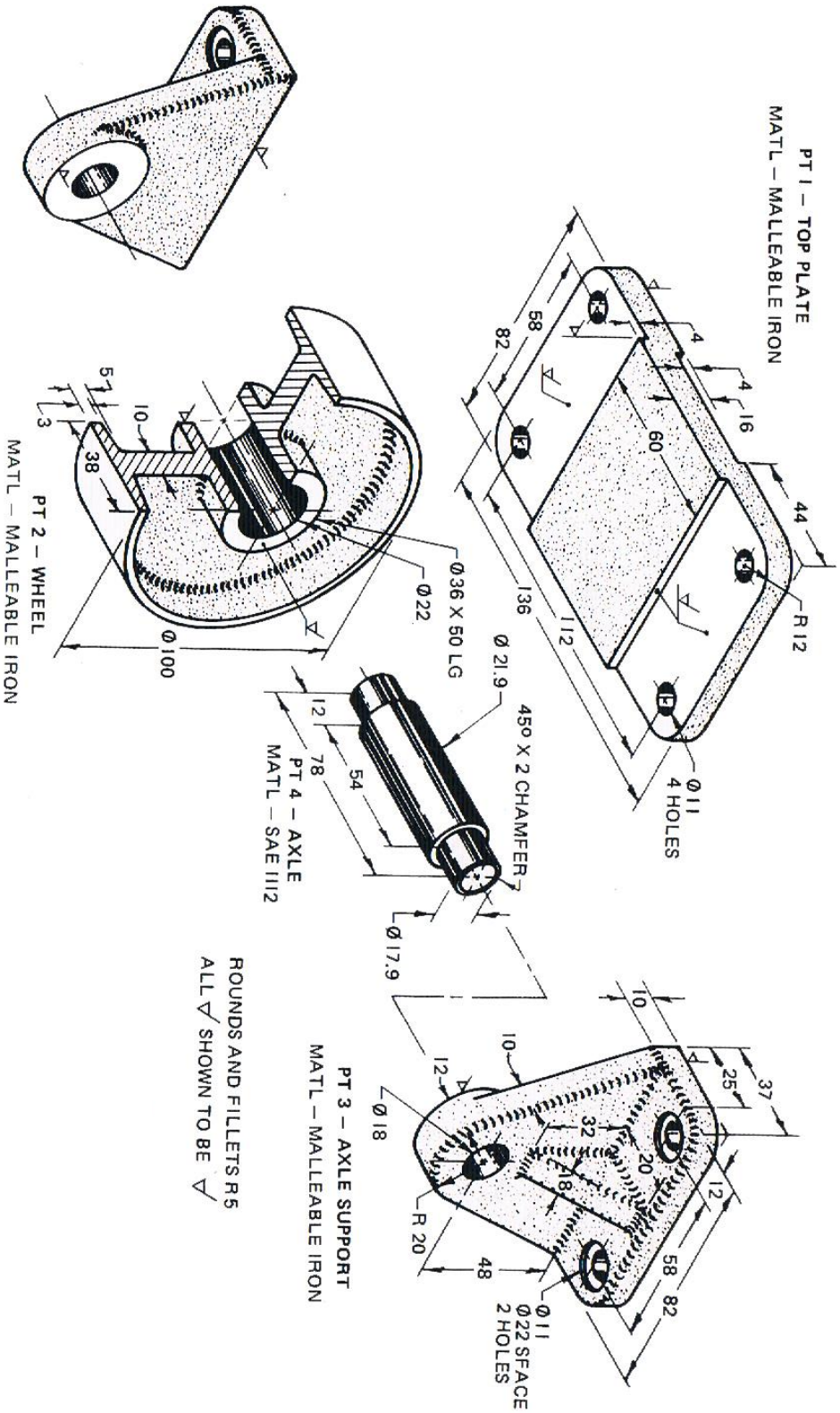


Fig. 1.43 Die sets (parts).

