

# desenhista de máquinas

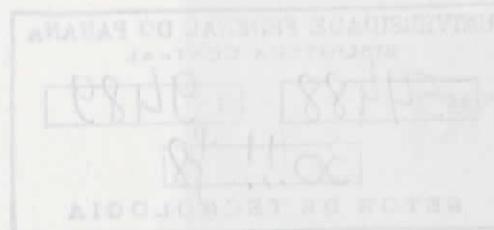
Organizado e coordenado pelo Eng. Ind. Mec. F. PROVENZA

Ex- Orientador Técnico dos Cursos Profissionais e do Ginásio Industrial "Pro-Tec". Eng. Projetista da General Motors do Brasil, Prof. Ass. da Fac. Eng. Ind. da PUCSP, Prof. Contr. da Univ. Mackenzie e Prof. Regente da Escola de Eng. Mauá.

Colaboração do Eng. HIRAN R. DE SOUZA

Diretor Técnico da Escola "Pro-Tec"

621.82  
2969  
3. ed.



Escola  
**pro-tec**

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RUA SÃO SEBASTIÃO, 650 - FONE: 61-5206 - BROOKLYN PAULISTA - SP



# **prefácio**

A antiga publicação "Prontuário do Projetista de Máquinas" abrangia duas áreas: a de desenho mecânico e a de projetos de máquinas.

O progresso industrial e o avanço da tecnologia no Brasil obrigou-nos a rever, ampliar e adaptar às condições atuais a referida obra.

Desse trabalho resultaram dois livros:

**"Desenhista de Máquinas"**, do qual o presente prefácio faz parte, constituído de noções práticas, concisas e completas para uma fácil, rápida e exata leitura, interpretação ou execução do desenho de elementos de máquinas.

**"Projetista de Máquinas"** constituído de tabelas, normas, fórmulas, relações, dados técnicos e características dos materiais para o cálculo rápido de elementos de máquinas.

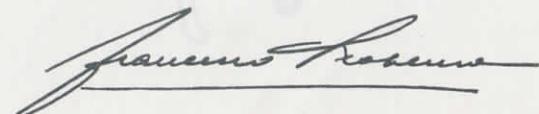
Estas publicações visam os mesmos objetivos do antigo prontuário, quais sejam, facilitar a árdua tarefa dos alunos e dos mestres na coleta de informações técnico-didáticas e representam uma fonte de consulta para os profissionais.

Nossa preocupação foi a de apresentar um trabalho elementar de fácil consulta e não uma obra-prima reservada apenas aos entendidos.

Ficaremos satisfeitos se conseguirmos alcançar estes objetivos.

Agradecemos a todos aqueles que participaram da realização dessa publicação, aos que formularem críticas, aos que apontarem as eventuais falhas e erros e em particular à equipe encabeçada pelo Eng. Hiran Rodrigues de Souza e formada pelos desenhistas Y. Numakura, T. Tsukamoto e J. Sérgio Campos.

São Paulo, outubro de 1976



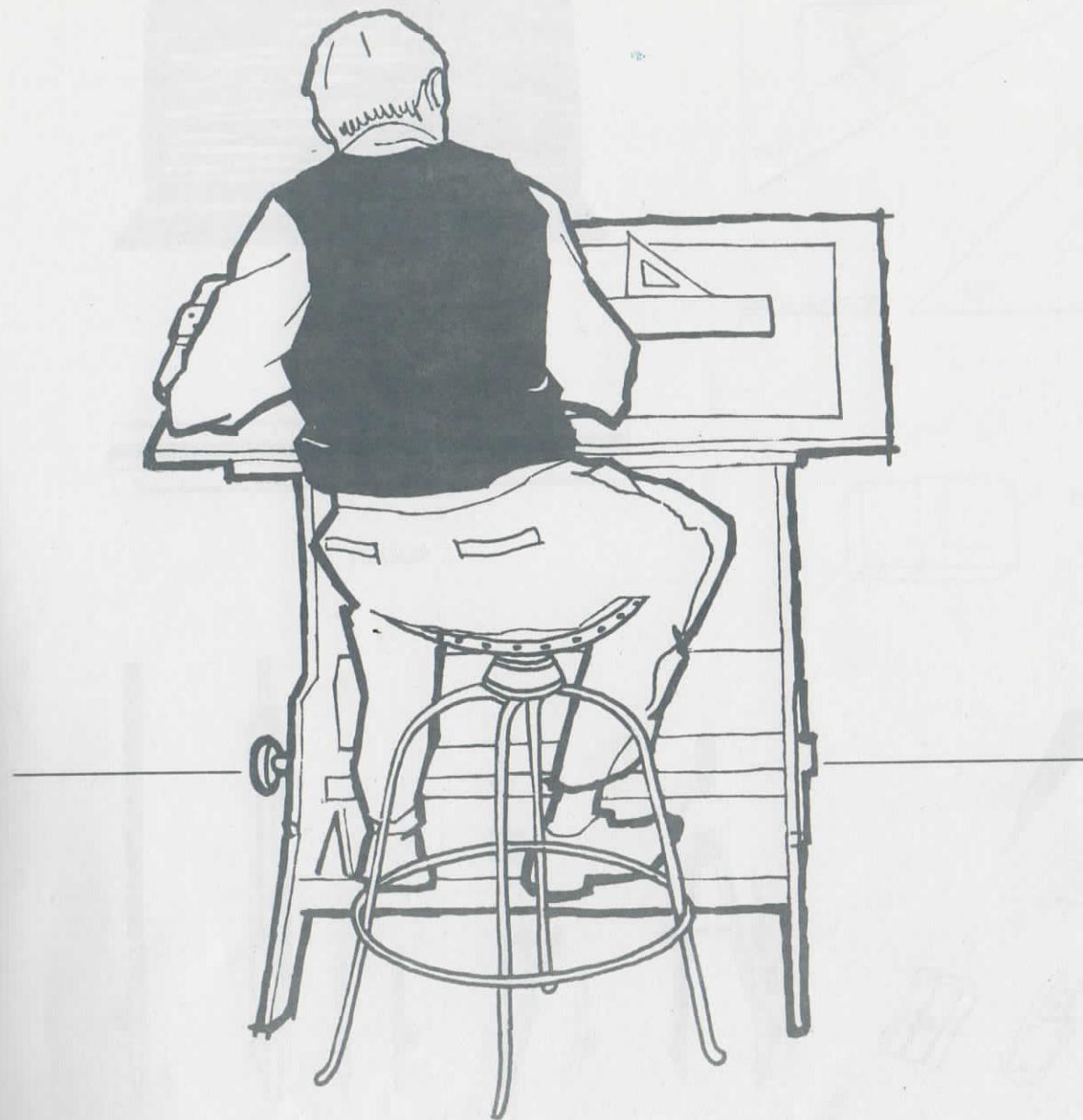
Este livro foi totalmente composto pelo Centro de Comunicação Gráfica "PRO-TEC", sob os auspícios da administração:

Prof. Francisco Marath Pieber  
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Eng. Francesco Provenza

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3ª edição – 1976

Exemplar nº .....



1

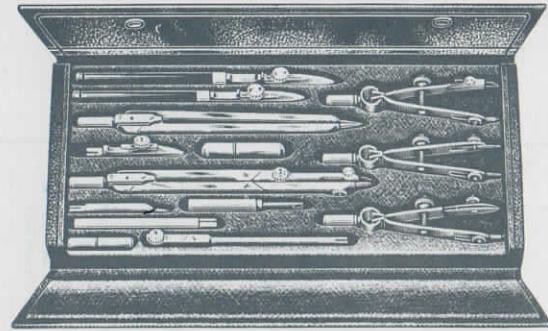
# material de desenho e seu uso

material de desenho

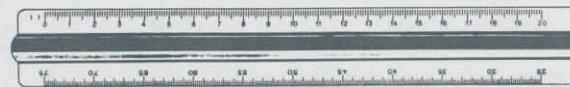
lápis

esquadro

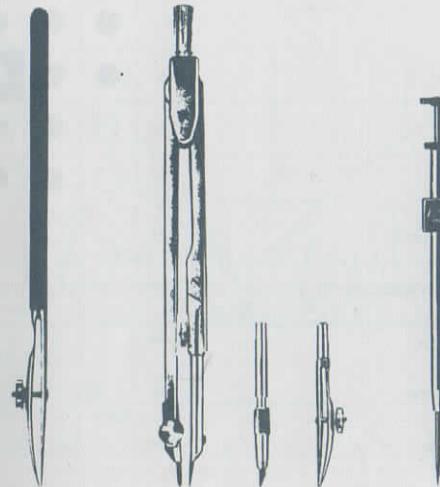
compasso



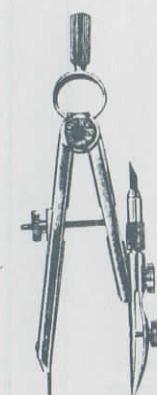
ESTOJO



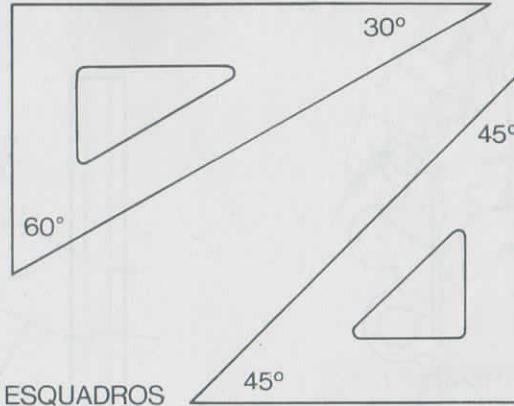
RÉGUA



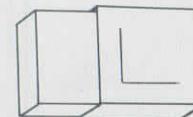
TIRA-LINHA



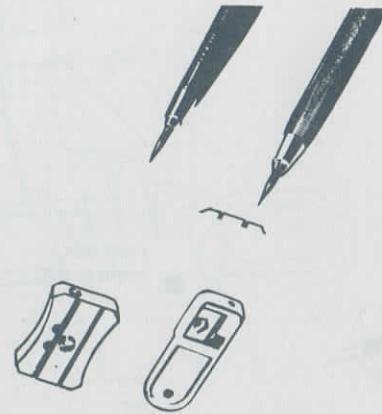
COMPASSOS



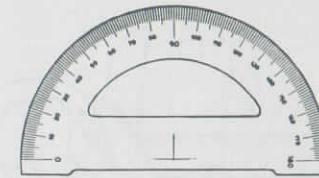
ESQUADROS



BORRACHA



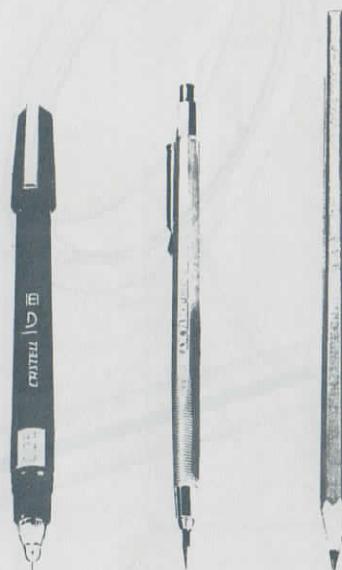
APONTADORES



TRANSFERIDOR



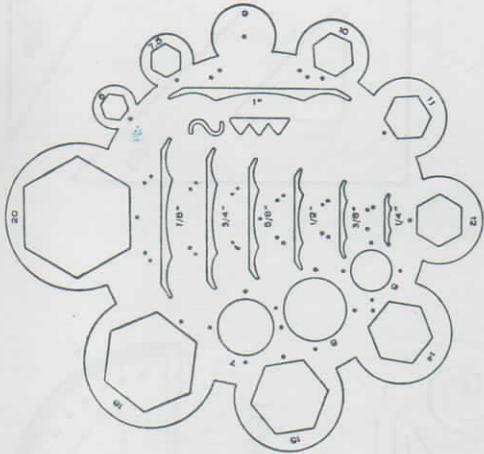
CURVA FRANCESA



CANETA LAPISEIRA LAPIIS

## DUREZA DOS LÁPIS

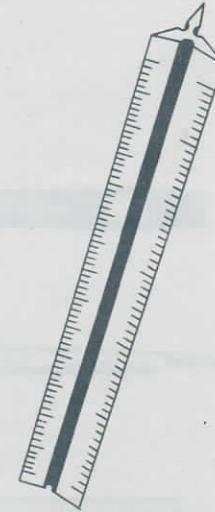
LÁPIIS COMUM	QUALIDADE	CÓPIAS A LUXO PARA TRATAR
	Macio especial, intensamente preto	7B
	Extraordinariamente macio e preto	6B
	Notavelmente macio e preto	5B
	Bem macio e preto	4B
1	Bem macio e bem preto	3B
	Macio e bem preto	2B
2	Macio e preto	B
	Semimacio e preto	HB
3	Semimacio	F
4	Duro	H
	Macio duro	2H
5	Bem duro	3H
	Notavelmente duro	4H
	Extraordinariamente duro	5H
	Mulfissimo duro	6H
	Dureza de pedra	7H
	Dureza de aço	8H
	Dureza de diamante	9H



GABARITO

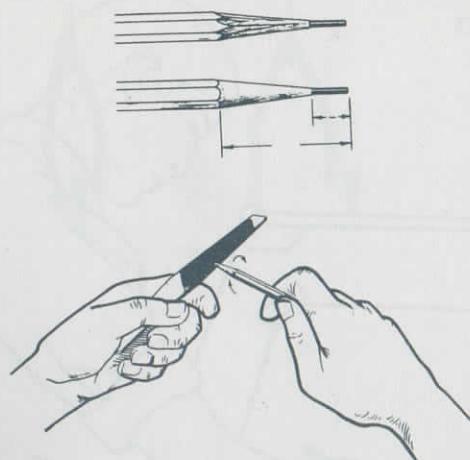


FITA  
ADESIVA

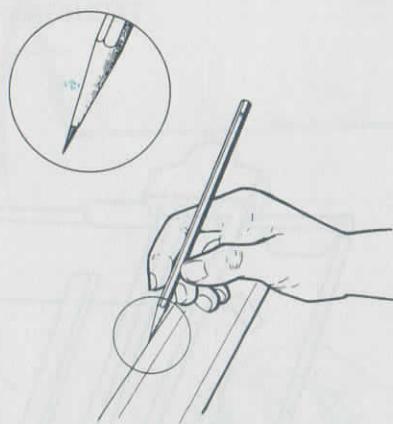


ESCALA

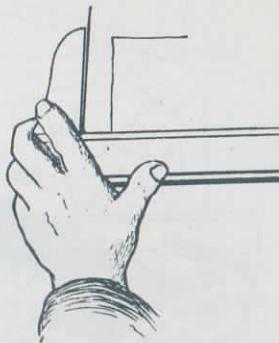
Para uso preferencial  Para uso em segundo plano   
Para uso em terceiro plano



CUIDADOS COM A PONTA DO LAPIS



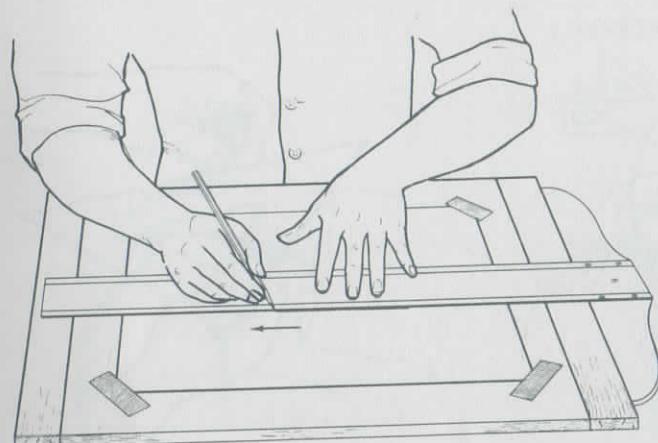
LAPISEIRA



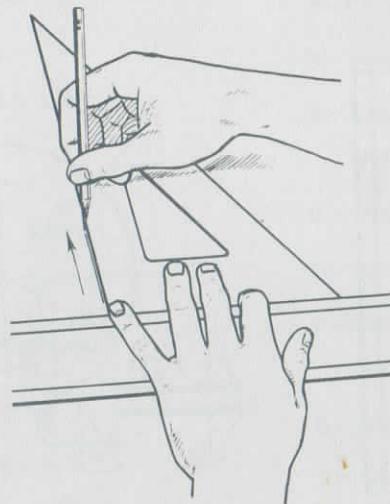
APOIANDO A RÉGUA T



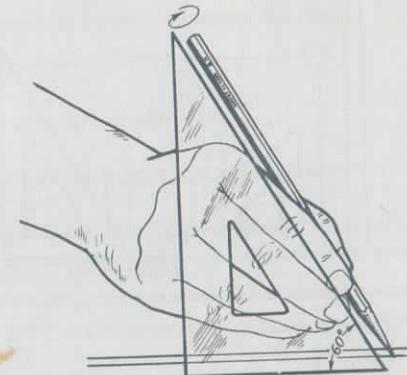
PORTA MINAS



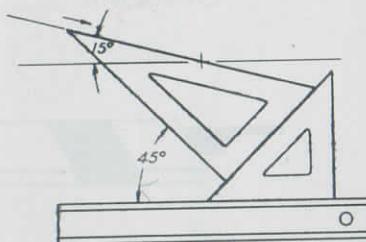
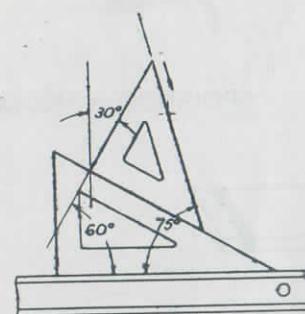
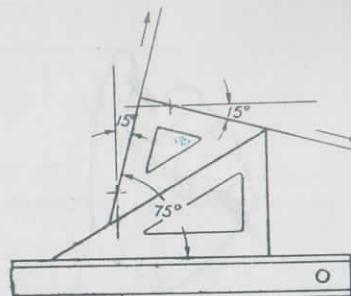
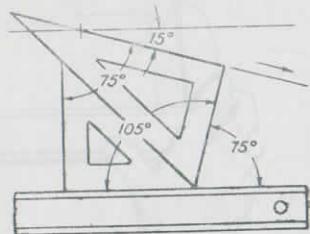
RETA HORIZONTAL



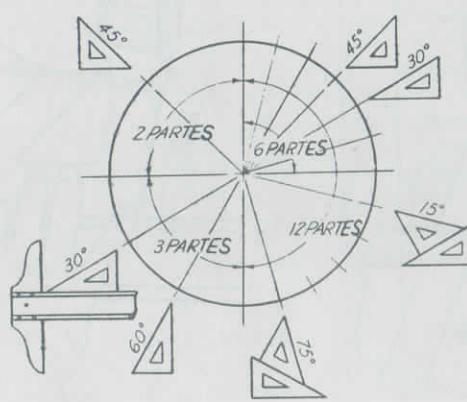
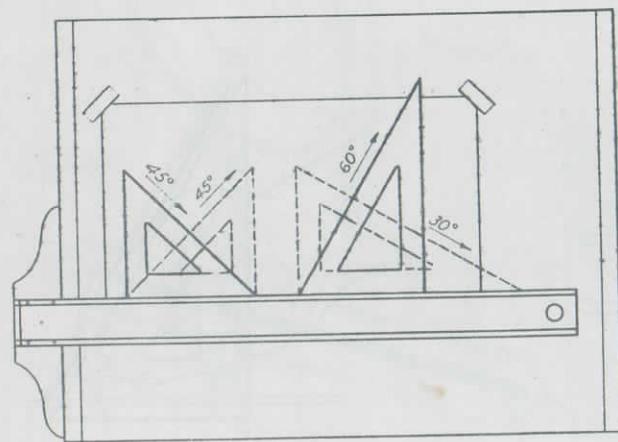
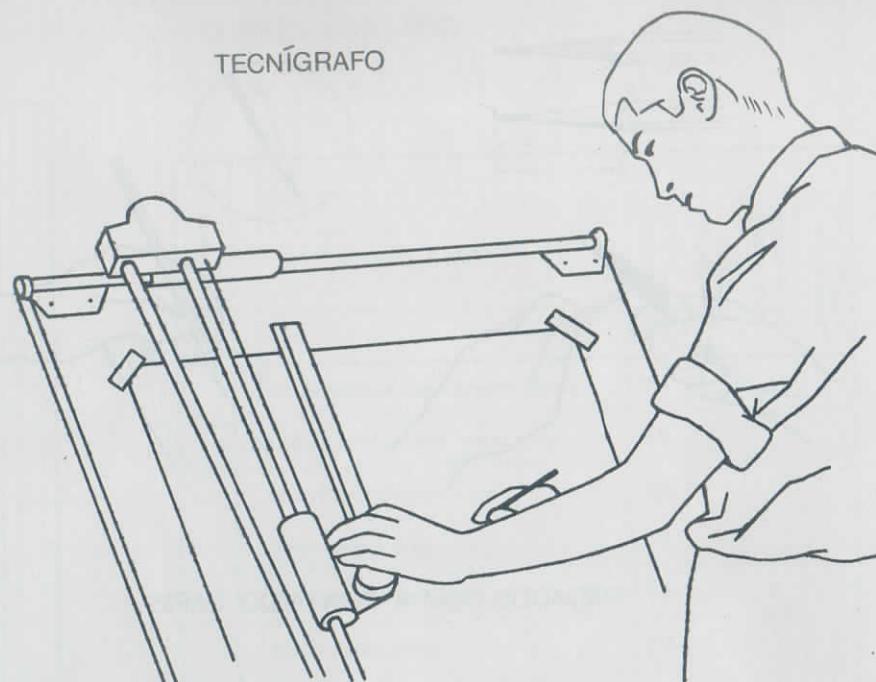
RETA VERTICAL



INCLINAÇÃO DO LAPIS



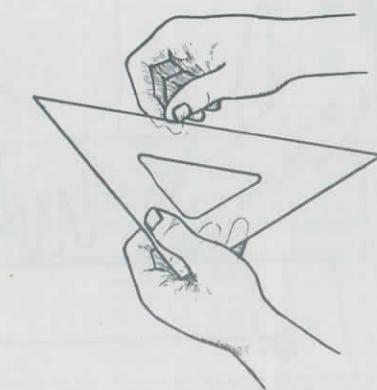
TECNÍGRAFO

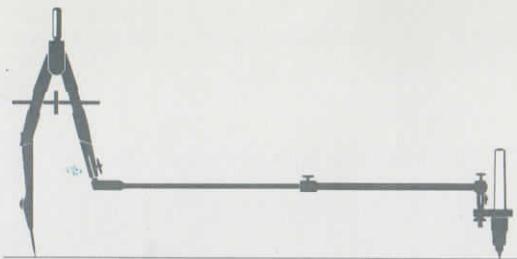
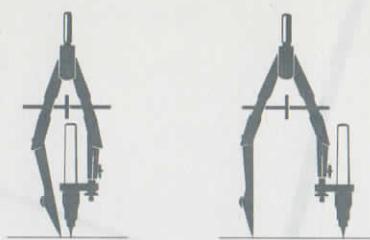


USO DO ESQUADRO

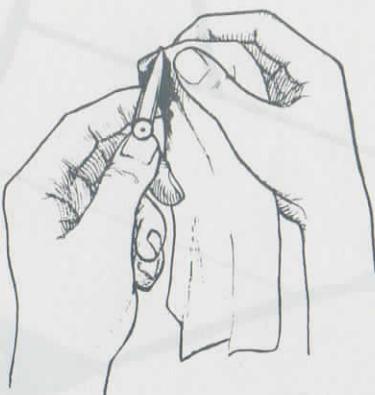
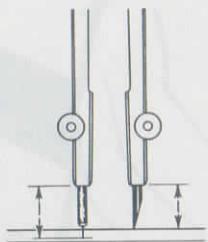
DIVISÃO DA CIRCUNFÉRENCIA

VERIFICAÇÃO DO ESQUADRO

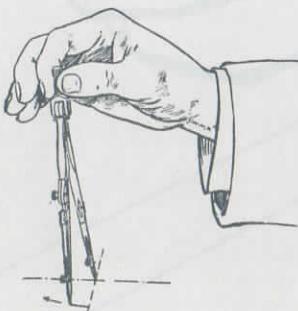
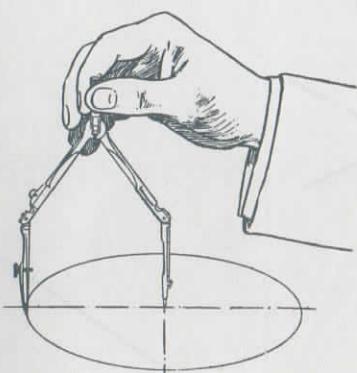




ESTOJO DE PENAS



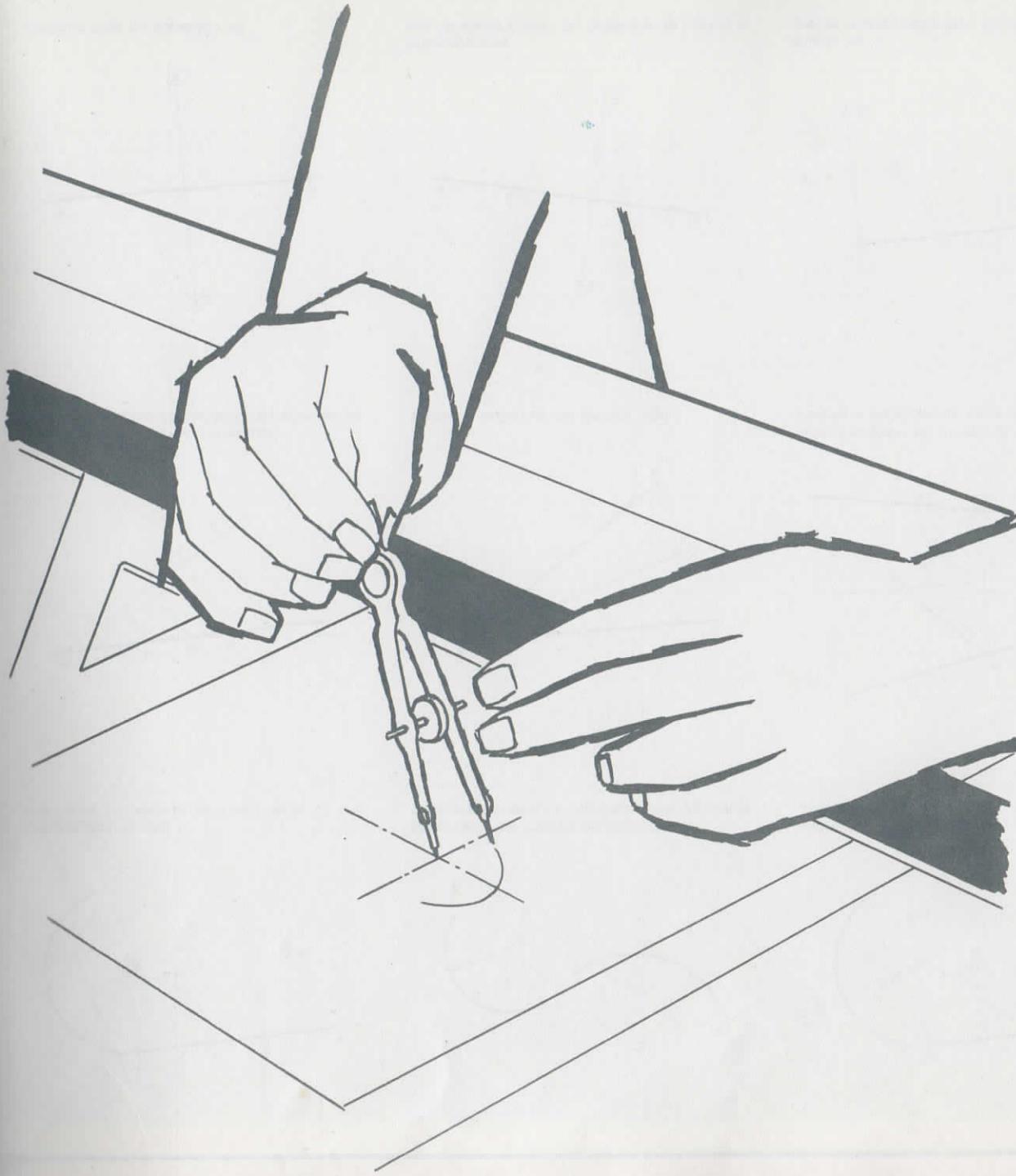
LIMPEZA DO TIRA-LINHA



USO DO COMPASSO

## CONSELHOS E RECOMENDAÇÕES

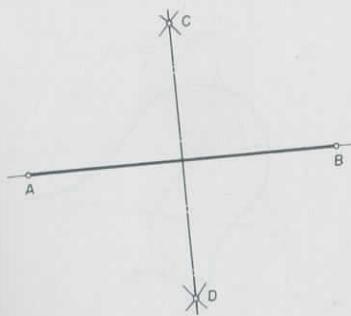
- 1 – Trabalhar com prancheta e material de desenho limpos
- 2 – Fixar a folha de desenho sobre a mesa com fita adesiva.
- 3 – Verificar os instrumentos antes de iniciar o trabalho.
- 4 – Desenhar sempre com a aresta superior da régua T ou similar.
- 5 – Usar a escala apenas para medir.
- 6 – Apontar o lapis ou lapiseira fora da mesa de desenho.
- 7 – Usar a borracha o m<sup>ín</sup>imo indispensável eliminando as partículas com escova ou flanela.
- 8 – Não apoiar sobre o desenho objetos que possam sujá-lo .
- 9 – Não diluir a tinta nanquim com águia.
- 10 – Não cortar o papel com lâmina utilizando a régua de desenho.



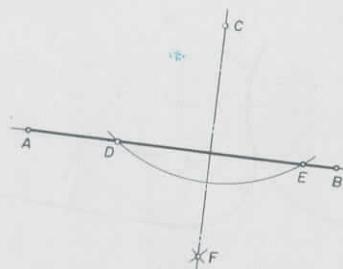
## 2 desenho geométrico

construções  
fundamentais  
cônicas  
cíclicas  
hélices

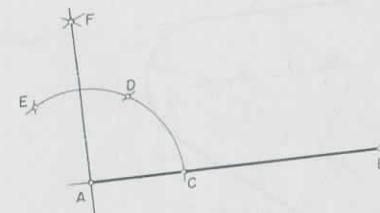
TRAÇAR O EIXO DO SEGMENTO AB



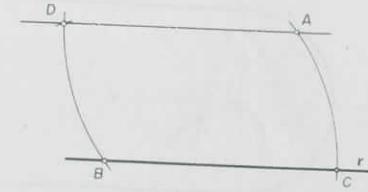
POR UM PONTO C FORA DO SEGMENTO AB TRAÇAR A PERPENDICULAR.



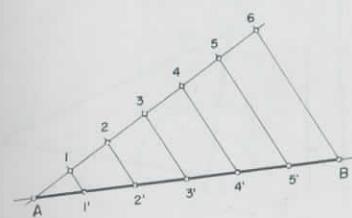
TRAÇAR A PERPENDICULAR À EXTREMIDADE DO SEGMENTO AB.



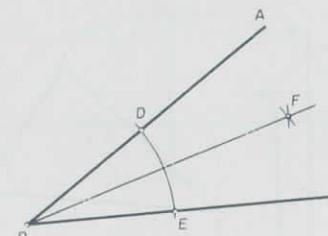
TRAÇAR A PARALELA À RETA r, PELO PONTO A.



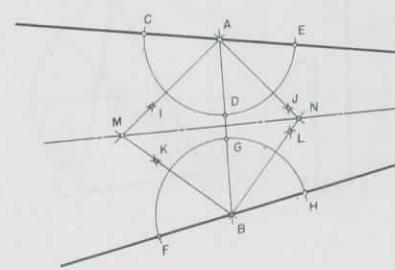
DIVIDIR O SEGMENTO AB EM QUALQUER NÚMERO DE PARTES IGUAIS. EXEMPLO: 6 PARTES.



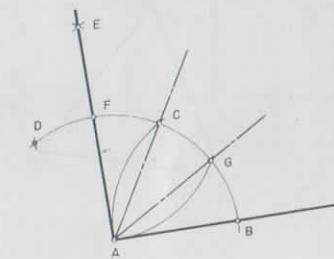
TRAÇAR A BISSETRIZ DO ÂNGULO ABC.



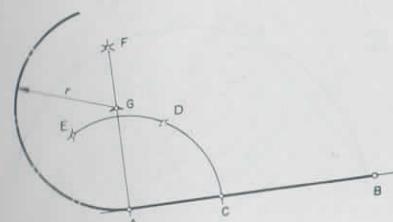
TRAÇAR A BISSETRIZ DE UM ÂNGULO QUALQUER, DESCONHECENDO-SE O VÉRTICE.



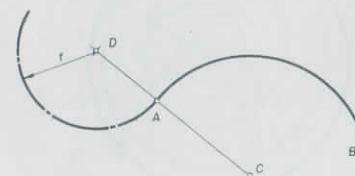
DIVIDIR O ÂNGULO RETO EM 3 PARTES IGUAIS.



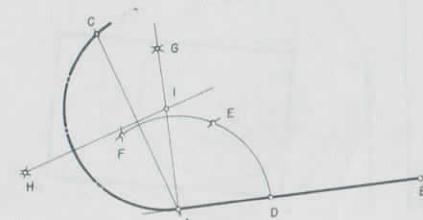
CONCORDAR O SEGMENTO AB COM O ARCO DE CIRCUNFERÊNCIA DE RAIO r.



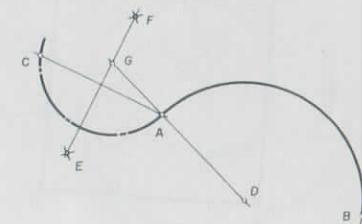
CONCORDAR O ARCO DE CIRCUNFERÊNCIA  $\widehat{AB}$ , COM UM OUTRO ARCO DE CIRCUNFERÊNCIA DE RAIO r.



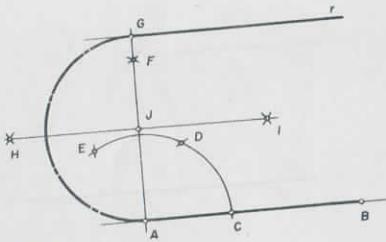
CONCORDAR O SEGMENTO AB, COM O ARCO DE CIRCUNFERÊNCIA QUE PASSA PELO PONTO C.



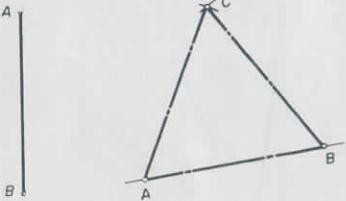
CONCORDAR O ARCO DE CIRCUNFERÊNCIA  $\widehat{AB}$ , COM UM OUTRO ARCO DE CIRCUNFERÊNCIA QUE PASSA PELO PONTO C.



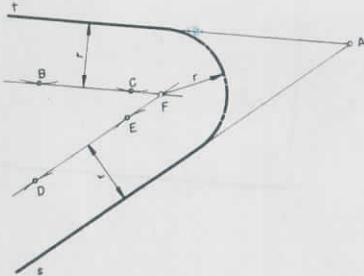
CONCORDAR A RETA  $r$ , PARALELA AO SEGMENTO AB, COM UM ARCO DE CIRCUNFERÊNCIA.



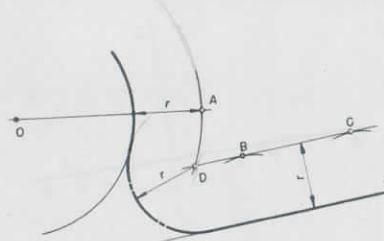
CONSTRUIR O TRIÂNGULO EQUILÁTERO DE LADO AB.



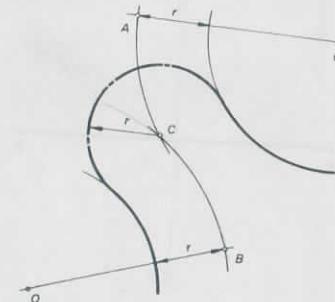
CONCORDAR AS RETAS  $t$  e  $s$  CONVERGENTES NO PONTO A COM UM ARCO DE CIRCUNFERÊNCIA DE RAIO  $r$ .



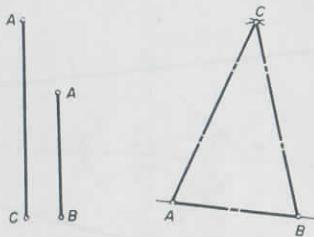
CONCORDAR A RETA  $t$  E O ARCO DE CIRCUNFERÊNCIA DE CENTRO O, COM UM OUTRO ARCO DE CIRCUNFERÊNCIA DE RAIO  $r$ .



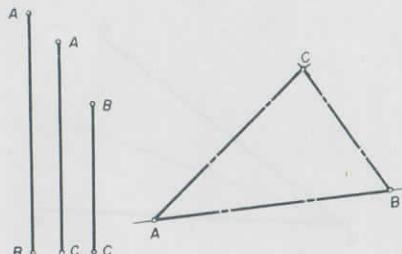
CONCORDAR OS ARCOS DE CIRCUNFERÊNCIA DE CENTROS O e O' COM UM OUTRO ARCO DE CIRCUNFERÊNCIA DE RAIO  $r$ .



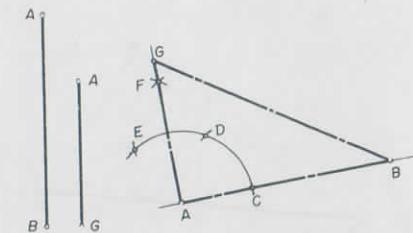
CONSTRUIR O TRIÂNGULO ISÓSCELES DE BASE AB E LADO AC.



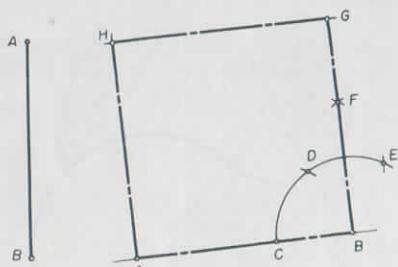
CONSTRUIR O TRIÂNGULO ESCALENO DE LADOS AB, BC e AC.



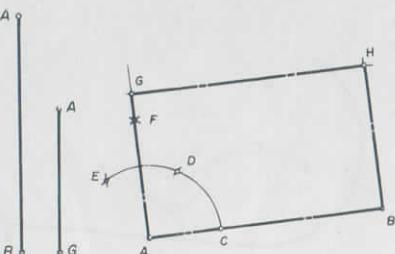
CONSTRUIR O TRIÂNGULO RETÂNGULO DE CATETOS AB e AG.



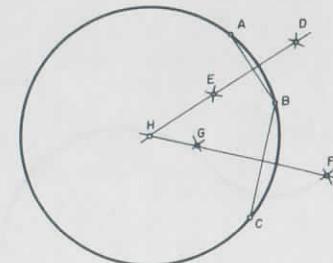
CONSTRUIR O QUADRADO DE LADO AB.



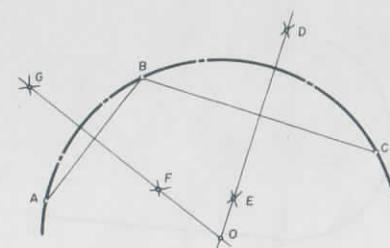
CONSTRUIR O RETÂNGULO DE LADOS AB e AG



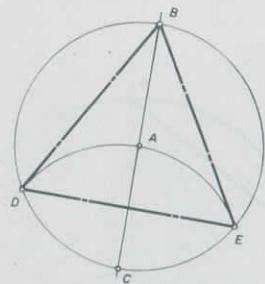
ACHAR O CENTRO H DA CIRCUNFERÊNCIA.



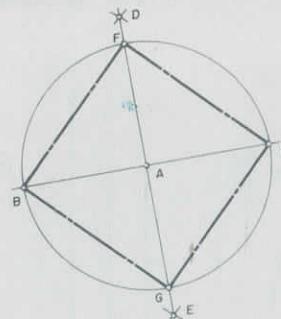
TRAÇAR O ARCO DE CIRCUNFERÊNCIA DE CENTRO O, QUE PASSA PELOS PONTOS ABC.



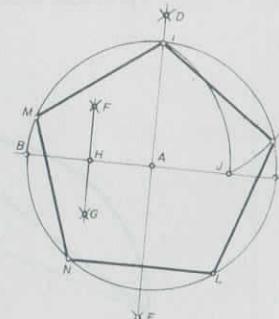
DIVIDIR A CIRCUNFERÊNCIA EM 3 PARTES IGUAIS, E  
INSCREVER O TRIÂNGULO EQUILÁTERO.



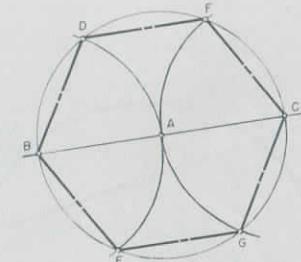
DIVIDIR A CIRCUNFERÊNCIA EM 4 PARTES IGUAIS, E  
INSCREVER O QUADRADO.



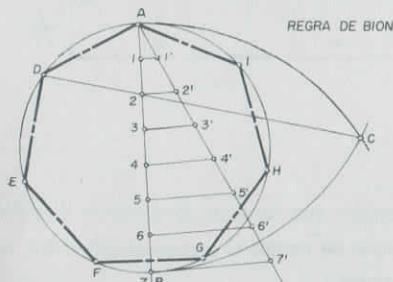
DIVIDIR A CIRCUNFERÊNCIA EM 5 PARTES IGUAIS, E  
INSCREVER O PENTÁГОNO REGULAR.



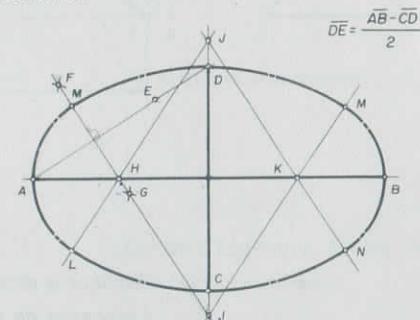
DIVIDIR A CIRCUNFERÊNCIA EM 6 PARTES IGUAIS, E  
INSCREVER O HEXÁGONO REGULAR.



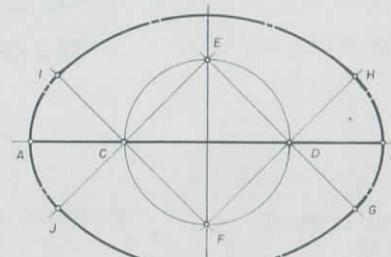
DIVIDIR A CIRCUNFERÊNCIA EM QUALQUER NÚMERO  
DE PARTES IGUAIS. EXEMPLO: 7 PARTES E INSCRE-  
VER O HEPTÁГОNO REGULAR.



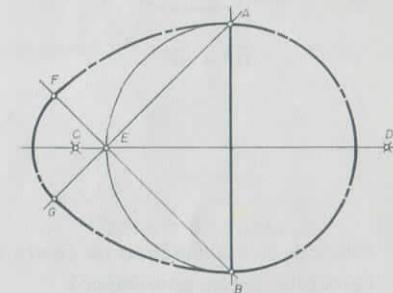
CONSTRUIR A OVAL DADOS O EIXO MAIOR AB E O  
MENOR CD.



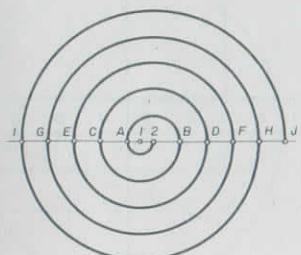
CONSTRUIR A OVAL DADO O EIXO MAIOR AB



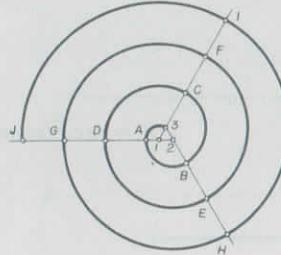
CONSTRUIR A OVAL IRREGULAR DADO O EIXO MENOR  
AB.



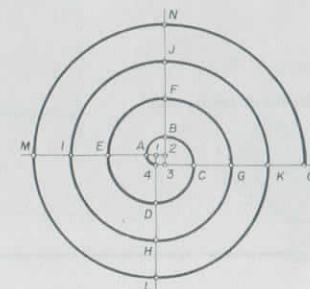
TRAÇAR A ESPIRAL DE DOIS CENTROS, SENTIDO HO-  
RARIO.



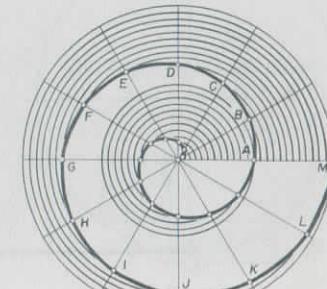
TRAÇAR A ESPIRAL DE TRÊS CENTROS, SENTIDO AN-  
TI-HORÁRIO.



