

desenhista de máquinas

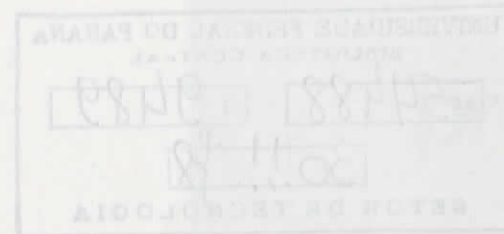
Organizado e coordenado pelo Eng. Ind. Mec. F. PROVENZA

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
P969
3. ed.



Escola
pro-tec

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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.

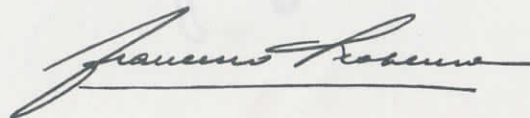
Estas publicações visam os mesmos objetivos do antigo prontuário, quais sejam, facilitar a árdua tarefa dos alunos e dos mestres na coleta de informações técnico-didáticas e representam uma fonte de consulta para os profissionais.

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



prefácio

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

Prof. Francisco Marath Pieber
Sr. Dario Alcazar Valencia
Srta. Gisela Postatni
Sra. Erecina Neves do Nascimento
Eng. Francesco Provenza

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3ª edição — 1976

Exemplar nº



1

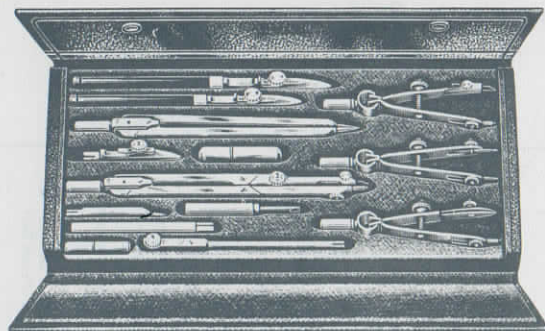
material de desenho e seu uso

material de desenho

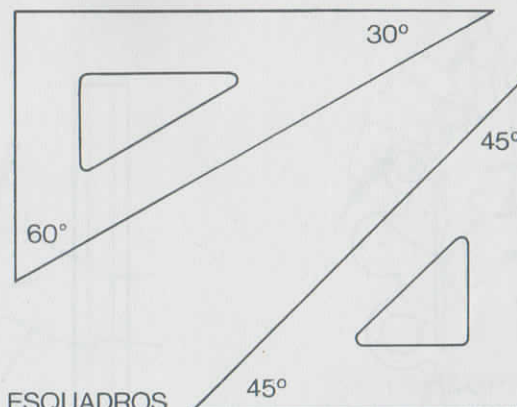
lápiz

esquadro

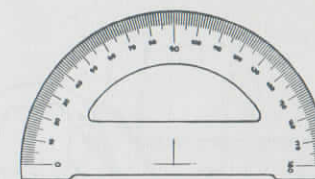
compasso



ESTOJO



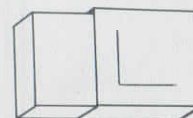
ESQUADROS



TRANSFERIDOR



RÉGUA



BORRACHA



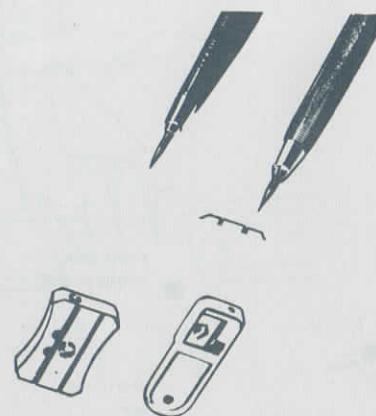
CURVA FRANCESA



TIRA-LINHA



COMPASSOS



APONTADORES



CANETA

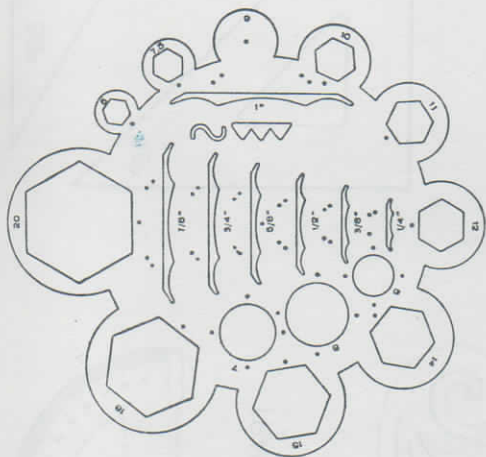


LAPISEIRA

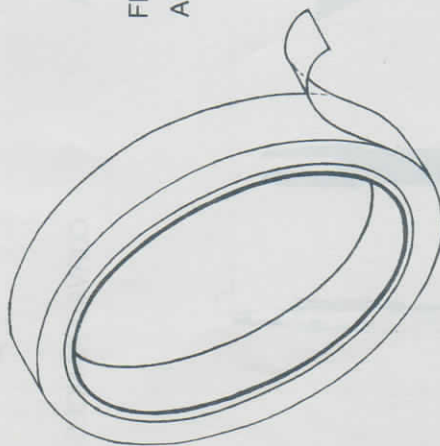


LAPIS

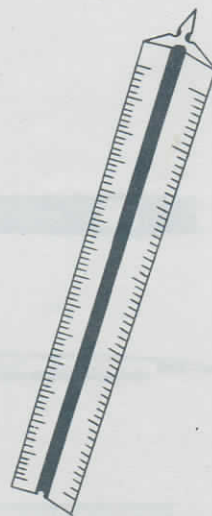
DUREZA DOS LÁPIS



GABARITO



FITA ADESIVA



ESCALA



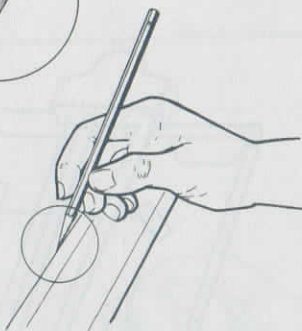
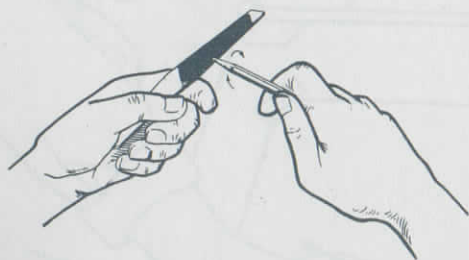
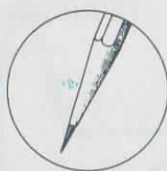
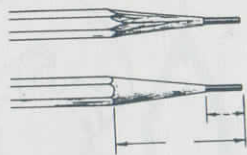
LÁPIS COMUM	OS MELHORES PARA DESENHO	PARA CROQUIS TÉCNICOS	PARA DESENHO DE PLANTAS	PARA TIRAR CÓPIAS A LUZ
	Macio especial, intensamente preto	7B		
	Extraordinariamente macio e preto	6B		
	Notavelmente macio e preto	5B		
	Bem macio e preto	4B		
1	Bem macio e bem preto	3B	●	
	Macio e bem preto	2B	○	
2	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	○	
	Multíssimo duro	6H	○	
	Dureza de pedra	7H		
	Dureza de aço	8H		
	Dureza de diamante	9H		