1.4.17 Wheel puller

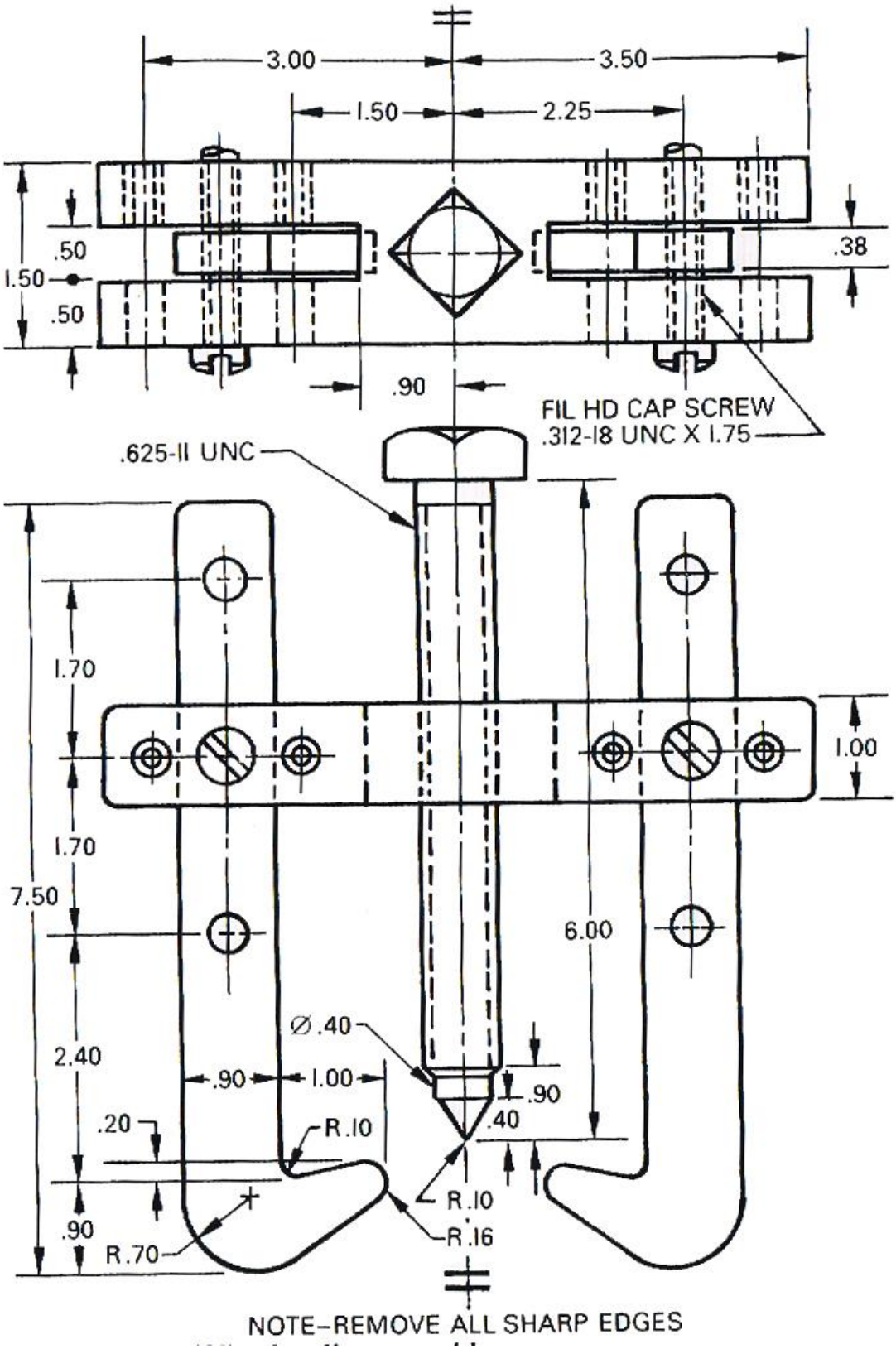


Fig. 1.44 Wheel puller (parts).