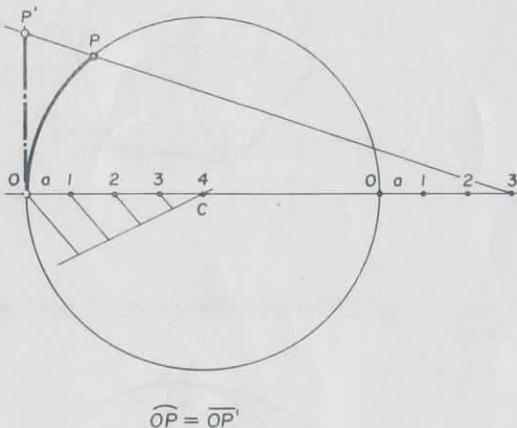
TRAÇAR A ESPIRAL DE QUATRO CENTROS, SENTIDO  
HORÁRIO.



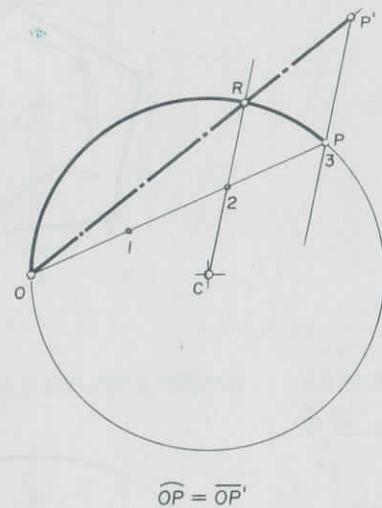
TRAÇAR A ESPIRAL DE ARQUIMEDES SENTIDO AN-  
TI-HORÁRIO.



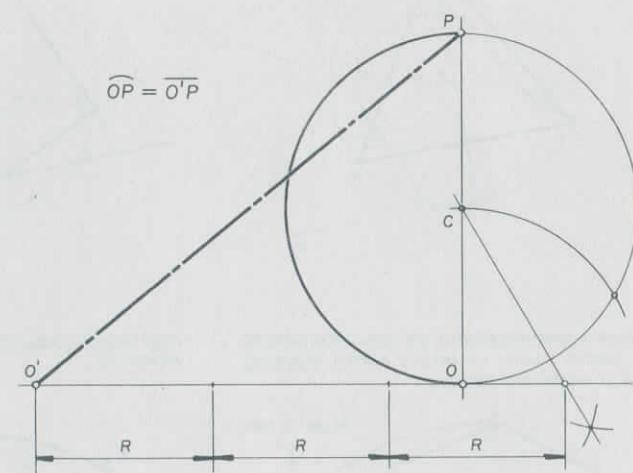
Retificar o arco  $OP$  menor que  $90^\circ$



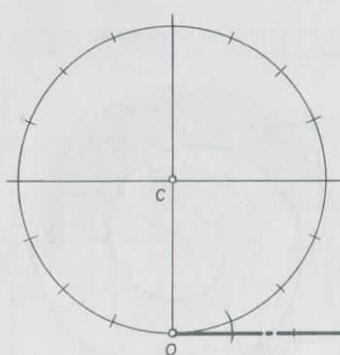
Retificar o arco  $OP$  maior que  $90^\circ$   
(processo D'OCAGNE)



Retificar a semicircunferência  $OP$  de centro  $C$  e raio  $R$ .  
(processo Kochansky)

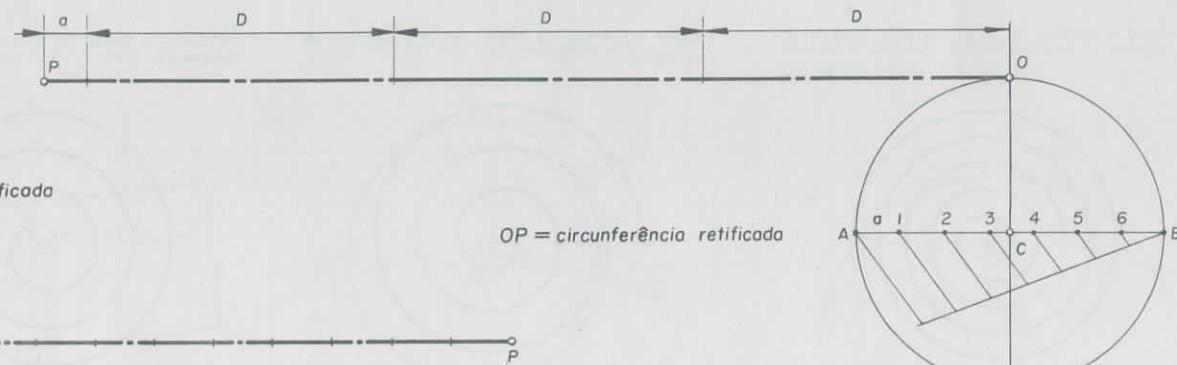


Retificar a circunferência de centro  $C$ .  
(processo direto, aproximado)



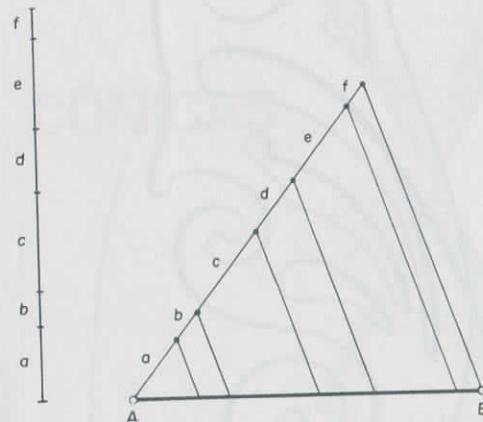
$OP = \text{circunferência retificado}$

Retificar a circunferência de centro  $C$  e diâmetro  $D$ .  
(processo de Arquimedes)

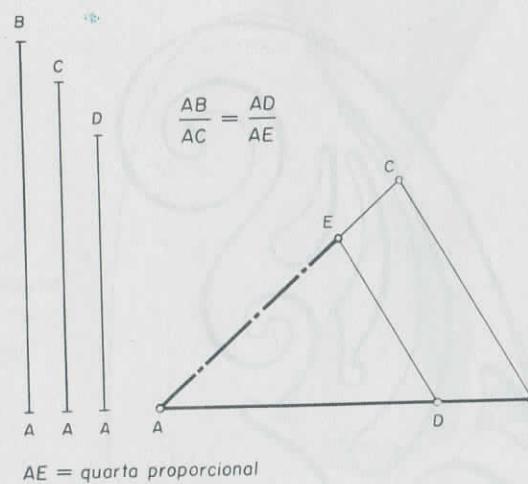


$OP = \text{circunferência retificado}$

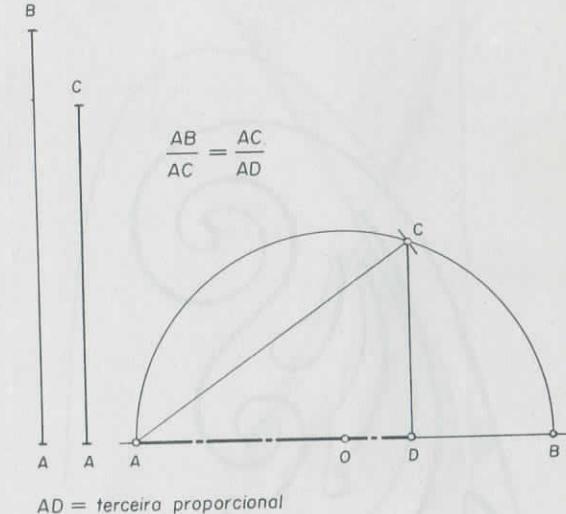
Dividir o segmento AB em partes proporcionais  $a : a, b, c, d, e, f$ .



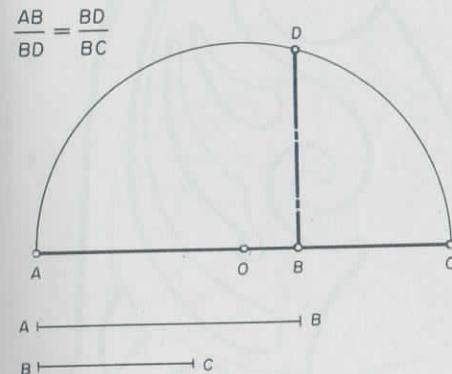
Achar a quarta proporcional dos segmentos AB, AC e AD.



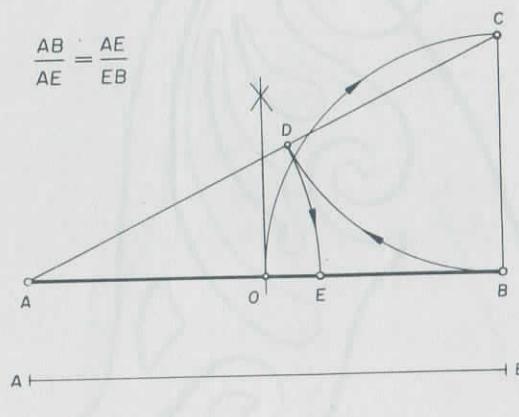
Achar a terceira proporcional entre os segmentos AB e AC.



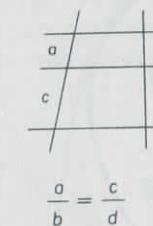
Achar a média proporcional dos segmentos AB e BC.



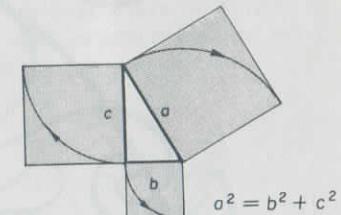
Dividir o segmento AB em média e extrema razão (secção áurea).



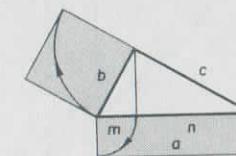
Teorema de Tales



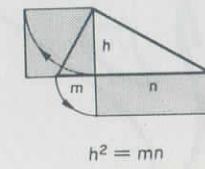
Teorema de Pitágoras

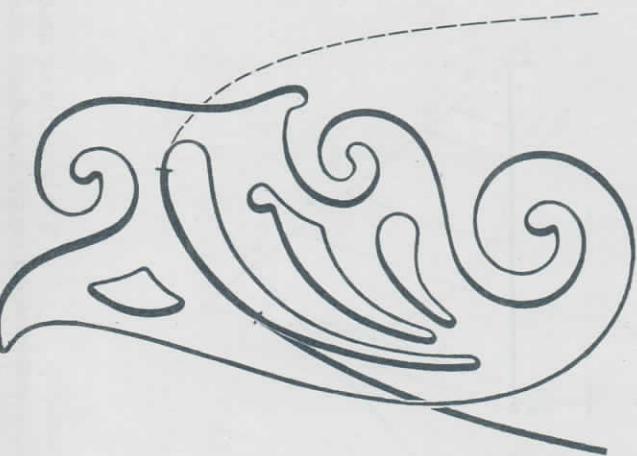


1º Teorema de Euclides

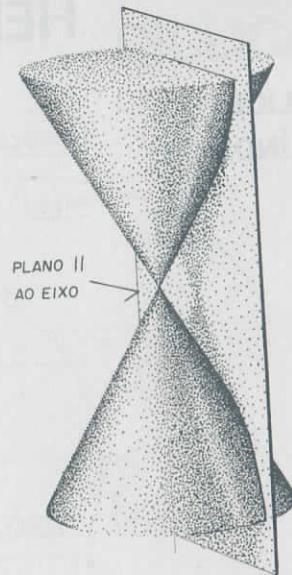
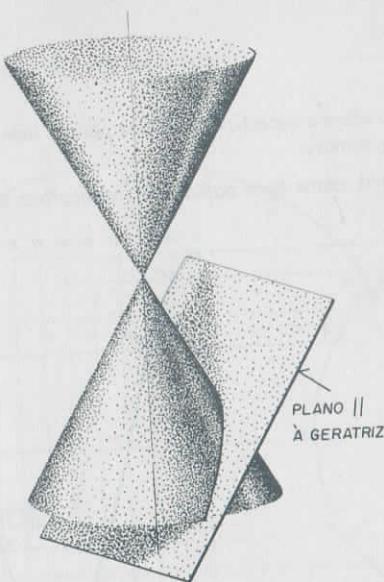
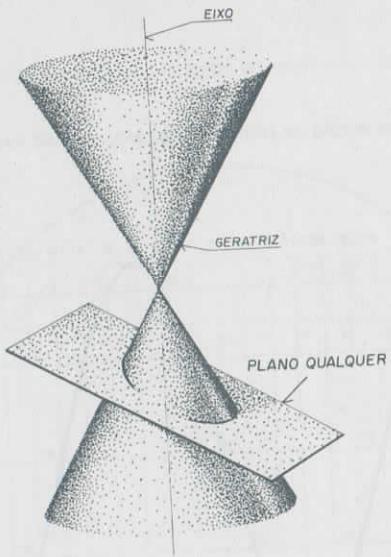


2º Teorema de Euclides



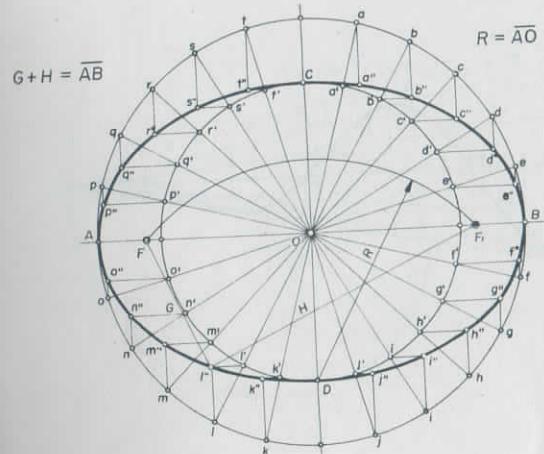


# CÔNICAS



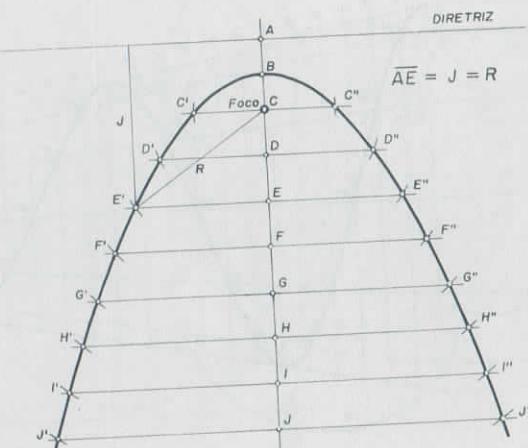
## ELIPSE

DEFINIÇÃO: é uma curva plana fechada cuja soma das distâncias de qualquer de seus pontos aos focos  $F$  e  $F_1$  é constante e igual ao eixo maior  $AB$ .



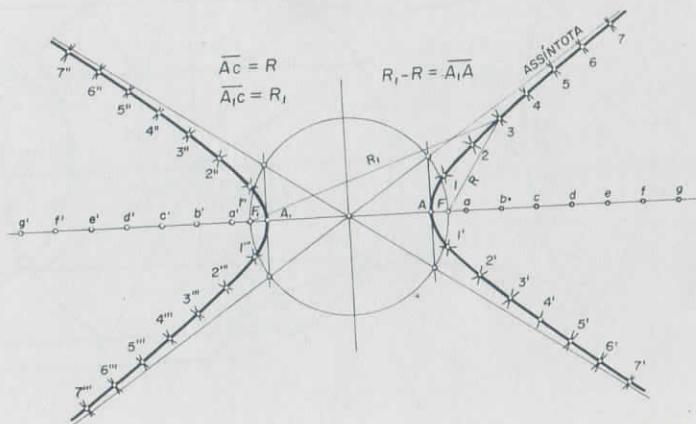
## PARÁBOLA

DEFINIÇÃO: é uma curva plana aberta cujos pontos são equidistantes do foco e da diretriz.



## HIPÉROBOLE

DEFINIÇÃO: é uma curva plana constituída de duas partes simétricas cujos pontos têm diferença constante entre as distâncias dê-las aos focos  $F$  e  $F_1$ , e igual à distância entre os vértices  $A$  e  $A_1$ .

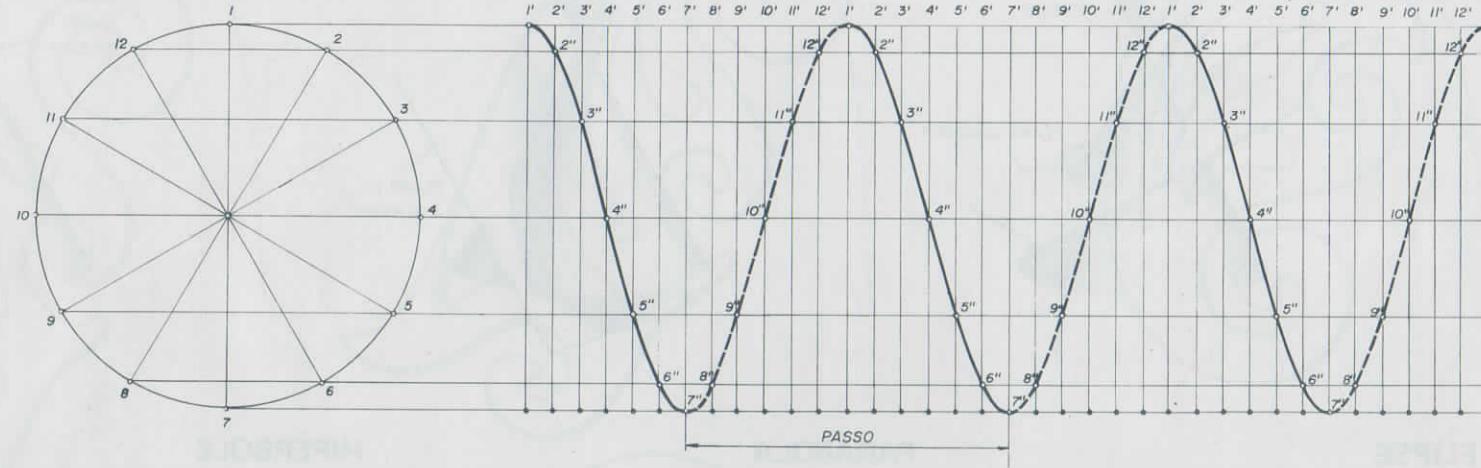


# HÉLICES

## HÉLICE CILÍNDRICA

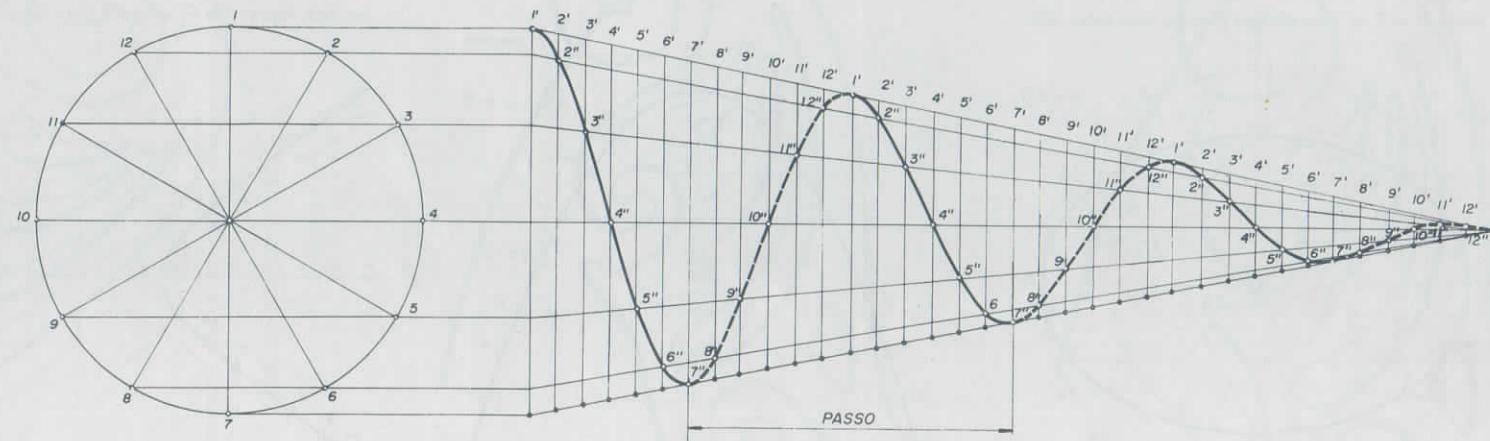
DEFINIÇÃO: é a curva formada sobre a superfície cilíndrica por um lado de um ângulo que se enrola no cilindro, enquanto o outro lado se enrola no círculo da base do cilindro.

PASSO: é o segmento da geratriz entre duas passagens consecutivas da hélice



## HÉLICE CÔNICA

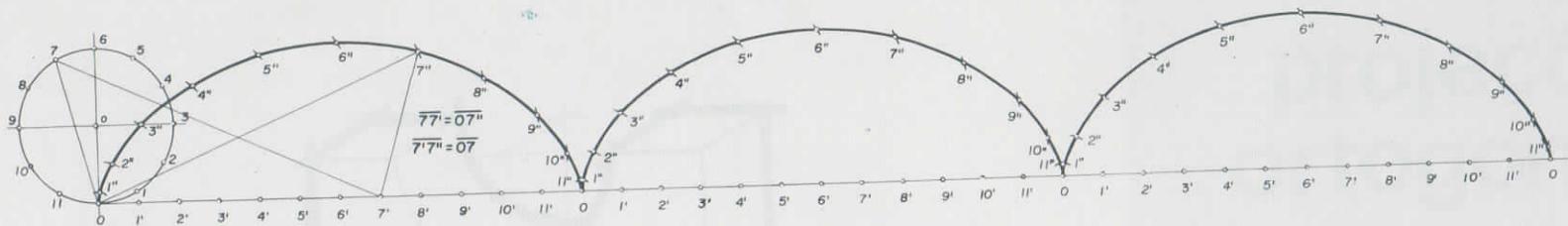
DEFINIÇÃO: é a curva formada por um fio que se enrola sobre uma superfície côncica. Pode ser com passo ou inclinação constante ou variável.



## CICLÓIDE

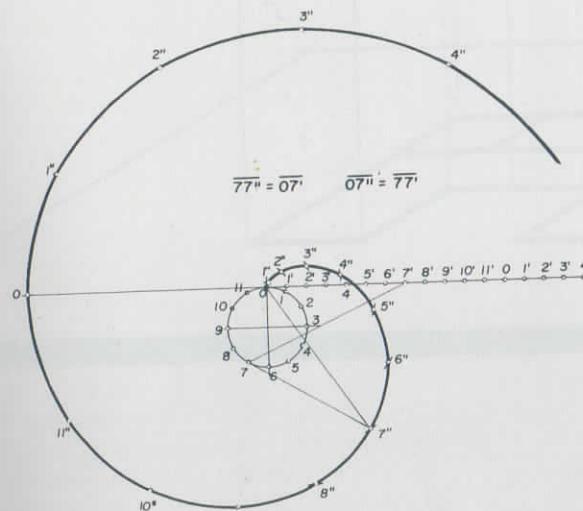
## CÍCLICAS

DEFINIÇÃO: é a curva gerada por um ponto de uma circunferência que rola sobre uma reta, sem escorregar.



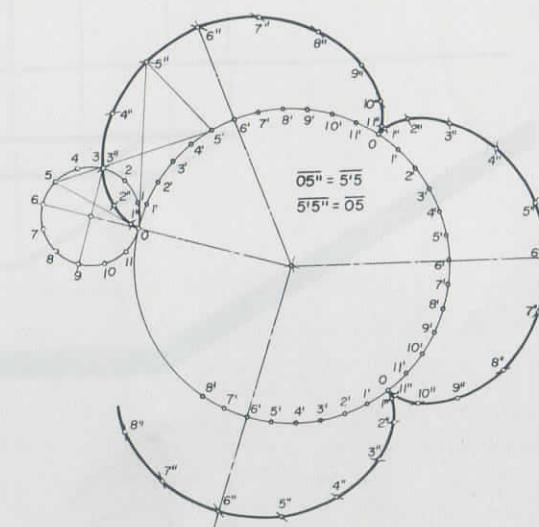
## EVOLVENTE

DEFINIÇÃO: é a curva gerada por um ponto de uma reta em rotação sobre um círculo.



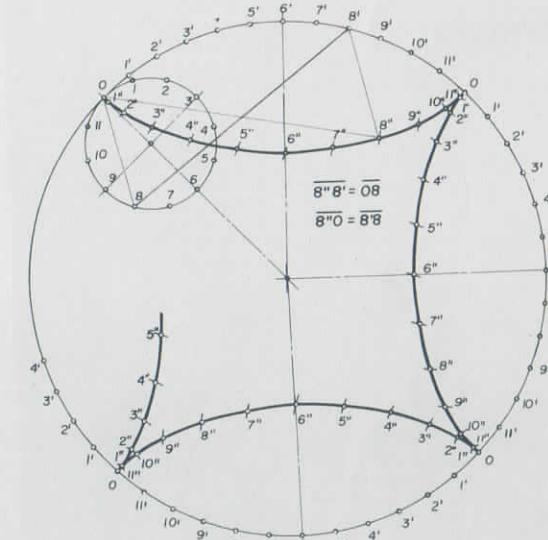
## EPICICLÓIDE

DEFINIÇÃO: é a curva gerada por um ponto de uma circunferência que rola exteriormente à outra, sem escorregar.



## HIPOCICLÓIDE

DEFINIÇÃO: é a curva gerada por um ponto de uma circunferência que rola interiormente à outra, sem escorregar.

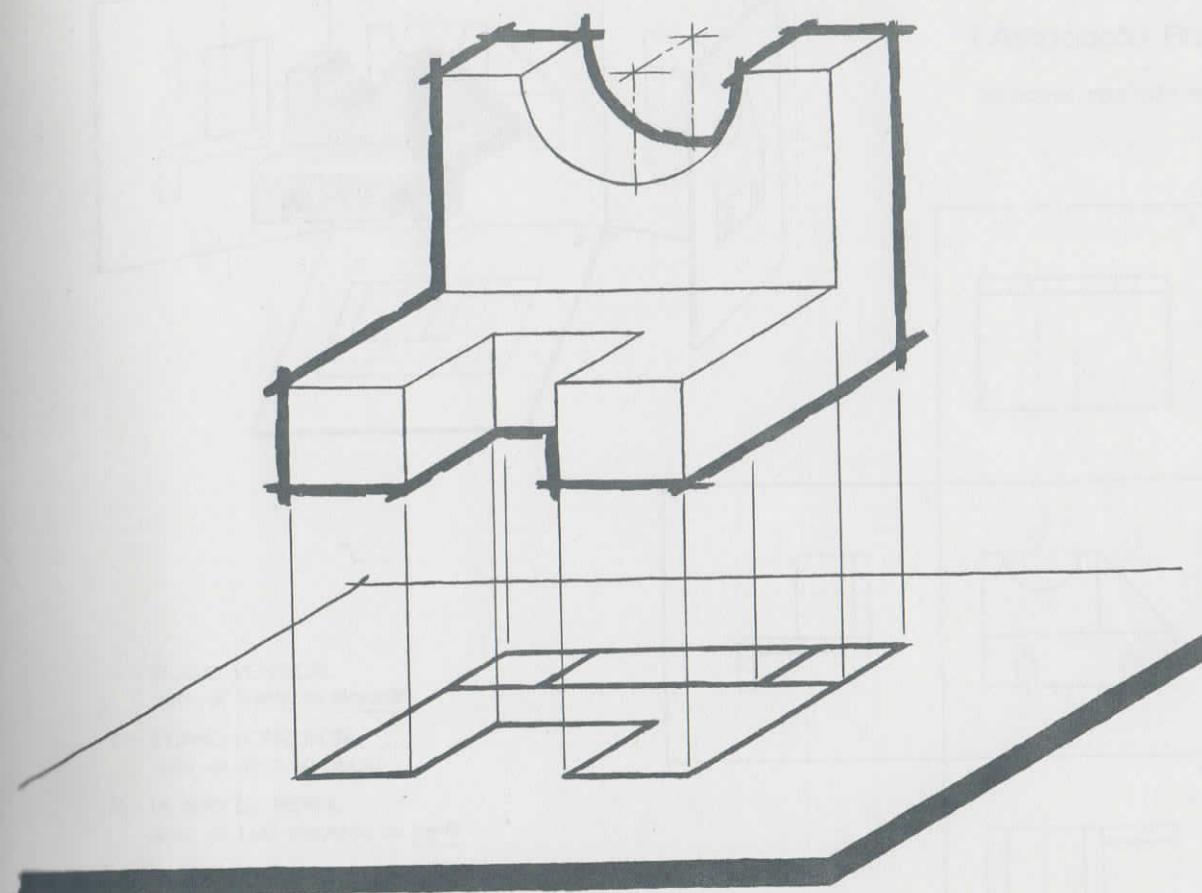


3

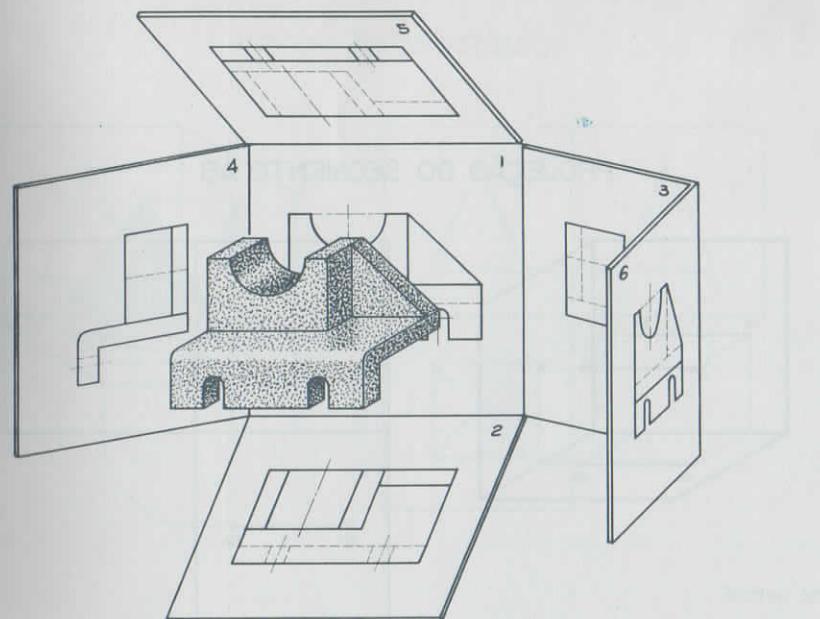
# projeções ortogonais

norma  
americana

norma  
européia



# PROJEÇÃO ORTOGONAL



1 - PLANO VERTICAL  
vista de frente ou elevação

2 - PLANO HORIZONTAL  
vista de cima ou planta

3 - PLANO DE PERFIL  
vista do lado esquerdo ou perfil

4 - PLANO DE PERFIL  
vista do lado direito

5 - PLANO HORIZONTAL  
vista de baixo

6 - PLANO VERTICAL  
vista de trás

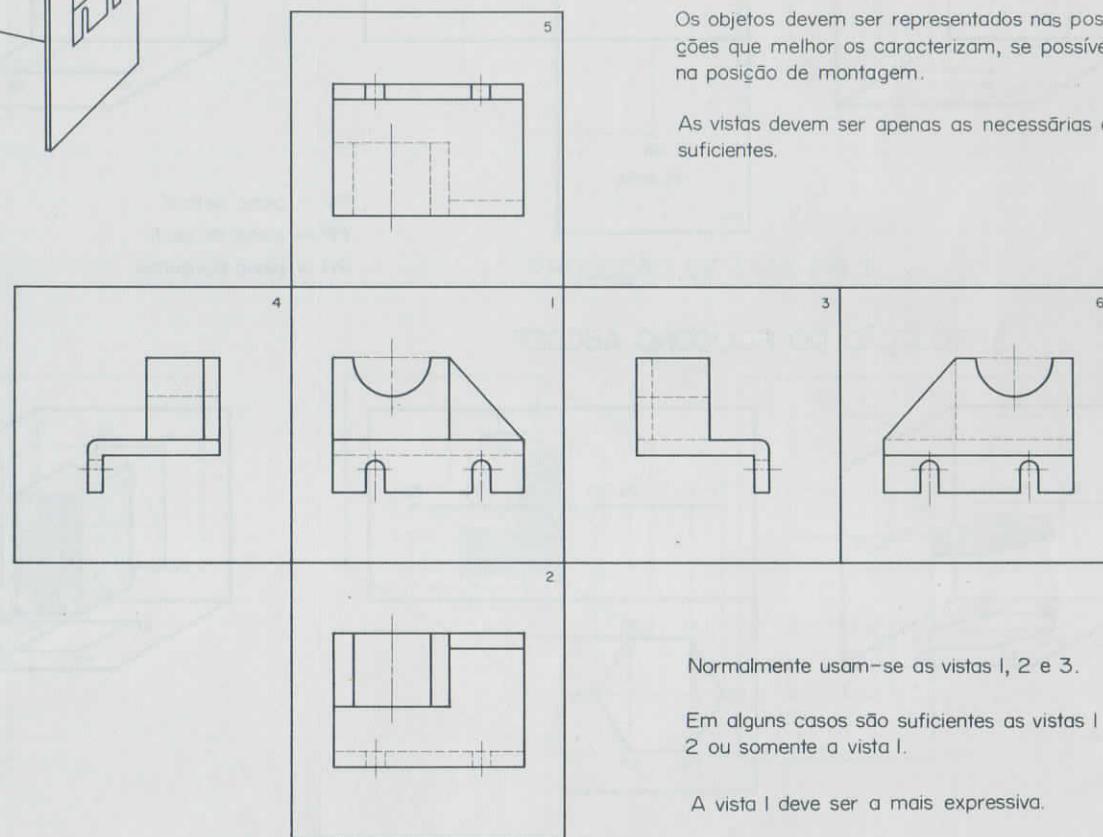
NORMA EUROPEIA adotada pela ABNT

(Associação Brasileira de Normas Técnicas)

De acordo com esta norma, o objeto se localiza na frente do plano do desenho.

Os objetos devem ser representados nas posições que melhor os caracterizam, se possível, na posição de montagem.

As vistas devem ser apenas as necessárias e suficientes.



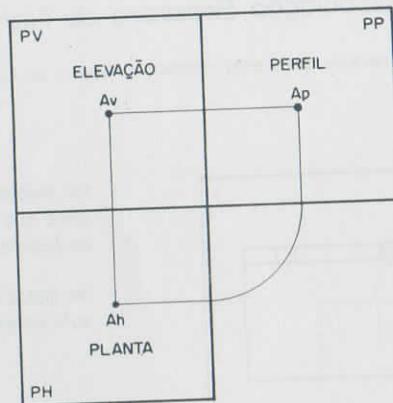
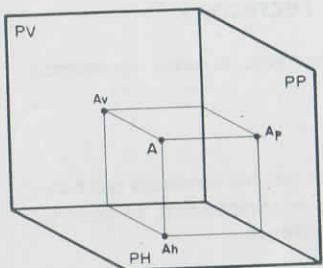
Normalmente usam-se as vistas 1, 2 e 3.

Em alguns casos são suficientes as vistas 1 e 2 ou somente a vista 1.

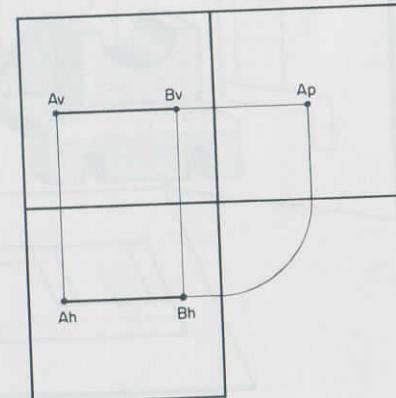
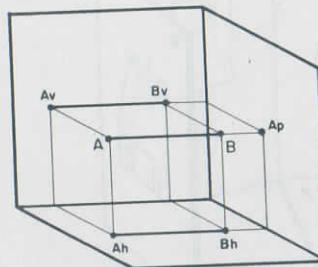
A vista 1 deve ser a mais expressiva.

# EXEMPLOS

PROJEÇÃO DO PONTO A

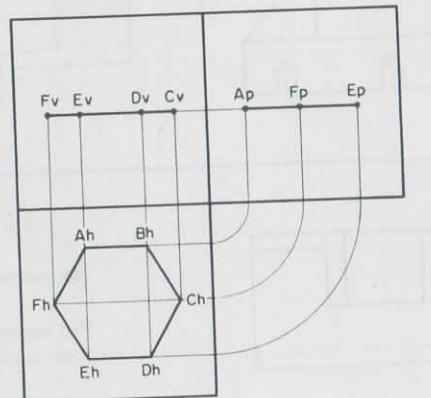
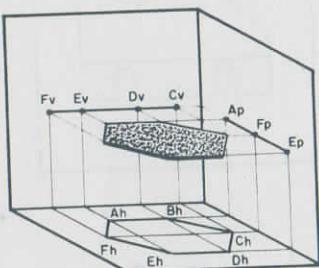


PROJEÇÃO DO SEGMENTO AB

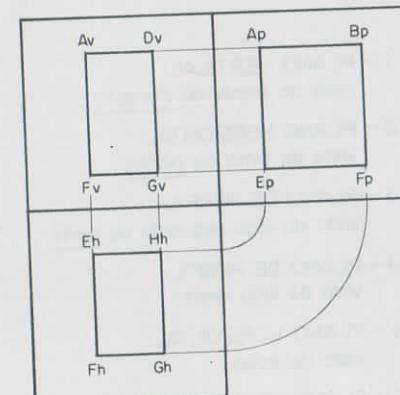
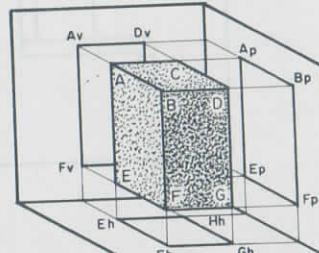


PV = plano vertical  
PP = plano de perfil  
PH = plano horizontal

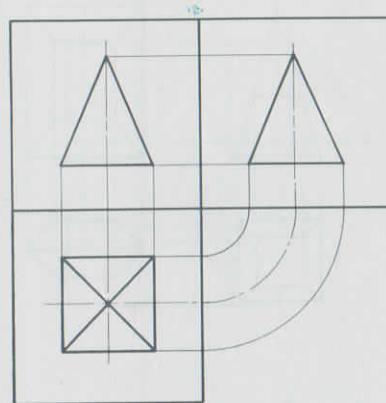
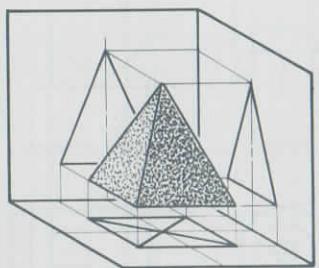
PROJEÇÃO DO POLÍGONO ABCDEF



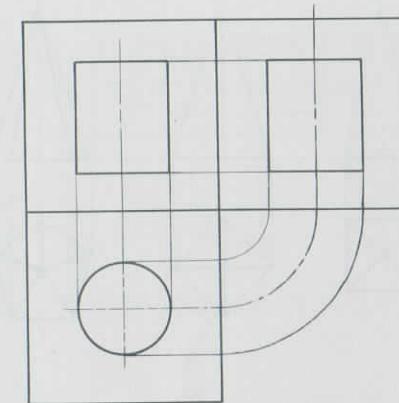
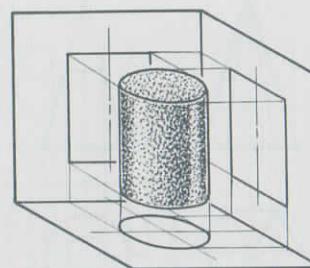
PROJEÇÃO DO PRISMA



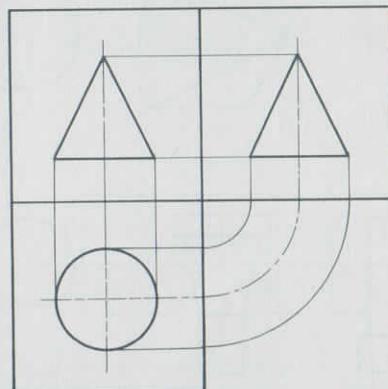
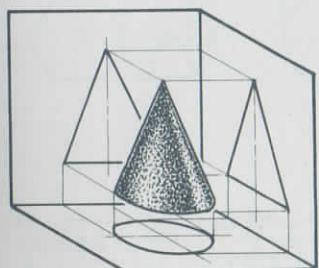
PROJEÇÃO DA PIRÂMIDE



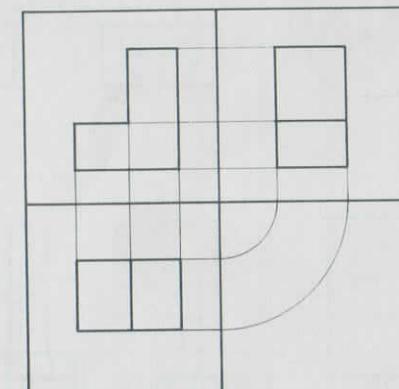
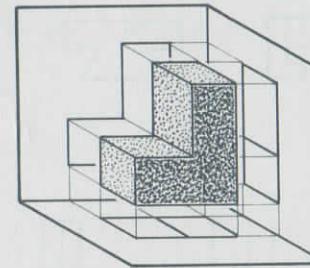
PROJEÇÃO DO CILINDRO



PROJEÇÃO DO CONE

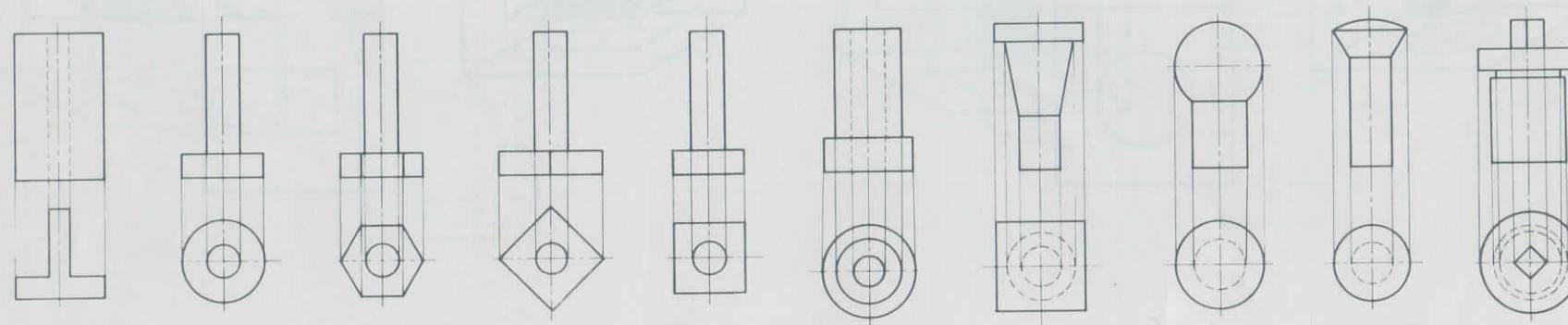
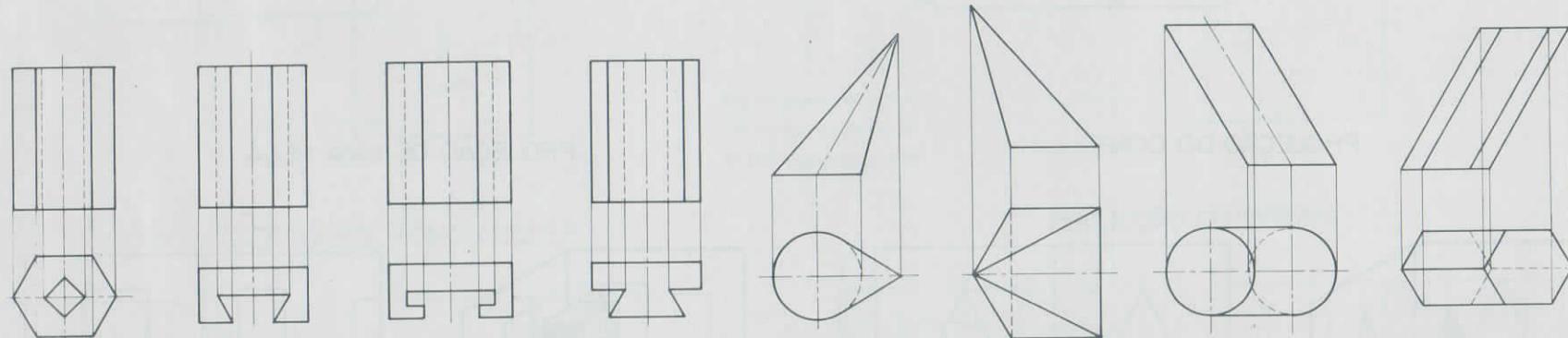
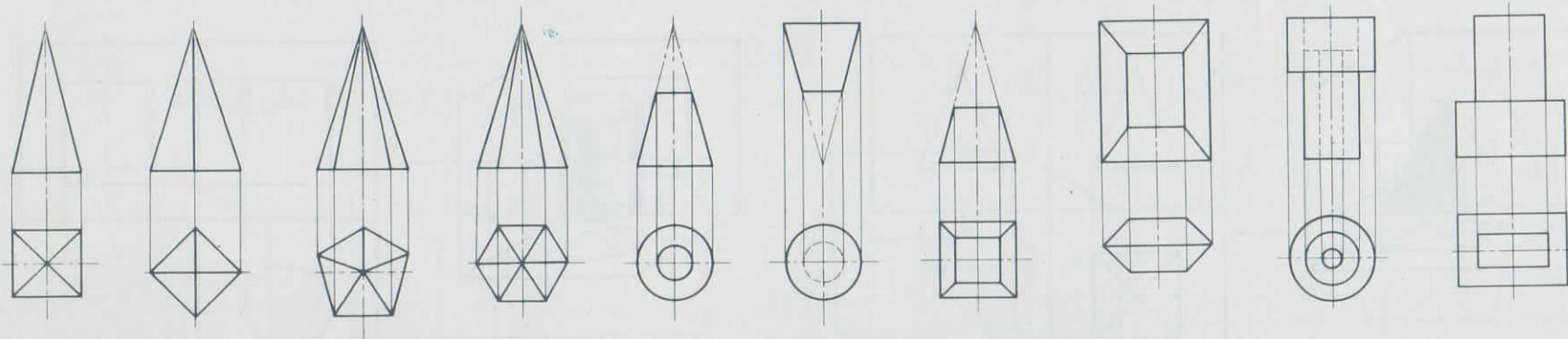