Para uso preferencial ●

Para uso em segundo plano ○

Para uso em terceiro plano ●

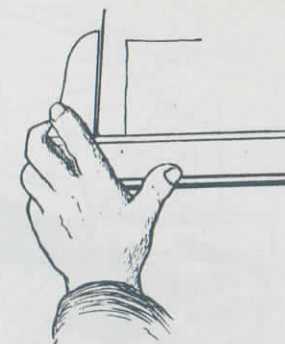
Denota a dureza de uso corrente ■



CUIDADOS COM A PONTA DO LAPIS



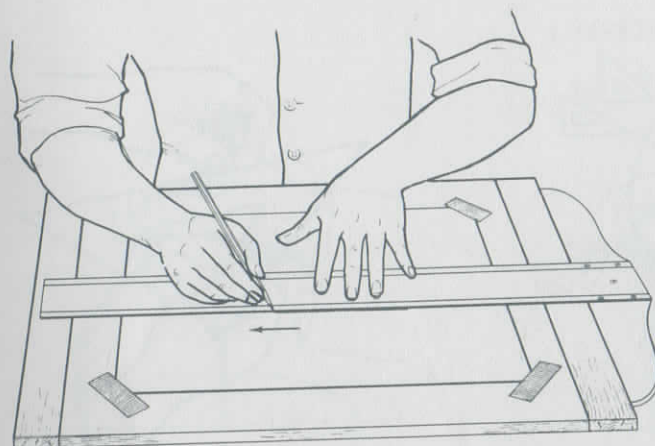
LAPISEIRA



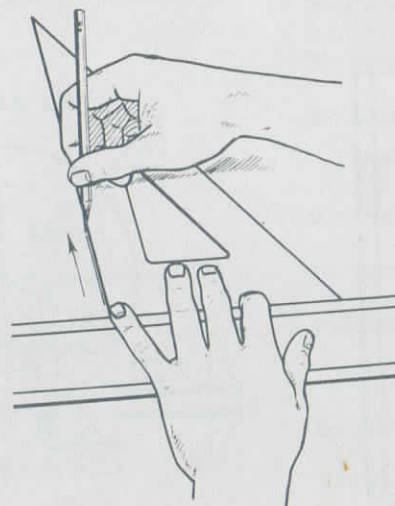
APOIANDO A RÉGUA T



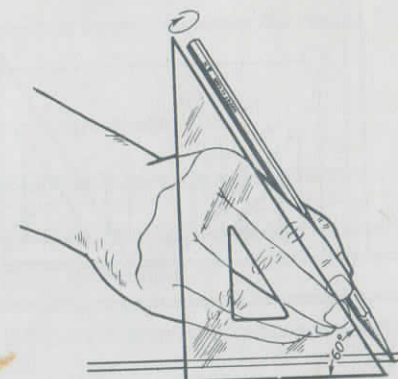
PORTA MINAS



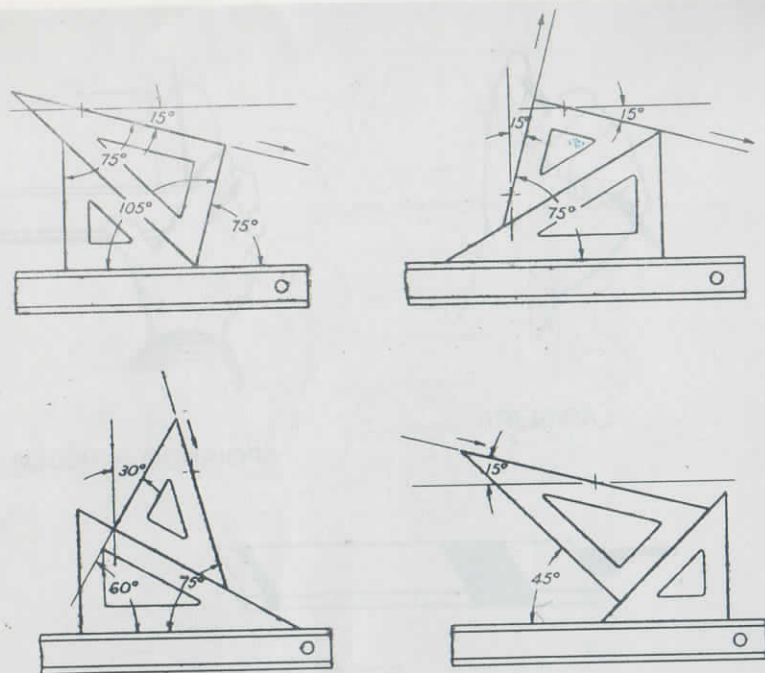
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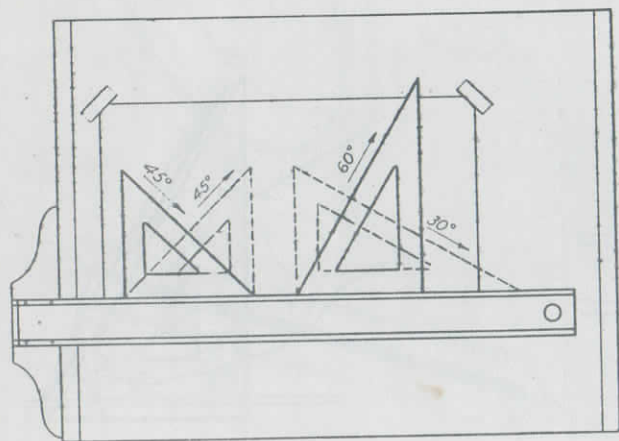
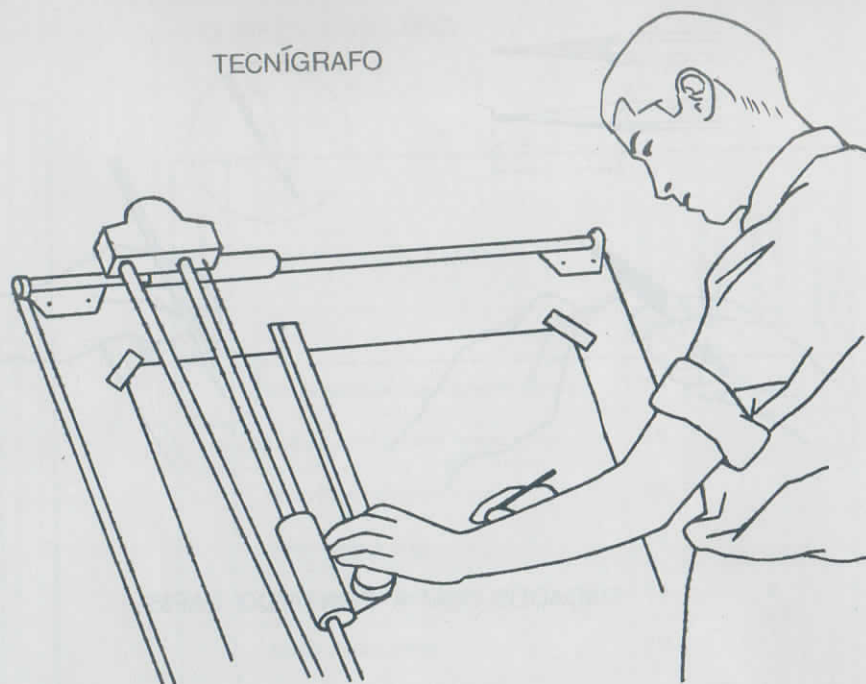
RETA VERTICAL