1.4.18 Stillson wrench

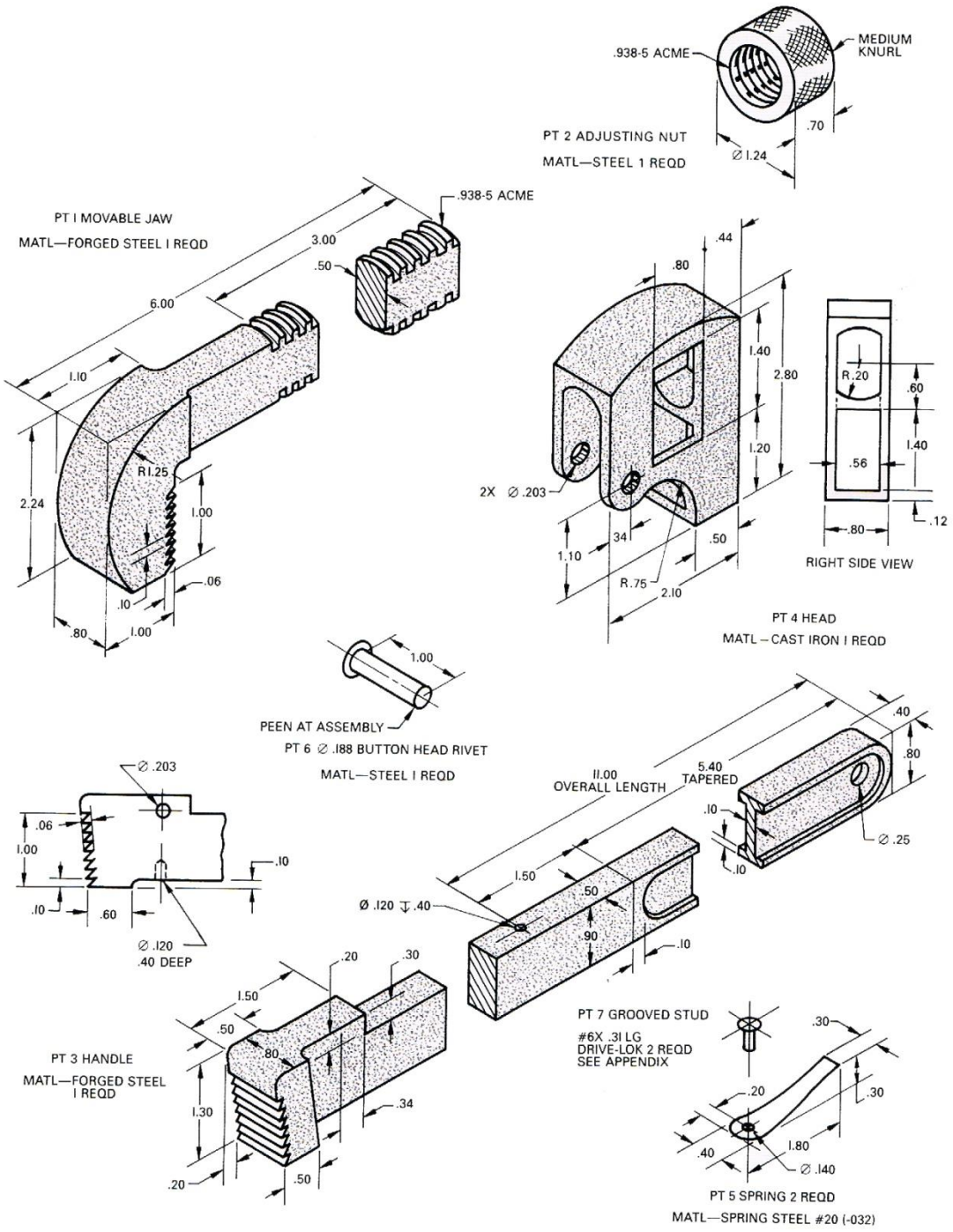


Fig. 1.45 Stillson wrench (parts).

1.4.19 Journal jack

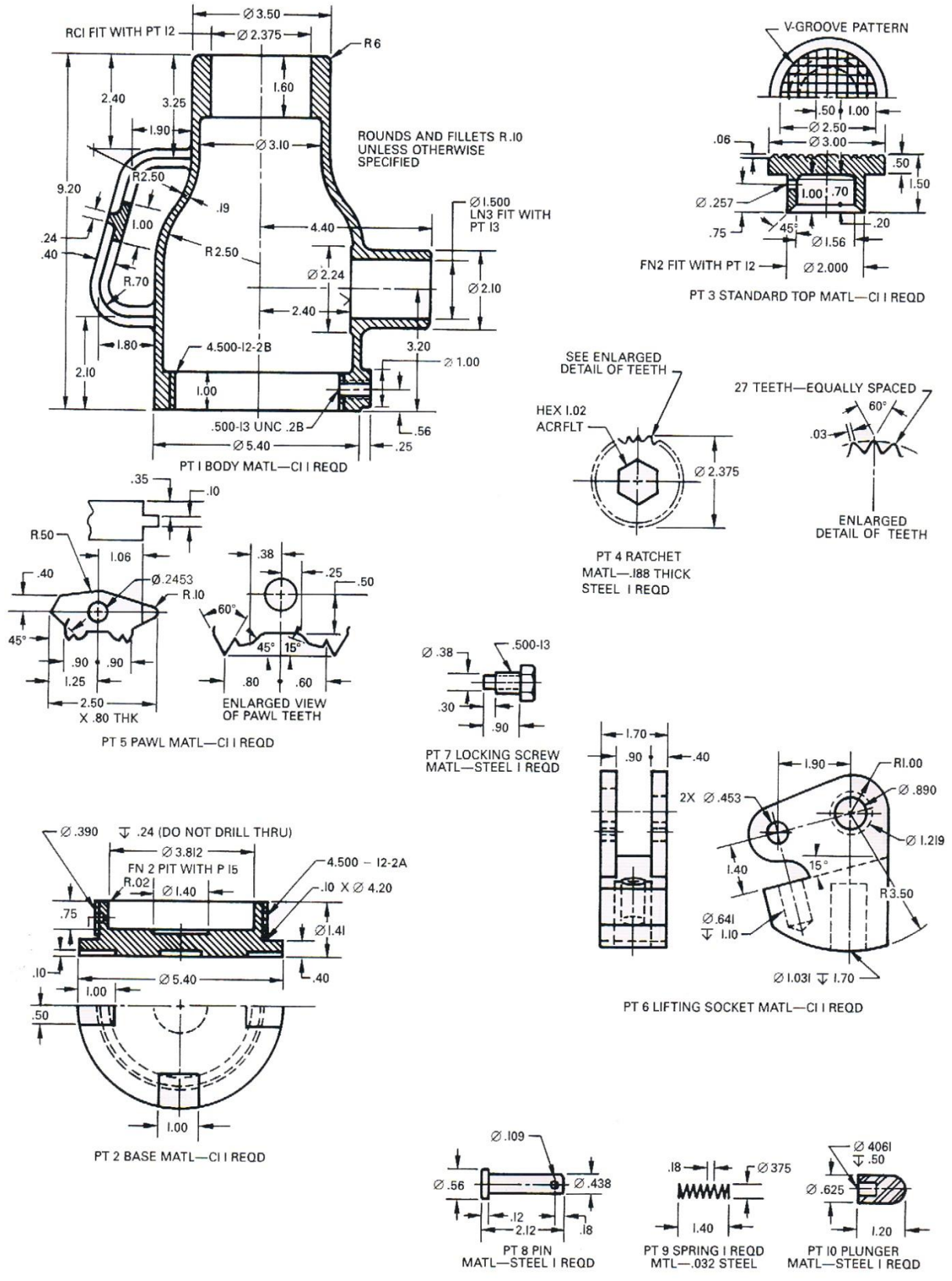
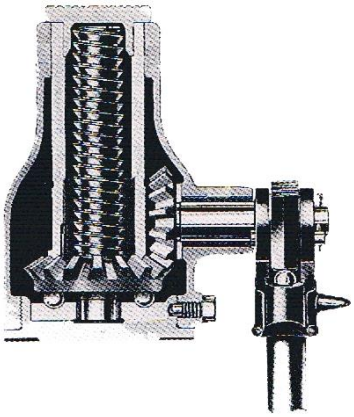
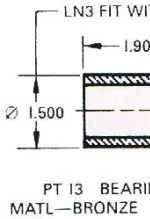