PROJEÇÃO DE UMA PEÇA



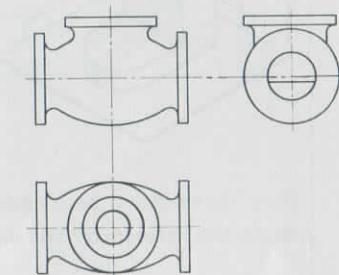
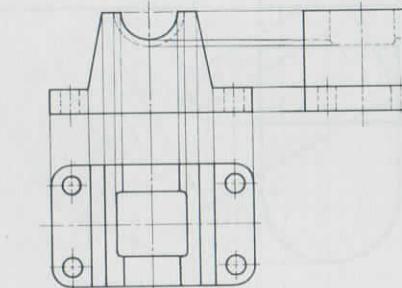
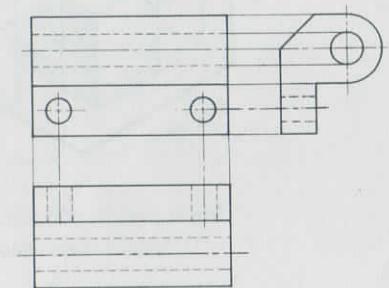
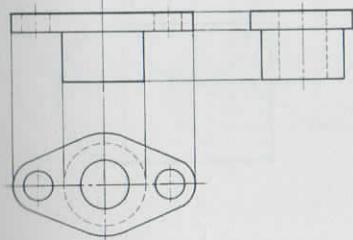
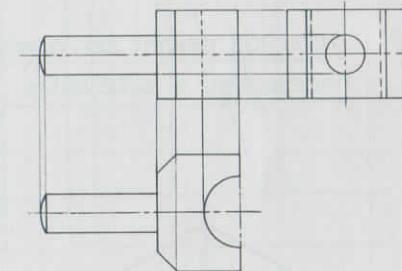
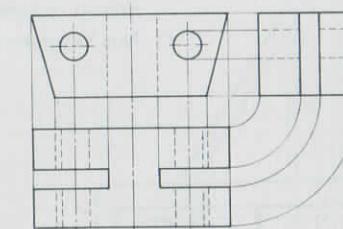
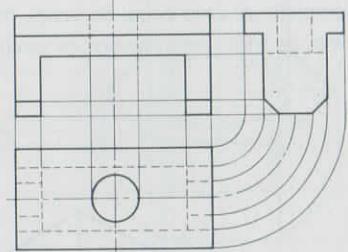
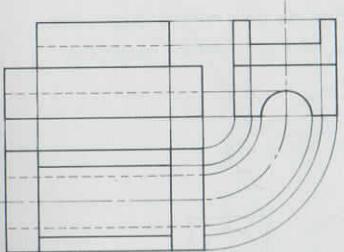
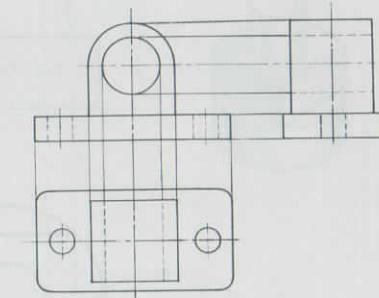
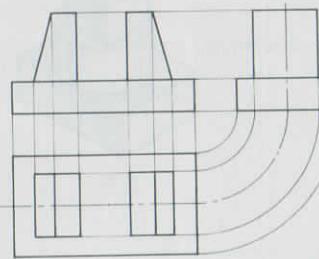
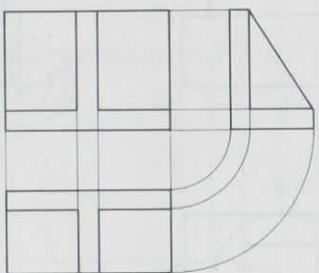
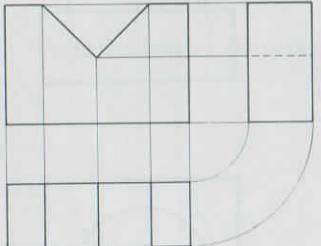
# REPRESENTAÇÃO EM DUAS VISTAS

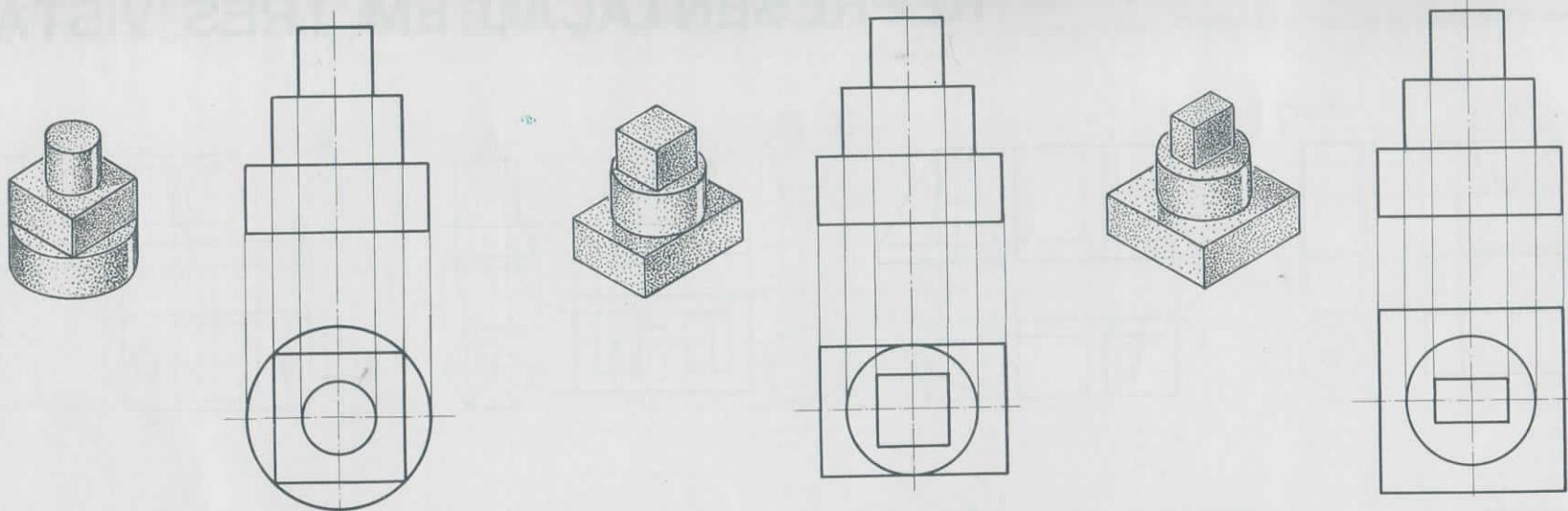
Alguns destes exemplos podem ser representados com uma vista apenas, se forem observadas as "Normas e Convenções."



Alguns destes exemplos podem ser representados com duas vistas  
abertas, se forem observadas as "Normas e Convenções."

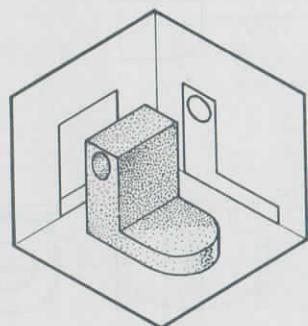
## REPRESENTAÇÃO EM TRES VISTAS



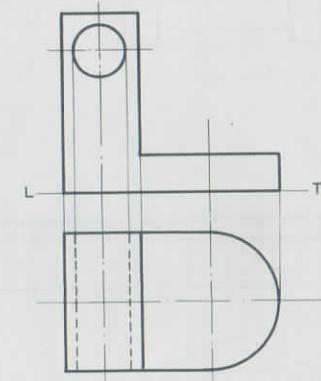
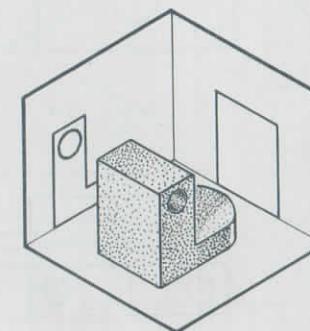
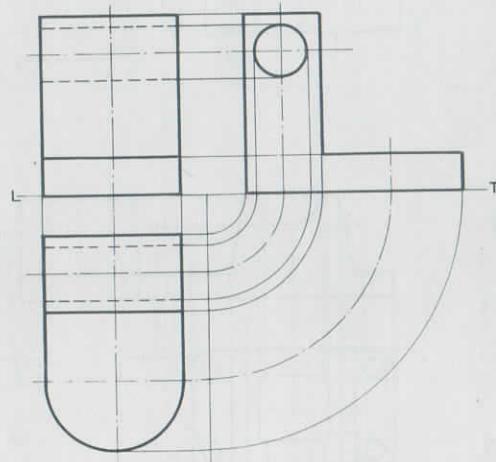


As vistas devem ser apenas as necessárias e suficientes.

Para a representação completa de uma peça, às vezes, há necessidade de pelo menos duas vistas. Nas representações acima, as três peças, apesar de serem diferentes, têm as mesmas elevações.



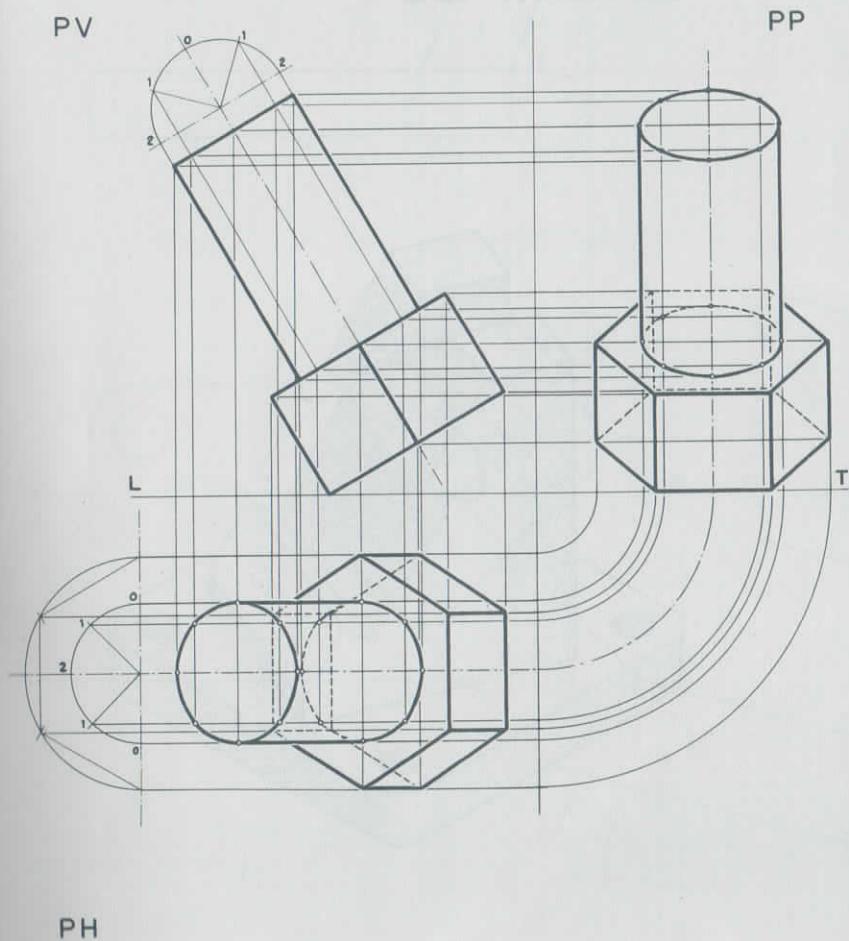
Para representar a peça nesta posição, são necessárias três vistas.



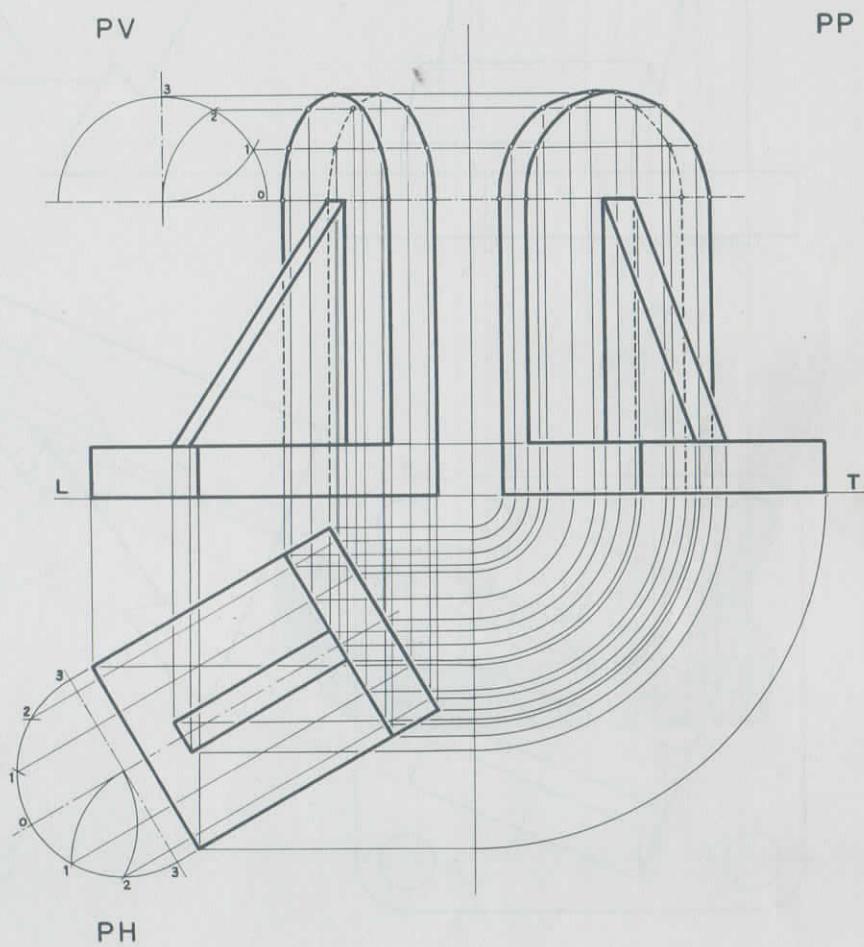
Nesta posição são suficientes apenas duas vistas.

# ELEMENTOS INCLINADOS C/ OS PLANOS DE PROJEÇÃO

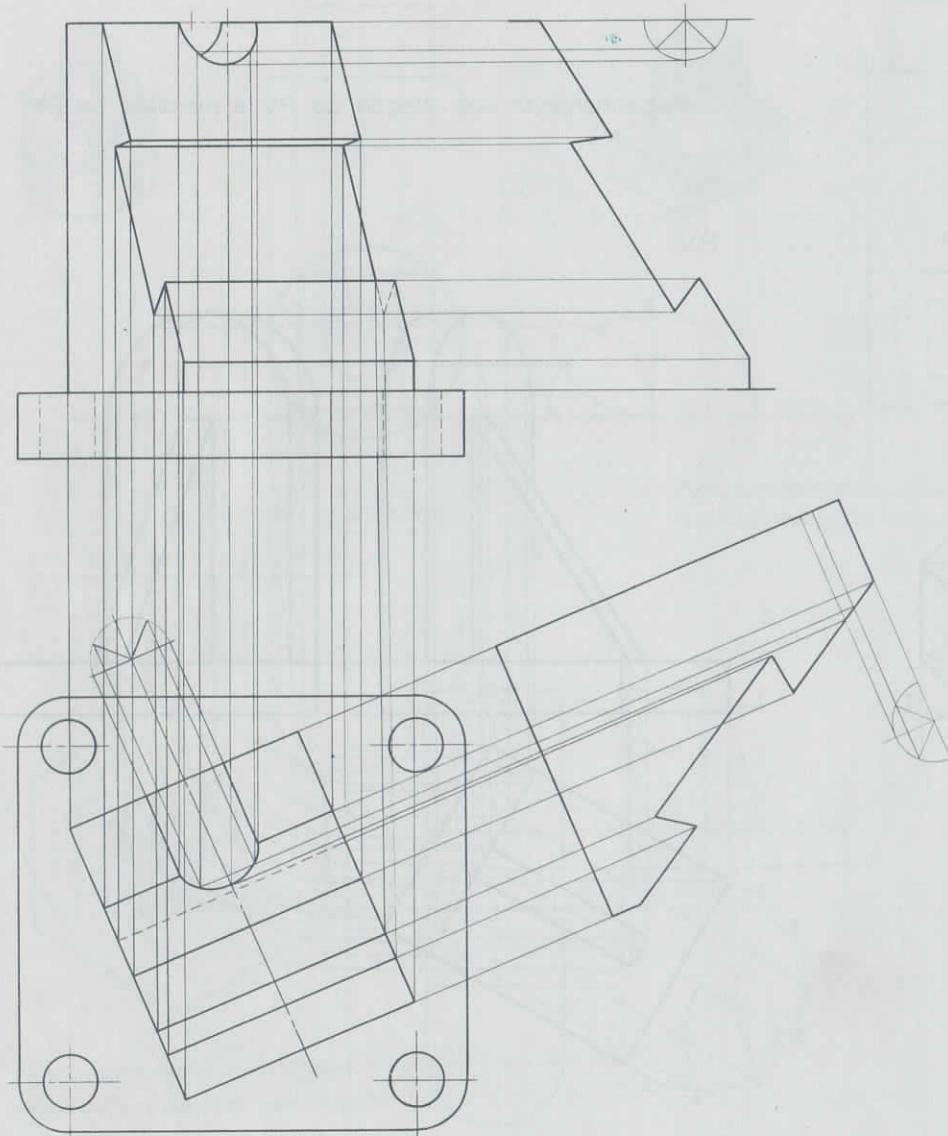
Peca inclinada em relação ao PH e paralela ao PV.



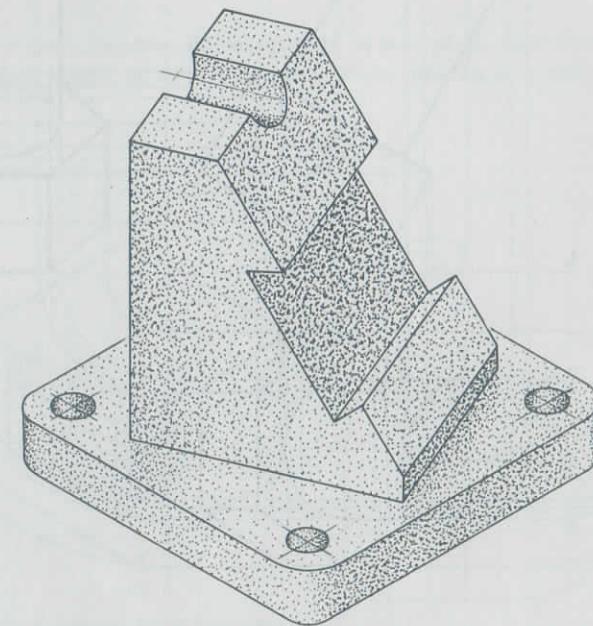
Peca inclinada em relação ao PV e paralela ao PH.



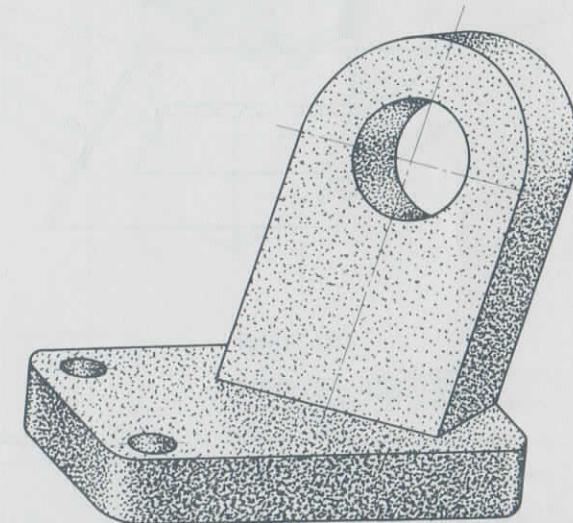
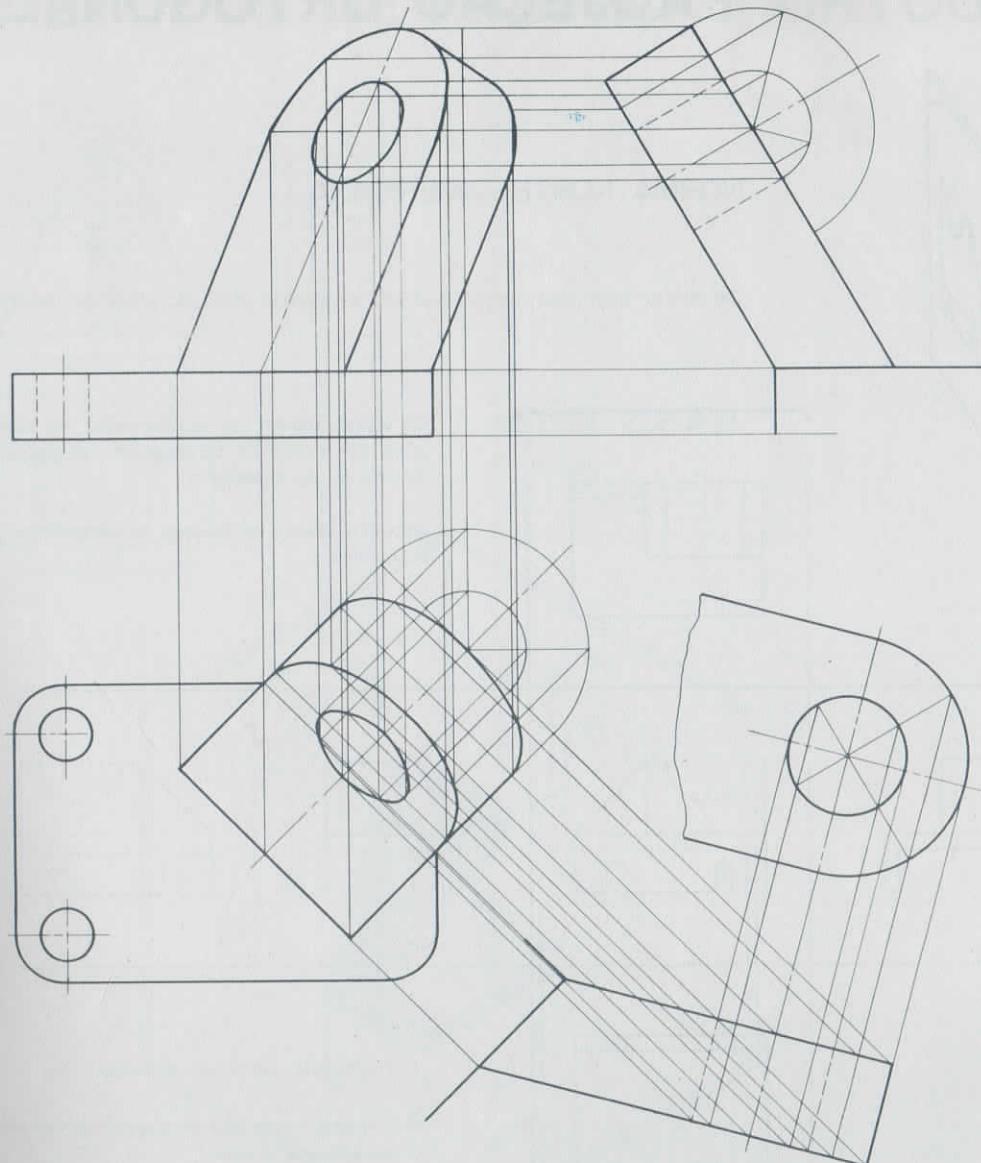
# ELEMENTOS INCLINADOS OS PLANOS DE PROJEÇÃO



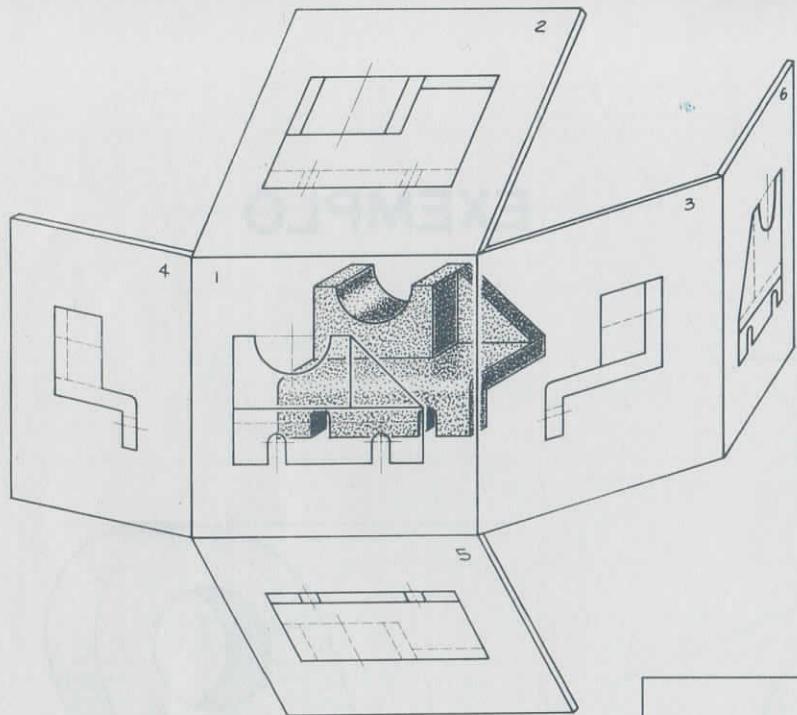
## EXEMPLO



## EXEMPLO



# PROJEÇÃO ORTOGONAL



1 - PLANO VERTICAL  
vista de frente ou elevação

2 - PLANO HORIZONTAL  
vista de cima ou planta

3 - PLANO DE PERFIL  
vista do lado direito ou perfil

4 - PLANO DE PERFIL  
vista do lado esquerdo

5 - PLANO HORIZONTAL  
vista de baixo

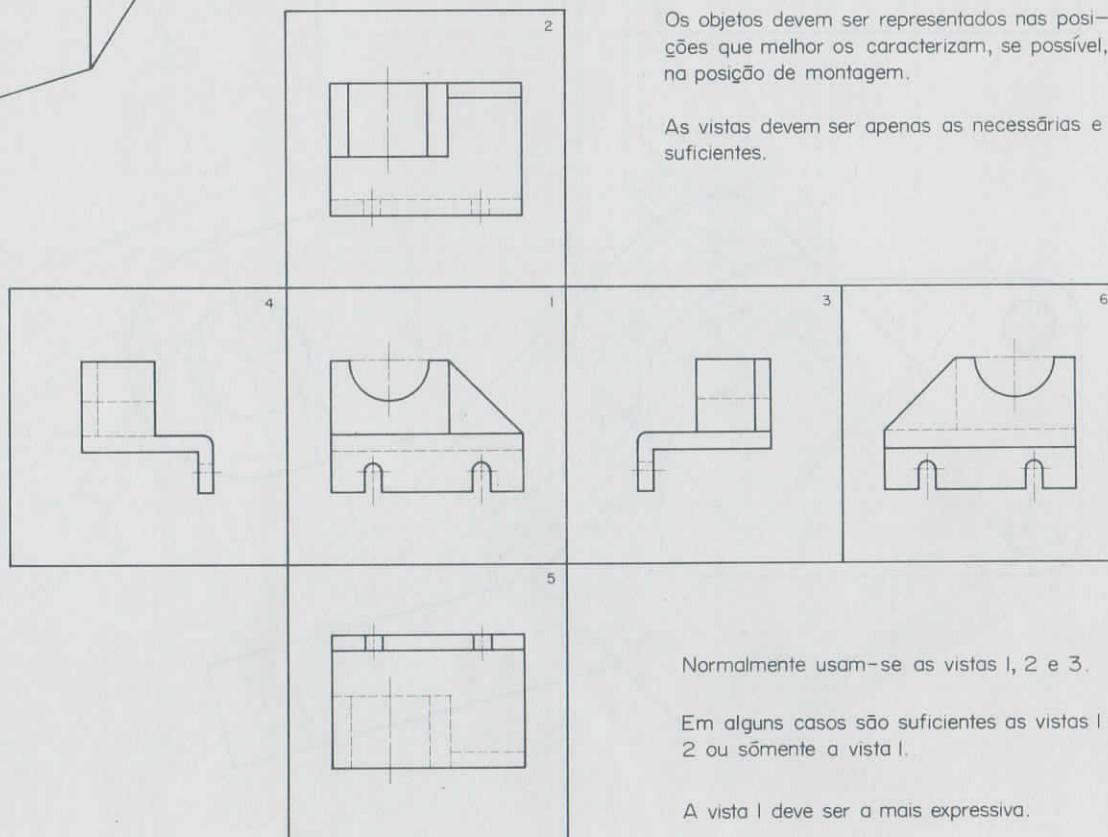
6 - PLANO VERTICAL  
vista de trás

## NORMA NORTE - AMERICANA

De acordo com esta norma, o objeto se localiza atrás do plano do desenho.

Os objetos devem ser representados nas posições que melhor os caracterizam, se possível, na posição de montagem.

As vistas devem ser apenas as necessárias e suficientes.

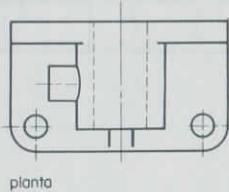
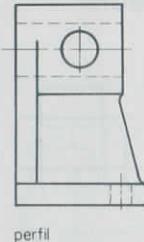
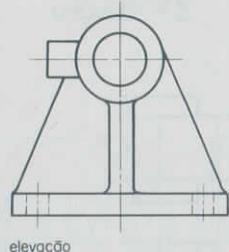


Normalmente usam-se as vistas 1, 2 e 3.

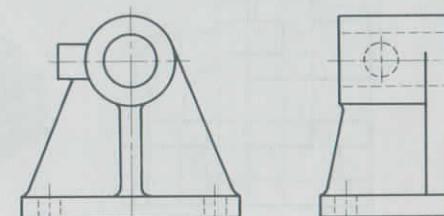
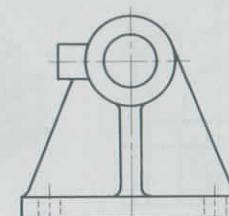
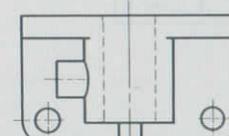
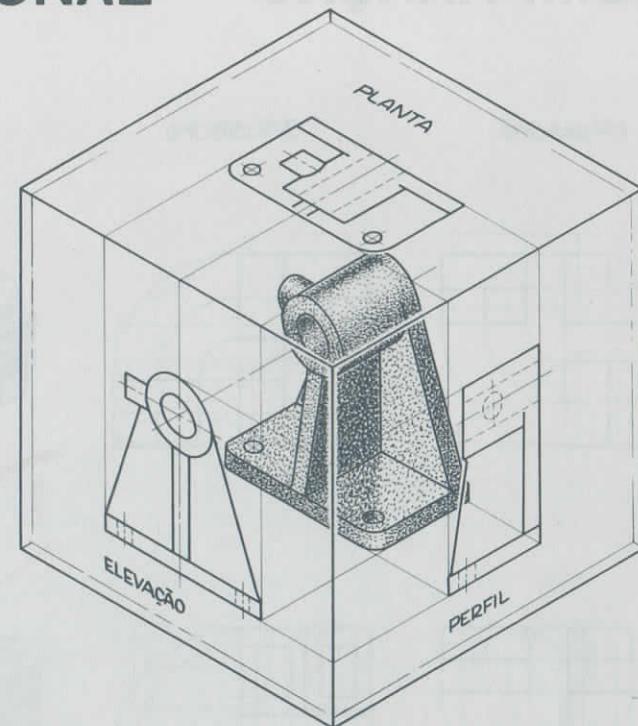
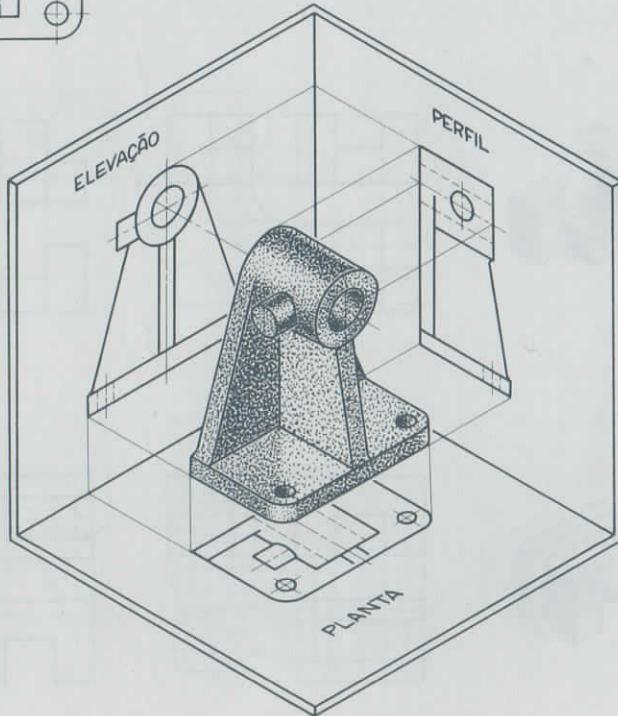
Em alguns casos são suficientes as vistas 1 e 2 ou sómente a vista 1.

A vista 1 deve ser a mais expressiva.

# MÉTODOS DE PROJEÇÃO ORTOGONAL

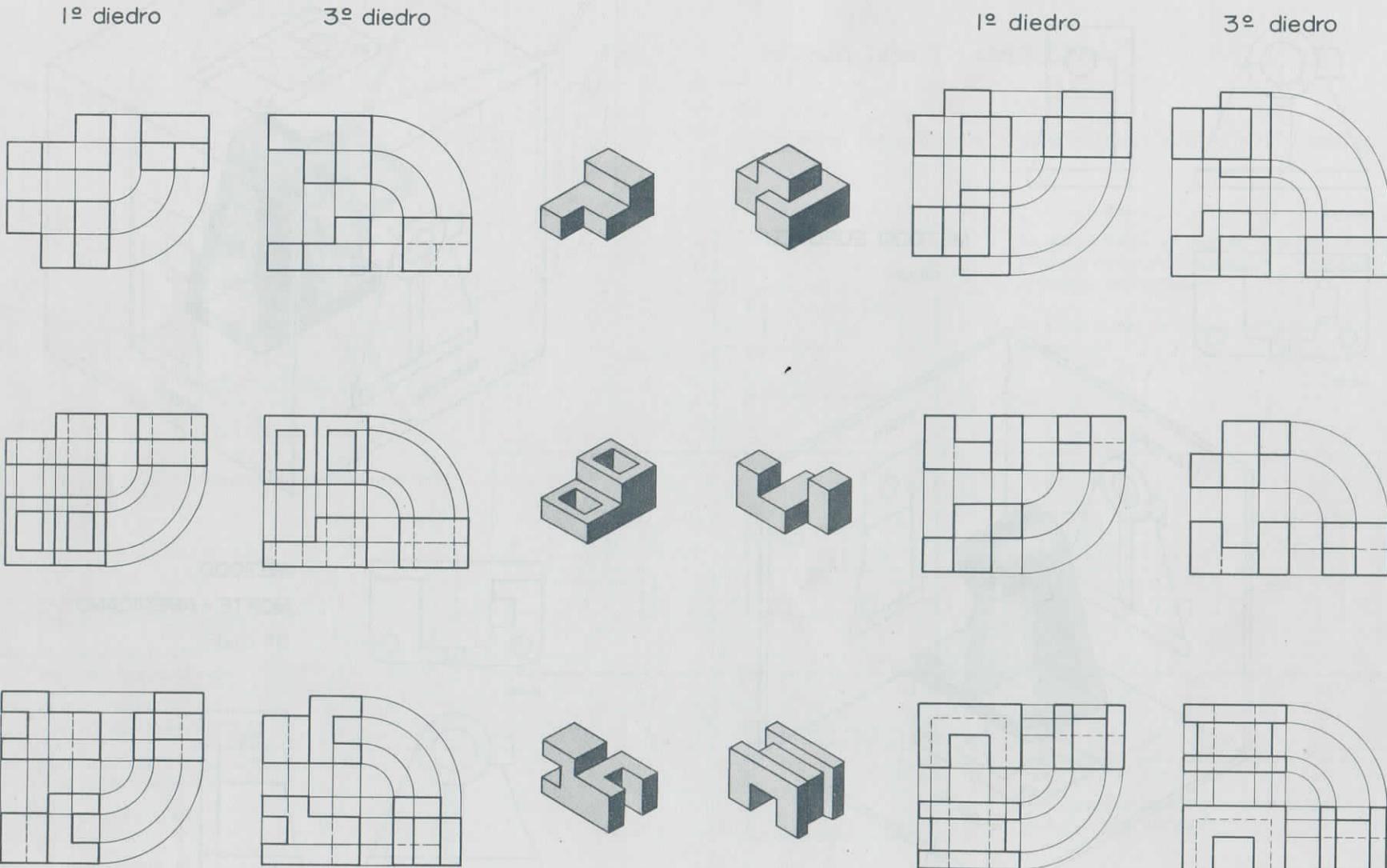


MÉTODO EUROPEU  
1º diedro

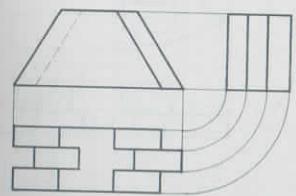


MÉTODO  
NORTE - AMERICANO  
3º diedro

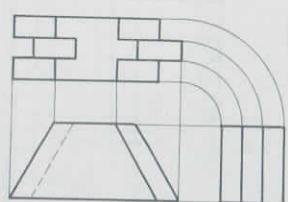
# COMPARAÇÃO



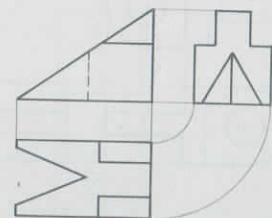
1º diedro



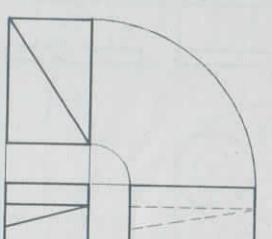
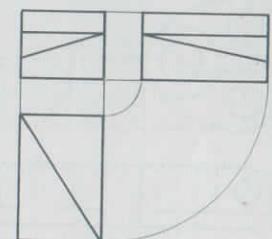
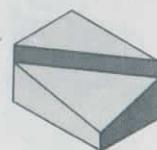
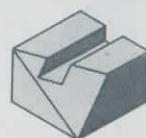
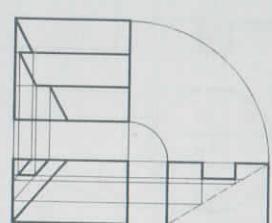
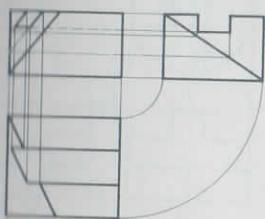
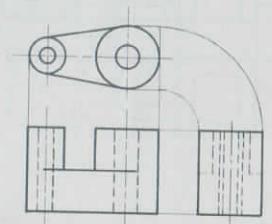
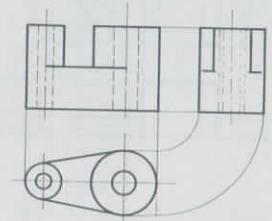
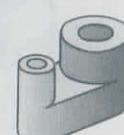
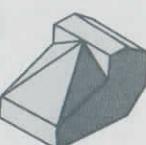
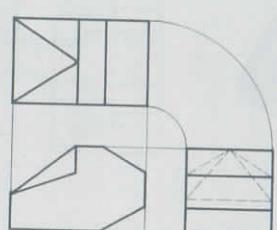
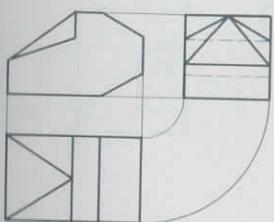
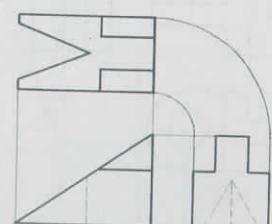
3º diedro

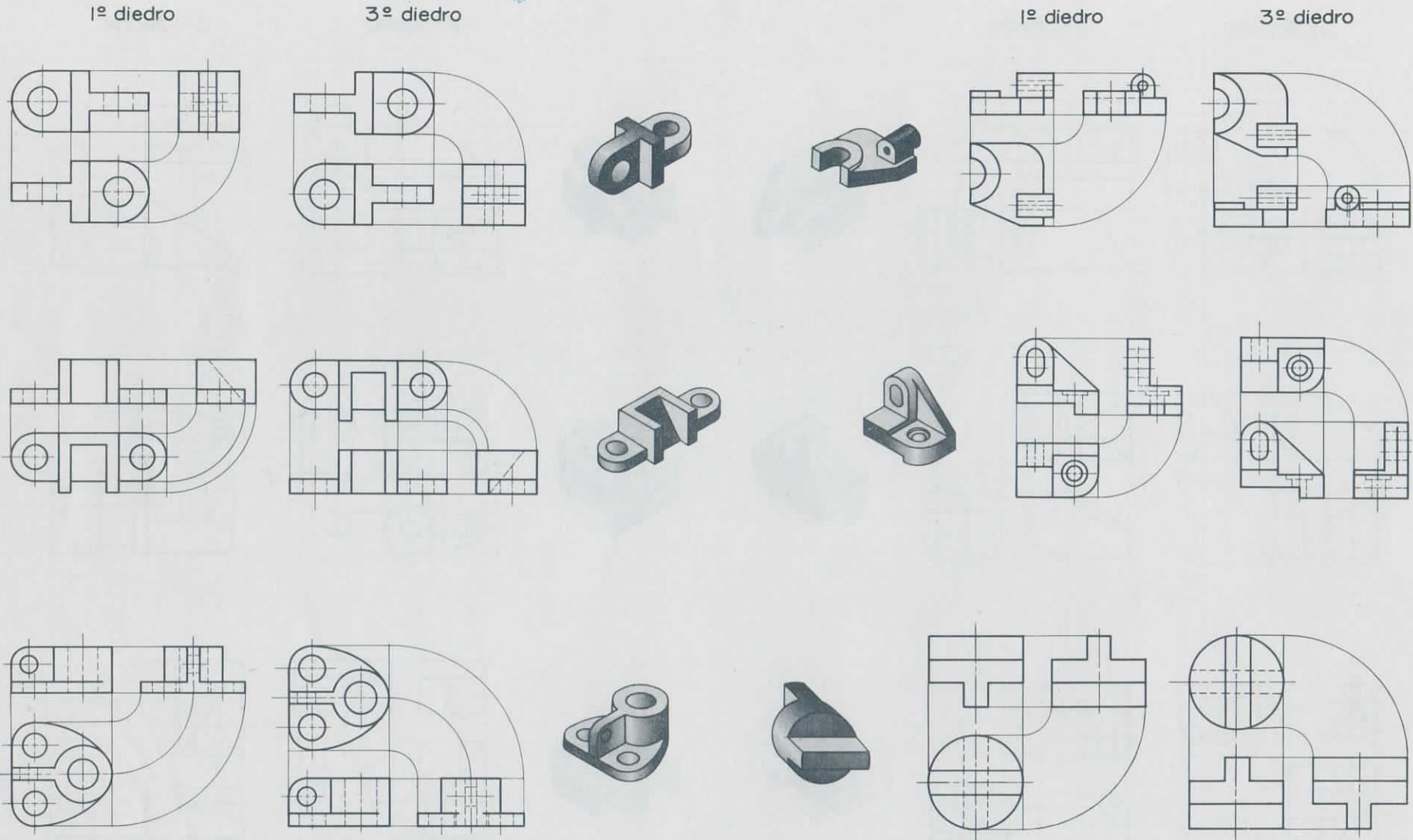


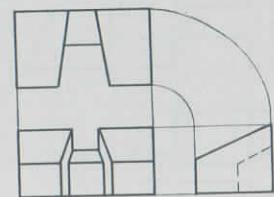
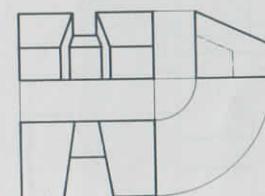
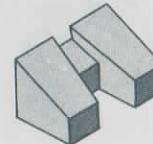
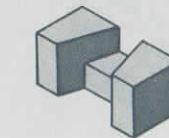
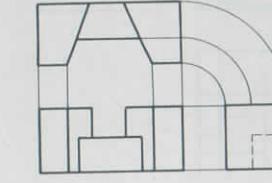
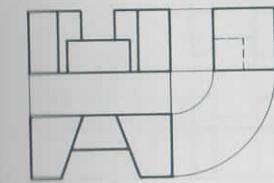
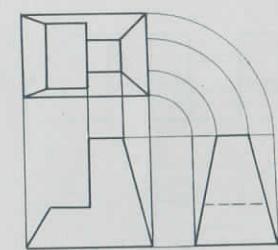
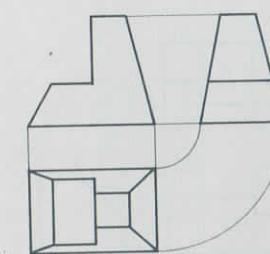
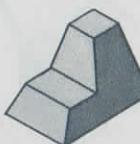
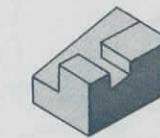
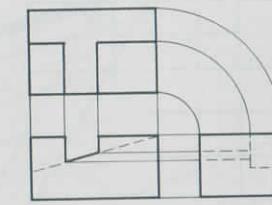
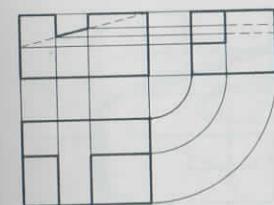
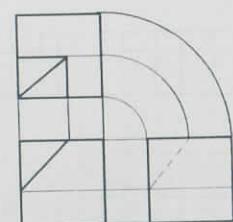
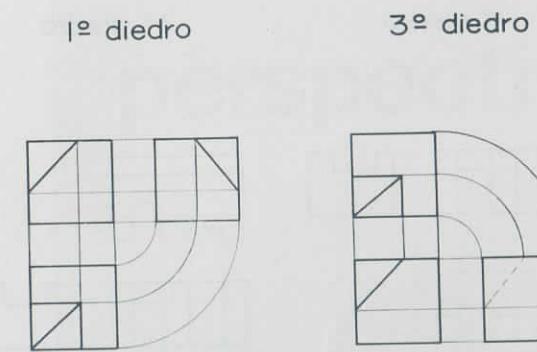
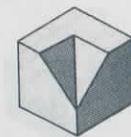
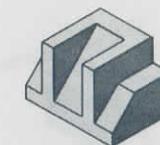
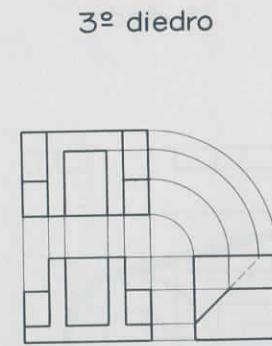
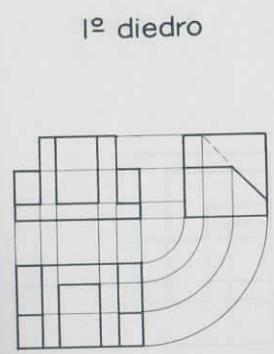
1º diedro