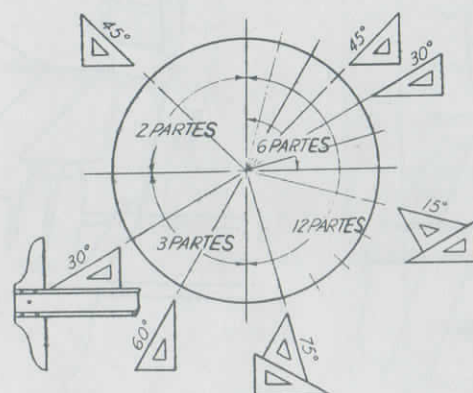
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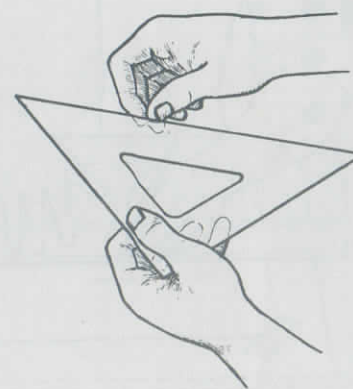
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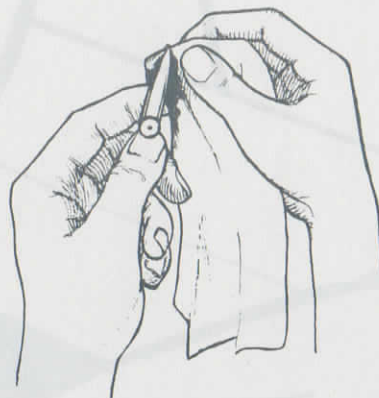
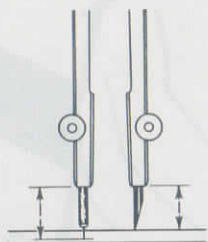
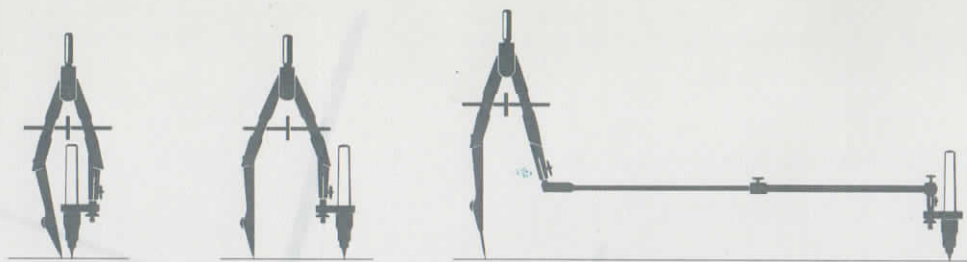
USO DO ESQUADRO