Fig. 1.46 Journal jack (parts).

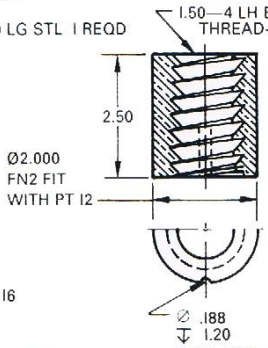
1.4.20 Journal jack (Duff Norton)



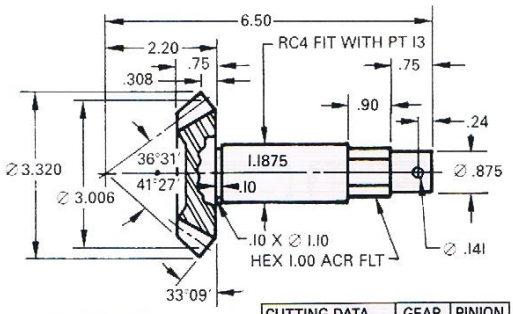
PT 19 FLAT WASHER MATL—STEEL
1.19 ID × 2.25 OD × .180 1 REQD
PT 20 PIN MATL—STEEL Ø.188 × 1.00 LG 1 REQD
PT 21 BALL BEARING SØ .625 MATL—STEEL 12 REQD
PT 22 KEY—608 WOODRUFF, 1 REQD
PT 23 PIN MATL—STEEL Ø.25 × .40 LG 1 REQD
PT 24 COTTER PIN Ø.125 × 1.25 LG 1 REQD
PT 25 COTTER PIN Ø.094 × .75 LG 1 REQD
PT 26 HANDLE .875 ID × 1.00 OD × 18.00 LG STL 1 REQD