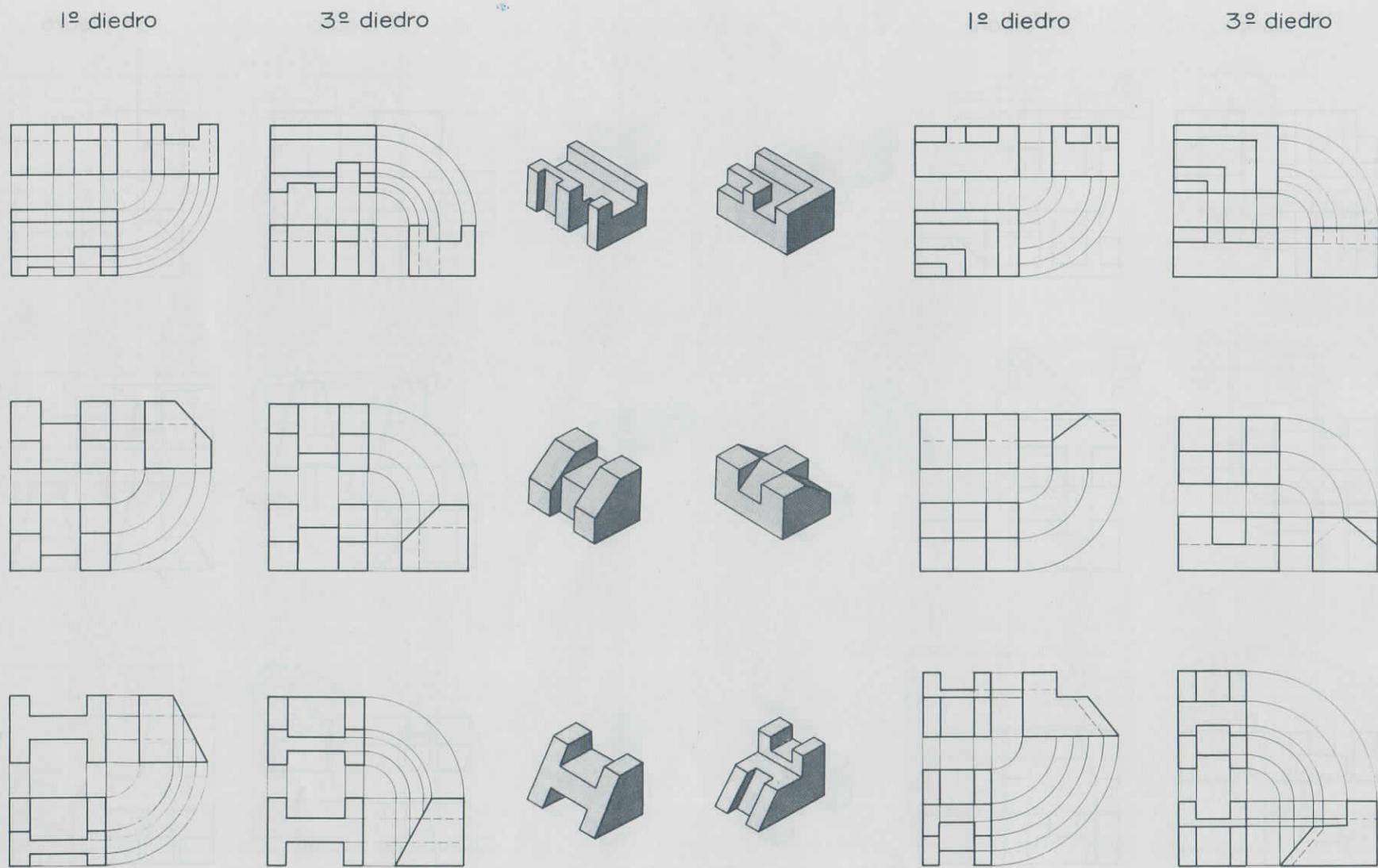


3º diedro









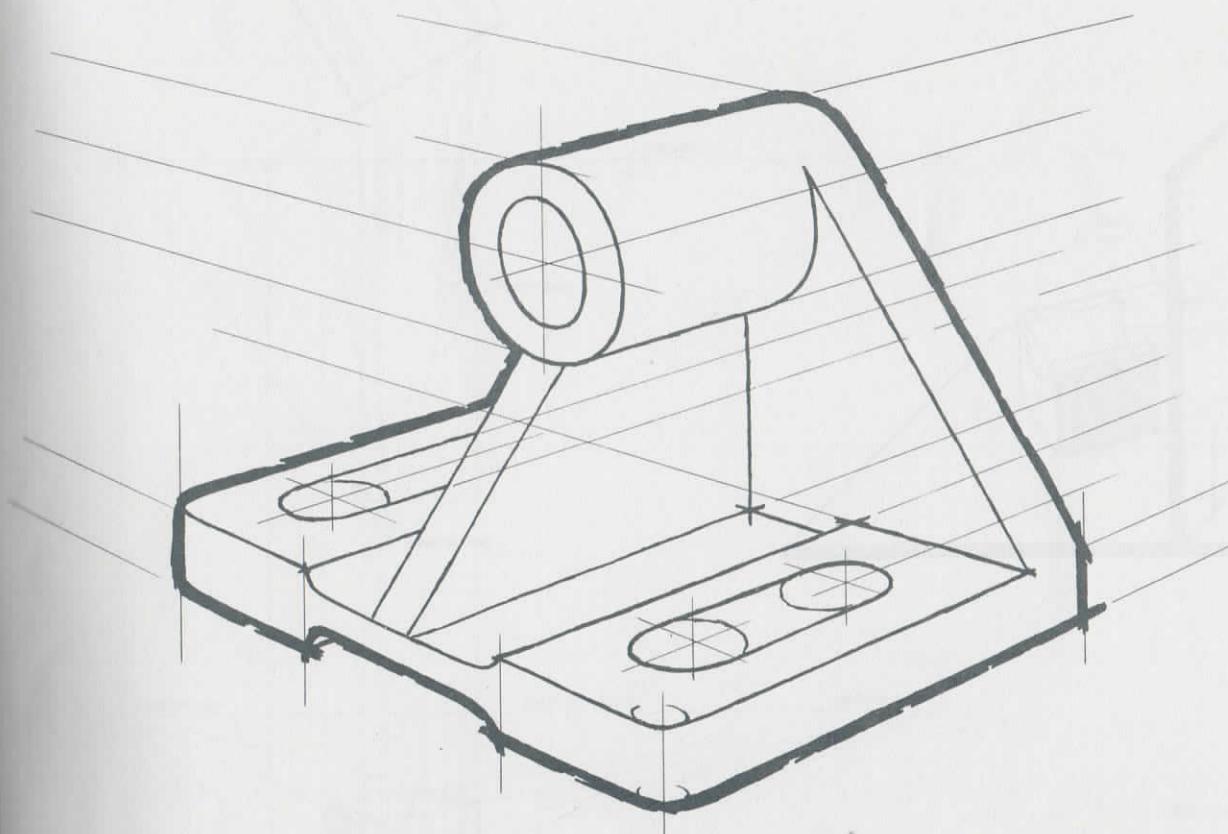
# 4 perspectiva

exata

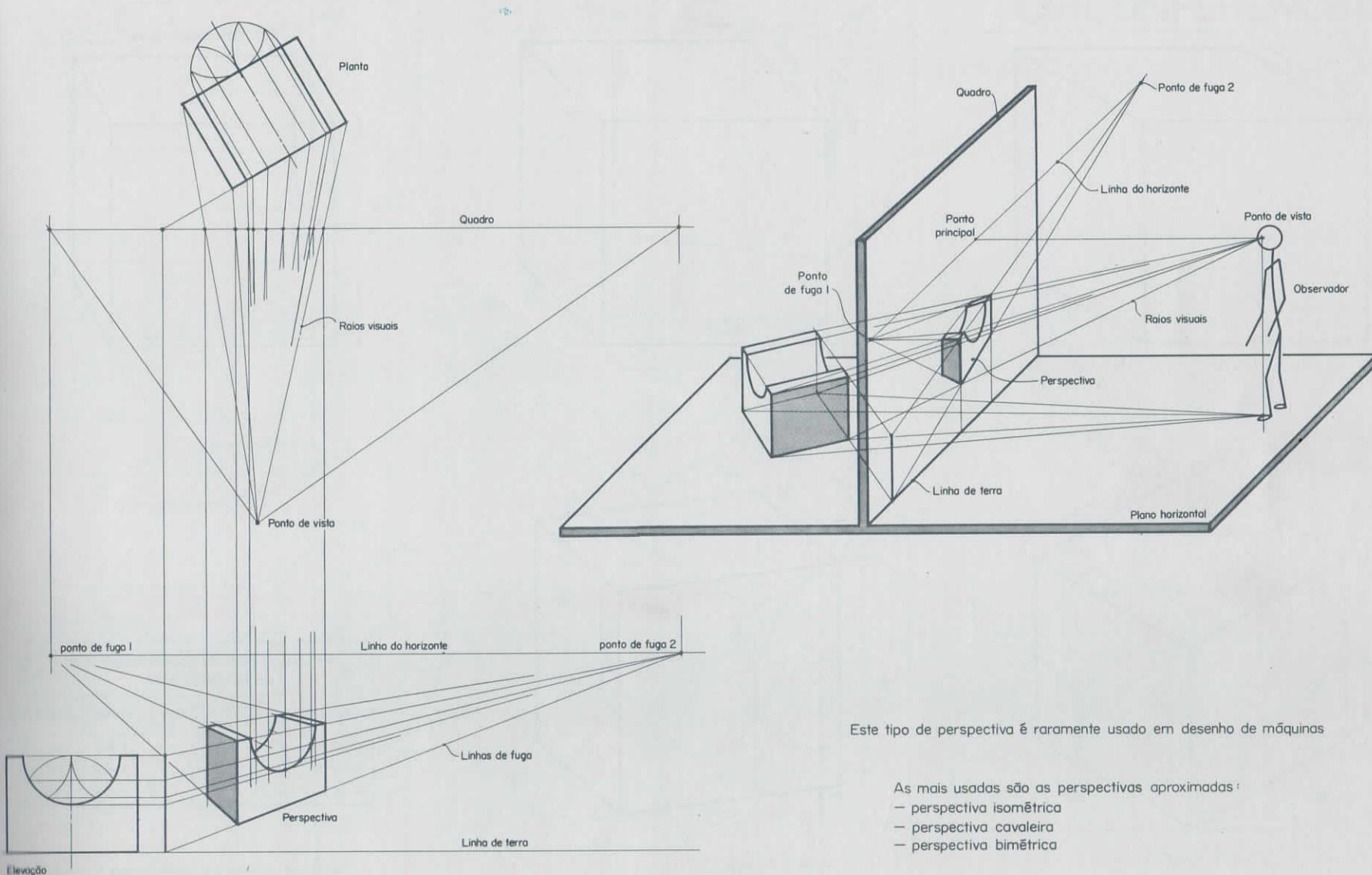
cavaleira

bimétrica

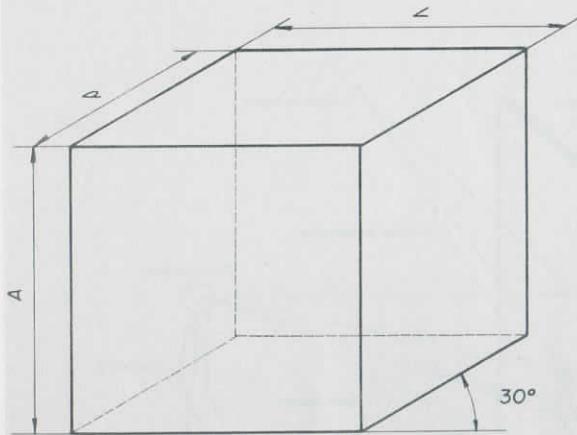
isométrica



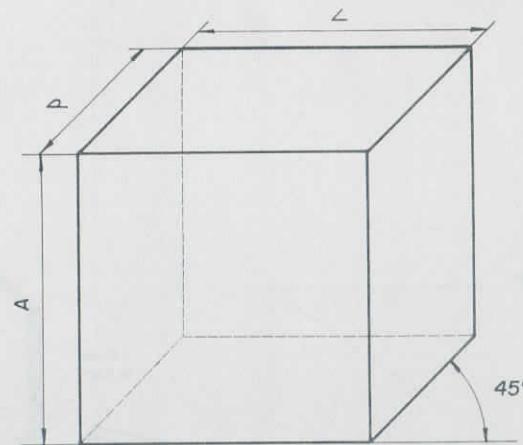
# PERSPECTIVA EXATA



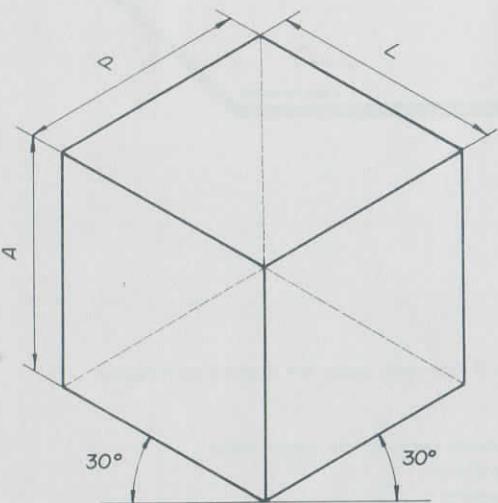
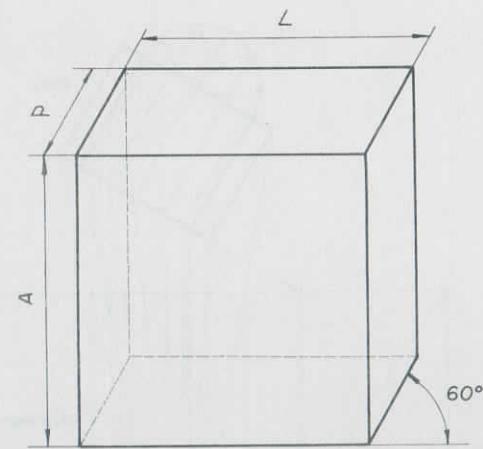
cavaleira à 30°



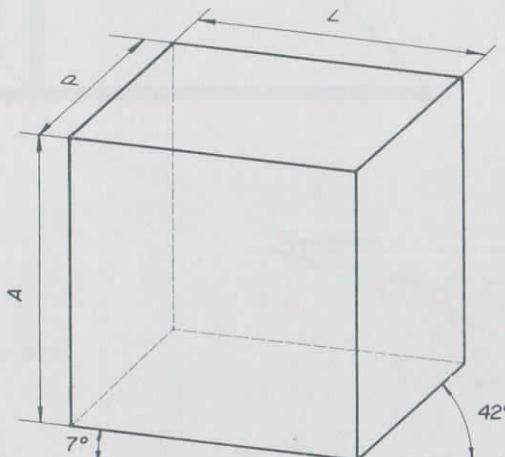
cavaleira à 45°



cavaleira à 60°



isométrica



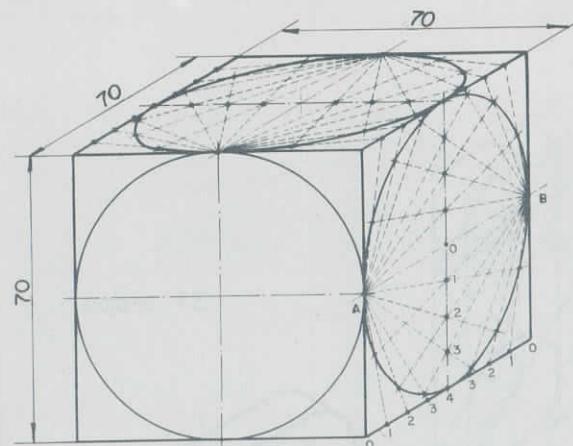
bimétrica

RELAÇÃO DAS MEDIDAS REAIS COM AS DO DESENHO

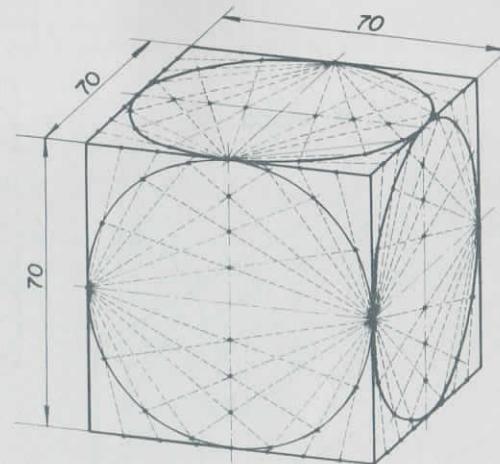
PERSPEC.	CAVALEIRA			ISOMÉT.	BIMÉT.
	30°	45°	60°		
LARGURA	1:1	1:1	1:1	1:4/5	1:1
ALTURA	1:1	1:1	1:1	1:4/5	1:1
PROFUND	1:2/3	1:1/2	1:1/3	1:4/5	1:1/2

As medidas devem ser demarcadas sempre nos planos de referências. ( horizontais e verticais)

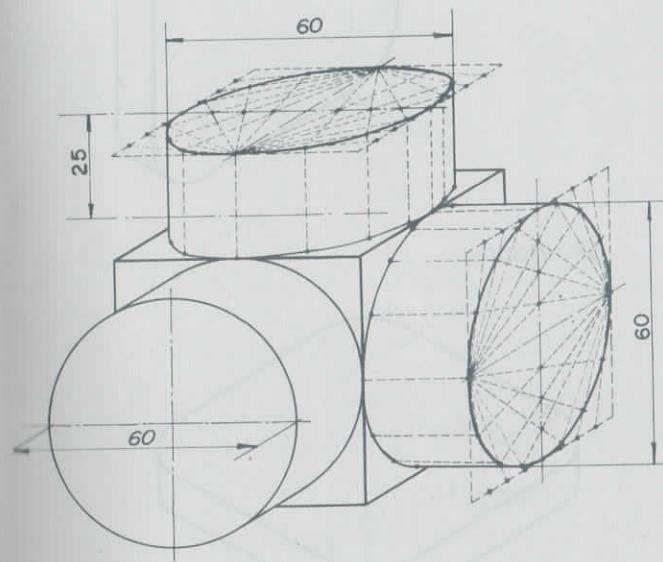
## PERSPECTIVA DE CIRCUNFERÊNCIAS



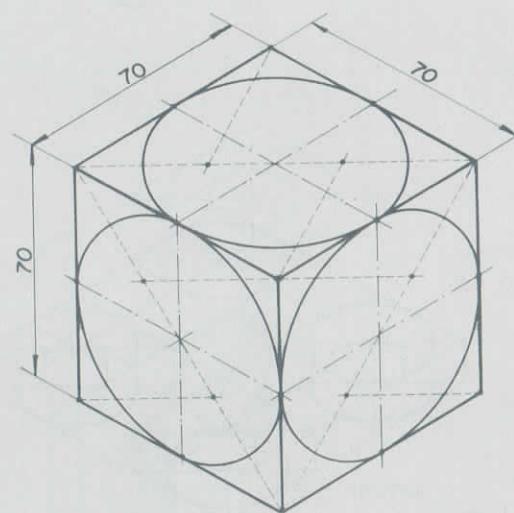
CAVALEIRA A  $30^\circ$



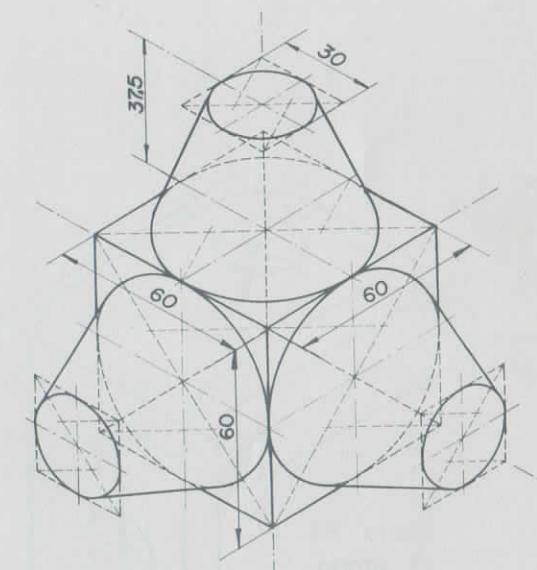
BIMÉTRICA



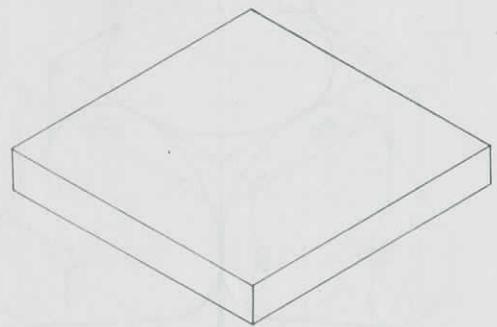
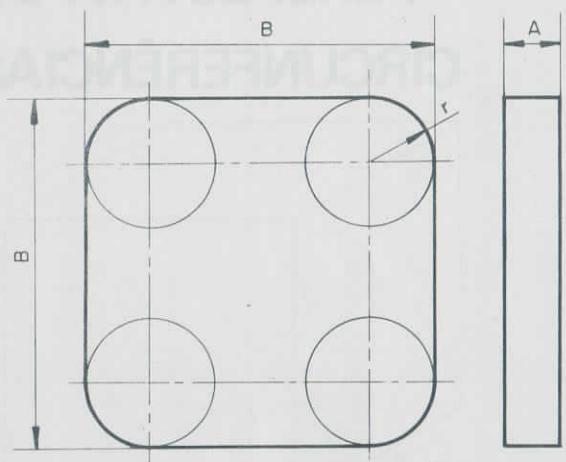
CAVALEIRA A  $30^\circ$



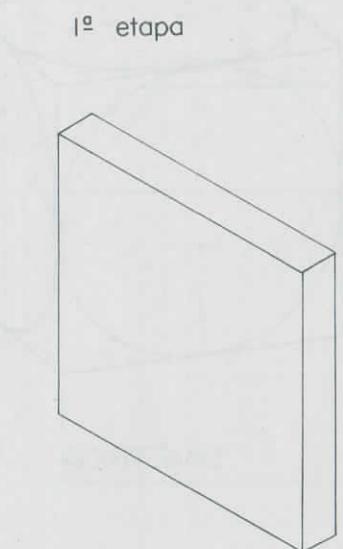
ISOMÉTRICA



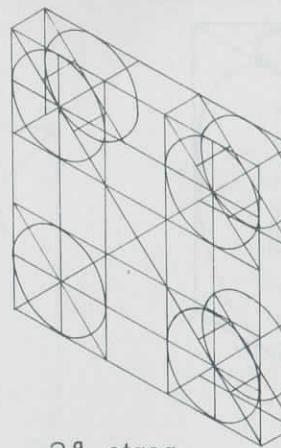
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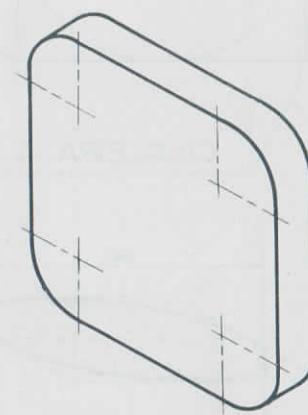
1<sup>a</sup> etapa



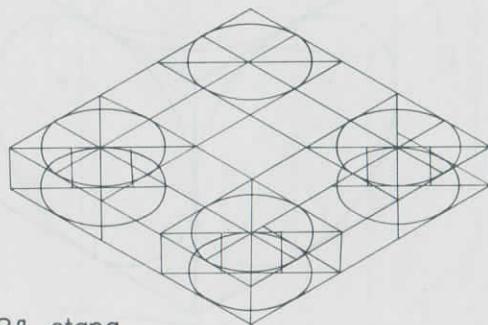
1<sup>a</sup> etapa



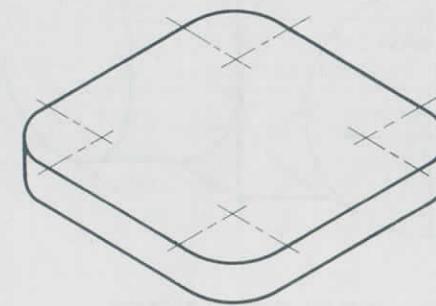
2<sup>a</sup> etapa



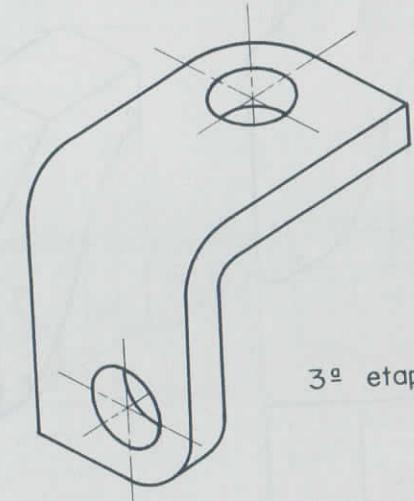
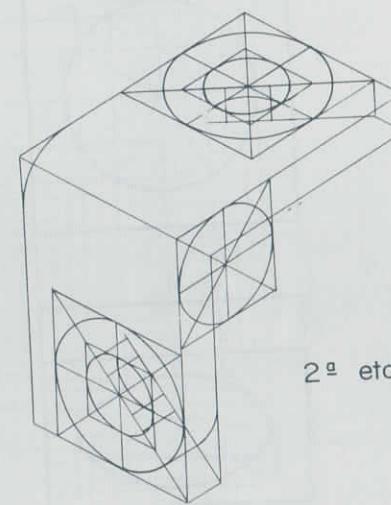
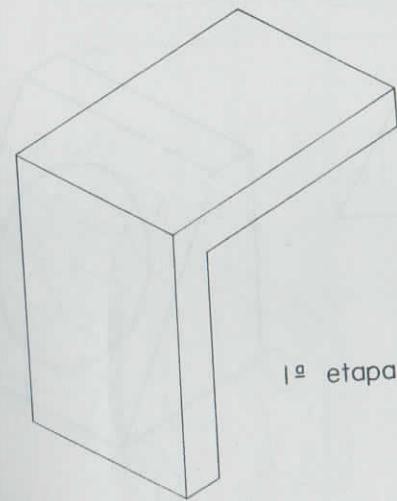
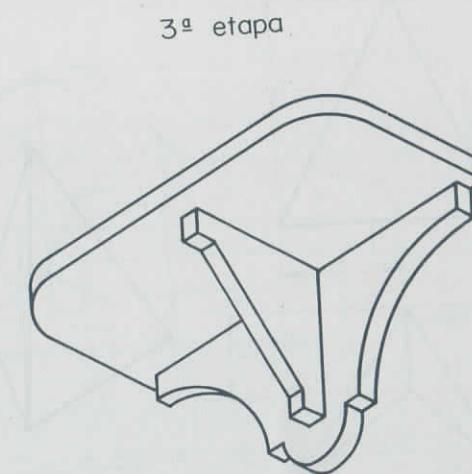
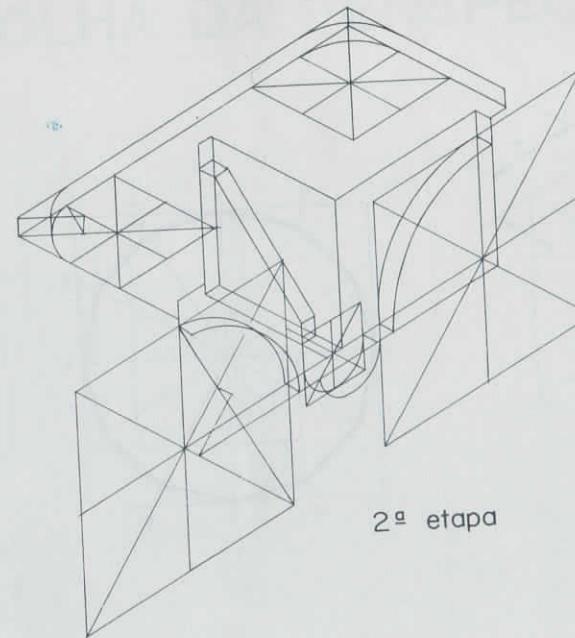
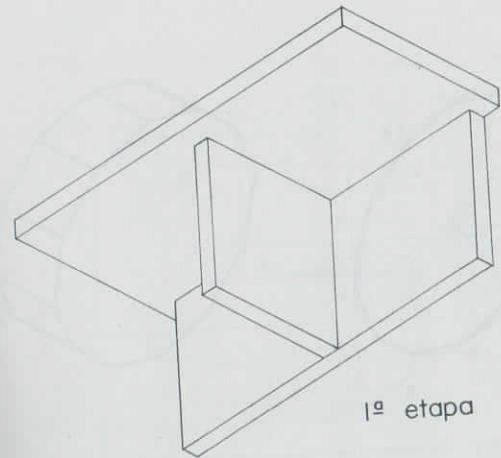
3<sup>a</sup> etapa

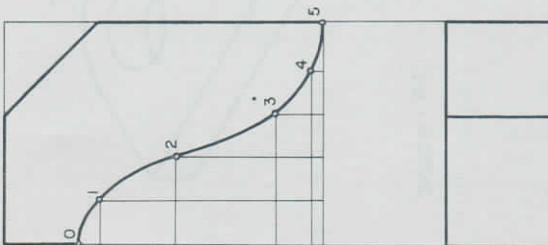
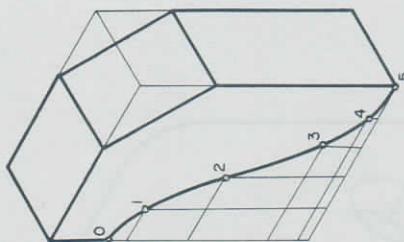
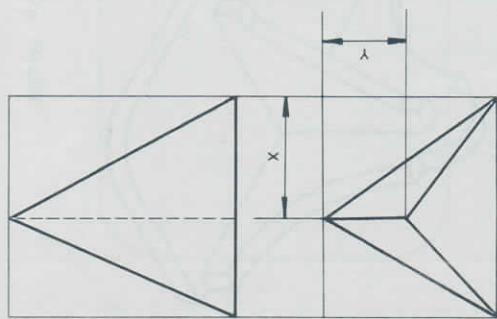
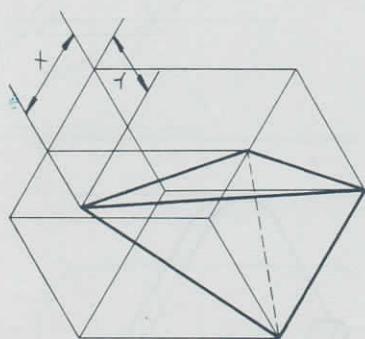
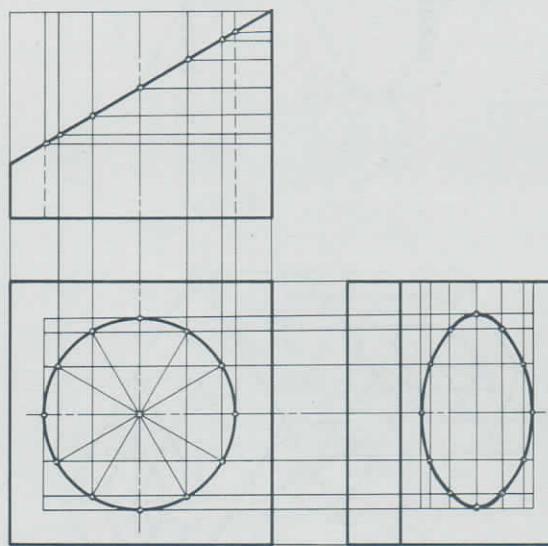
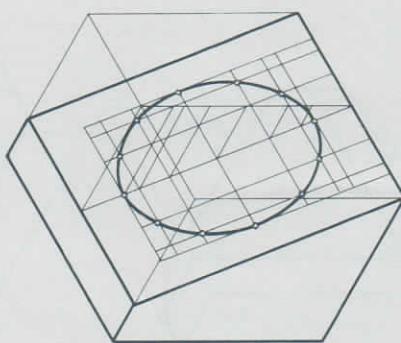
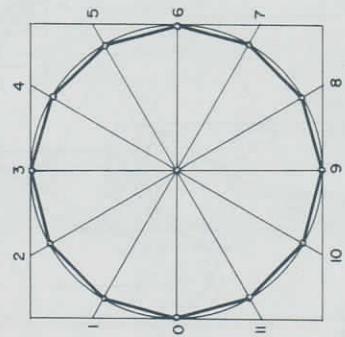
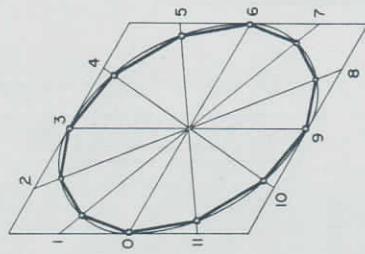
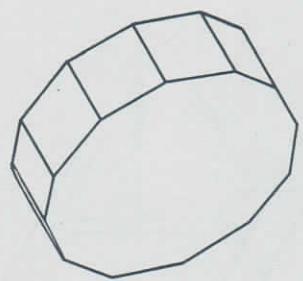


2<sup>a</sup> etapa

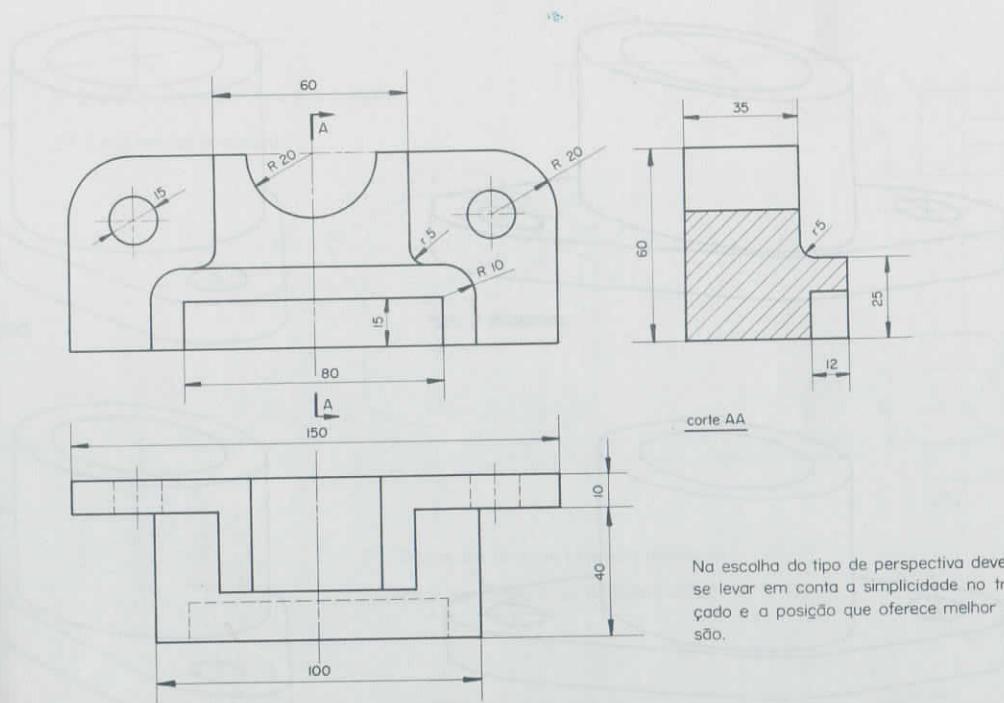


3<sup>a</sup> etapa

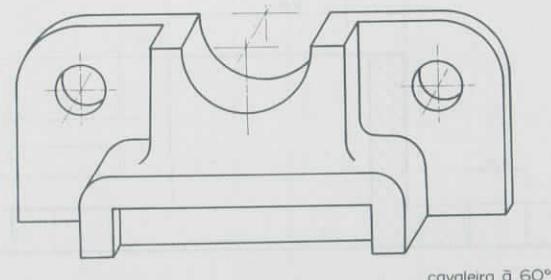




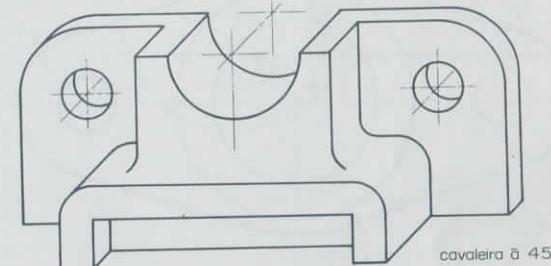
# ESCOLHA DA PERSPECTIVA



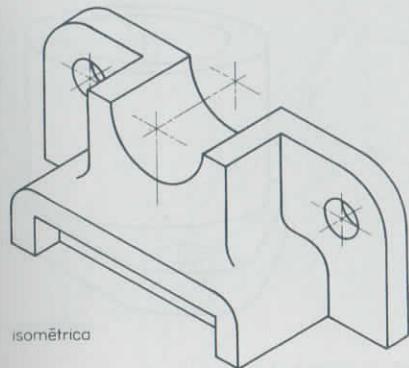
Na escolha do tipo de perspectiva deve-se levar em conta a simplicidade no traçado e a posição que oferece melhor visão.



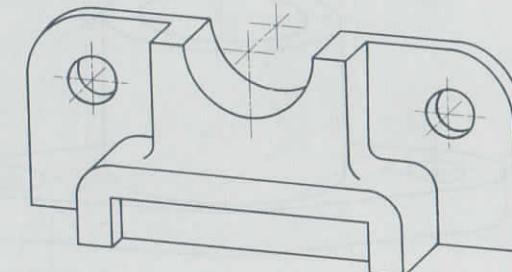
Solução fácil, porém, pouco expressiva



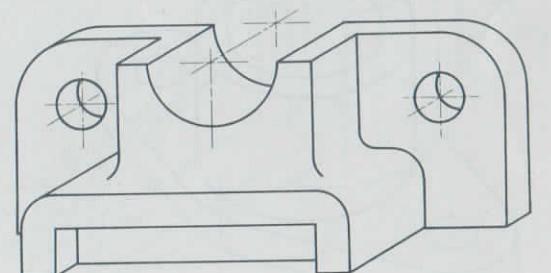
Solução fácil e bastante expressiva



Solução mais ou menos trabalhosa, porém, muito expressiva.

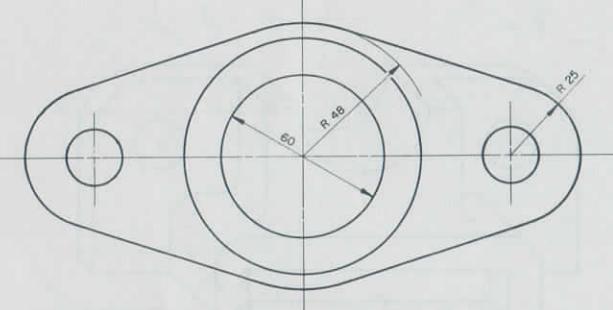
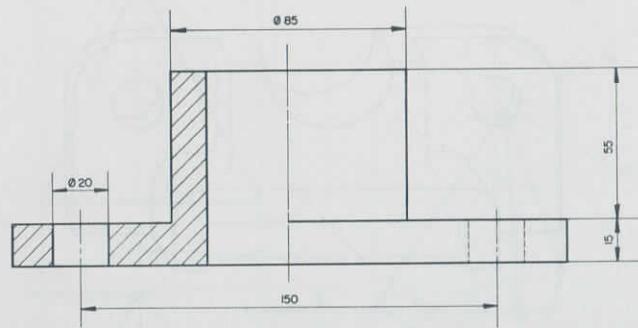


Solução muito trabalhosa e não expressiva

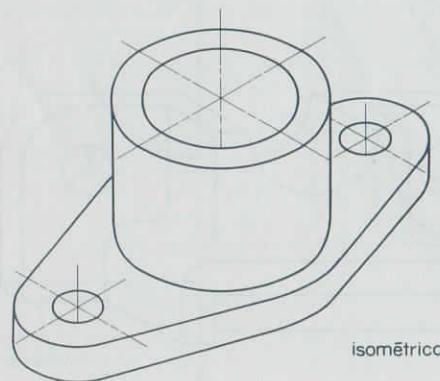


Solução fácil e mais ou menos expressiva

# ESCOLHA DA POSIÇÃO

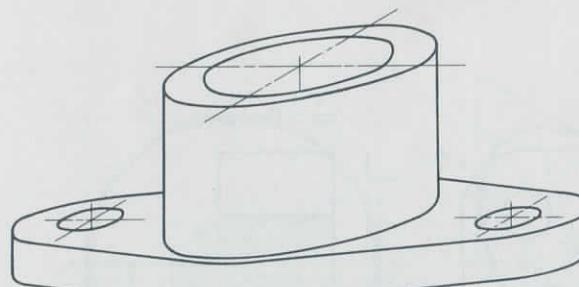


Os objetos devem ser representados nas posições que melhor os caracterizam.