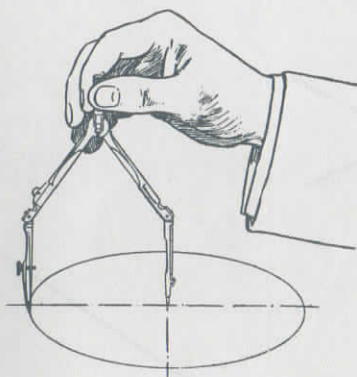
DIVISÃO DA CIRCUNFÊRENCIA



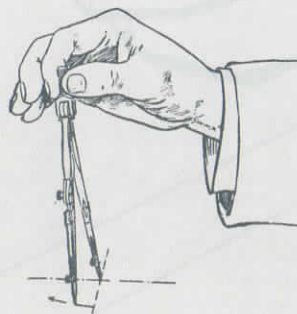
VERIFICAÇÃO DO ESQUADRO



LIMPEZA DO TIRA-LINHA



USO DO COMPASSO

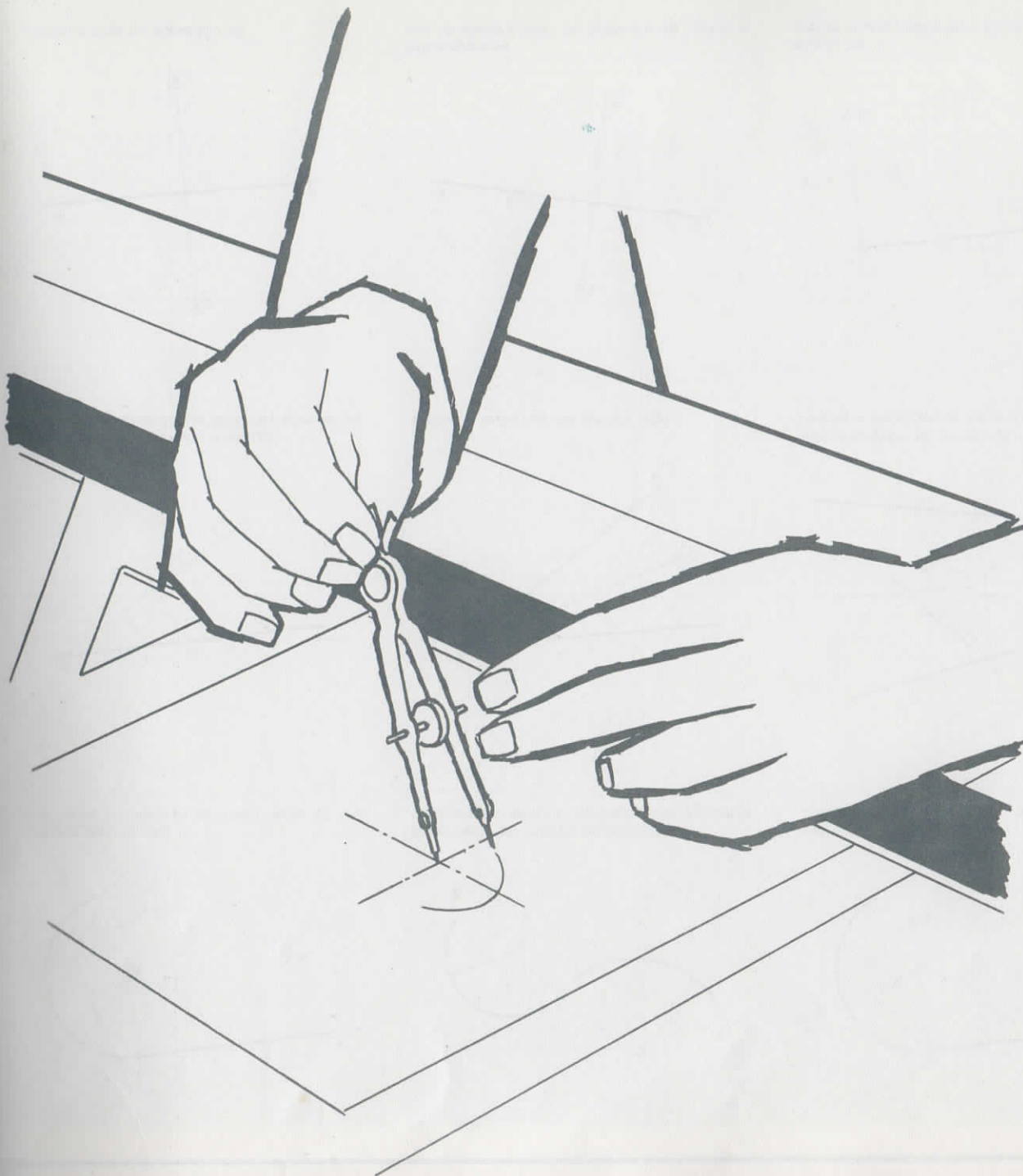


ESTOJO DE PENAS



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 mínimo 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 água.
- 10 - Não cortar o papel com lâmina utilizando a régua de desenho.



2

desenho geométrico

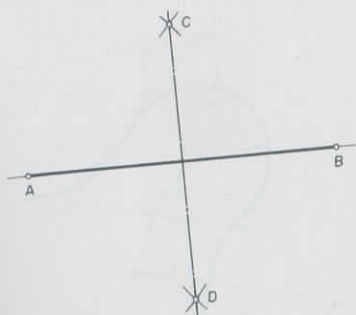
construções
fundamentais

cônicas

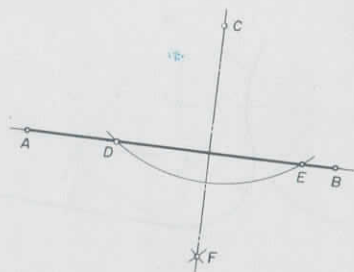
cíclicas