PT 13 BEARING
MATL—BRONZE 1 REQD

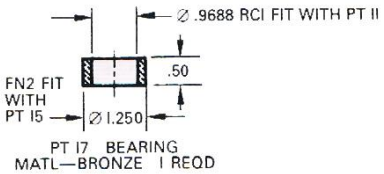


PT 14 LIFTING NUT
MATL—BRONZE 1 REQD

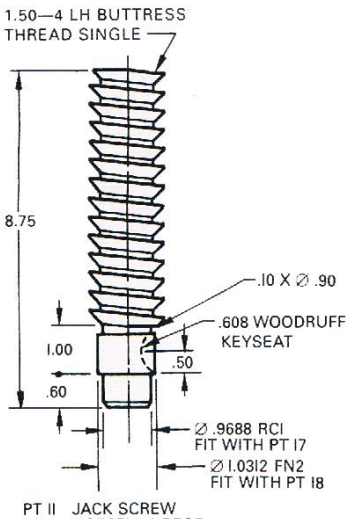


PT 16 BEVEL PINION
MATERIAL—STEEL 1 REQD

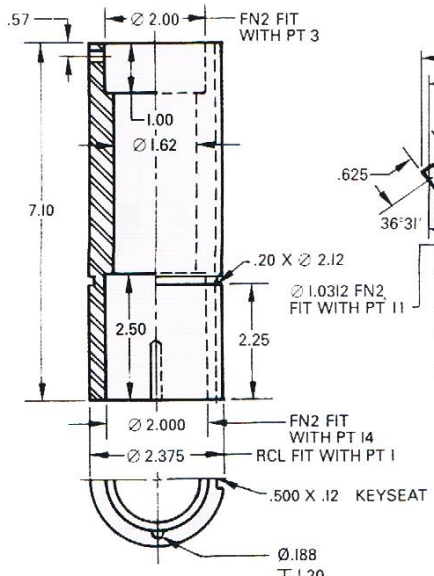
CUTTING DATA	GEAR	PINION
NO. OF TEETH	20	15
DIAMETRAL PITCH	5	5
TOOTH FORM	14-1/2°	14-1/2°
CUTTING ANGLE	47°-50'	31°-46'
WHOLE DEPTH	.431	.431
CHORDAL ADD	.203	.203
CHORDAL THICK	.314	.314



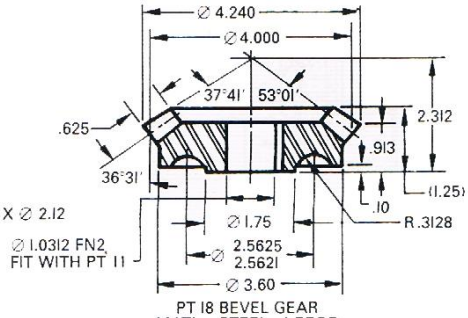
PT 17 BEARING
MATL—BRONZE 1 REQD



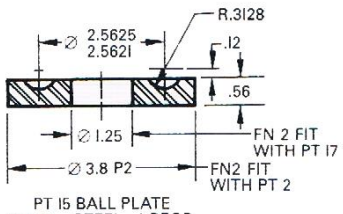
PT 11 JACK SCREW
MATL—STEEL 1 REQD



PT 12 STANDARD
MATL—STEEL 1 REQD



PT 18 BEVEL GEAR
MATL—STEEL 1 REQD



PT 15 BALL PLATE
MATL—STEEL 1 REQD

Fig. 1.47 Journal jack (parts).