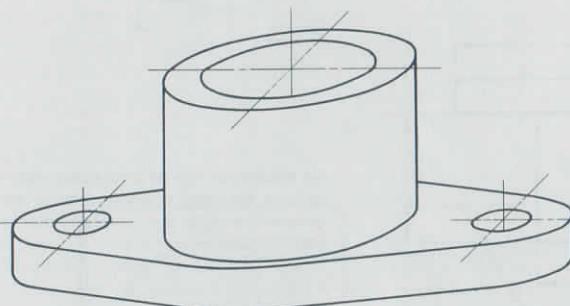


isométrica

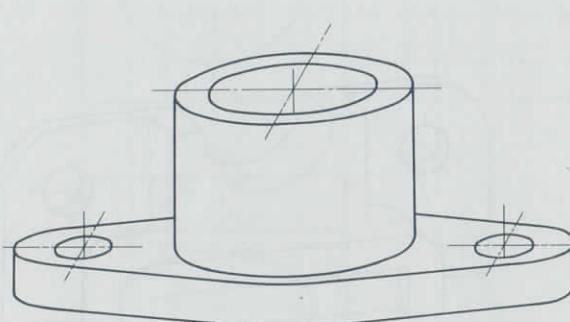
MELHOR SOLUÇÃO ( simples e expressiva )



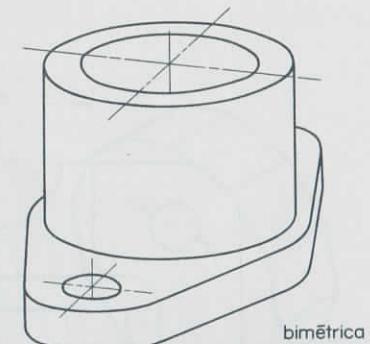
cavaleira à 30°



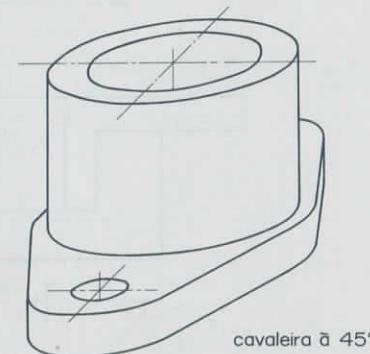
cavaleira à 45°



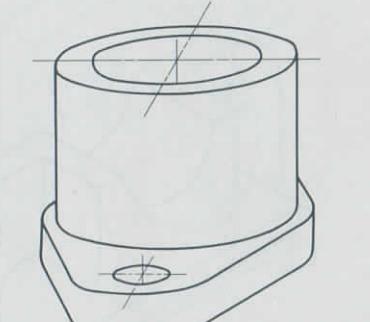
cavaleira à 60°



bimétrica



cavaleira à 45°



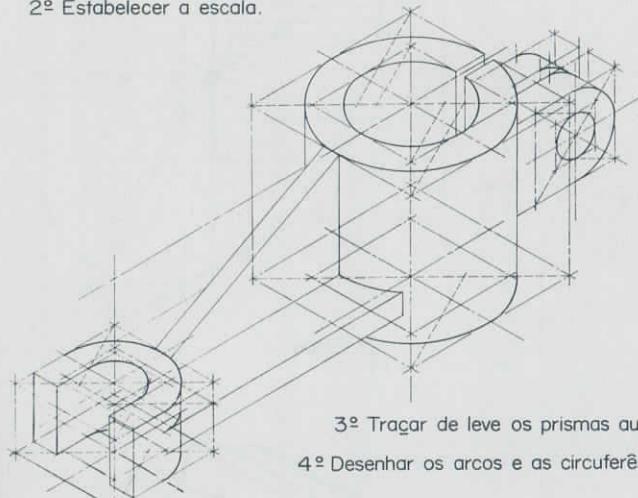
cavaleira à 60°

SOLUÇÕES NÃO RECOMENDÁVEIS ( trabalhosas e com efeito de distorção )

## SEQUÊNCIA DO TRAÇADO

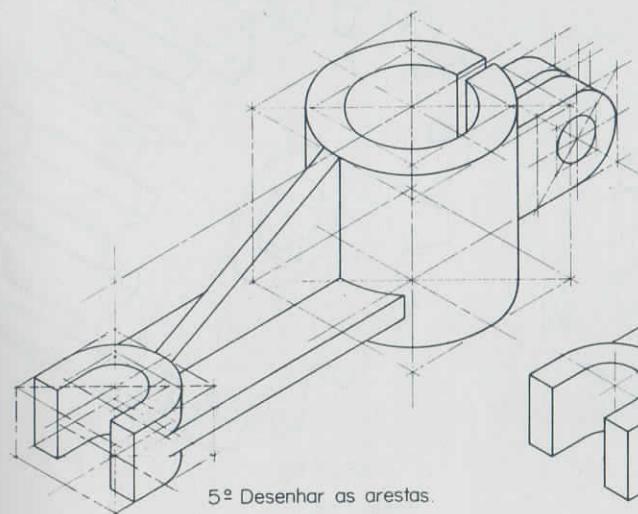
1º Escolher a perspectiva e a posição.

2º Estabelecer a escala.

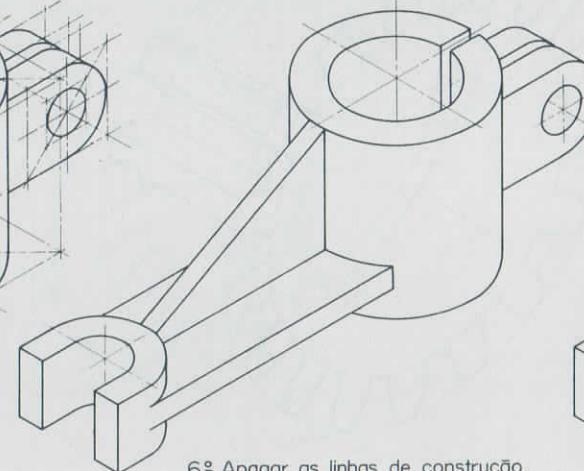


3º Tracar de leve os prismas auxiliares.

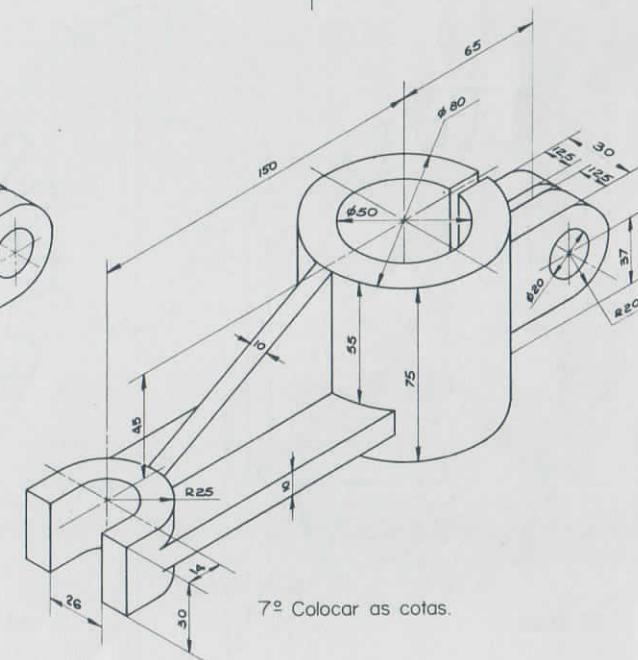
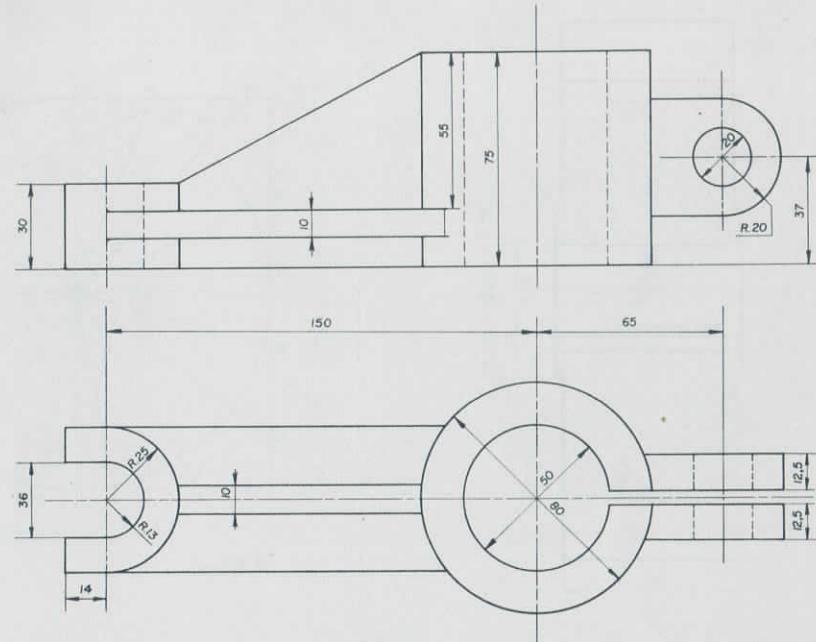
4º Desenhar os arcos e as circuferências.

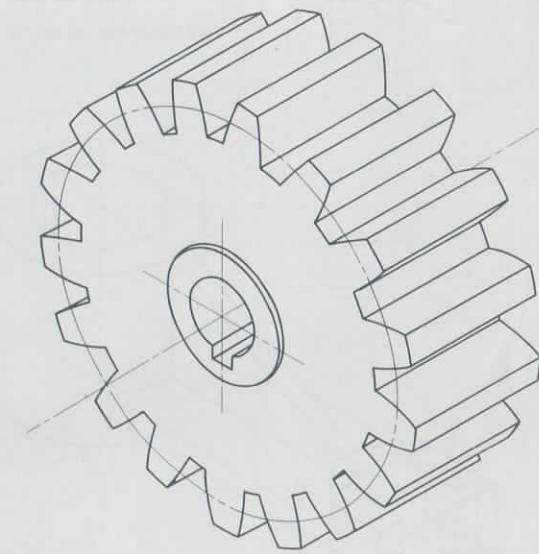
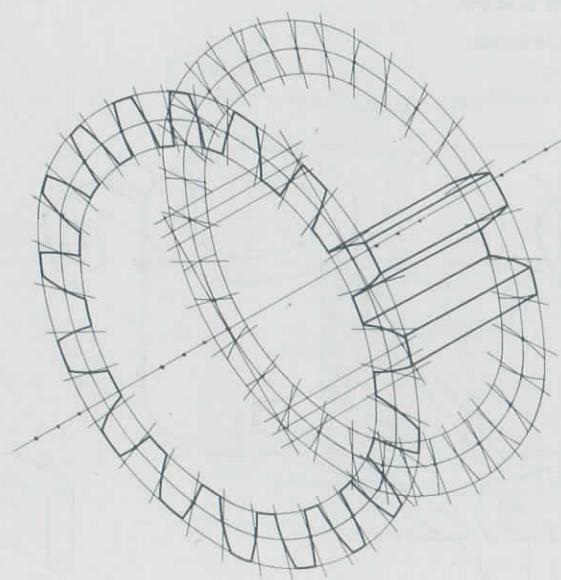
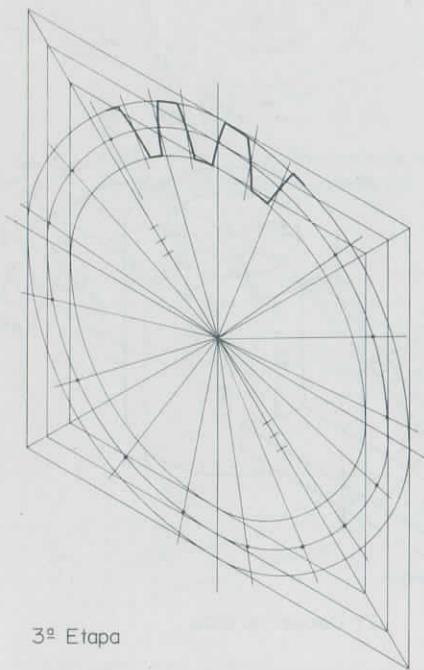
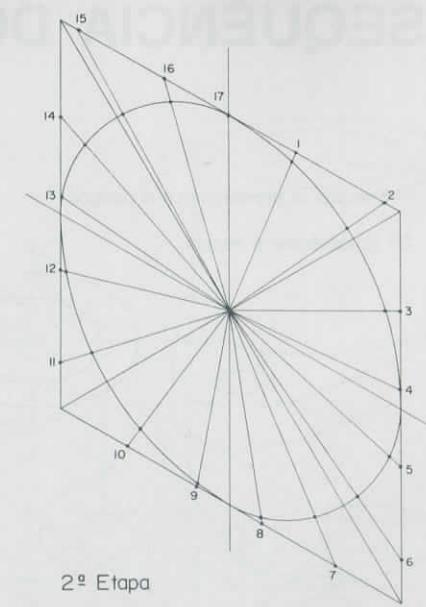
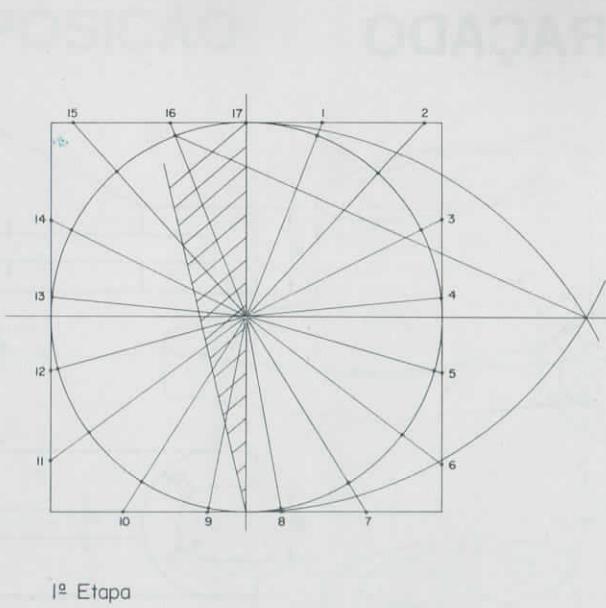
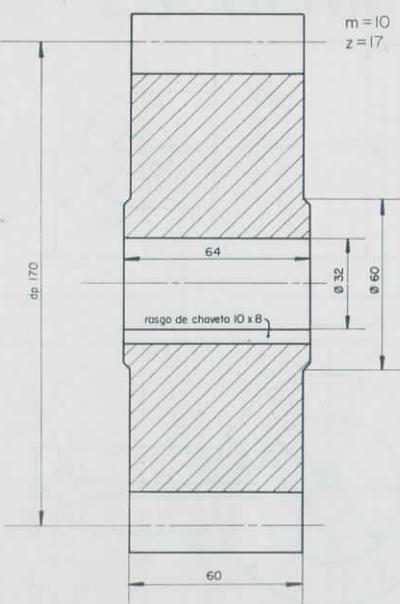


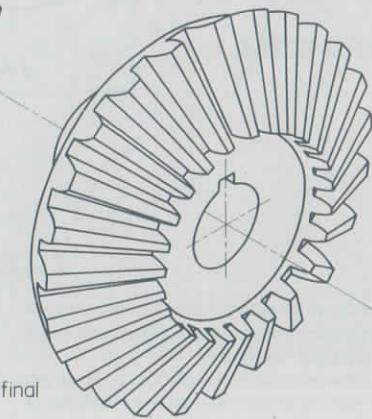
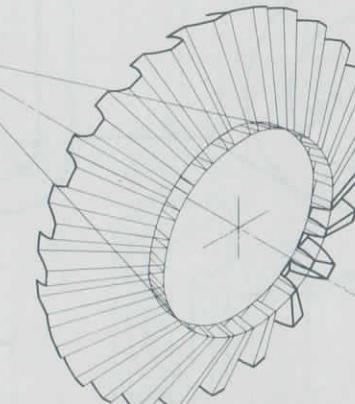
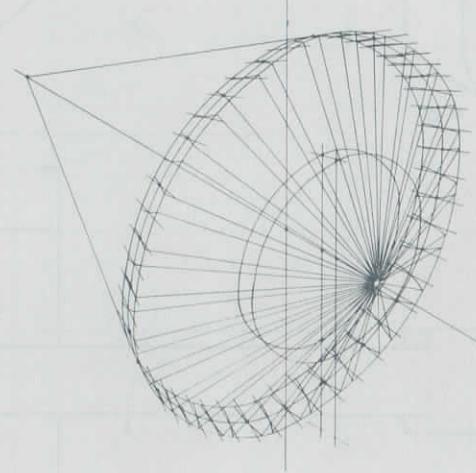
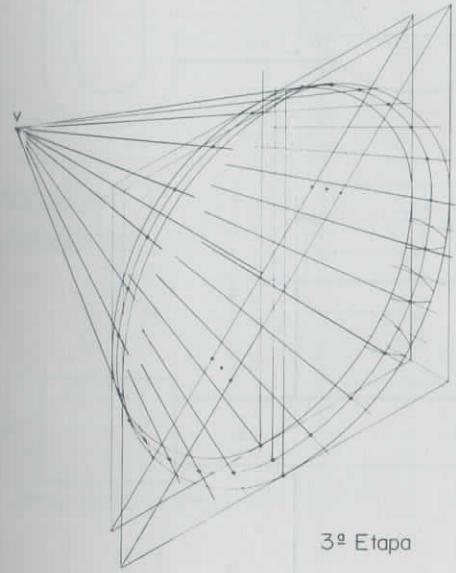
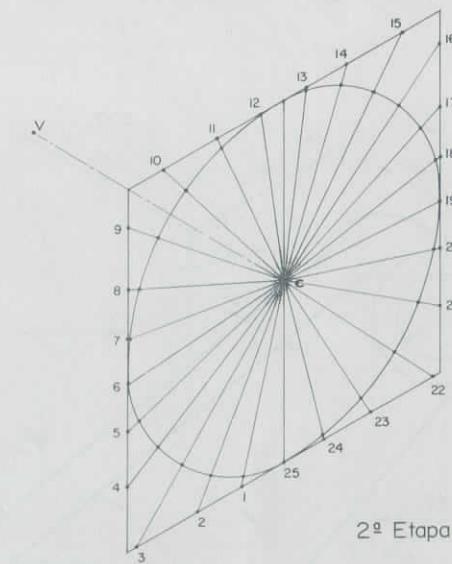
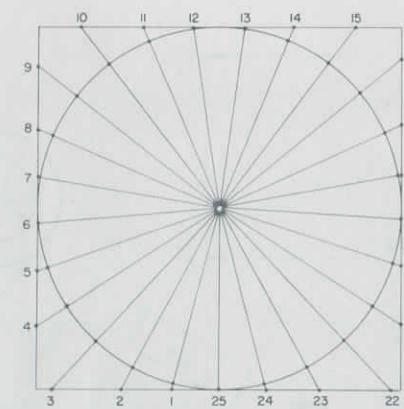
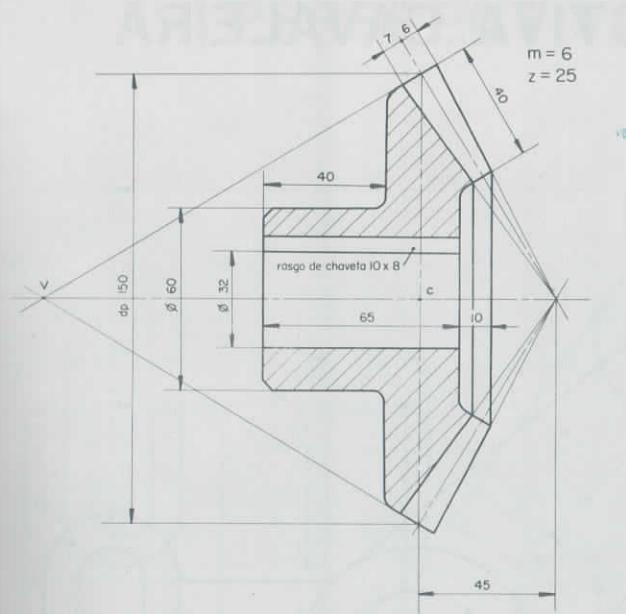
5º Desenhar as arestas.



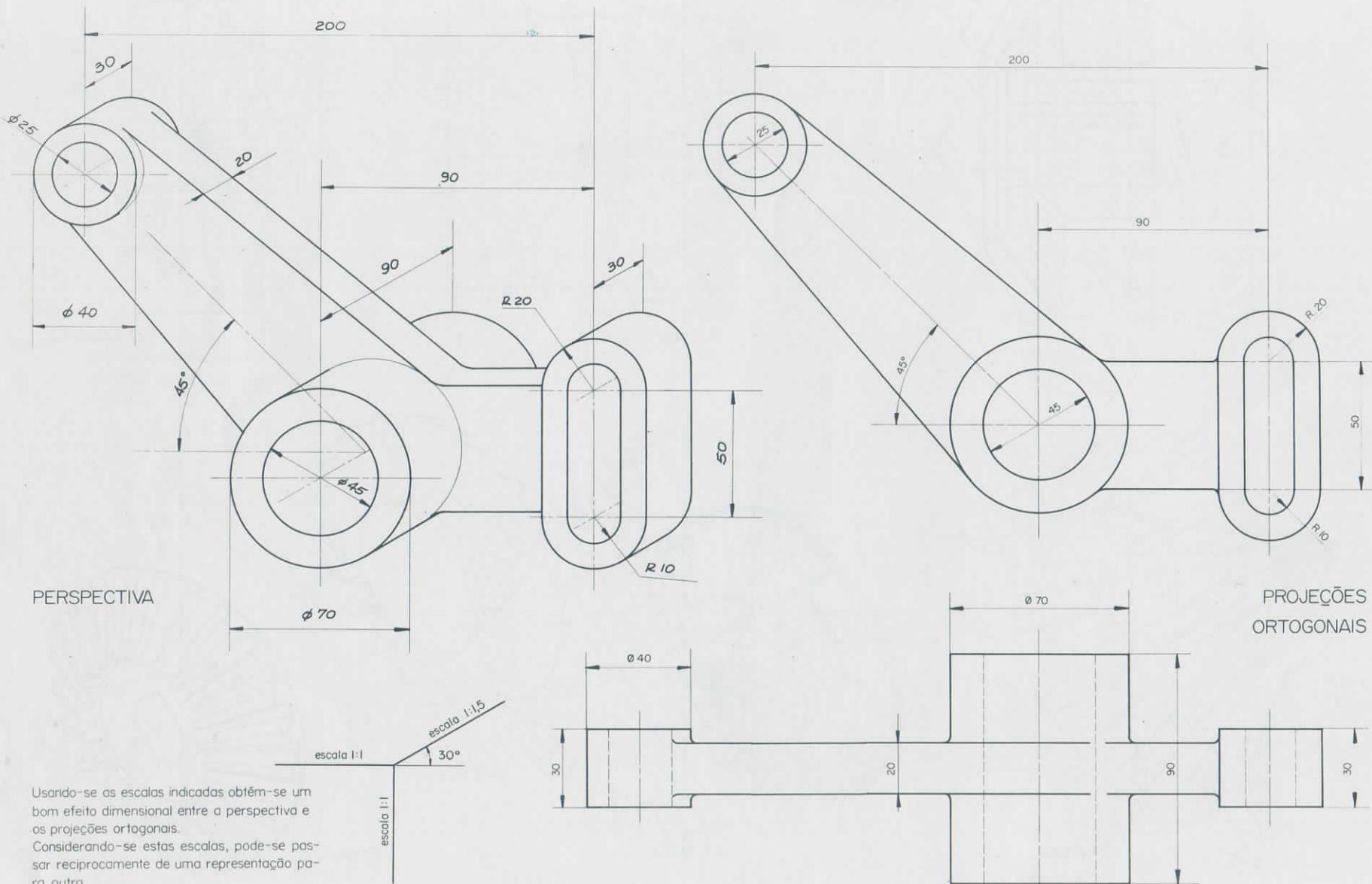
6º Apagar as linhas de construção.



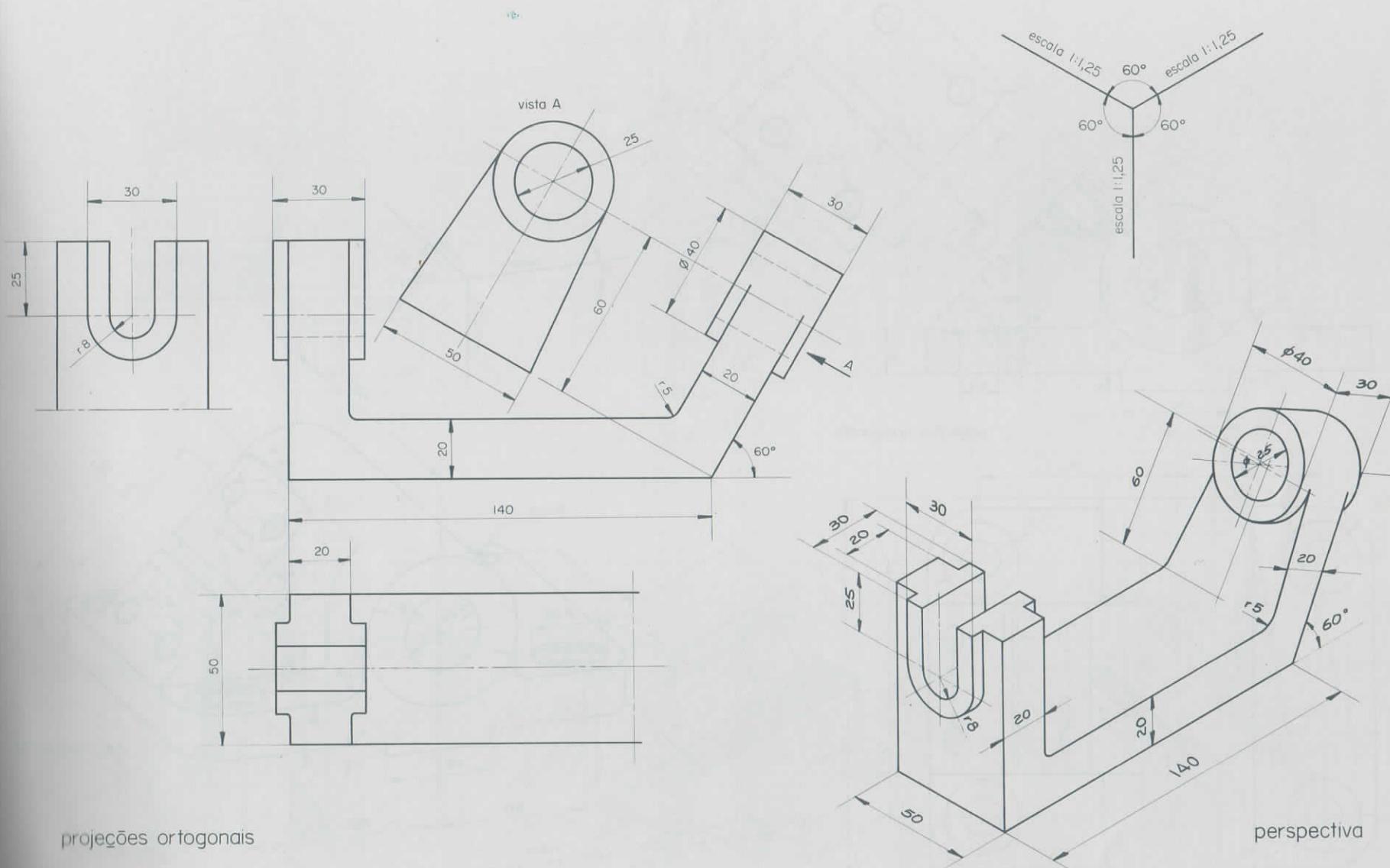




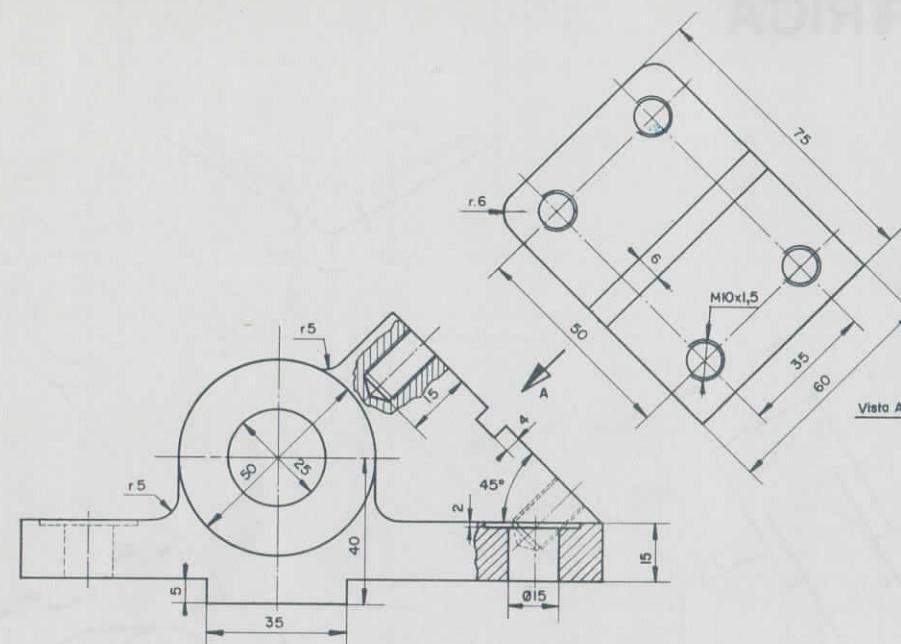
# PERSPECTIVA CAVALEIRA



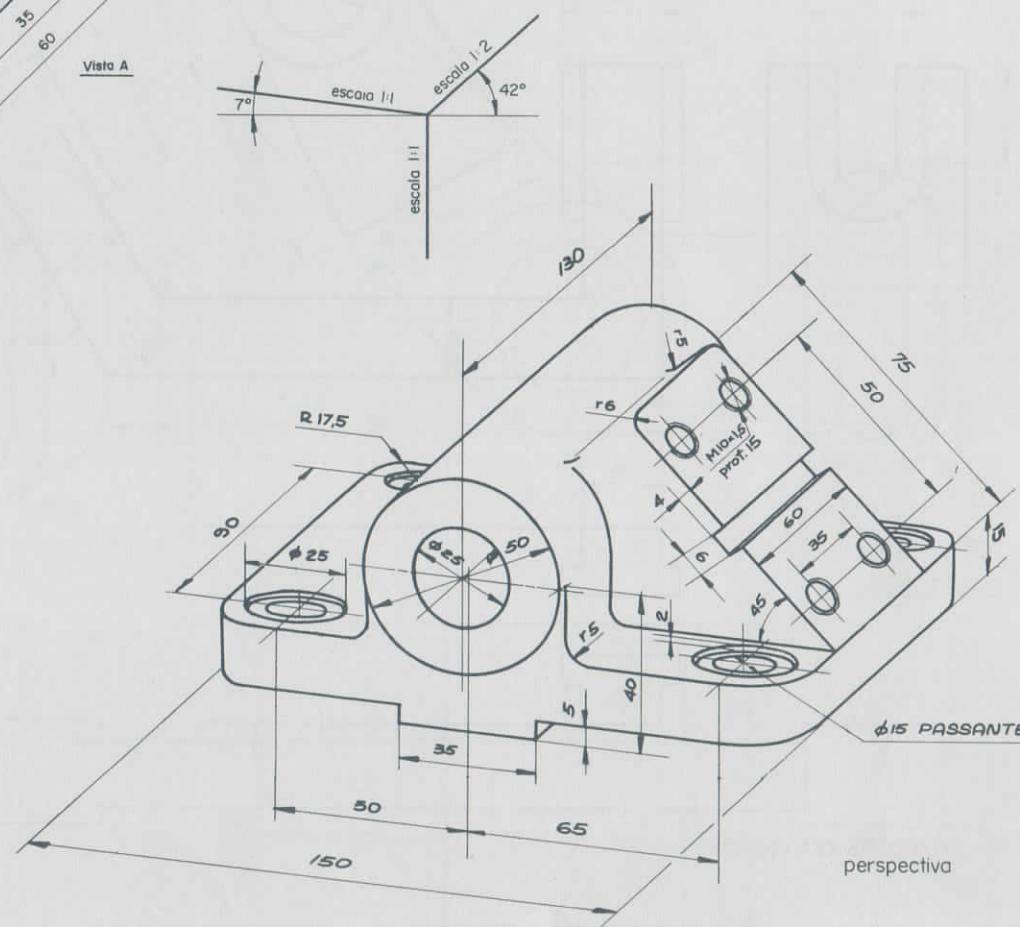
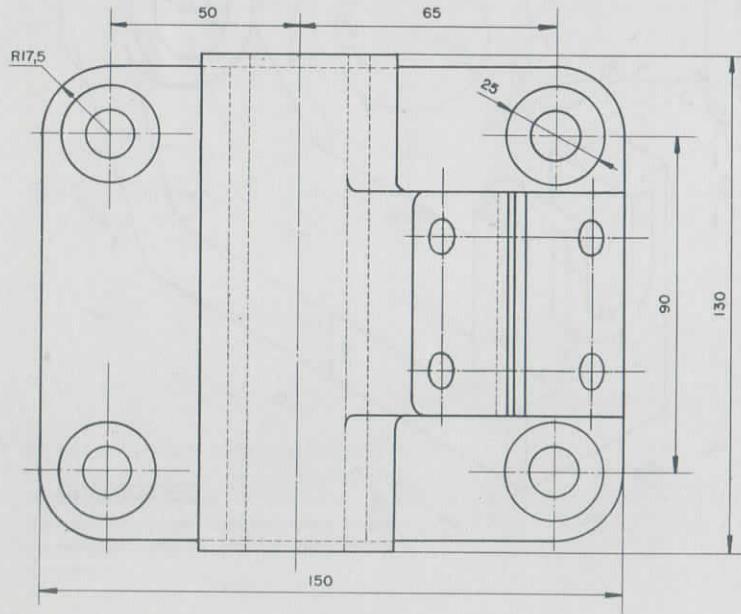
# PERSPECTIVA ISOMÉTRICA



## PERSPECTIVA BIMÉTRICA

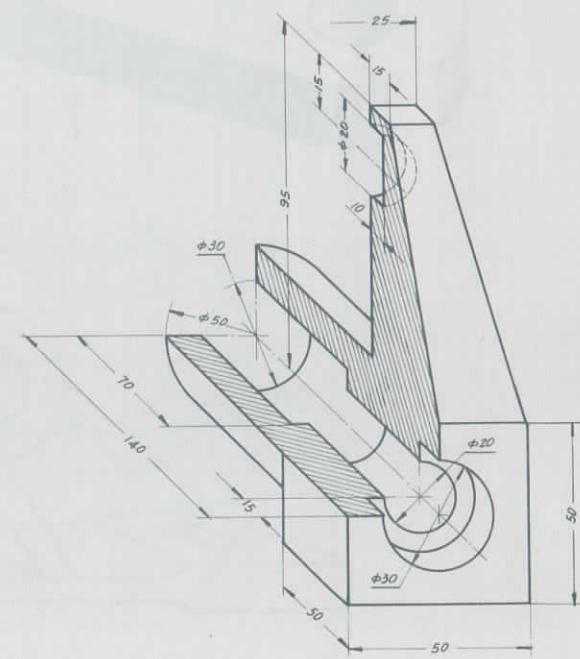
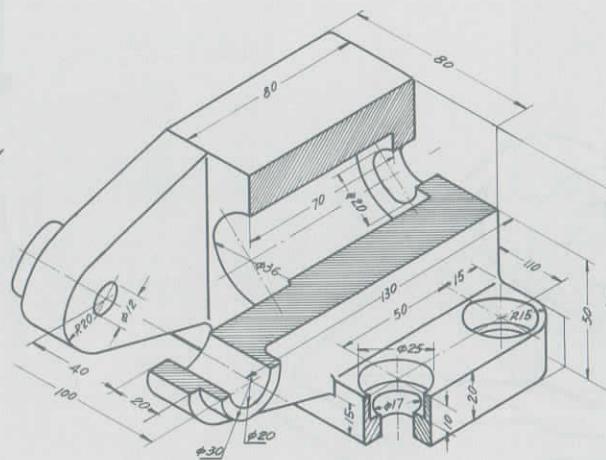
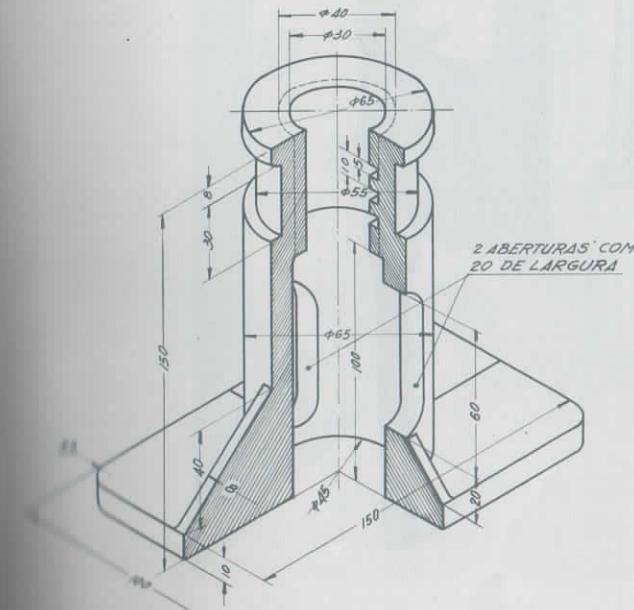
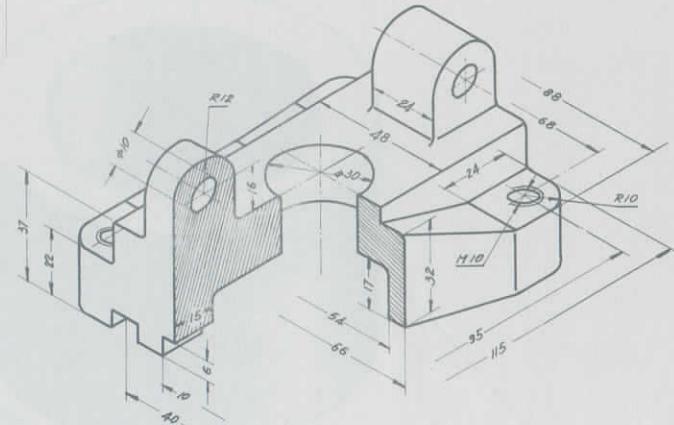
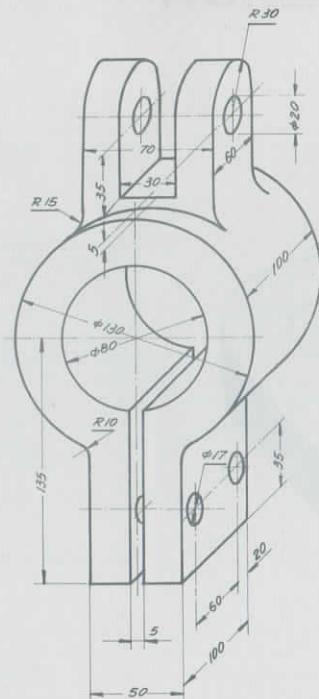
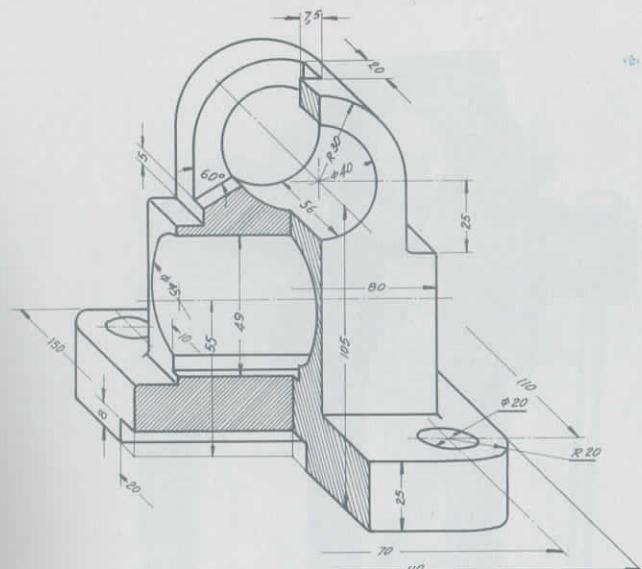


## projeções ortogonais

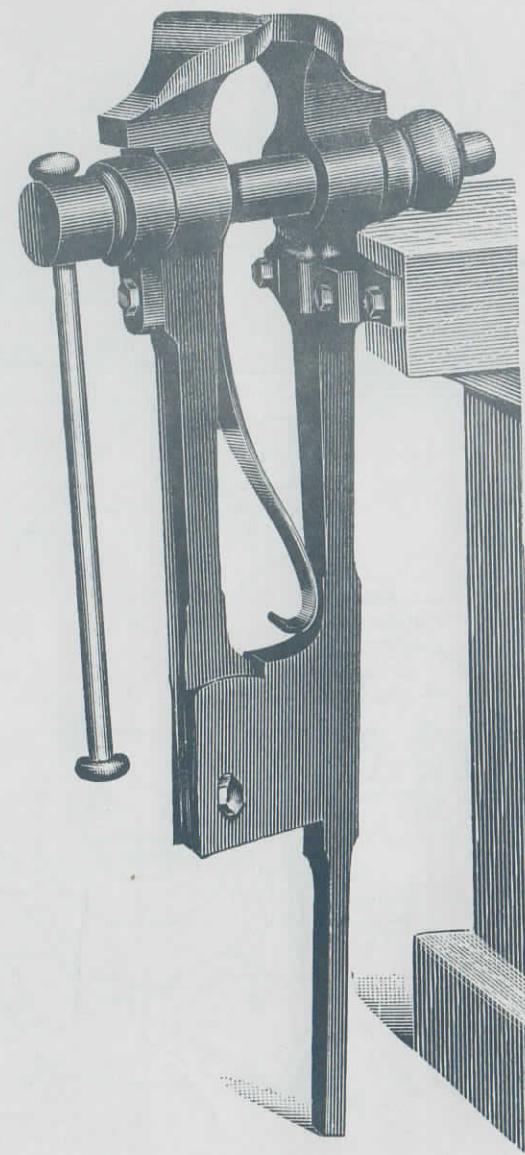
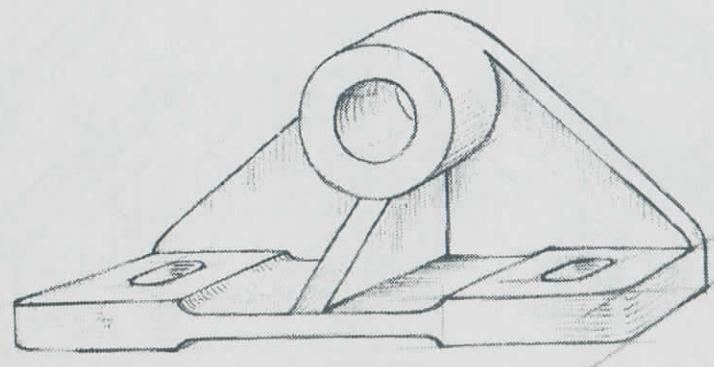
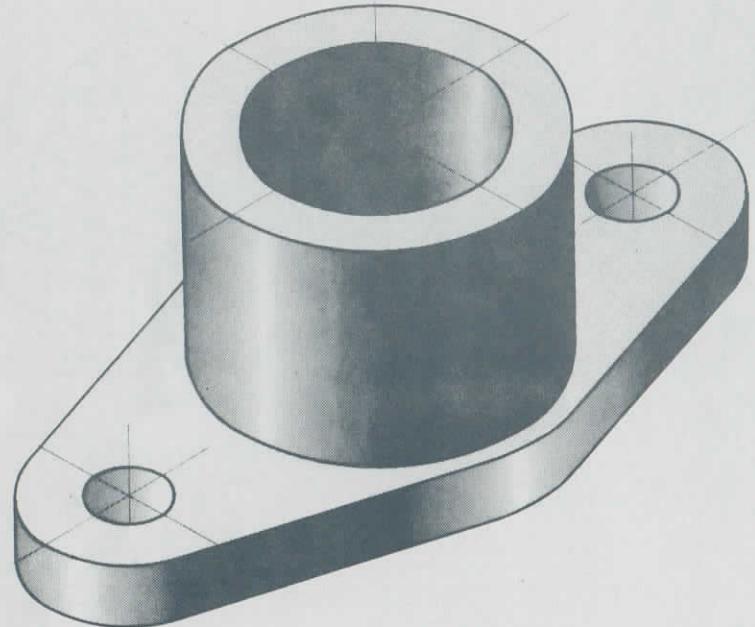