hêlices

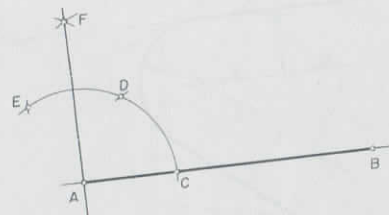
TRAÇAR O EIXO DO SEGMENTO AB



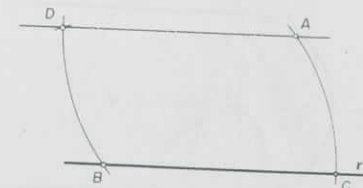
POR UM PONTO C FORA DO SEGMENTO AB TRAÇAR A PERPENDICULAR.



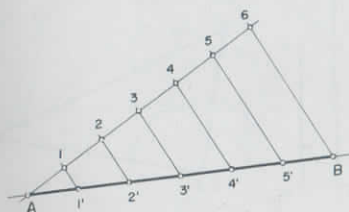
TRAÇAR A PERPENDICULAR À EXTREMIDADE DO SEGMENTO AB.



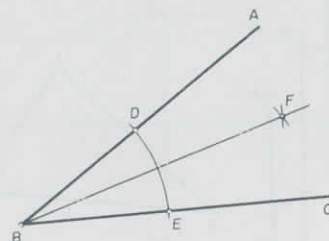
TRAÇAR A PARALELA À RETA r , PELO PONTO A.



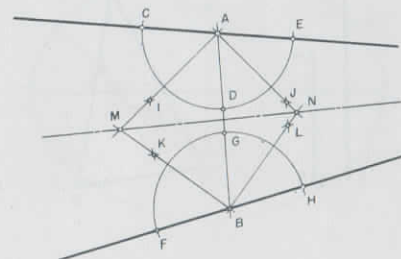
DIVIDIR O SEGMENTO AB EM QUALQUER NÚMERO DE PARTES IGUAIS. EXEMPLO: 6 PARTES.



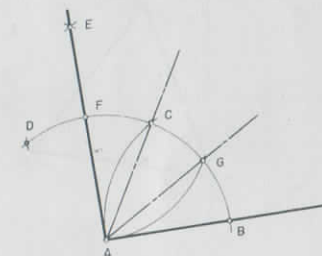
TRAÇAR A BISSETRIZ DO ÂNGULO \widehat{ABC} .