1.4.21 Turnbuckle

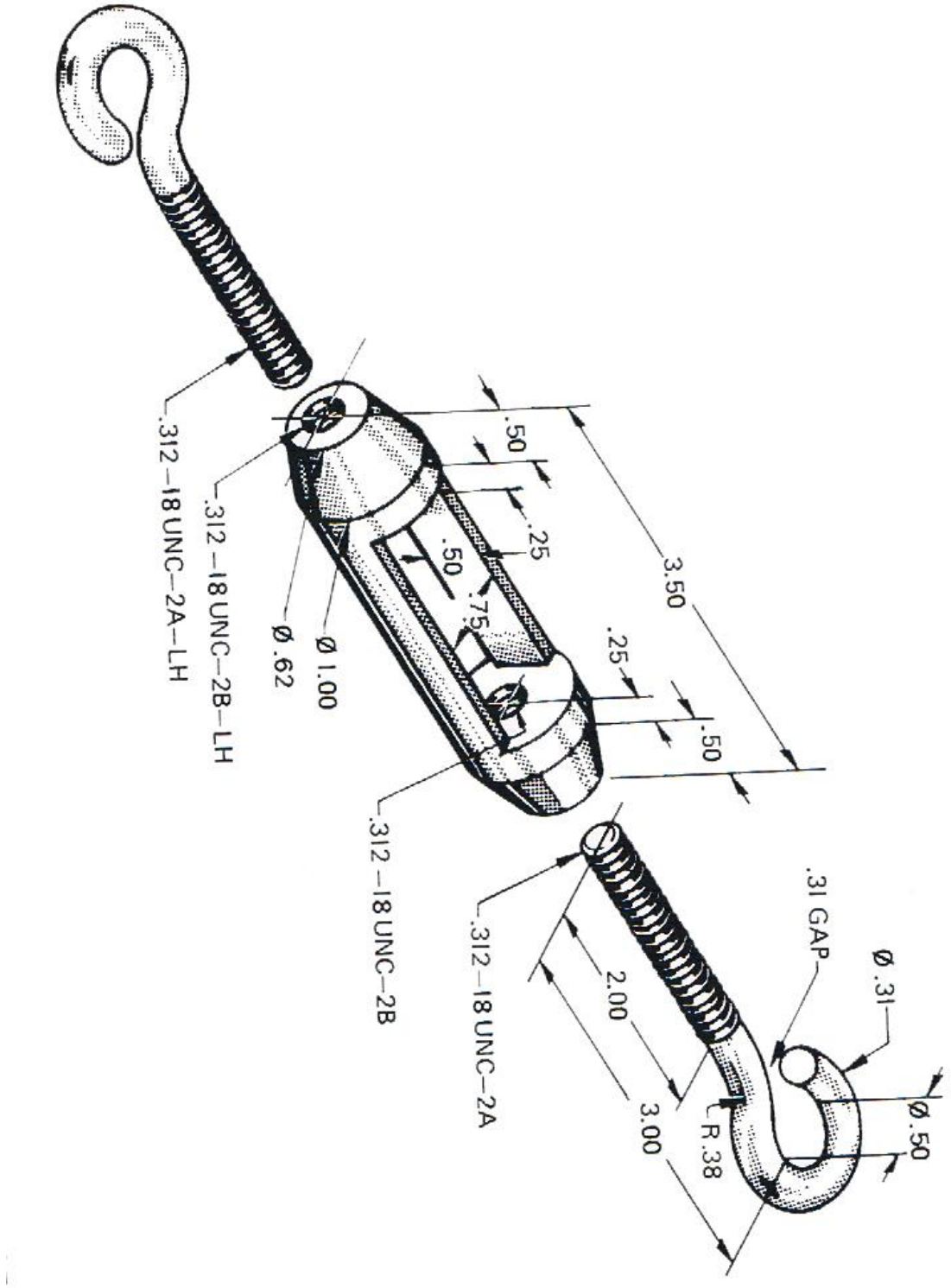
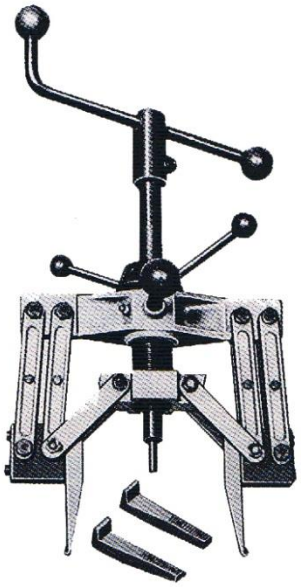
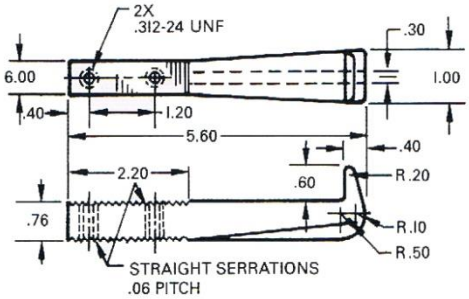


Fig. 1.48 Turnbuckle (parts).

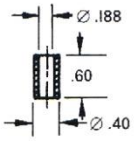
1.4.22 Two-arm parallel puller

PT 19 BALL BEARING Ø .375 MATL—STEEL, 1 REQD
PT 20 GREASE CUP
PT 21 BOLT—HEX HD .312 UNF X 1.50 LG, 6 REQD
PT 22 BOLT—HEX HD .312 UNF X 1.75 LG, 5 REQD
PT 23 BOLT—HEX HD .312 UNF X 2.50 LG, 4 REQD
PT 24 MACH SCREW—HEX HD 8-32 X 1.25 LG, 4 REQD
PT 25 NUT—HEX HD .312 UNF, 10 REQD
PT 26 NUT—HEX HD 8-32, 4 REQD
PT 27 SETSCREW—HEADLESS .375 UNF X .50 LG CUP POINT, 2 REQD
PT 28 SETSCREW—HEADLESS 8-32 X .25 LG FULL DOG, 2 REQD