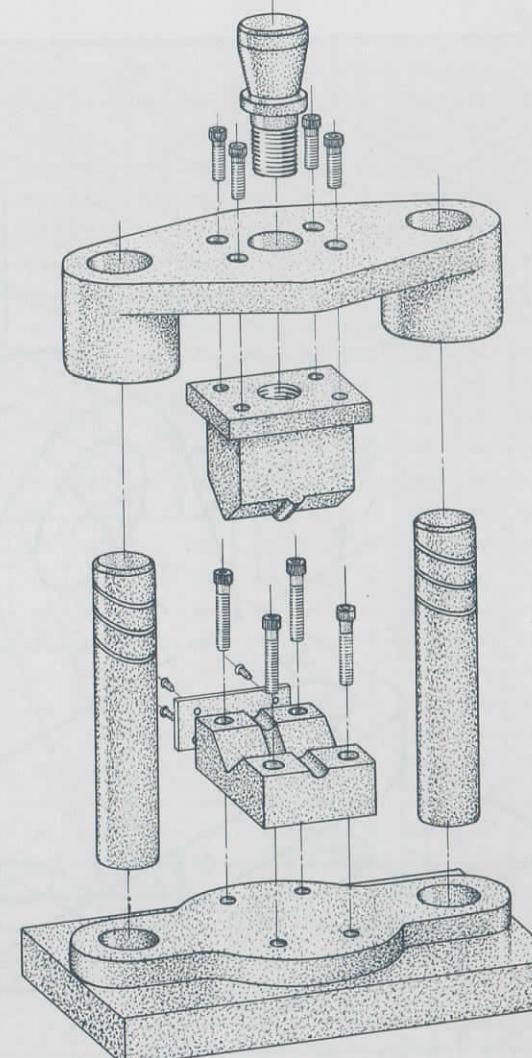
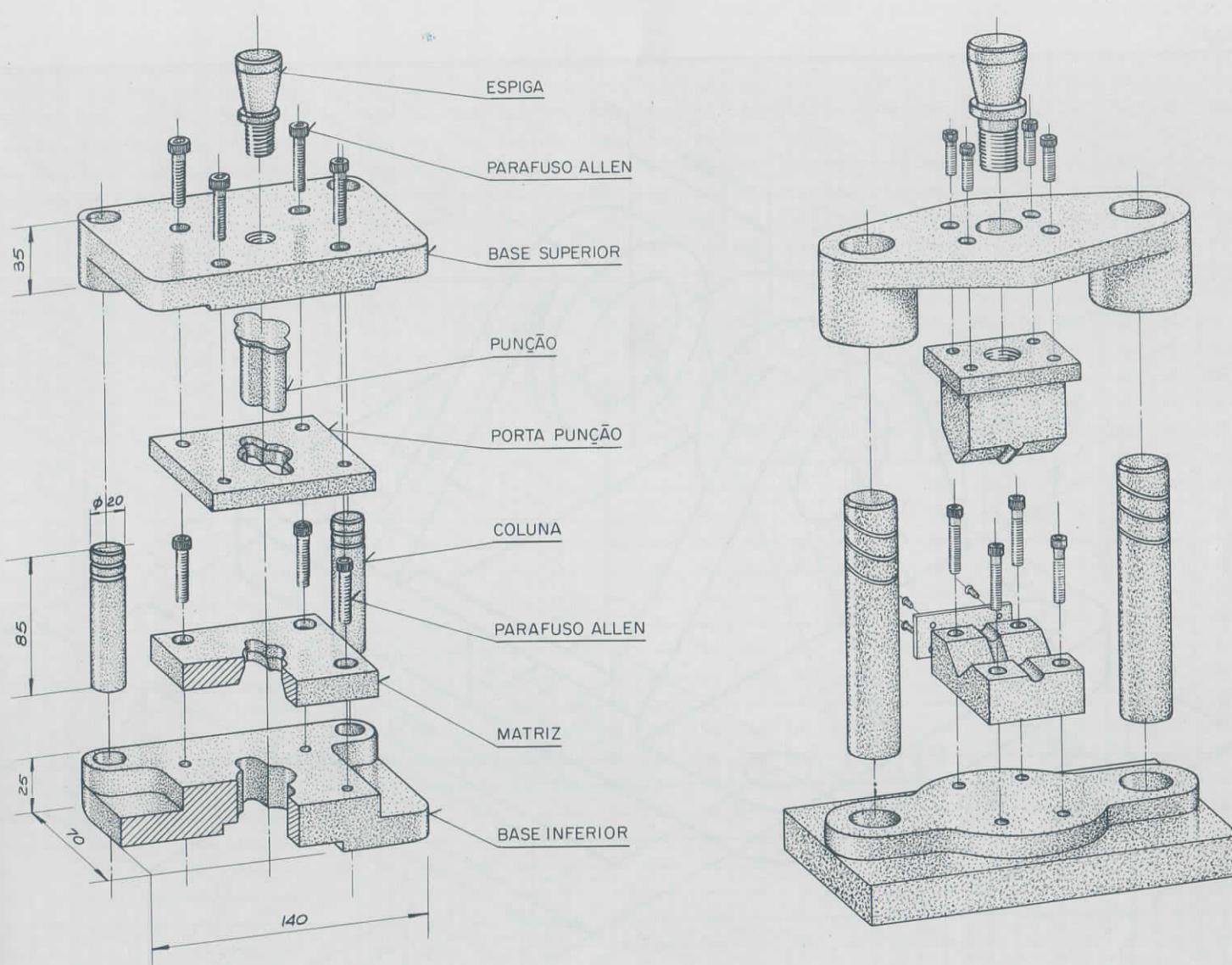
perspectiva

## EXEMPLOS



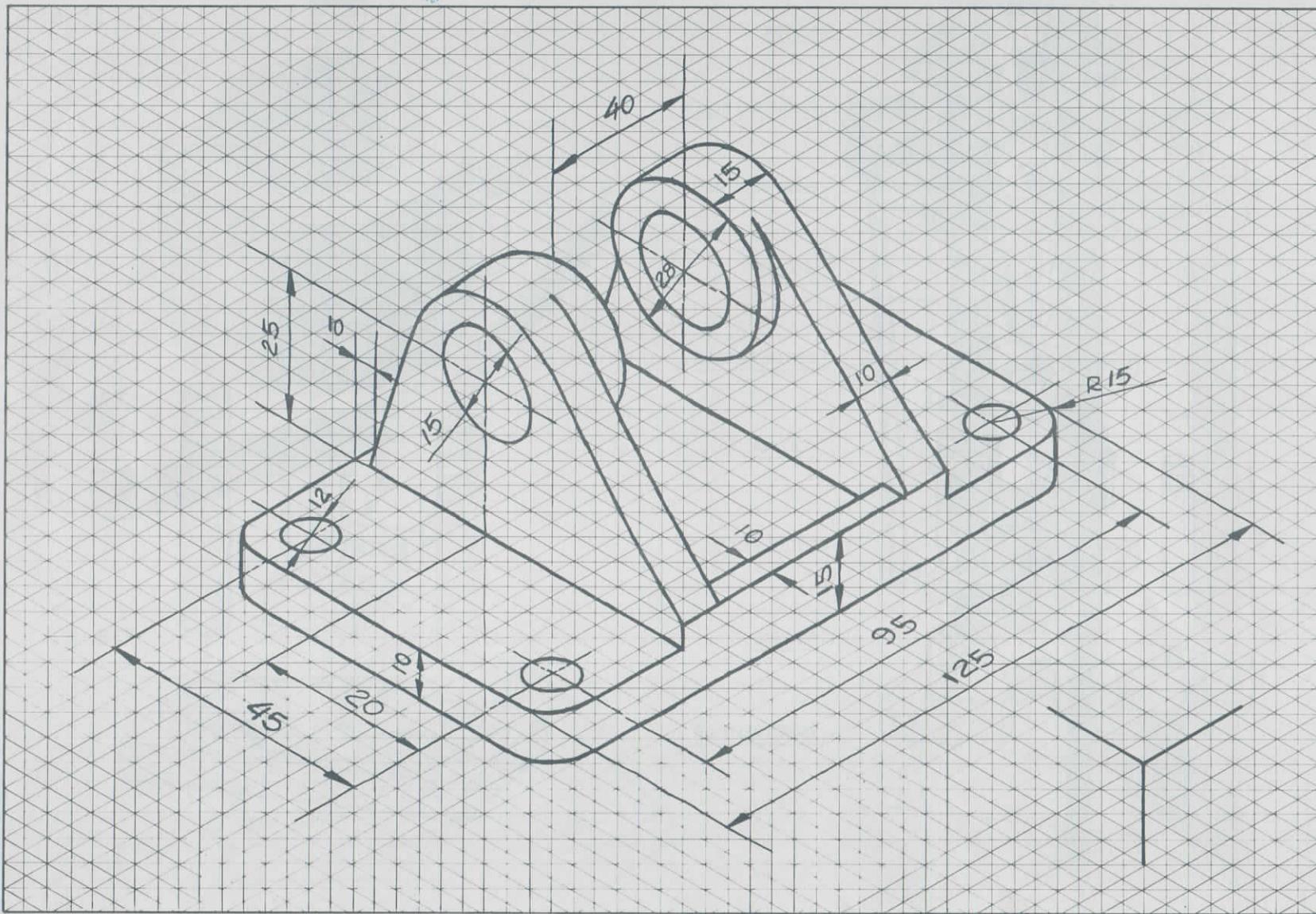
## PERSPECTIVA SOMBREADA





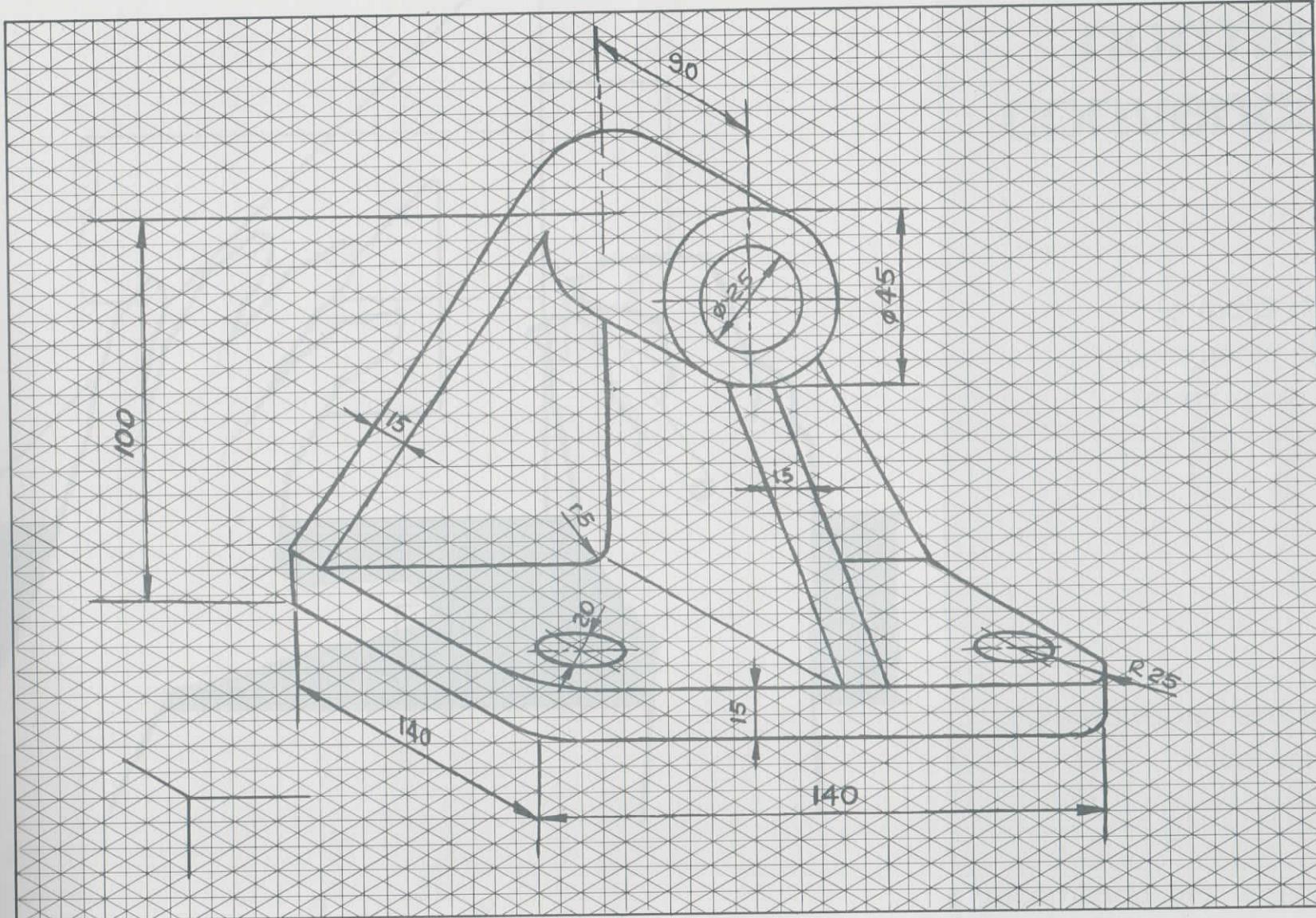
# CROQUIS EM PERSPECTIVA ISOMÉTRICA

Papel isométrico



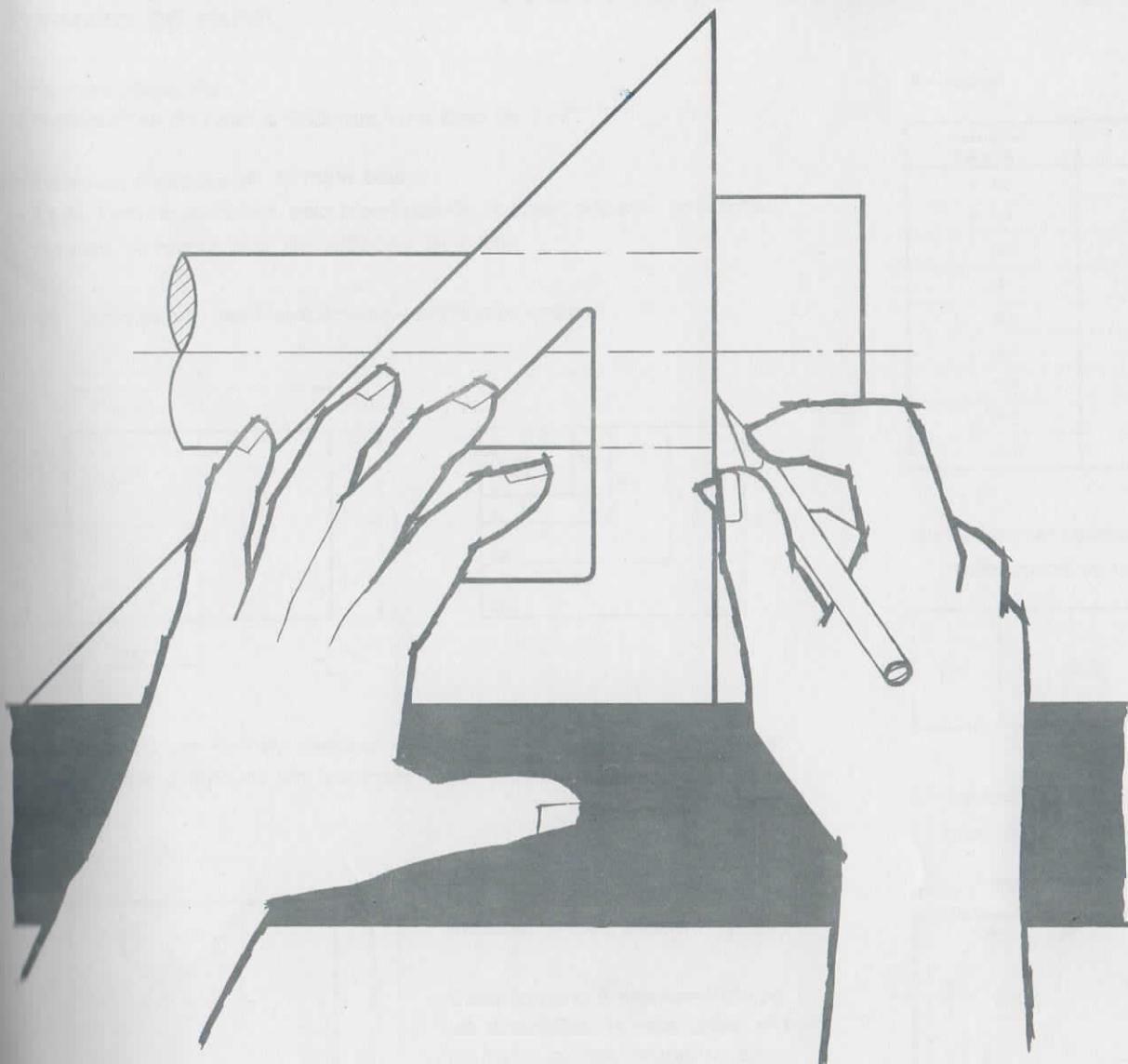
# CROQUIS EM PERSPECTIVA CAVALEIRA

Papel isométrico



# 5

## normas e convencões



formato de papel  
dobramento da folha  
letras e algarismos  
linhas  
escala  
vistas  
hachuras  
cortes e secções  
rupturas  
representações simplificadas  
e convencionais  
sinais  
cotas  
recomendações e conselhos

# NORMAS E CONVENÇÕES

## FORMATO DE PAPEL

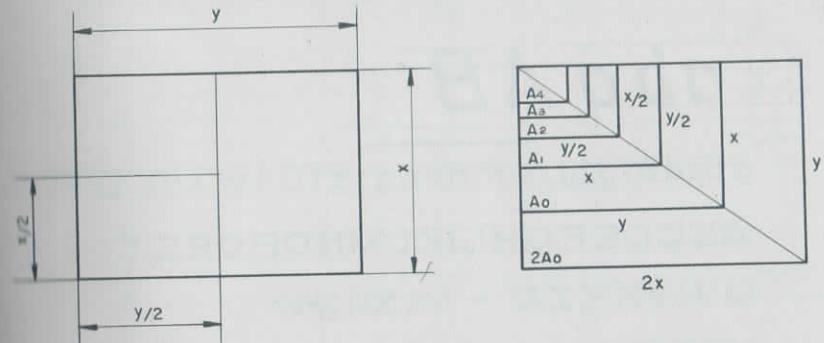
### 1 - Formato básico A<sub>0</sub>:

- Retângulo de 841 mm x 1189 mm com área de 1 m<sup>2</sup>

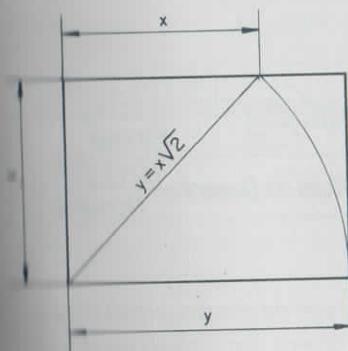
### 2 - Formatos derivados do formato básico:

- Cada formato se obtém pela bipartição do anterior, segundo uma linha paralela ao menor lado do retângulo bipartido.

- Os formatos são geometricamente semelhantes entre si.



- Os lados de um formato qualquer guardam entre si a mesma razão que existe entre o lado de um quadrado e sua diagonal.



- As áreas dos formatos derivados são múltiplas ou submúltiplas da área do formato básico (1 m<sup>2</sup>).

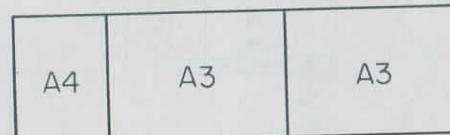
- Cada formato é representado pelas dimensões de seus lados em milímetro ou pelo respectivo símbolo.

Ex.: 210 mm x 297 mm ou A4

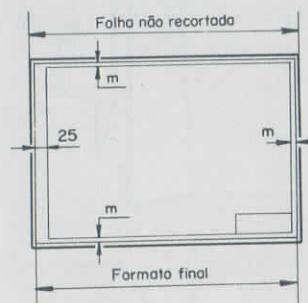
### 3 - Tabela

Formato Série A	Linha de corte mm	Margem "m" mm	Fôlha não cortada (medida mín.) mm
4 A <sub>0</sub>	1.682 x 2.378	20	1.720 x 2.420
2 A <sub>0</sub>	1.189 x 1.682	15	1.230 x 1.720
A <sub>0</sub>	841 x 1.189	10	880 x 1.230
A <sub>1</sub>	594 x 841	10	625 x 880
A <sub>2</sub>	420 x 594	10	450 x 625
A <sub>3</sub>	297 x 420	10	330 x 450
A <sub>4</sub>	210 x 297	5	240 x 330
A <sub>5</sub>	148 x 210	5	165 x 240
A <sub>6</sub>	105 x 148	5	120 x 165

4 - Podem ser usados formatos compostos obtidos pela conjugação de formatos iguais ou consecutivos.



5 - No lado vertical esquerdo, recomenda-se uma margem de 25 mm, no caso de arquivamento do desenho em classificadores.



Formato segundo a ASA

Formato	Linha de corte pol.	Margem pol.
1	8-1/2 x 11	1/2
2	11 x 17	1/2
3	17 x 22	1/2
4	22 x 34	1/2
5	25-1/2 x 44	1/2
6	34 x 55	1/2

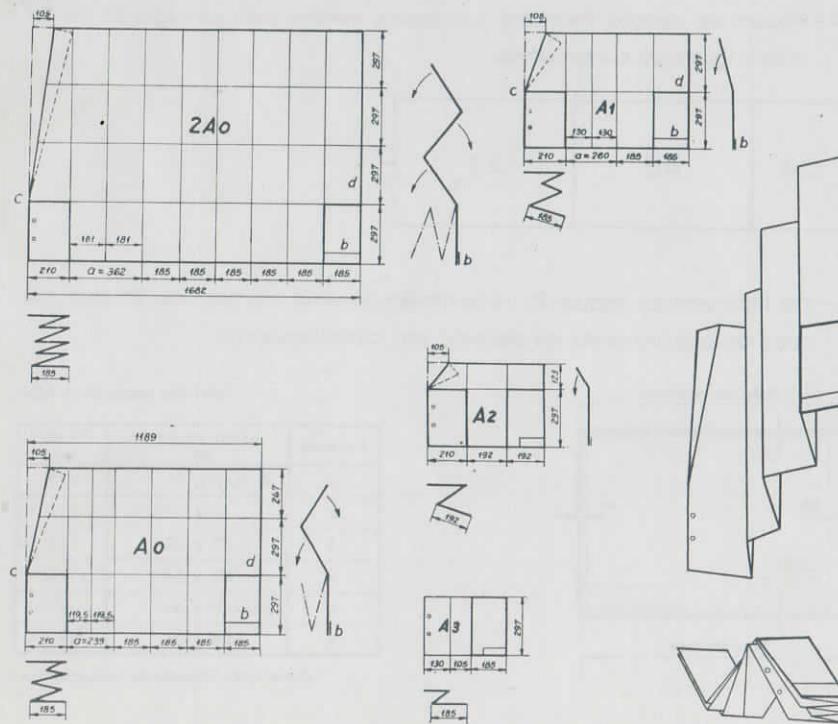
(American Standards Association)

## DOBRAMENTO DA FOLHA

6 – Sendo necessário o dobramento de folhas, o formato final deve ser o A4 de modo a deixar visível e quadro destinado à legenda.

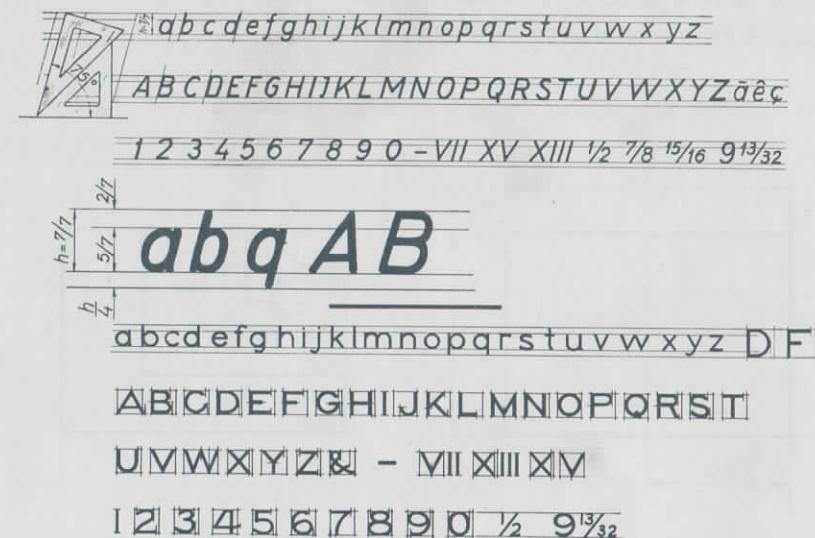
O dobramento das folhas pode ser efetuado da seguinte maneira:

- Efetua-se o dobramento a partir do lado d em dobras verticais de 185 mm; a parte final a é dobrada ao meio.
- Para o formato A2, é permitido um dobramento simplificado com dobras verticais de 192 mm.
- Em seguida a folha será dobrada segundo a altura, em dobras horizontais de 297 mm.
- A fim de facilitar o dobramento, aconselha-se assinalar nas margens, as posições das dobras.
- O canto superior esquerdo pode ser dobrado conforme indicado.



## LETROS E ALGARISMOS

7 – Os tipos de letras e algarismos usados em cotas, legendas e anotações devem ser bem legíveis, de rápida execução e proporcionais ao desenho, podendo ser verticais ou inclinados, executados a mão livre ou com auxílio de normógrafo.



8 – Toda folha desenhada deve levar no canto inferior direito, um quadro destinado à legenda conforme modelos abaixo.

Formatos		Formatos	
A0, A1 e A2	175 50	A0, A1, A2 e A3	120 20
A2, A3 e A4	120 35	A3, A4 e A5	90 15
A4 e A6	90 25		

Desenhado (Data) (Nome)		Visto (Data) (Nome)	Firma
Copiado (Data) (Nome)	Aprovado (Data) (Nome)	Número	L
Escala	Título do Gráfico		H

Peca	Denominações e observações	Assinatura do chefe responsável	Materiais e dimensões
Data			
Cod.			
Escala			
Título do Desenho		em substituição de: substituído por:	
		Número	

9 – Lista de peças, relação de materiais, descrição de modificações e indicações suplementares, quando necessárias, devem ser apresentadas preferivelmente acima ou então à esquerda da legenda.

## LINHAS

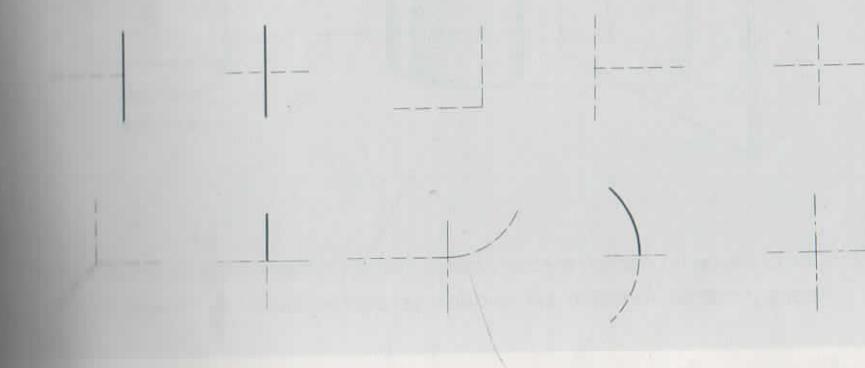
10 – As linhas utilizadas em desenho técnico são :

TIPO		EMPREGO
GROSSA	1	Arestas e contornos visíveis, circunferências de cabeça das engrenagens; cabeça de filetes de rosca...
	2	Fundo de filetes de rosca; circunferência de pé das engrenagens...
	3	Segões rebatidos, peças colocadas diante do objeto representado; peças contíguas para pô-las em relação, posições variáveis ou extremas no deslocamento; excesso para usinagem...
	4	Arestas e contornos invisíveis...
MÉDIA	5	Linhos de ruptura...
	6	Linhos de chamada, cotas, hachuras...
	7	Hachuras
FINA	8	Eixos de simetria; linhas de centro e demais linhas básicas.

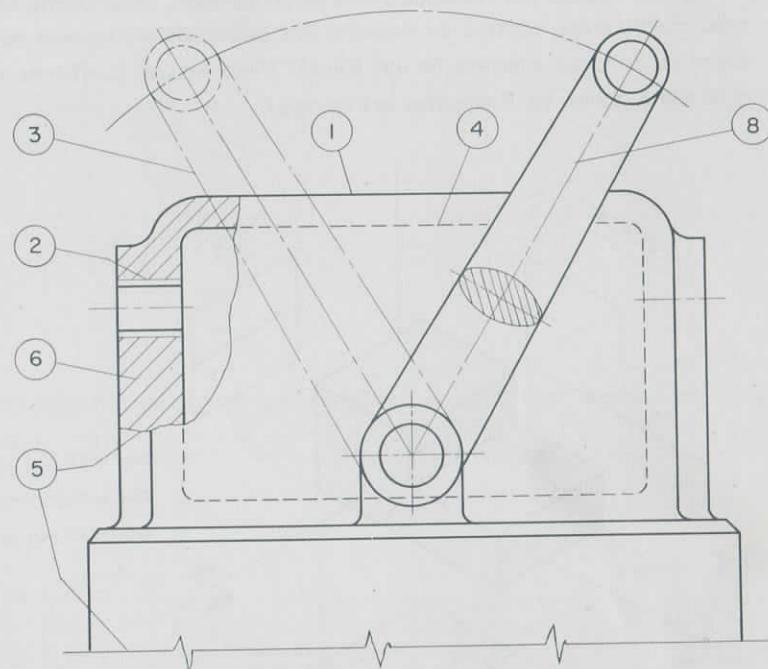
Quando necessário podem ser utilizados outros tipos de linhas.

Recorrer a representação de arestas e contornos invisíveis (tracejado) apenas nos casos de maior clareza do desenho.

II – Nos cruzamentos de linhas devem ser observadas as seguintes indicações :



Exemplo :



## ESCALA

12 – A escala do desenho deve, obrigatoriamente, ser indicada na legenda.

13 – Constando na mesma folha desenhos em escalas diferentes, estas devem ser indicadas tanto na legenda como junto aos desenhos a que correspondem.

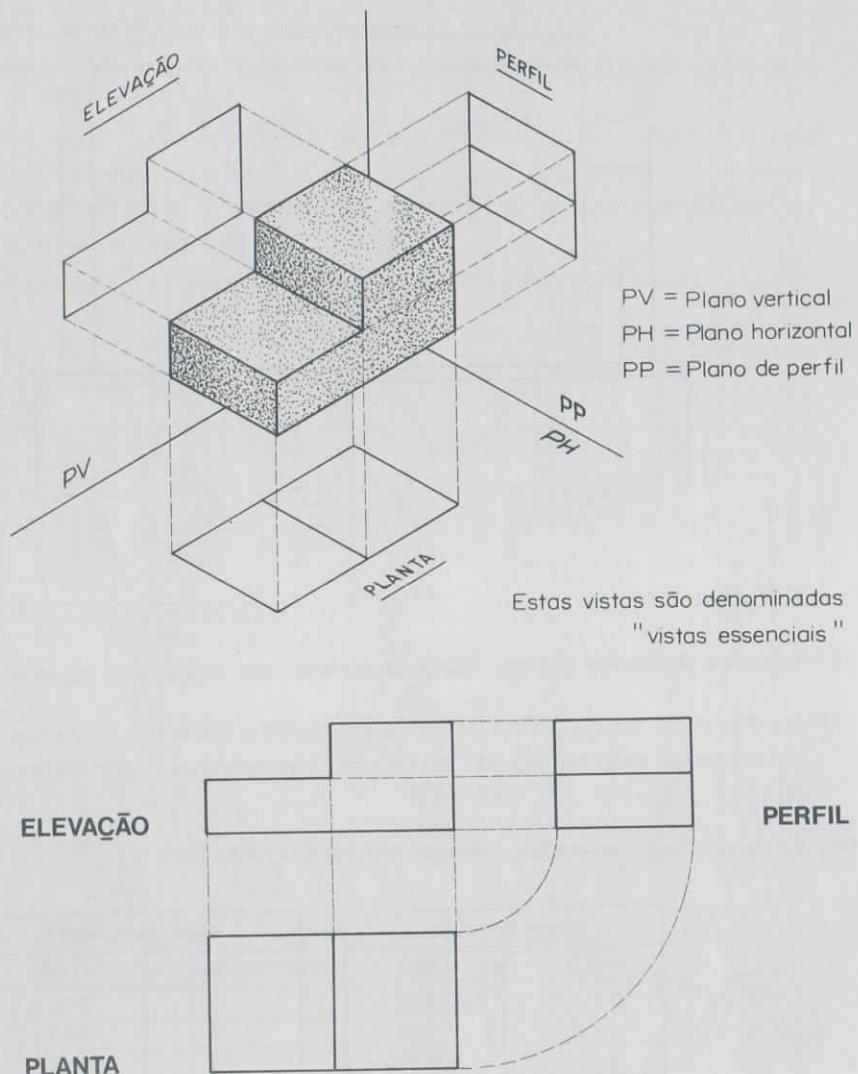
14 – As escalas recomendadas, além da natural (1:1), são :

PARA REDUÇÃO	
1:2,5	1:100
1:5	1:200
1:10	1:500
1:20	1:1000

PARA AMPLIAÇÃO	
2:1	100:1
5:1	200:1
10:1	500:1
20:1	1000:1

## VISTAS

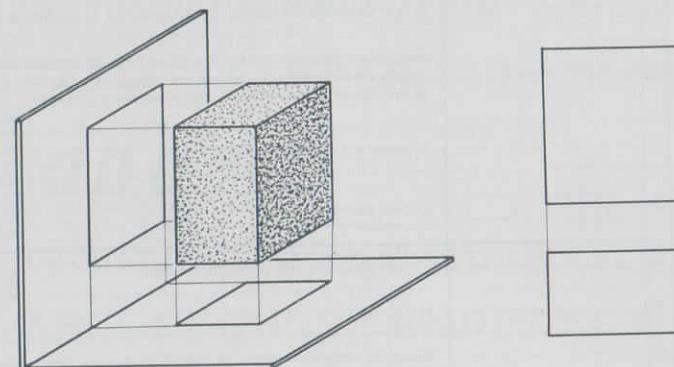
15 — As representações por meio de vistas serão obtidas, essencialmente, pelo rebatimento sobre o plano do desenho das projeções ortogonais da peça sobre as 3 faces internas de um triedro trirectangular, conforme mostra o desenho abaixo (v. Projeções ortogonais).



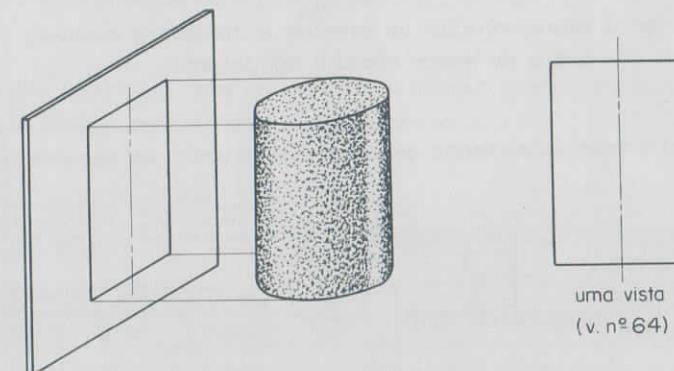
16 — Nos casos das vistas essenciais em posição normal, dispensam-se as suas denominações.

17 — As peças devem ser representadas na posição que melhor as caracteriza; em geral, na sua posição de montagem, podendo todavia, para desenho de detalhe, adotar-se qualquer posição conveniente.

18 — É permitida a representação das peças com menos das três vistas essenciais quando isso não afetar a sua clareza.



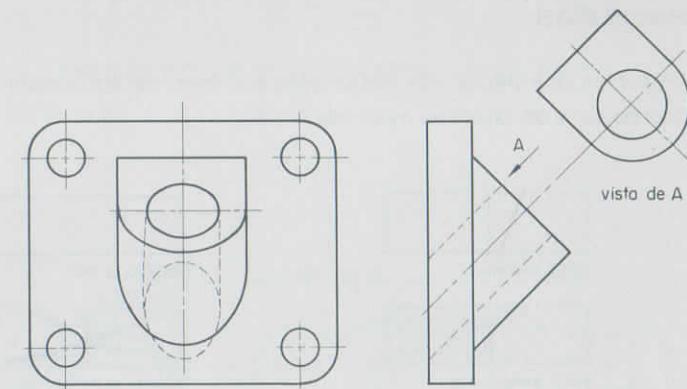
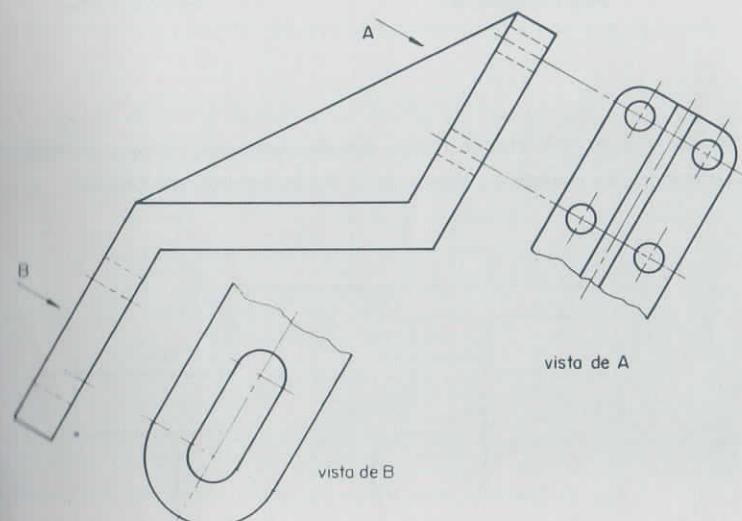
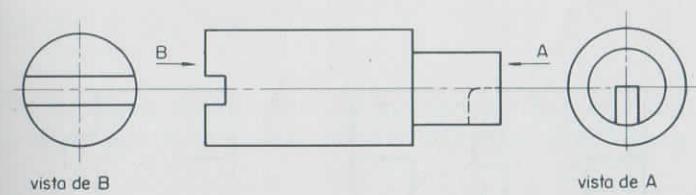
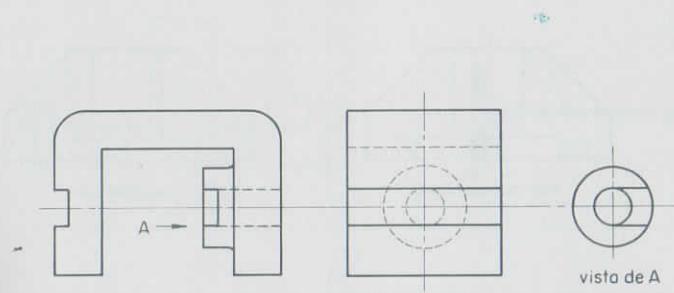
duas vistas



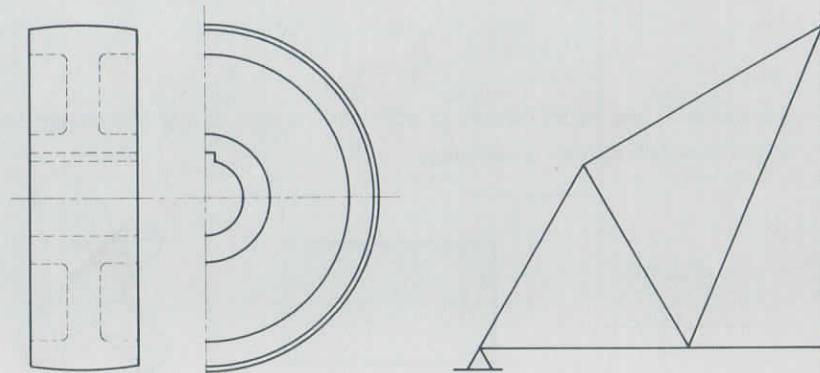
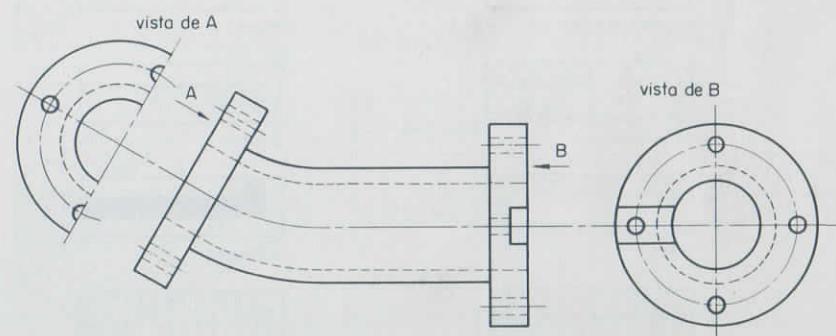
uma vista  
(v. nº 64)

19 — Como elemento complementar, para melhor compreensão da peça representada, poderão também ser usadas as perspectivas (v. Perspectiva).

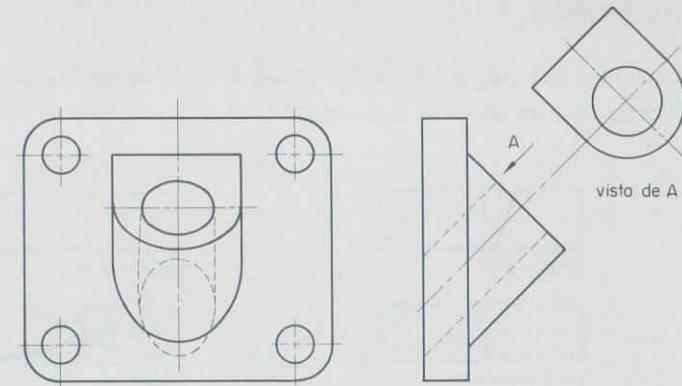
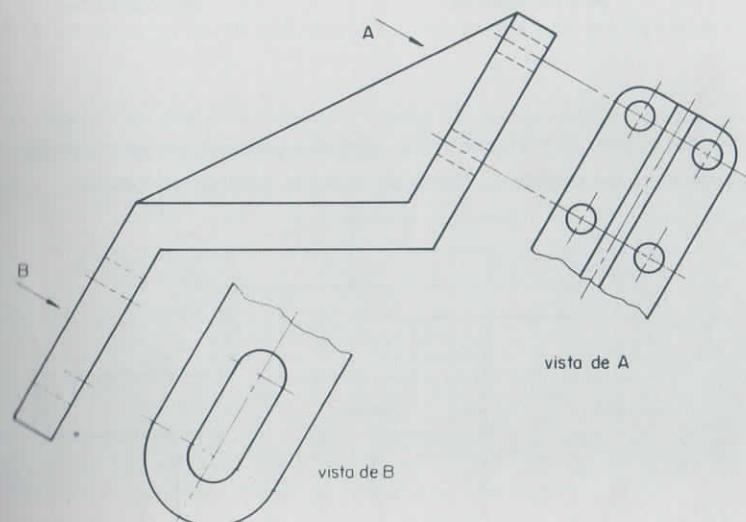
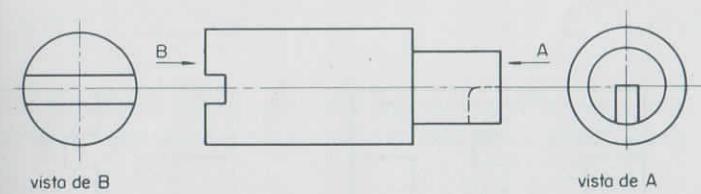
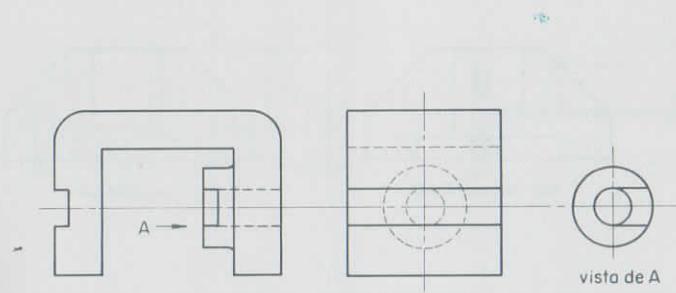
20 – Além das três vistas essenciais, outras poderão ser usadas bem como rebatimentos parciais, vistas auxiliares, etc., quando isso for necessário. Estas vistas deverão ser denominadas e assinaladas por letras e flechas



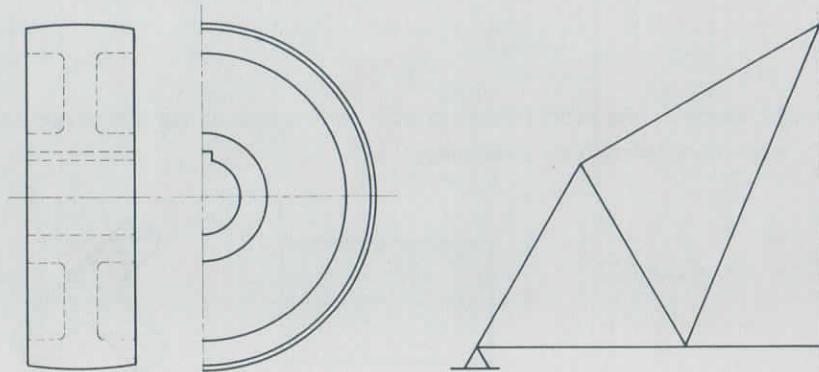
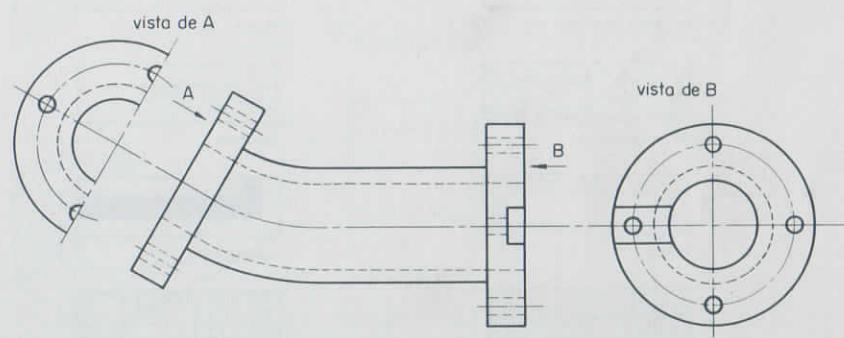
21 – Para ganhar espaço as vistas simétricas podem ser desenhadas em meia vista.



20 – Além das três vistas essenciais, outras poderão ser usadas bem como rebatimentos parciais, vistas auxiliares, etc., quando isso for necessário. Estas vistas deverão ser denominadas e assinaladas por letras e flechas.



21 – Para ganhar espaço as vistas simétricas podem ser desenhadas em meia vista.



## HACHURAS

22 – Os cortes das peças são destacadas por meio de hachurado que varia de acordo com os diversos materiais.