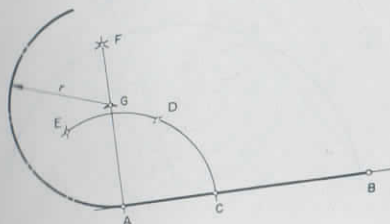
TRAÇAR A BISSETRIZ DE UM ÂNGULO QUALQUER, DESCONHECENDO-SE O VÉRTICE.



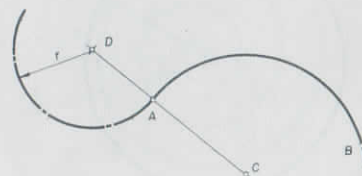
DIVIDIR O ÂNGULO RETO EM 3 PARTES IGUAIS.



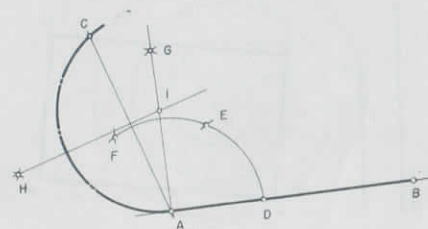
CONCORDAR O SEGMENTO AB COM O ARCO DE CIRCUNFERÊNCIA DE RAIO r .



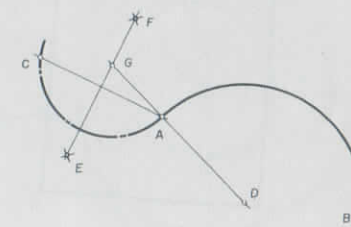
CONCORDAR O ARCO DE CIRCUNFERÊNCIA \widehat{AB} , COM UM OUTRO ARCO DE CIRCUNFERÊNCIA DE RAIO r .



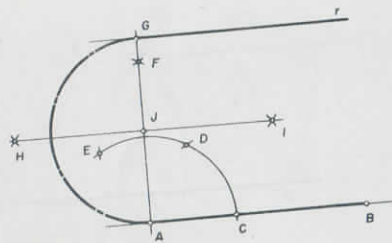
CONCORDAR O SEGMENTO AB, COM O ARCO DE CIRCUNFERÊNCIA QUE PASSA PELO PONTO C.



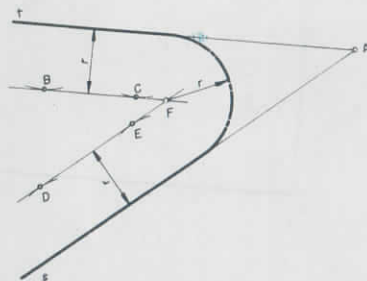
CONCORDAR O ARCO DE CIRCUNFERÊNCIA \widehat{AB} , COM UM OUTRO ARCO DE CIRCUNFERÊNCIA QUE PASSA PELO PONTO C.



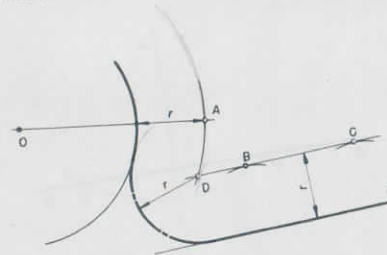
CONCORDAR A RETA r , PARALELA AO SEGMENTO AB , COM UM ARCO DE CIRCUNFERÊNCIA.



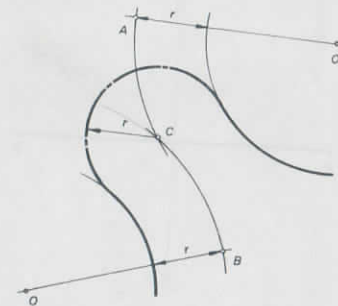
CONCORDAR AS RETAS t e s CONVERGENTES NO PONTO A COM UM ARCO DE CIRCUNFERÊNCIA DE RAIO r .



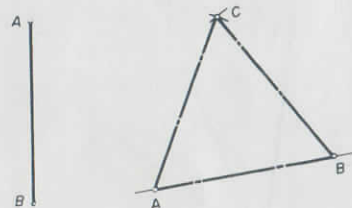
CONCORDAR A RETA t E O ARCO DE CIRCUNFERÊNCIA DE CENTRO O , COM UM OUTRO ARCO DE CIRCUNFERÊNCIA DE RAIO r .



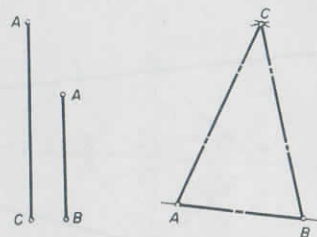
CONCORDAR OS ARCOS DE CIRCUNFERÊNCIA DE CENTROS O e O' COM UM OUTRO ARCO DE CIRCUNFERÊNCIA DE RAIO r .



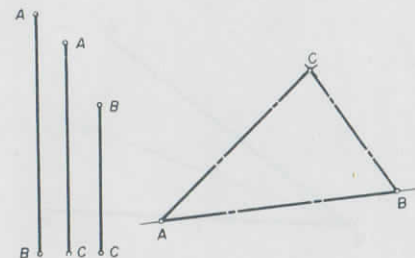
CONSTRUIR O TRIÂNGULO EQUILÁTERO DE LADO AB .