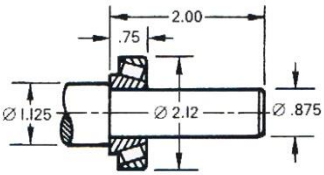




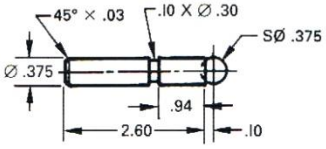
PT 11 FINGERS MATL—CI 2 REQD



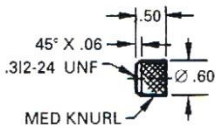
PT 12 SPACER
MATL—STEEL
4 REQD



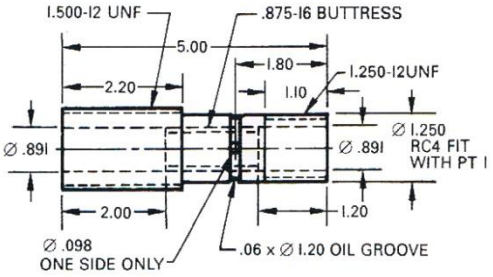
ASSEMBLY A



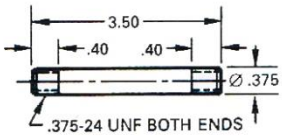
PT 14 CENTER ROD
MATL—STEEL 1 REQD



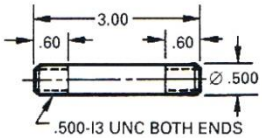
PT 15 NUT
MATL—STEEL 1 REQD



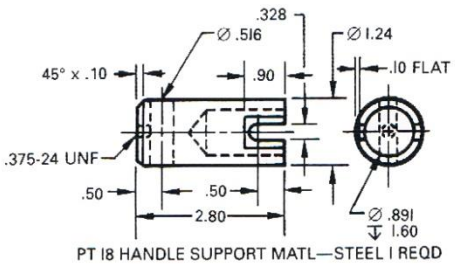
PT 13 ADJUSTING SCREW MATL—STEEL 1 REQD



PT 16 HANDLE MATL—STEEL 2 REQD



PT 17 HANDLE MATL—STEEL 1 REQD



PT 18 HANDLE SUPPORT MATL—STEEL 1 REQD

Fig. 1.49 Two-arm parallel puller (parts).