FERRO FUNDIDO



MADEIRA DE FACE



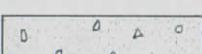
FERRO BATIDO E AÇO



MADEIRA DE TOPO



BRONZE, LATÃO, COBRE



CONCRETO



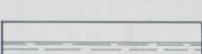
ALUMÍNIO, METAIS LEVES



PEDRA



METAL BRANCO



LÍQUIDOS



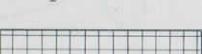
TERRA



GUARNIÇÃO



BORRACHA, FIBRA

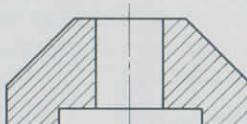


ENROLAMENTOS ELÉTRICOS

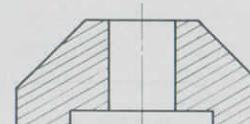
23 – As hachuras são habitualmente a  $45^\circ$  com o eixo da peça e devem ser feitas com linhas finas e paralelas.



24 – As hachuras podem tomar outra direção quando houver necessidade de evitar seu paralelismo com o contorno da seção.

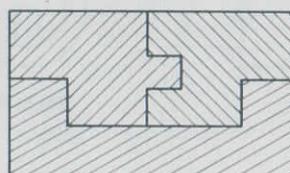


não aconselhável

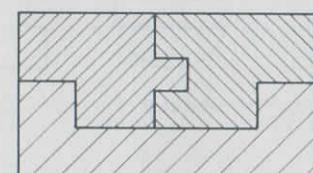


aconselhável

25 – As peças adjacentes devem figurar com hachuras diferindo pela direção ou pelo espaçamento.

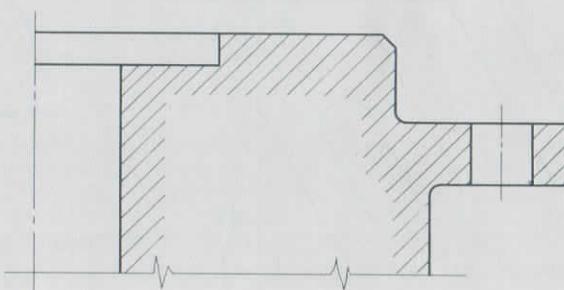


menos aconselhável

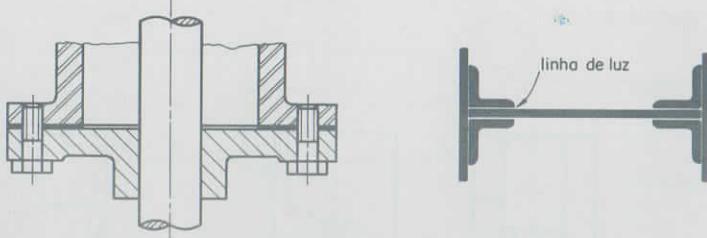


mais aconselhável

26 – Sendo a área a hachurar muito grande, pode-se limitar o hachurado à vizinhança do contorno, deixando a parte central em branco.



27 – Surgindo uma seção delgada, em vez de hachurada, ela pode ser enegrecida.



28 – Nas áreas hachuradas não se devem representar linhas invisíveis, excetuando-se os casos especiais em que se requer maior clareza.

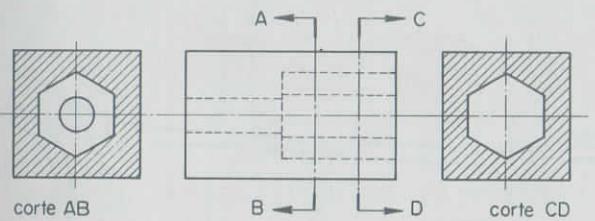
### CORTES E SECÕES

29 – O corte registra tanto a interseção do plano secante com a peça como a projeção da parte desta peça situada além desse plano secante.

30 – A seção registra somente a interseção do plano secante com a peça.

Tanto cortes como seções são empregadas para representar, com exatidão, detalhes ou perfis não revelados claramente nas outras vistas.

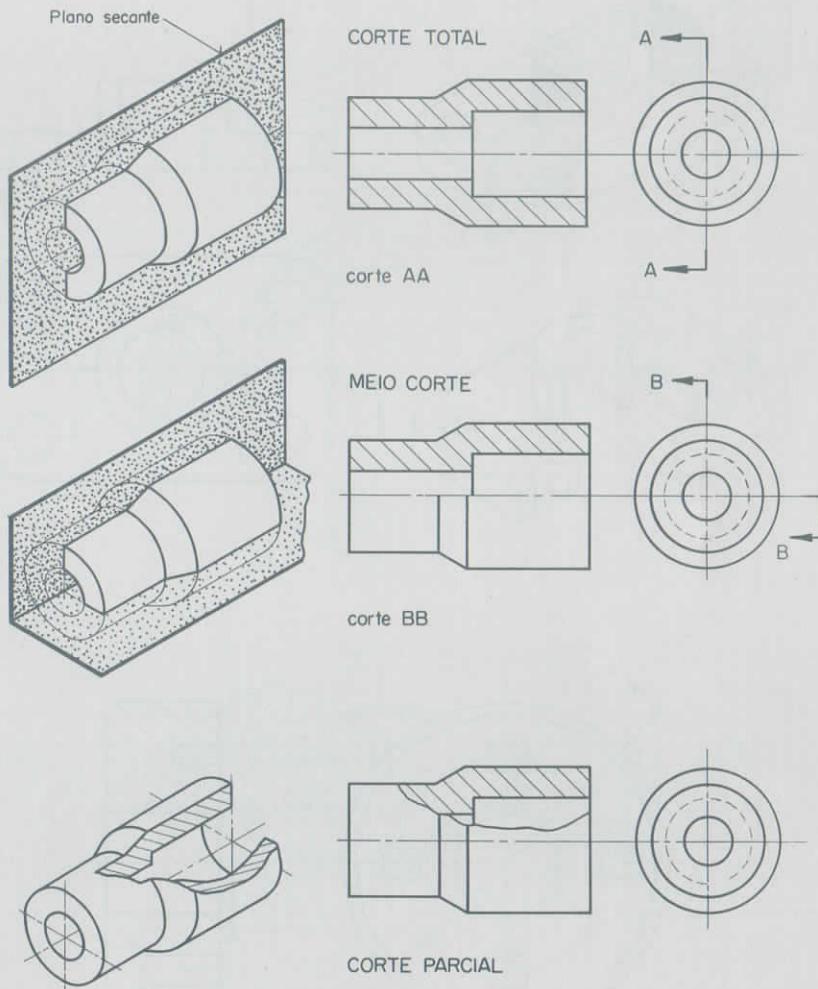
31 – A posição do plano secante e o sentido da visada são indicados por linha traço-ponto, flechas e letras.



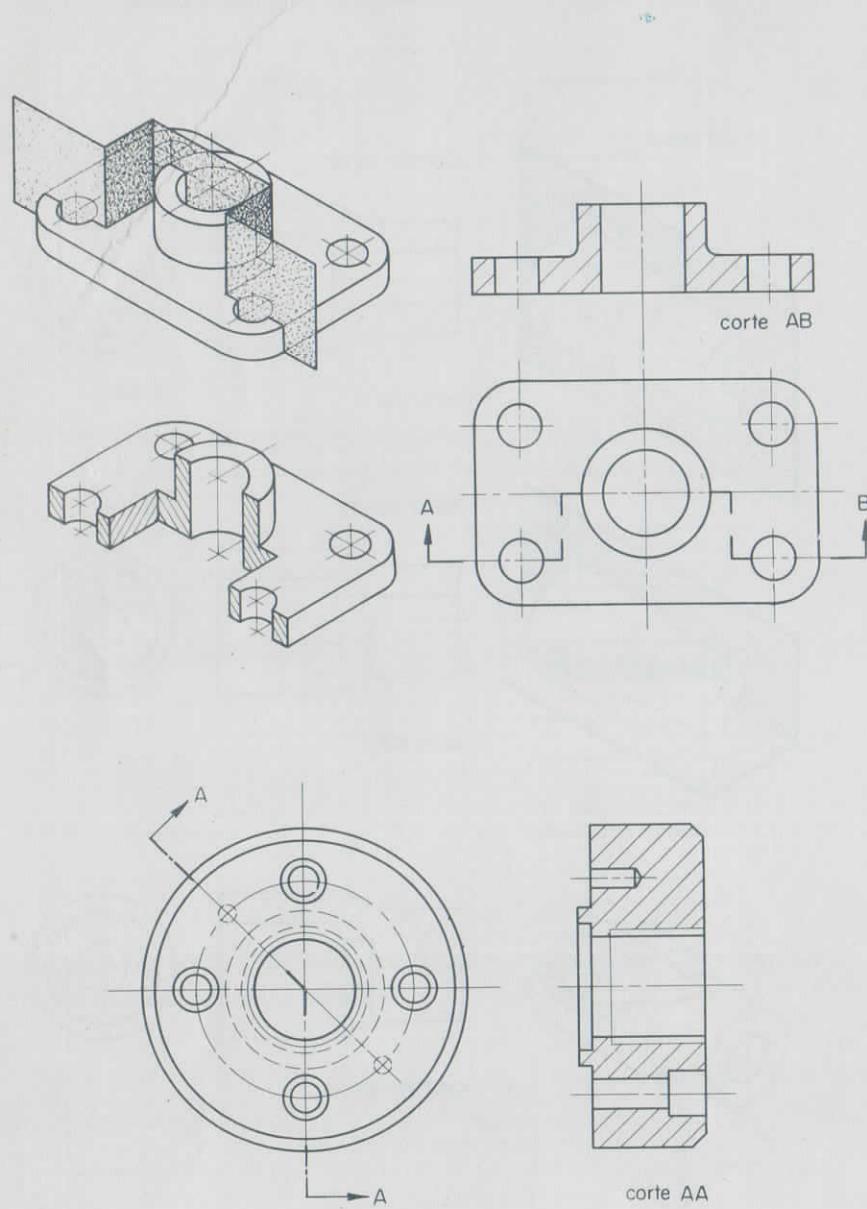
Nos casos evidentes, pode-se omitir esta indicação.

32 – Conforme a extensão em que se supõe cortada a peça, tem-se

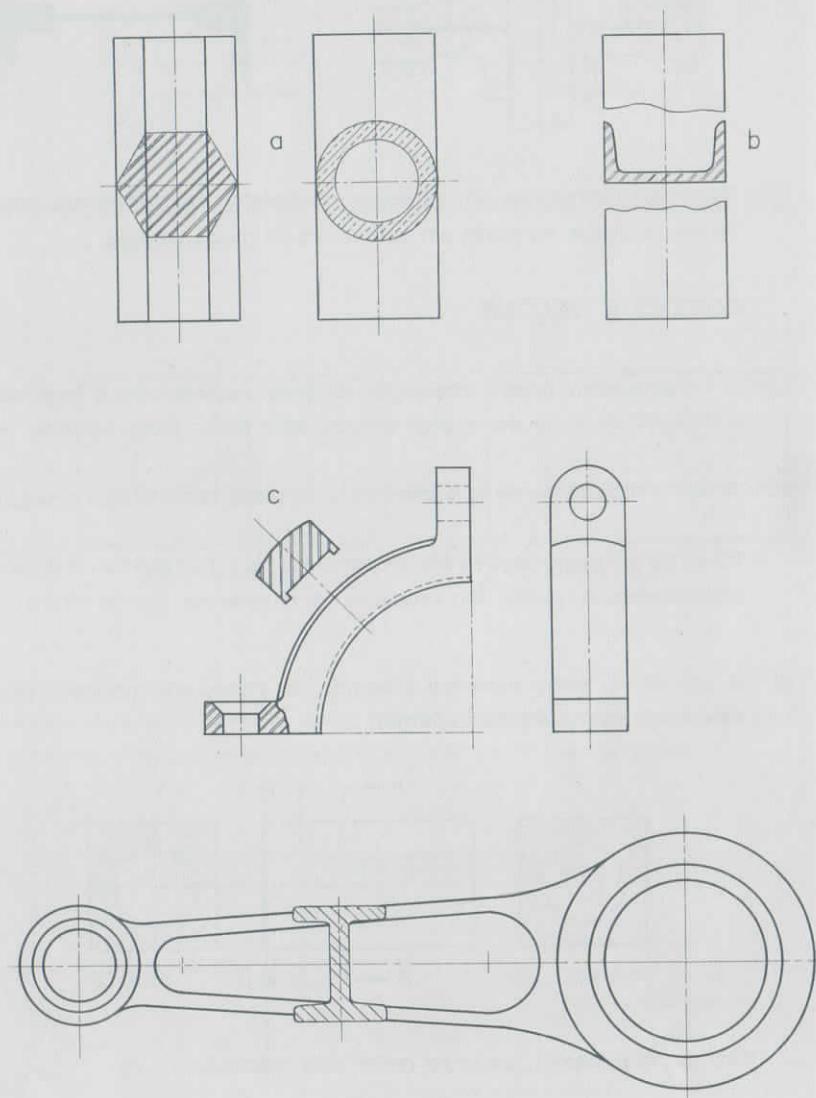
corte total      meio corte      corte parcial



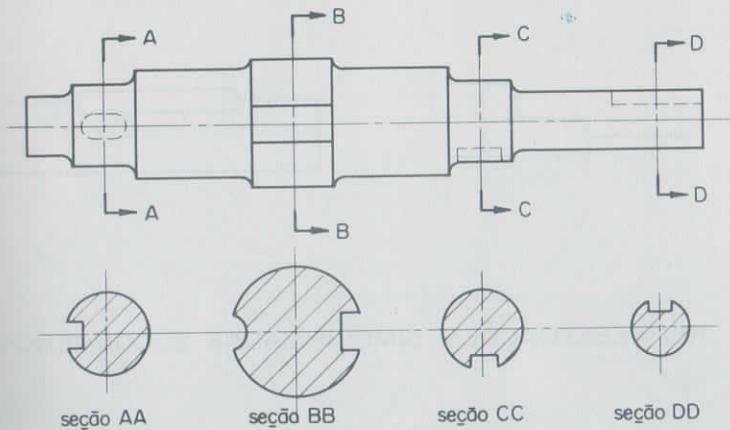
33 – Conforme a conveniência, um corte pode ser efetuado por uma associação de vários planos, constituindo um corte composto.



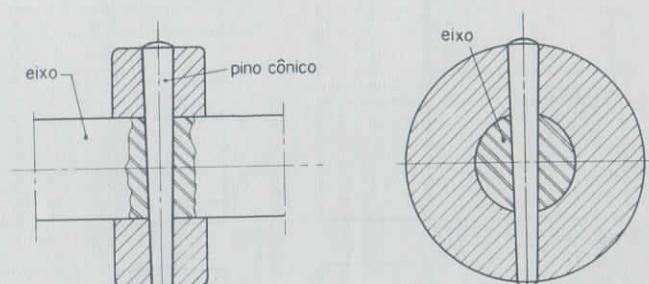
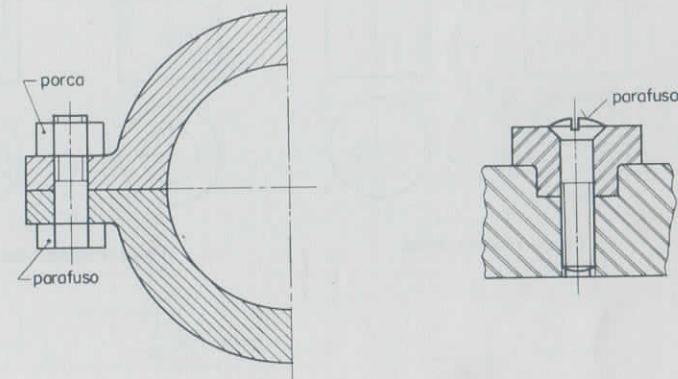
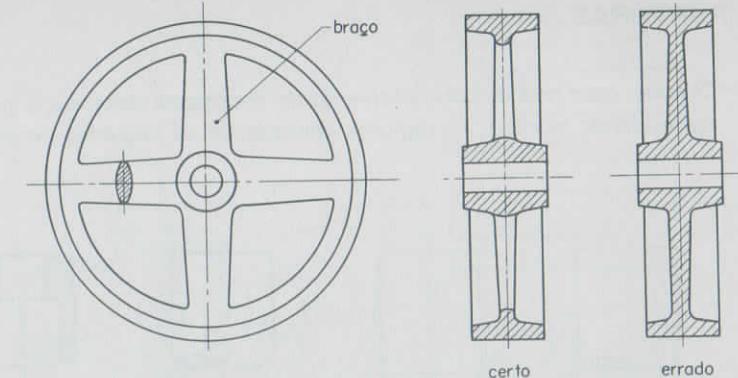
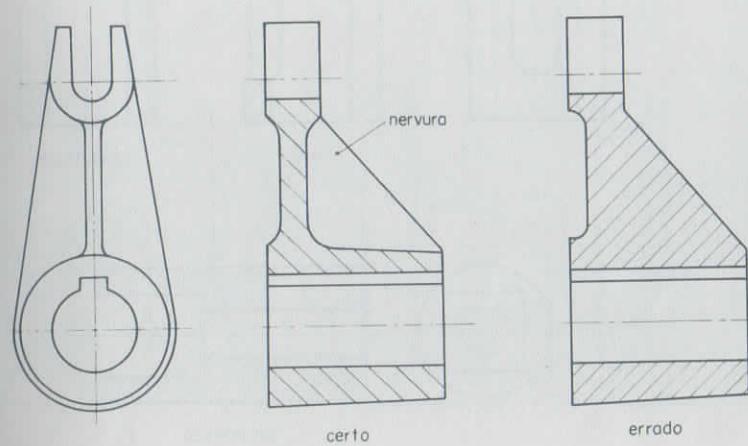
34 – Os cortes ou secções mostrando detalhes ao longo de uma peça, podem ser rebatidos dentro do contorno da vista, sem interrupção do traço da vista (a), com interrupção (b), ou ainda, removidos para fora desse contorno (c).



35 – Várias seções sucessivas podem ser indicadas no desenho.



36 – Nervuras, braços das rodas, eixos, chavetas, parafusos, porcas, cavilhas, rebites e esferas não são hachurados, quando atingidos longitudinalmente pelo corte.

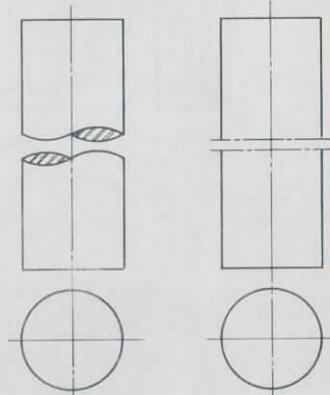


O eixo foi cortado somente para por em evidência a posição do pino.

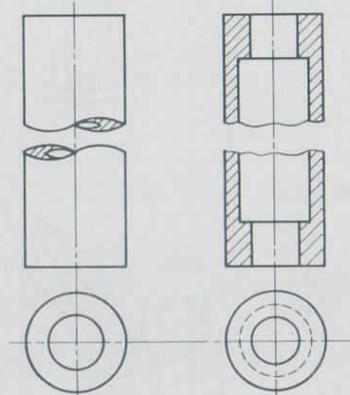
Neste caso o eixo foi cortado completamente, pois, o foi em sentido transversal.

## RUPTURAS

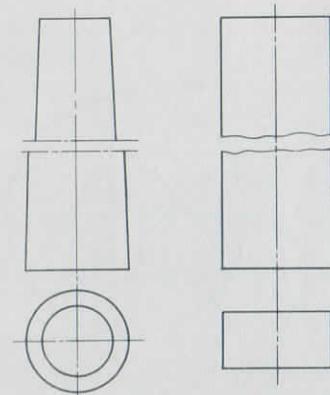
37 – Quando, para melhor aproveitamento de espaço no desenho, a peça for representada partida, as rupturas obecederão as seguintes convenções.



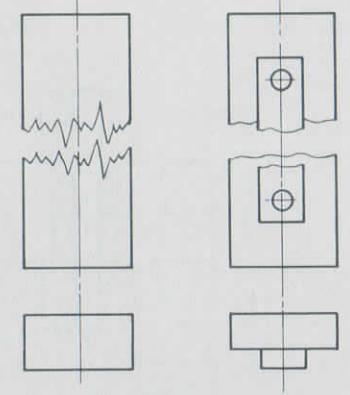
Pecas redondas cheias



Pecas redondas ocas



Peca cônica

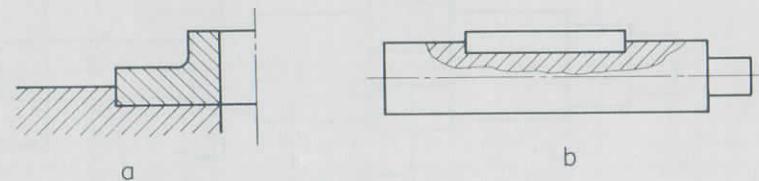


Peca prismática

Peca de madeira

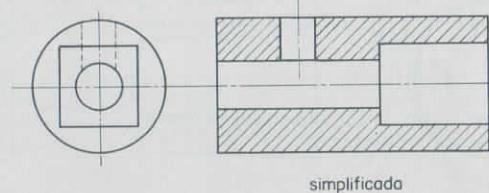
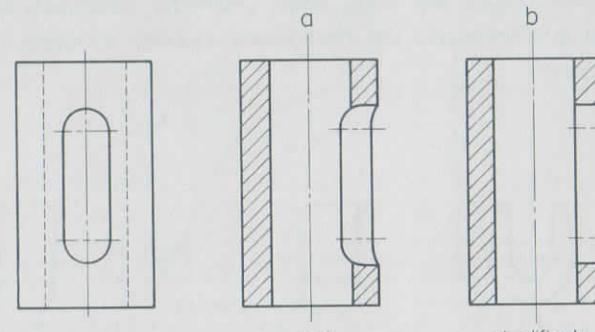
Pecas superpostas

38 – Para peças representadas em corte (a) com hachuras não devem ser usadas linhas de ruptura, com exceção dos cortes parciais (b).



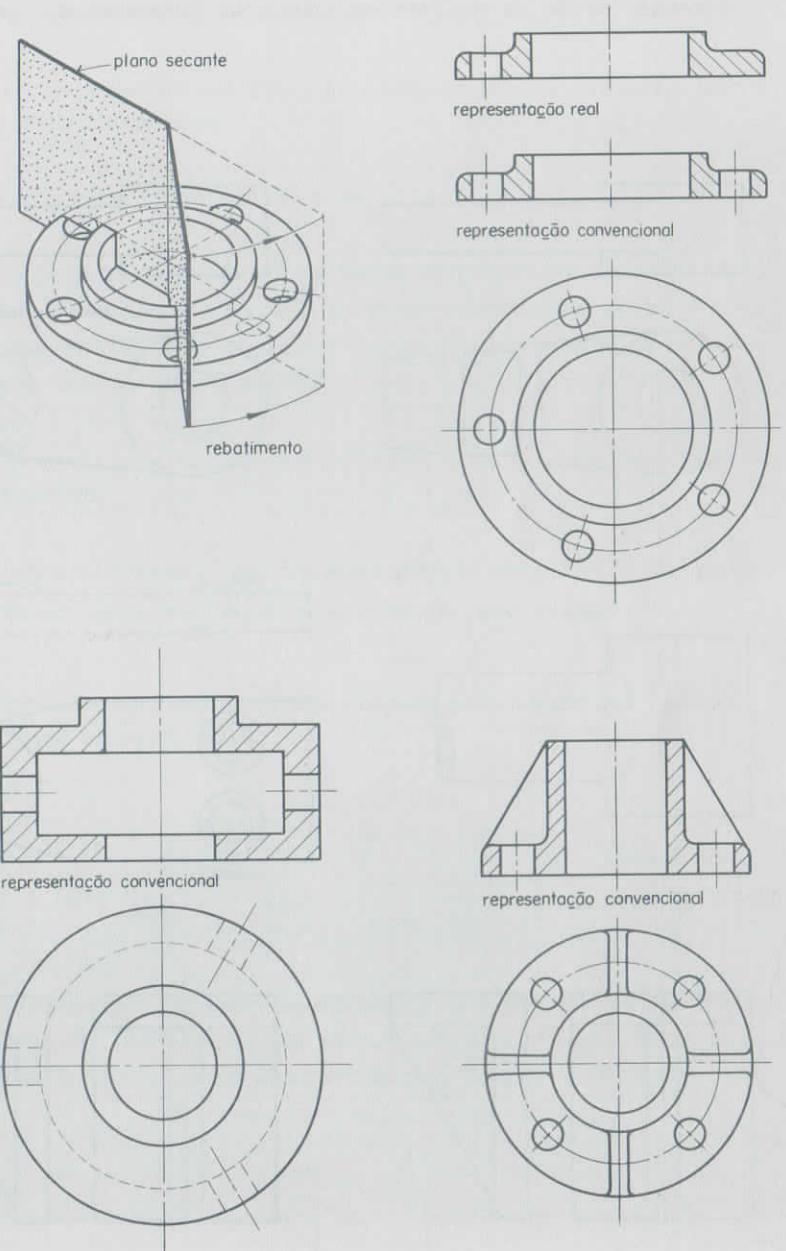
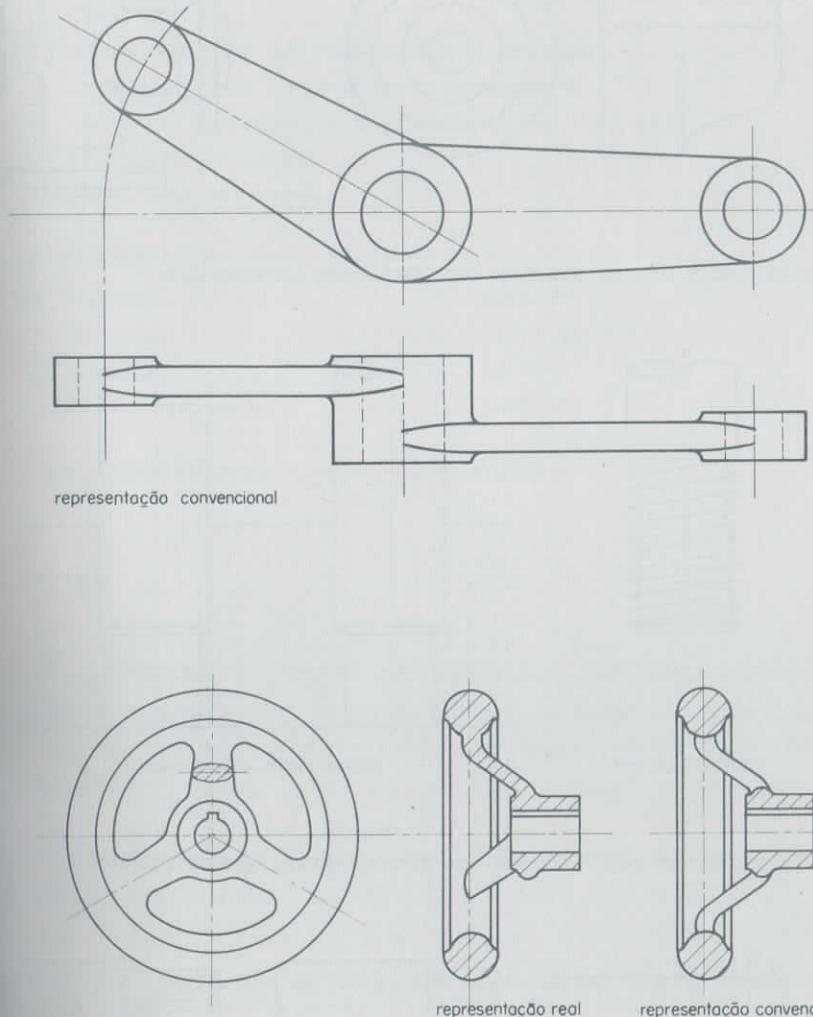
## REPRESENTAÇÕES SIMPLIFICADAS E CONVENCIONAIS

39 – As interseções onde intervêm corpos redondos podem ser representadas como em a, preferindo-se entretanto a representação simplificada b .

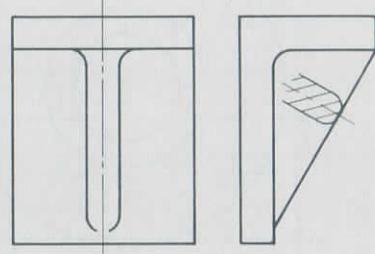
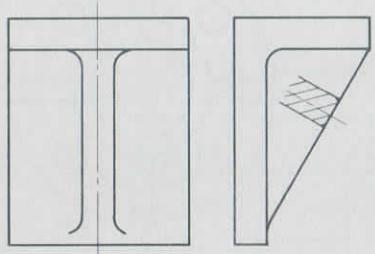
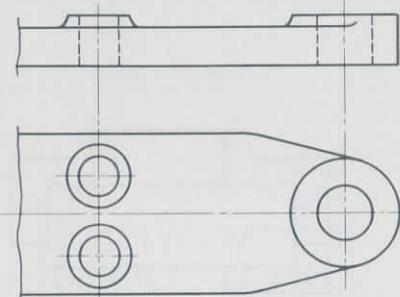
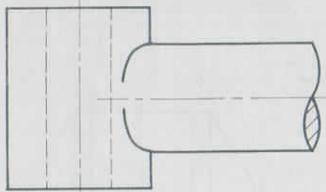
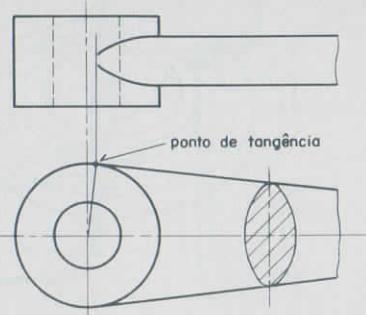
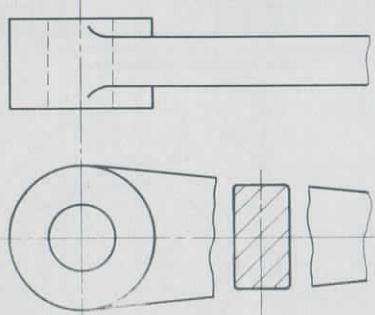


simplificado

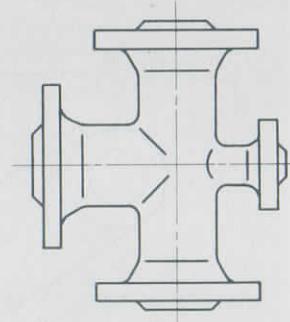
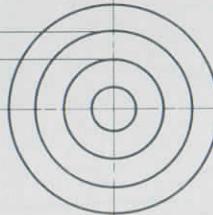
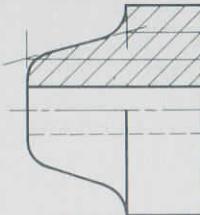
40 – A fim de evitar o encurtamento que resultaria da verdadeira projeção de detalhes inclinados, faz-se a rotação de tais detalhes, de modo a projetá-los sem deformação.



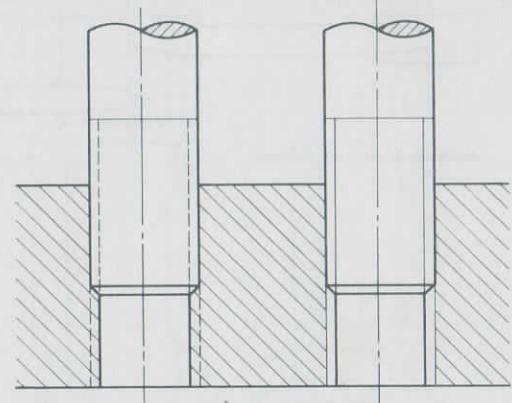
41 — Quando a intersecção de duas superfícies se fizer por uma concordância, empregar-se-ão as seguintes representações convencionais:



42 — Quando não ficar definida a forma da peça devido às concordâncias das superfícies que o delimitam, desenhar-se-ão linhas fictícias de intersecção.



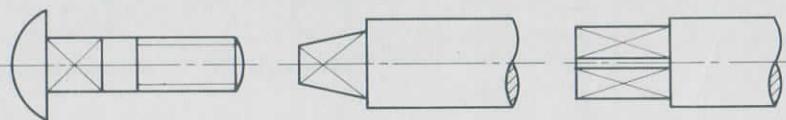
43 — As rosas têm as seguintes representações convencionais:



representação real

representações convencionais

44 — Faces planas são indicadas por duas diagonais que se cruzam.



## SINAIS

45 – Recomendam-se os seguintes sinais para serem colocados nas cotas, sempre antes dos algarismos,

- Ø usado nas cotas que indicam diâmetro.
- ☒ usado nas cotas que indicam quadrado, quando o desenho não mostra claramente.
- R usado nas cotas que indicam raio de curvatura.
- r usado nas cotas que indicam arredondamento.
- # usado nas indicações de bitolas em chapas, fios, etc.
- ∟ indica linha de centro.
- × indica linha de simetria.

Os seguintes sinais indicam o tipo de perfil

- |                    |                  |
|--------------------|------------------|
| ○ redondo          | T perfil T       |
| □ quadrado         | I perfil duplo T |
| ■ chato            | U perfil U       |
| L JL + cantoneiras | Z perfil Z       |

Para os demais sinais, consultar outros capítulos.

## COTAS

46 – Os desenhos devem conter as cotas necessárias, distribuídas nas vistas que melhor caracterizam as partes cotadas, de forma a permitir a execução da peça sem recorrer a medição no desenho, nem à cálculo de medidas.

47 – Poderão deixar de ser cotadas certas partes de menor importância (pequenos arredondamentos de cantos vivos e outras concordâncias).

48 – Além das cotas, devem ser também incorporadas ao desenho as informações necessárias à completa elucidação de todos os detalhes da peça representada.

49 – A cotagem deve ser executada considerando-se a função, a fabricação e a inspeção da peça.

50 – As cotas devem ser indicadas com a máxima clareza de modo a admitir uma única interpretação.

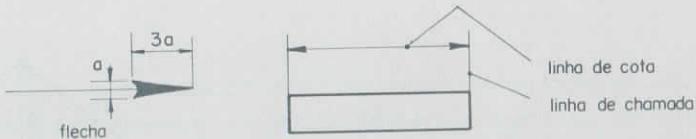
51 – Deve-se evitar a repetição de cotas.

52 – As cotas serão expressas em milímetros sem mencionar o símbolo desta unidade. Excepcionalmente, no caso de ser conveniente empregar outra unidade o símbolo desta deverá ser escrito obrigatoriamente ao lado da cota ou indicado junto à legenda.

53 – As linhas de cota são representadas por traço fino, limitadas pelas linhas de chamada.

54 – As linhas de chamada são representadas por traço fino, e são prolongadas um pouco, além da última linha de cota que abram.

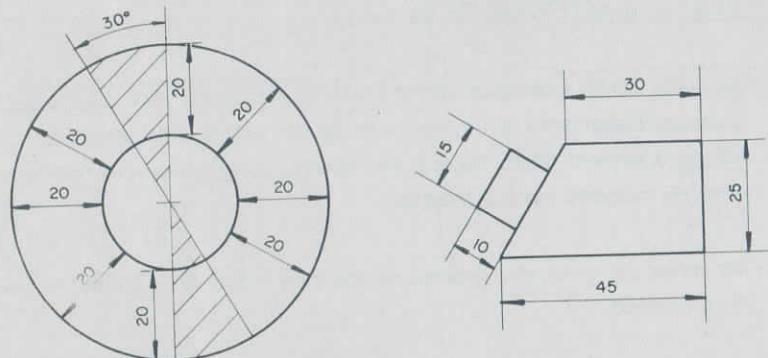
55 – As linhas de cota são terminadas em suas extremidades por flechas, conforme indicação abaixo.



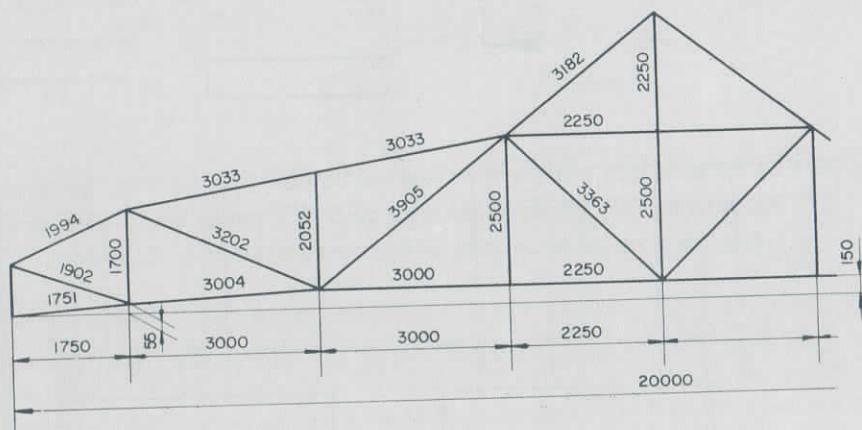
56 – Os números que exprimem os valores da cota são escritos, geralmente, equidistantes dos extremos da linha de cota e acima dela. Eventualmente, a linha de cota pode ser interrompida para colocar o algarismo.



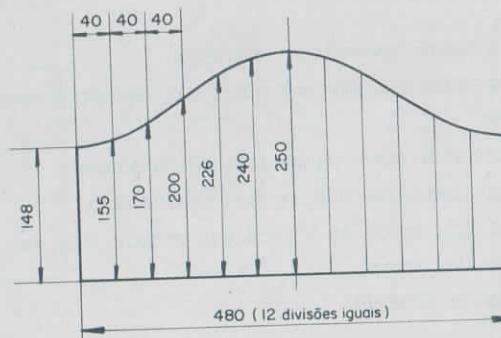
57 – Os algarismos são escritos segundo a direção das linhas de cota, evitando-se que estas linhas tenham uma direção compreendida dentro do ângulo de  $30^\circ$  hachurado, para que a leitura seja efetuada sem necessidade de virar o desenho. Dessa forma a leitura será efetuada de frente ou do lado direito do desenho.



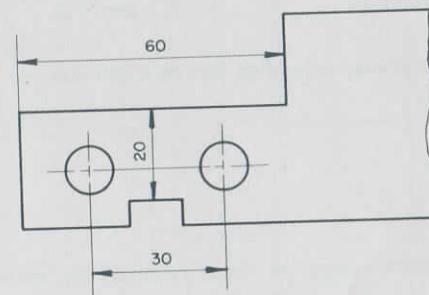
58 – Não se deve usar como linhas de cota, eixos, linhas de centro, arestas e contornos de objeto, com exceção de desenhos esquemáticas como estruturas.



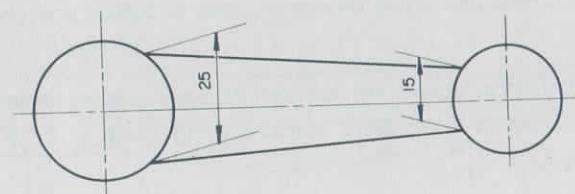
59 – Em casos especiais as linhas de chamada e as linhas de centro podem servir de linhas de cota.



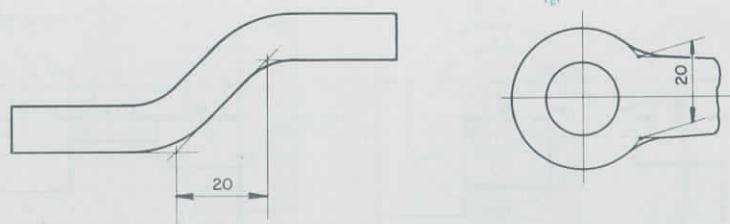
60 – As linhas de centro, eixos, arestas e contornos de peças podem substituir quando conveniente, as linhas de chamada.



61 – As linhas de chamada podem em caso de necessidade, serem traçadas obliquamente, mas paralelas entre si.

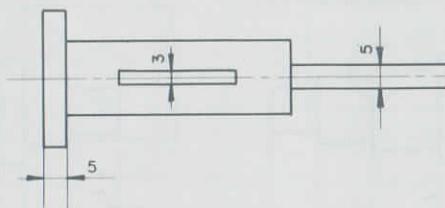


62 – Quando houver necessidade, a cota pode ser referida às linhas de construção.

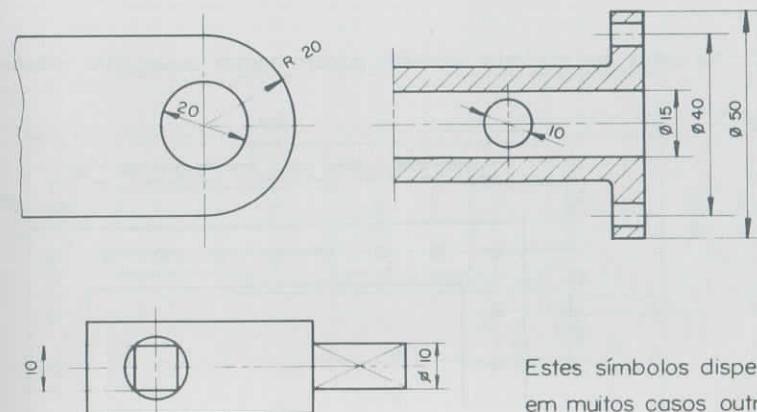


Não cotar as partes representadas com linhas invisíveis.

63 – Na falta de espaço deve-se desenhar as flechas externamente para atender os requisitos de melhor clareza.

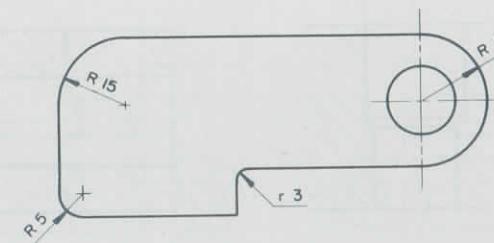


64 – Quando na vista cotada for evidente que se trata de diâmetro ou quadrado, o respectivo símbolo pode ser dispensado.

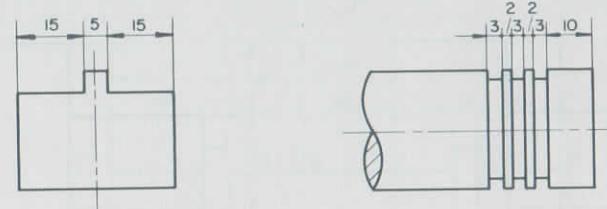


Estes símbolos dispensam em muitos casos outras vistas.

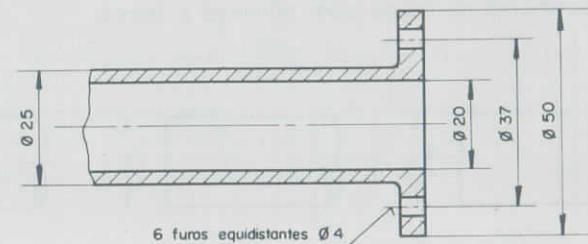
65 – As linhas de cotas de raios de arcos e de arredondamentos não levam flechas na extremidade que está no centro do arco.



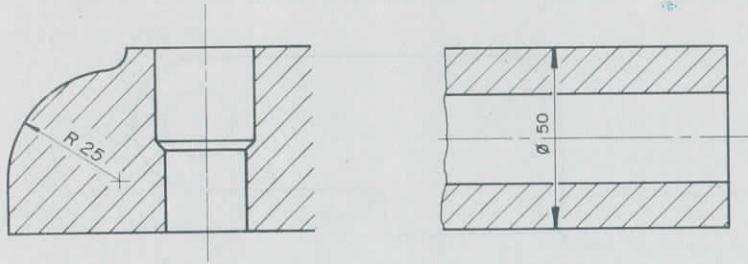
66 – Na impossibilidade de colocar flechas usar as indicações abaixo:



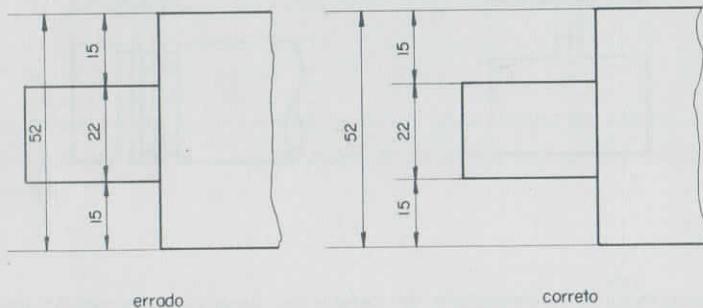
67 – Quando houver necessidade de referir no desenho informação escrita ou simbólica pertencente a um detalhe da peça procede-se conforme indicação abaixo:



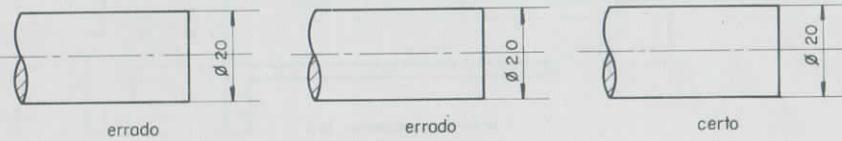
68—Quando uma cota for escrita no interior de uma seção as hachuras devem ser interrompidas.