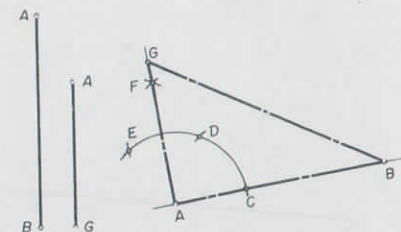
CONSTRUIR O TRIÂNGULO ISÓSCELES DE BASE AB E LADO AC .



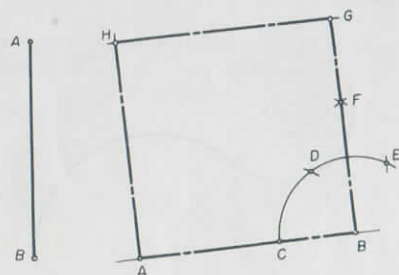
CONSTRUIR O TRIÂNGULO ESCALENO DE LADOS AB , BC e AC .



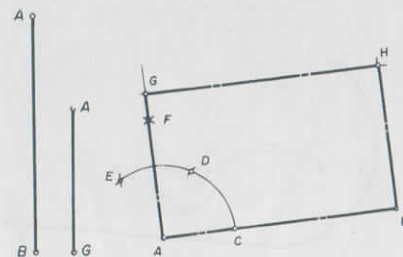
CONSTRUIR O TRIÂNGULO RETÂNGULO DE CATETOS AB e AG .



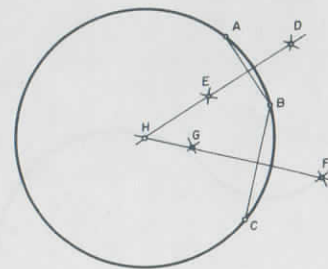
CONSTRUIR O QUADRADO DE LADO AB .



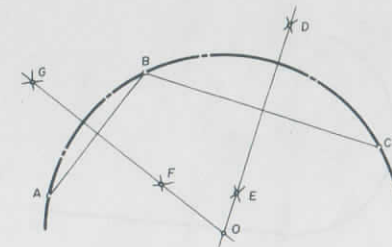
CONSTRUIR O RETÂNGULO DE LADOS AB e AG .



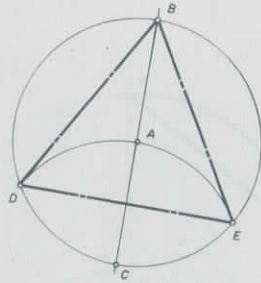
ACHAR O CENTRO H DA CIRCUNFERÊNCIA.



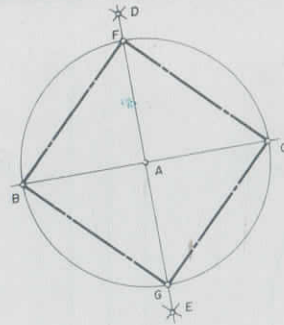
TRAÇAR O ARCO DE CIRCUNFERÊNCIA DE CENTRO O , QUE PASSA PELOS PONTOS ABC .



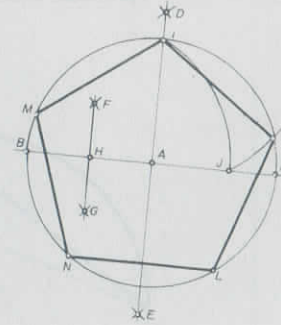
DIVIDIR A CIRCUNFERÊNCIA EM 3 PARTES IGUAIS, E INSCREVER O TRIÂNGULO EQUILÁTERO.



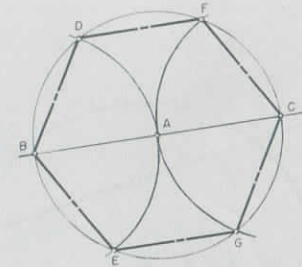
DIVIDIR A CIRCUNFERÊNCIA EM 4 PARTES IGUAIS, E INSCREVER O QUADRADO.



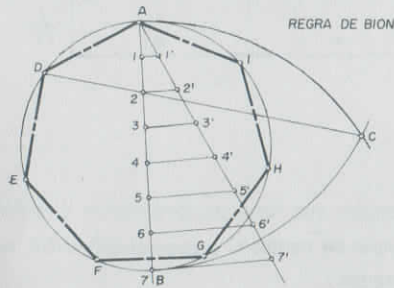
DIVIDIR A CIRCUNFERÊNCIA EM 5 PARTES IGUAIS, E INSCREVER O PENTÁGONO REGULAR.



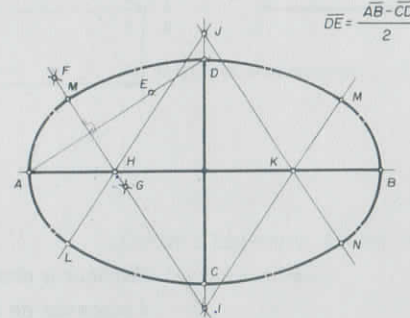
DIVIDIR A CIRCUNFERÊNCIA EM 6 PARTES IGUAIS, E INSCREVER O HEXÁGONO REGULAR.