1.4.23 Machinist's Jack

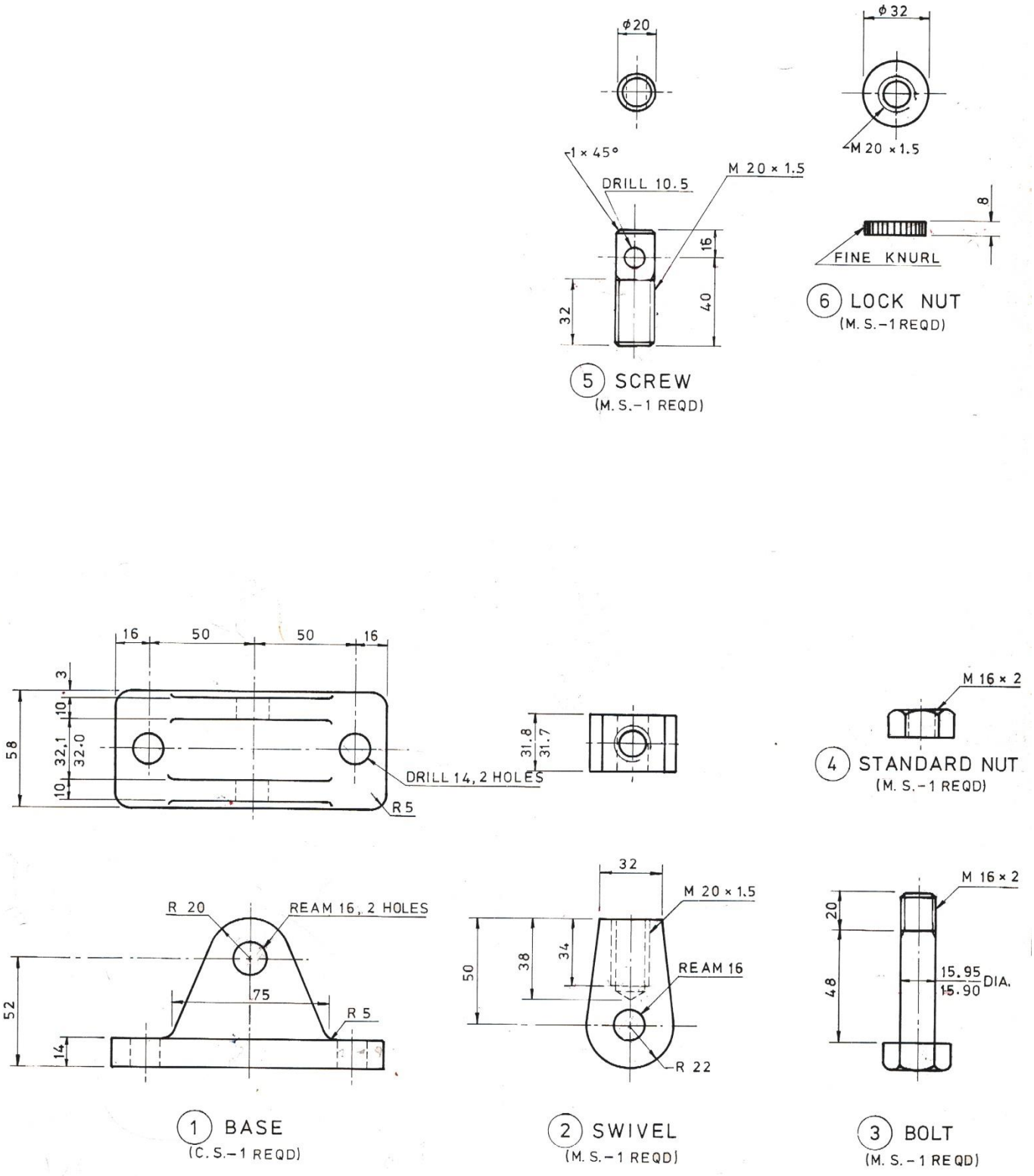


Fig. 1.50 Machinist's Jack parts

1.4.23 Governor Arm

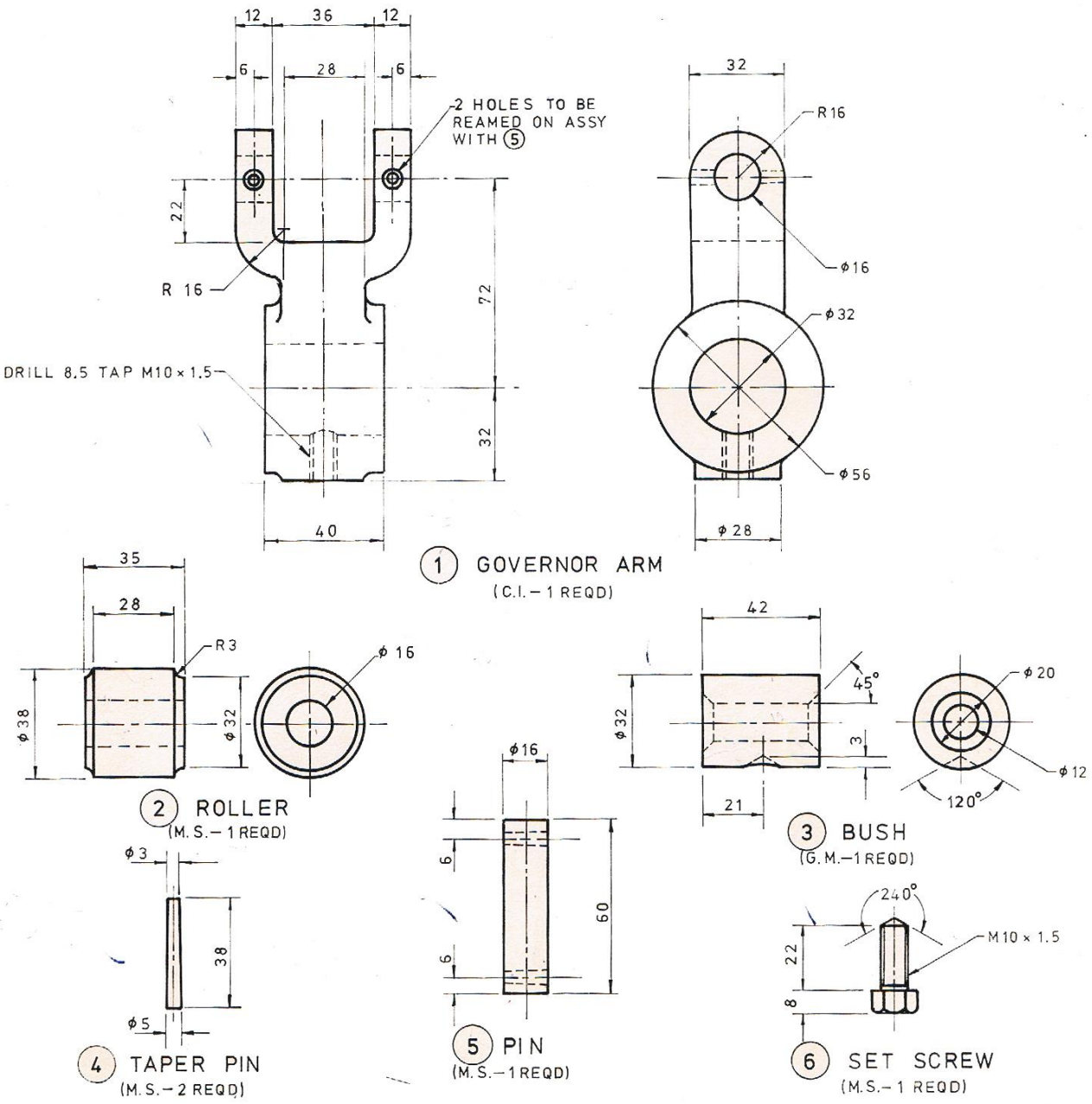


Fig. 1.51 Governor Arm (parts).

REFERENCES:

1- K.L.Narayana, P.Kannaiah, K.Venkata Reddy "**Machine Drawing** " third edition , new Delhi,2006.

2- Cecil Jensen, Jay D.Helsel "**Fundamentals of Engineering Drawing**" fourth edition, new York, 1996.

3- Albert Boundy "**Engineering Drawing**" second edition, new York ,1980.