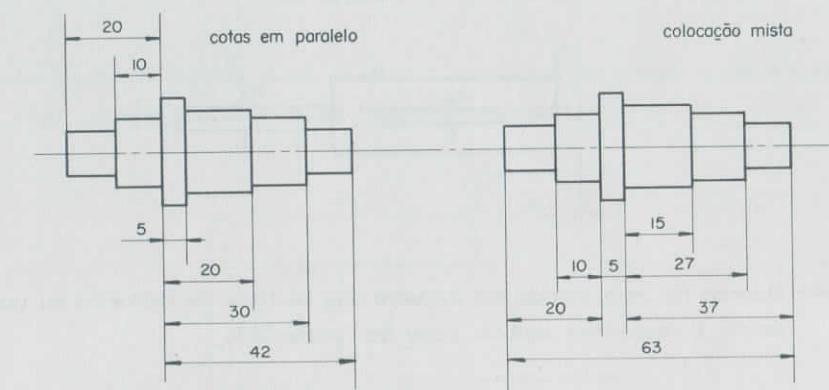
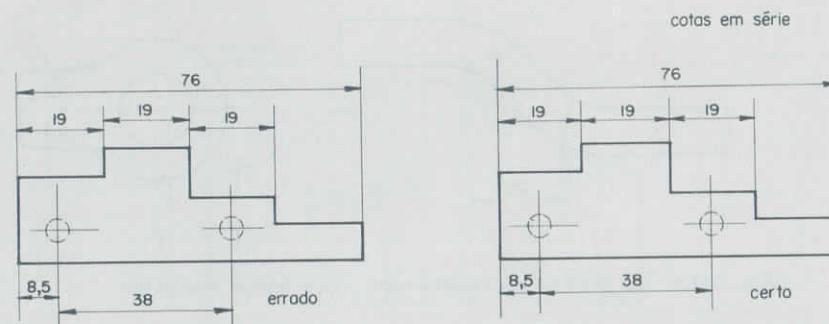
69—Deve-se evitar, se possível, que linhas de cota se cruzem entre si ou com linhas de desenho.



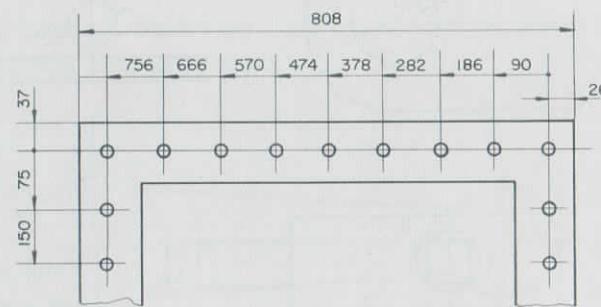
70—A colocação das cotas deve atender aos requisitos de maior clareza, compreensão e facilidade de execução do desenho, evitando qualquer cruzamento de linhas com números e letras.



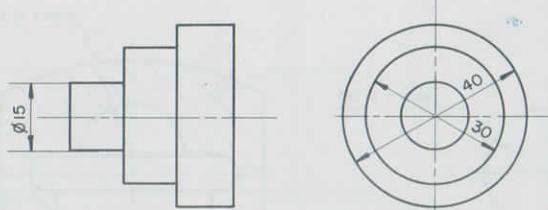
71—Cotas que tenham a mesma direção são dispostas em série e quando admitirem origem comum, em paralelo. É permitida a combinação dessas duas modalidades.



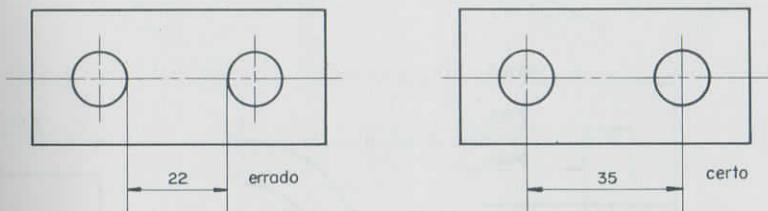
72—As cotas em paralelo também podem tomar a seguinte disposição.



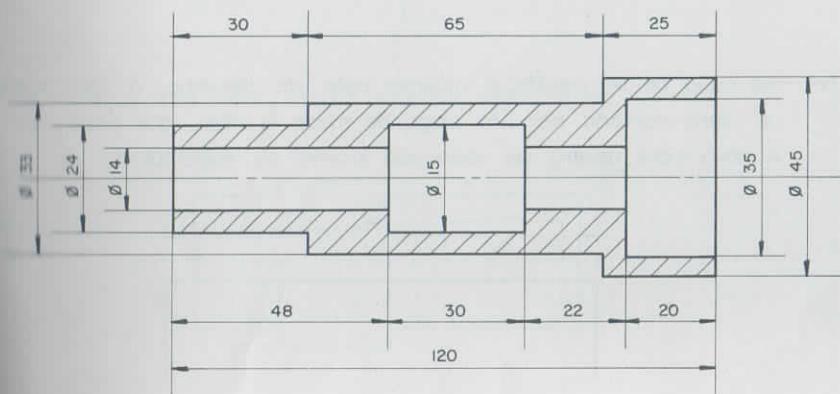
73 – Evitar colocar mais que duas cotas que passam pelo centro da circunferência.



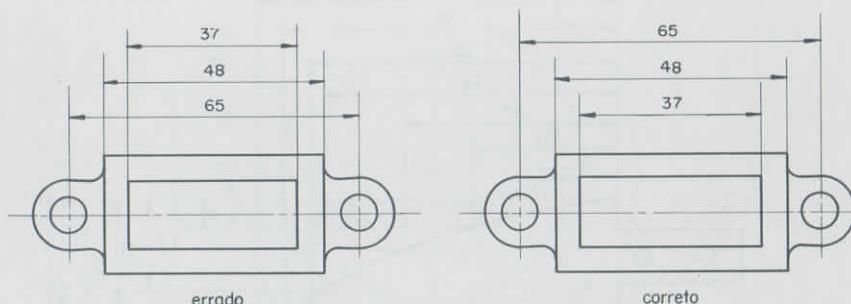
74 – Indicar a distância entre os centros dos furos e não entre as paredes.



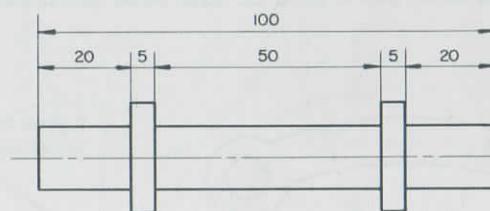
75 – É aconselhável separar as cotas internas das externas.



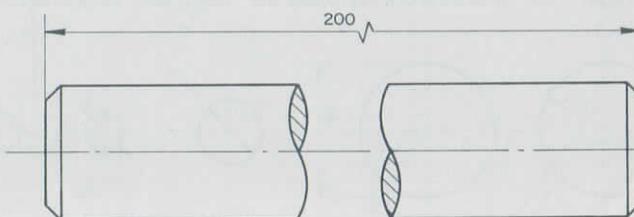
76 – As cotas maiores são colocadas por fora das menores, a fim de evitar cruzamentos.



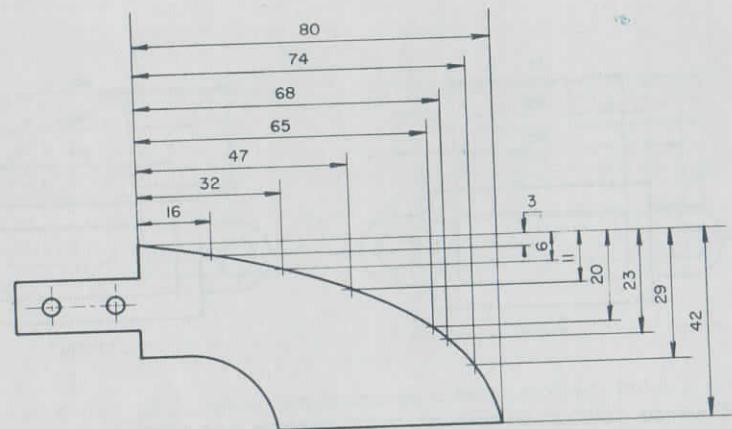
77 – Deve-se colocar sempre as cotas parciais e a total.



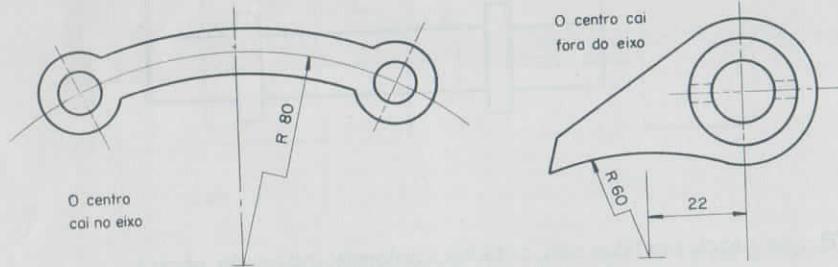
78 – As peças partidas são cotadas conforme indicação abaixo.



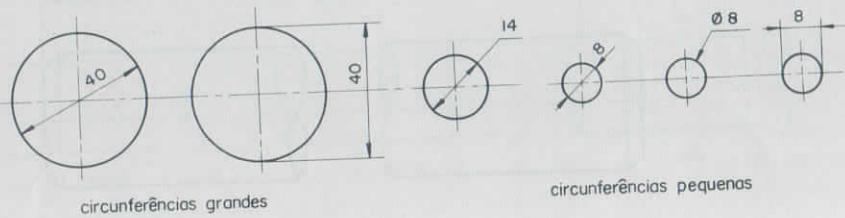
79 - Contornos irregulares podem ser cotados conforme indicação abaixo.



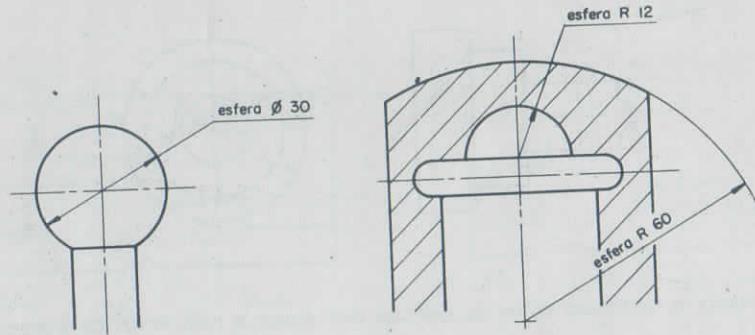
80 – Para os grandes raios a linha de cota pode ser quebrada em trechos paralelos.



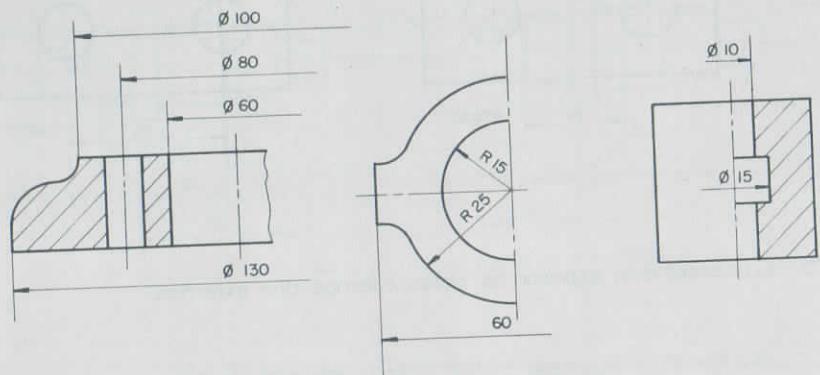
81 - A cotação de circunferências pode ser feita das seguintes maneiras:



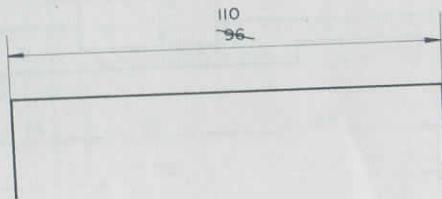
82 – Os elementos esféricos são cotados pelo diâmetro ou pelo raio, precedido da palavra "esfera".



83—Cotas de peças simétricas podem ser interrompidas.



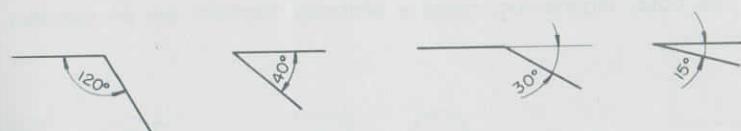
84 - No caso de se modificar alguma cota do desenho, a cota substituída será cortada por um traço, de modo, porém, que possa ser lida. A nova cota deverá ser colocada acima da substituída.



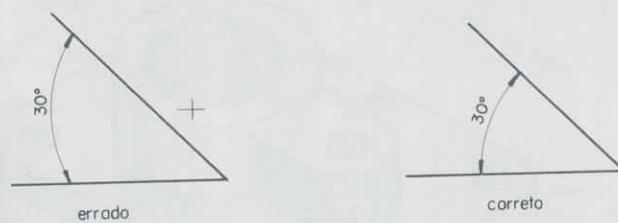
85 – As cotagens de corda, desenvolvimento de arco e ângulo se diferenciam conforme indicações abaixo.



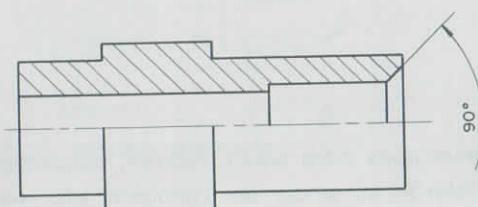
86 – Conforme o espaço disponível no desenho, os ângulos podem ser cotados como indicam as figuras abaixo:



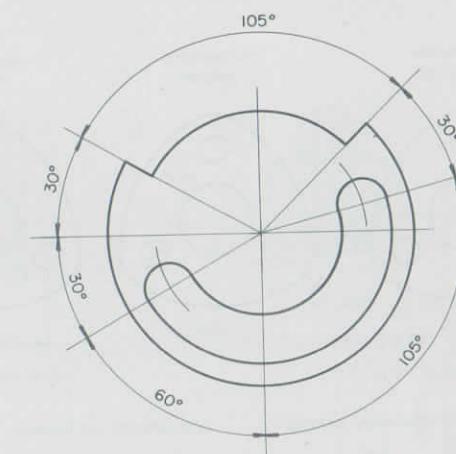
87 - O arco de cota do ângulo deverá ter o centro no vértice.



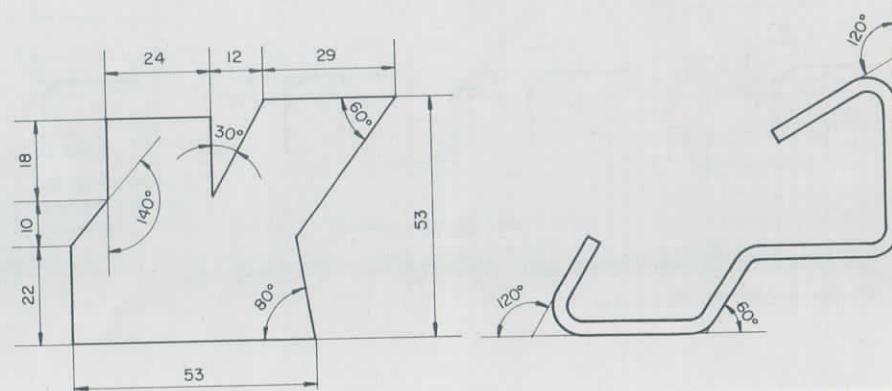
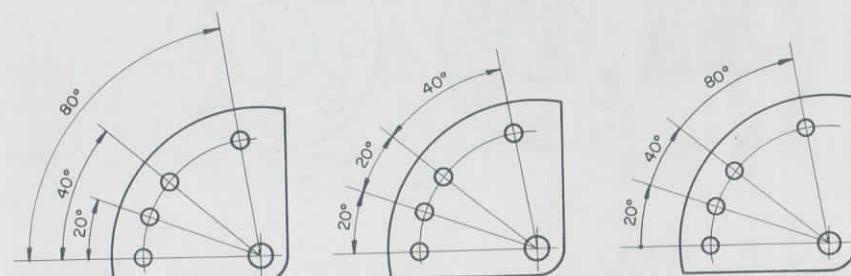
BB - Em peças simétricas, a cota pode ser interrompida.



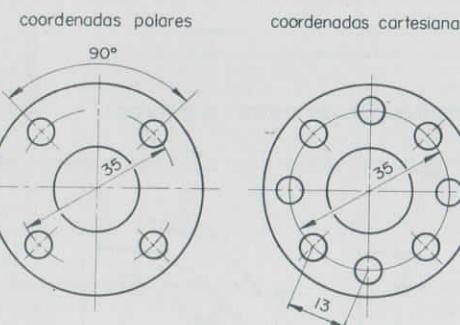
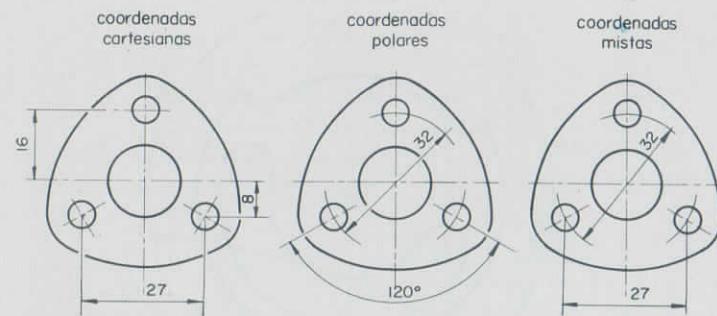
89—A colocação dos algarismos se efetuam da seguinte forma.



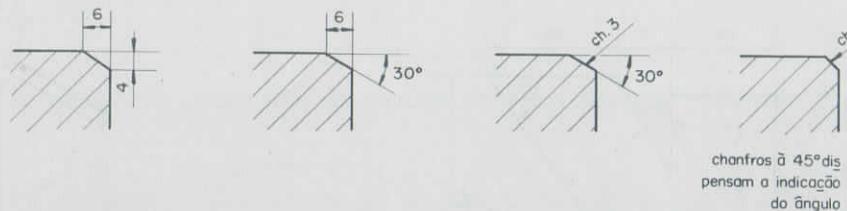
### 90 – Exemplo de disposição de cotas angulares:



91 – Os furos podem ser cotados em coordenadas polares, em coordenadas cartesianas ou coordenadas mistas.

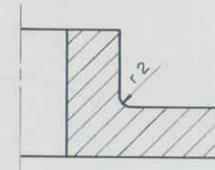


92 – Os chanfros (ch) podem ser cotados das seguintes maneiras:



Os chanfros aconselháveis são: 0,1 – 0,5 – 1 – 2 – 3 – 4 – 5.  
Evitar chanfros côncavos.

93 – Os arredondamentos são cotados da seguinte maneira.

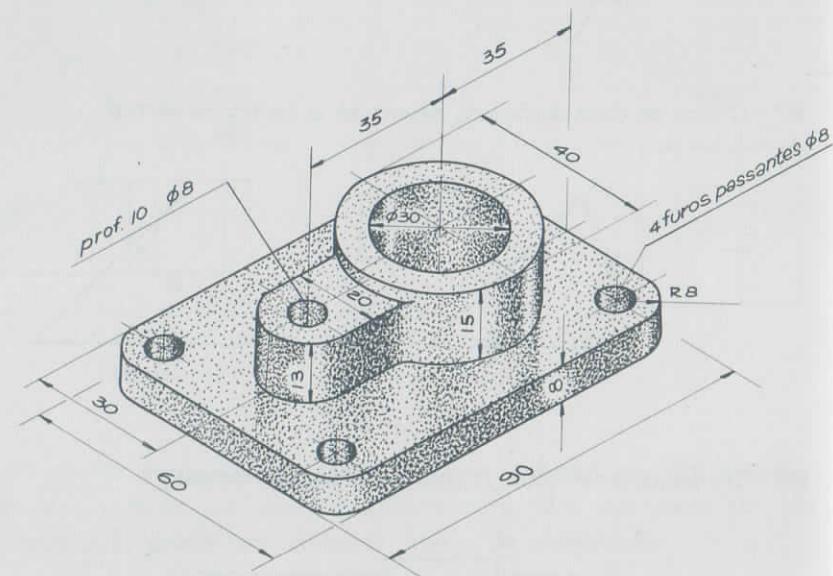


Os arredondamentos aconselháveis são os seguintes:

0,2 – 0,5 – 1 – 2 – 3 – 5 – 10

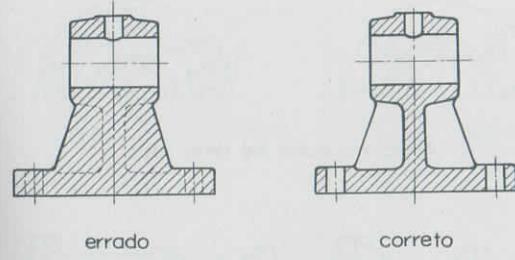
Evitar arredondamentos convexos.

94 – As peças em perspectiva devem apresentar linhas de chamada, linhas de cota, algarismos, notas e símbolos também em perspectiva.

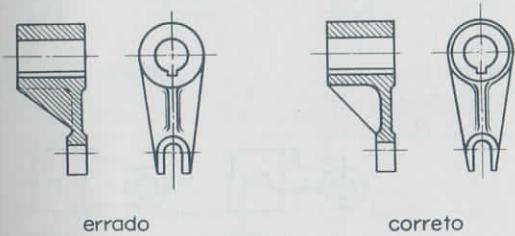


95 – Sinais e convenções para solda, rebites, canalizações, concidade, inclinação, tolerância, sinais de usinagem, etc. estão indicadas em outros capítulos.

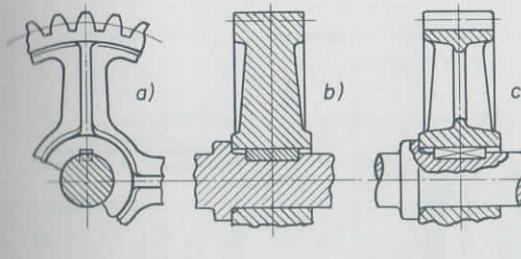
# RECOMENDAÇÕES E CONSELHOS



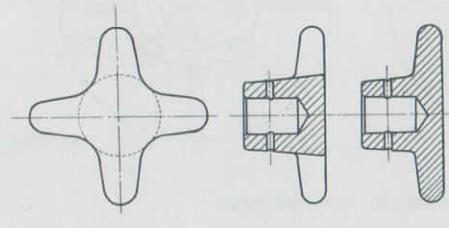
Representação de um suporte com nervura.



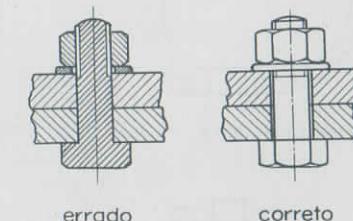
Representação de um suporte com nervura.



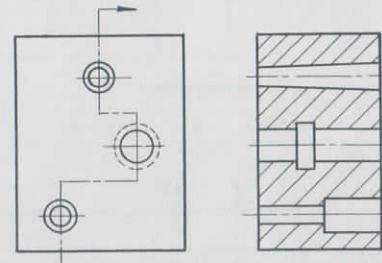
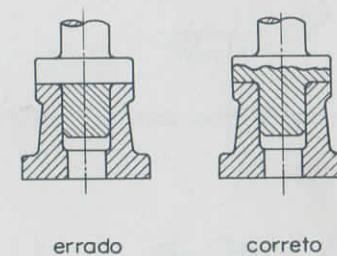
Representação de uma engrenagem



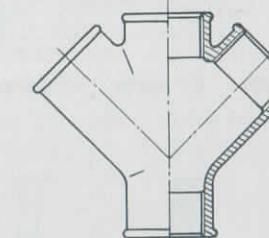
Representação de um manípulo de comando



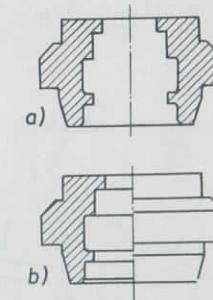
Representação de uma união com parafuso passante



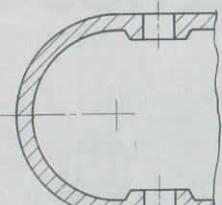
seção em vários planos



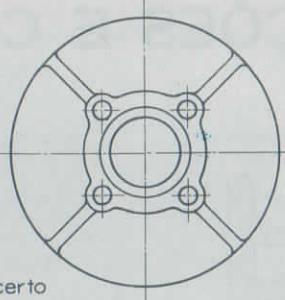
Representação em meio corte



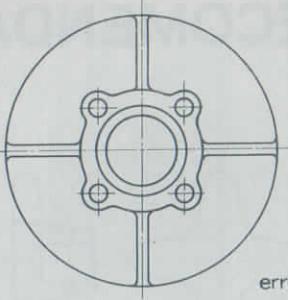
a) errado b) correto



usinagem difícil

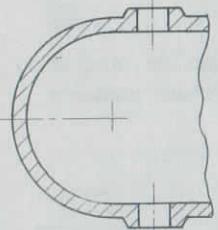


certo

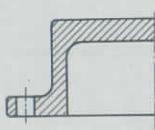


errad

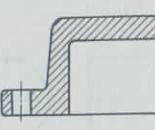
## Disposição das nervuras



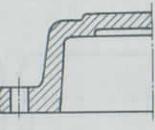
usinagem mais fácil



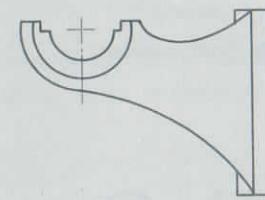
errado



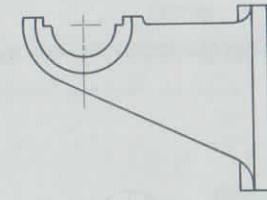
certo



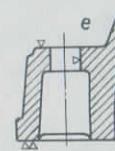
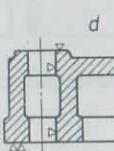
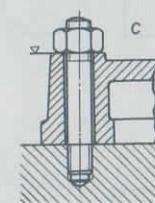
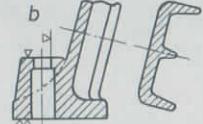
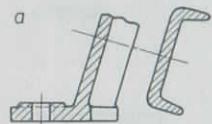
melhorado



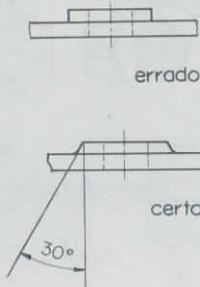
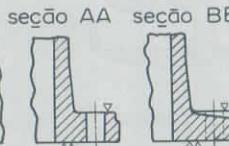
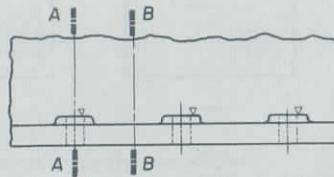
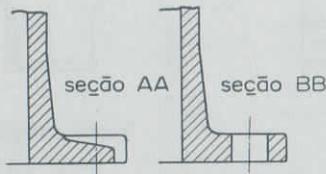
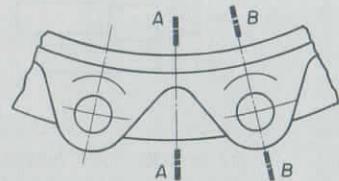
evitar



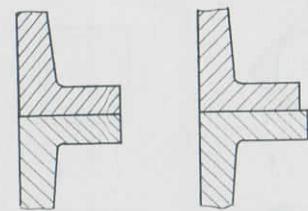
correto



Base das máquinas : a) errado b) certo c) certo d) certo e) melhorado.

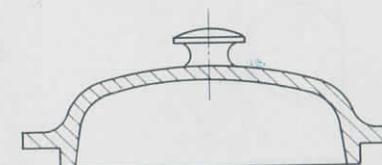


Reforçar os furos para parafusos de união, fixação ou chumbadores

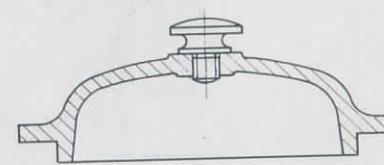


certo

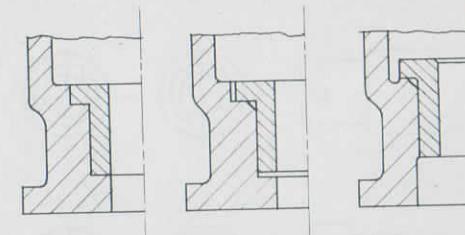
errado



dificuldade na fundição



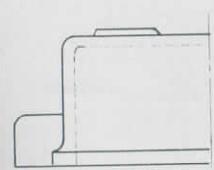
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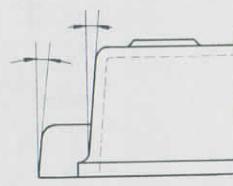
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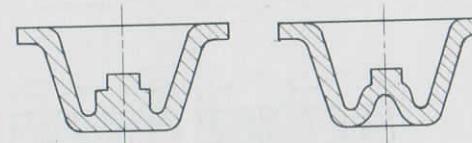
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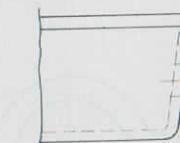


certo  
para facilitar a  
retirada do molde

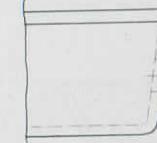


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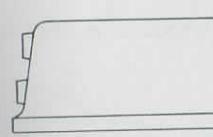
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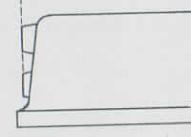
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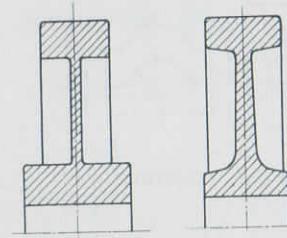
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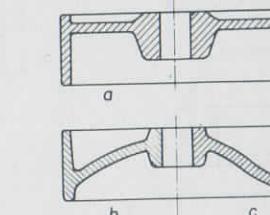


para facilitar o  
acabamento



errado

certo



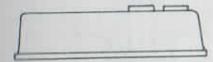
a) errado b) certo c) melhorado



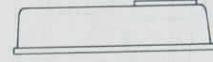
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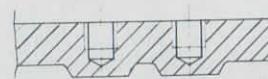
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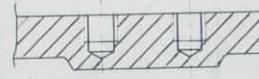
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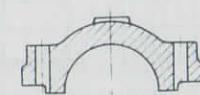
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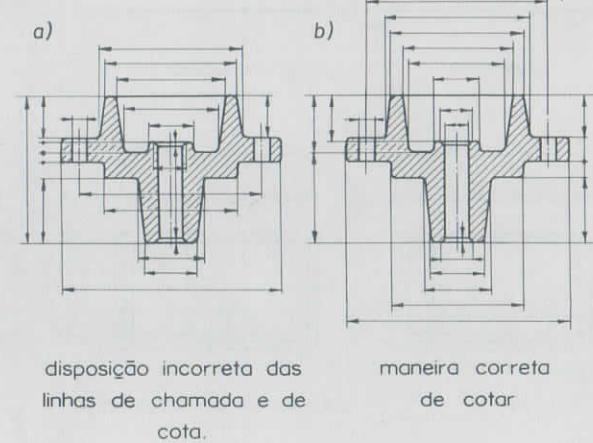
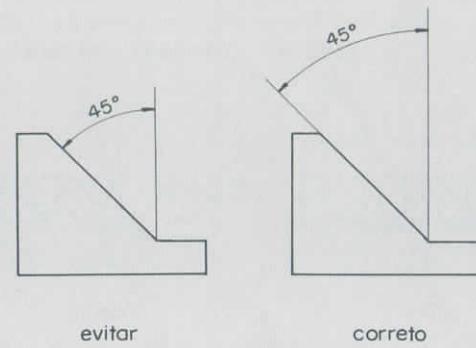
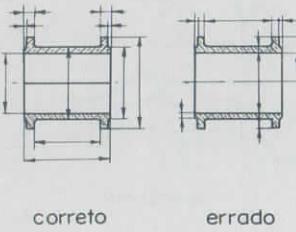
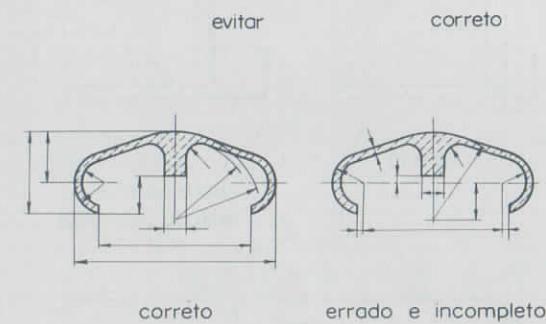
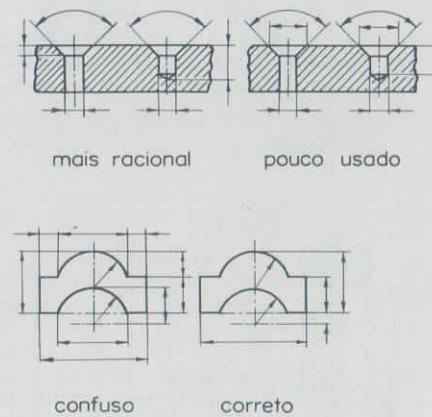
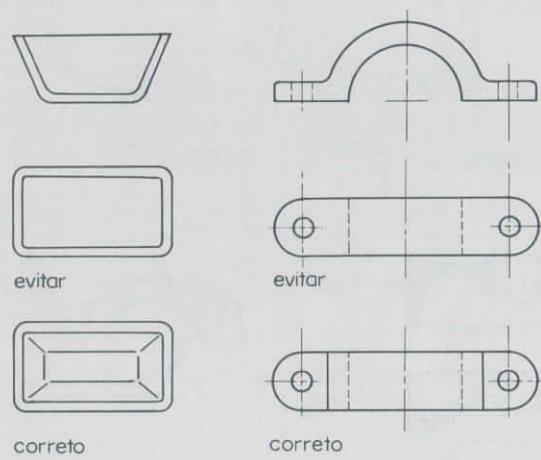
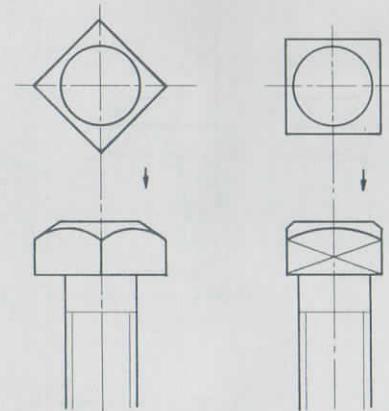
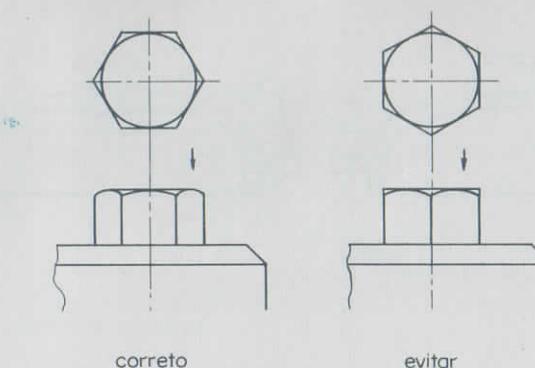
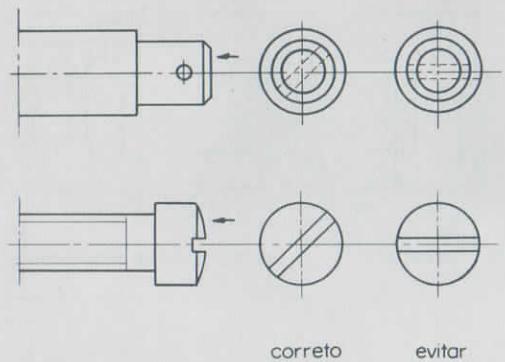
evitar

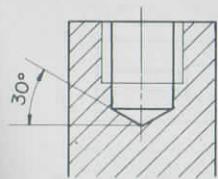


certo

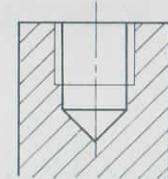


melhorado

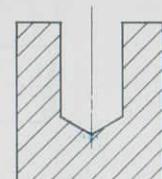




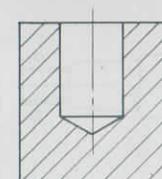
correto



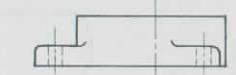
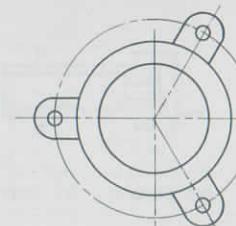
errado



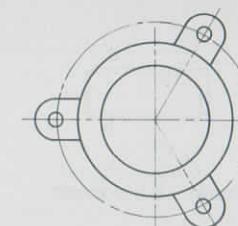
errado



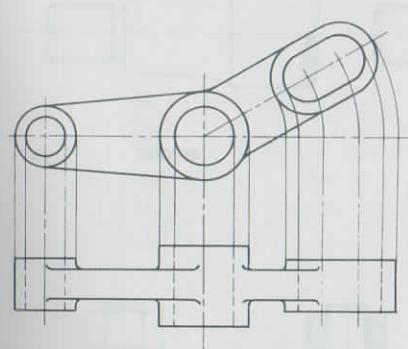
correto



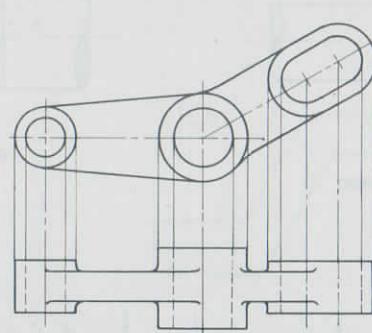
representação real



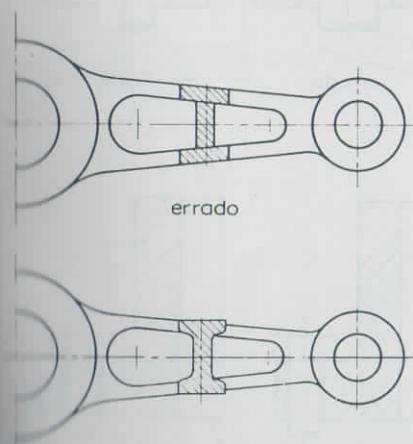
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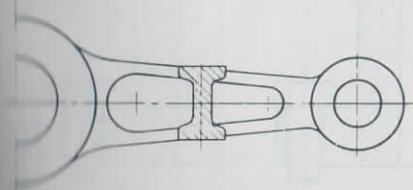
representação convencional



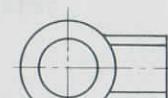
representação real



errado



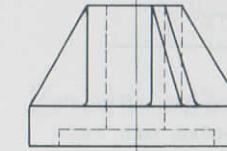
correto



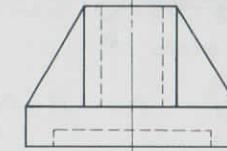
representação real



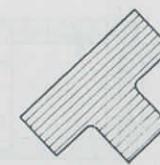
representação simplificada



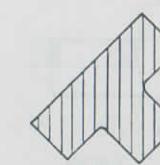
representação real



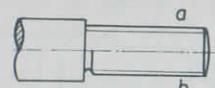
representação convencional



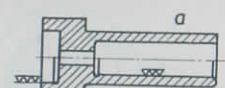
errado



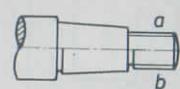
correto



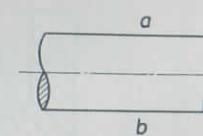
a) errado b) correto



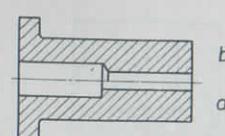
a) errado b) correto



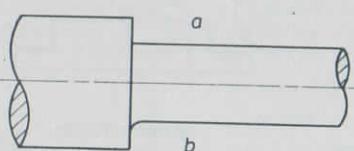
a) errado b) correto



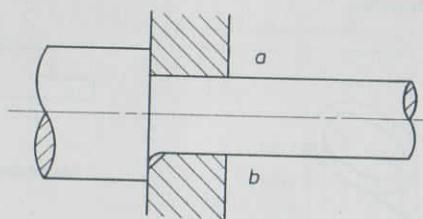
a) errado b) correto



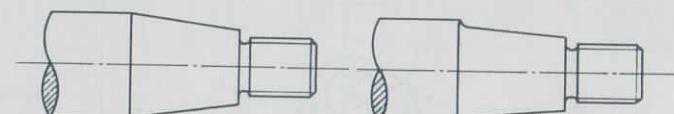
a) errado b) correto



a) errado b) correto

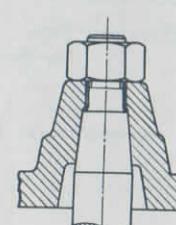
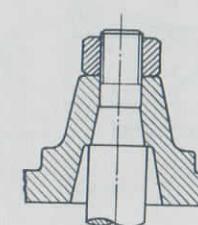
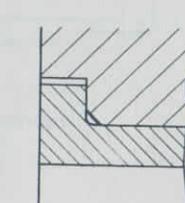
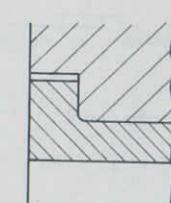
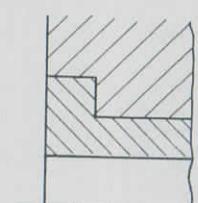
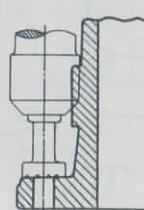
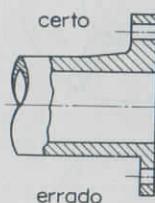


a) errado b) correto

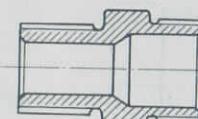
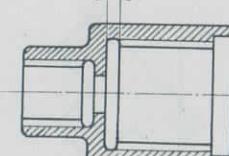
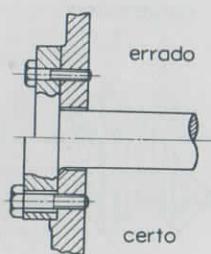


correto

errado



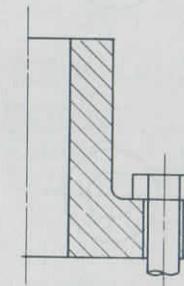
Deixar espaço suficiente  
p/ trabalhos com fresa



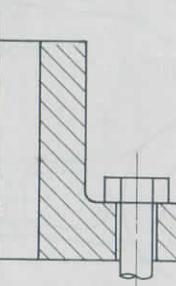
saída de rosas



a) errado b) correto

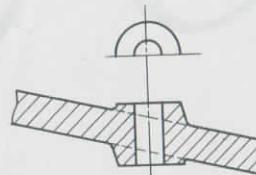
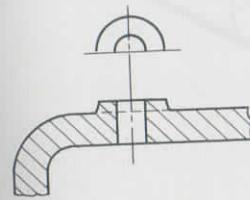
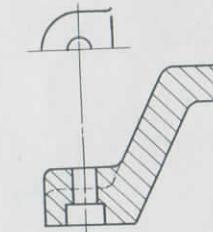
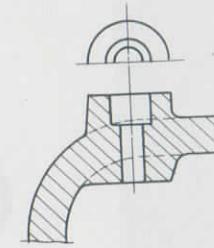
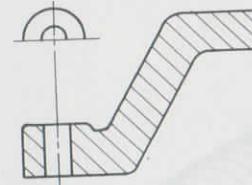
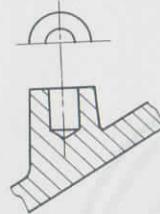
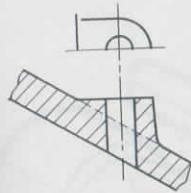
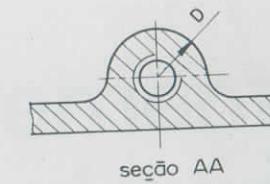
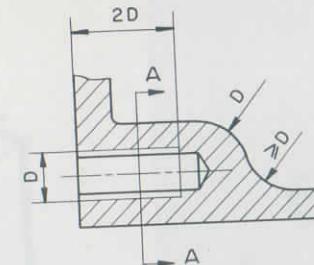
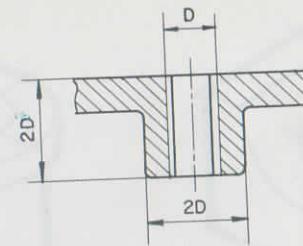
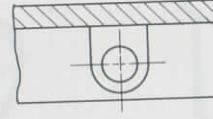
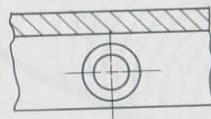


errado



certo

## TIPOS DE REFORÇOS



<b>A</b>	<b>B</b>	<b>Γ</b>	<b>Δ</b>	<b>E</b>	<b>Z</b>	<b>H</b>	<b>Θ</b>	<b>I</b>	<b>K</b>	<b>Λ</b>	<b>M</b>
a	β	γ	δ	ε	ζ	η	θ	ι	κ	λ	μ

alpha beta gama delta epsilon zeta eta teta iota capa lâmbda mu

<b>N</b>	<b>Ξ</b>	<b>Ο</b>	<b>Π</b>	<b>P</b>	<b>Σ</b>	<b>T</b>	<b>Υ</b>	<b>Φ</b>	<b>X</b>	<b>Ψ</b>	<b>Ω</b>
ν	ξ	ο	π	ρ	σ	τ	υ	φ	χ	ψ	ω

nu csi omicron pi ro sigma tau upsilon fi chi psi omega