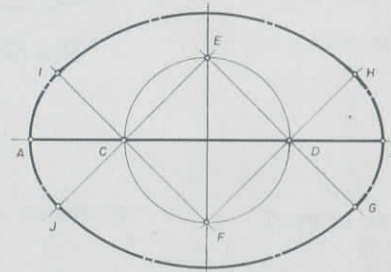
DIVIDIR A CIRCUNFERÊNCIA EM QUALQUER NÚMERO DE PARTES IGUAIS. EXEMPLO: 7 PARTES E INSCREVER O HEPTÁGONO REGULAR.



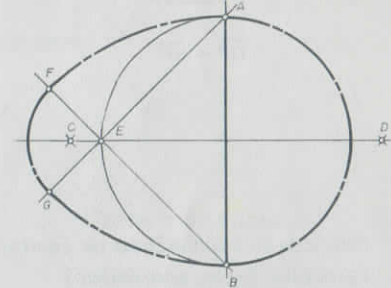
CONSTRUIR A OVAL DADOS O EIXO MAIOR AB E O MENOR CD.



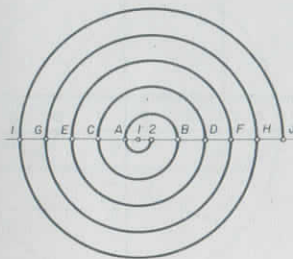
CONSTRUIR A OVAL DADO O EIXO MAIOR AB



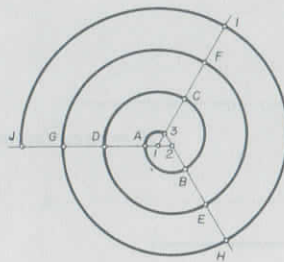
CONSTRUIR A OVAL IRREGULAR DADO O EIXO MENOR AB.



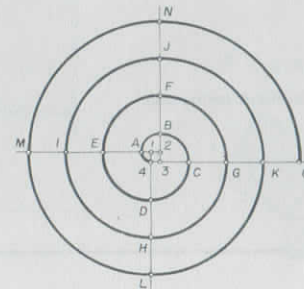
TRAÇAR A ESPIRAL DE DOIS CENTROS, SENTIDO HORÁRIO.



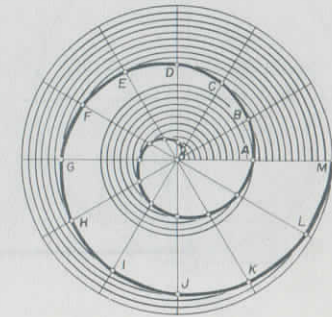
TRAÇAR A ESPIRAL DE TRÊS CENTROS, SENTIDO ANTI-HORÁRIO.



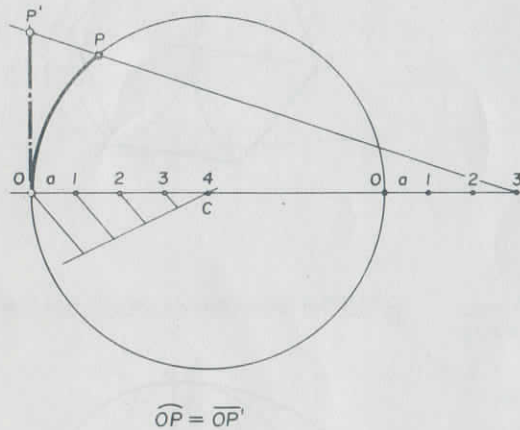
TRAÇAR A ESPIRAL DE QUATRO CENTROS, SENTIDO HORÁRIO.



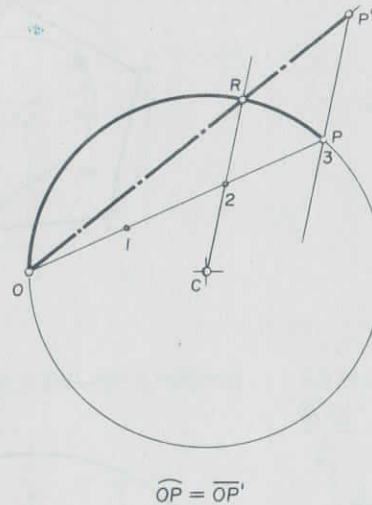
TRAÇAR A ESPIRAL DE ARQUIMEDES SENTIDO ANTI-HORÁRIO.



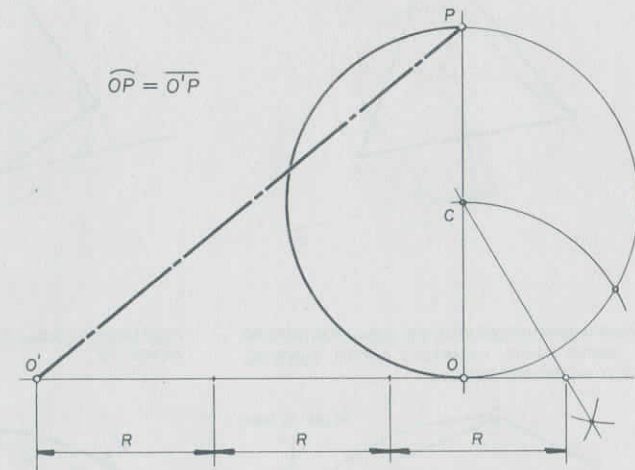
Retificar o arco OP menor que 90°



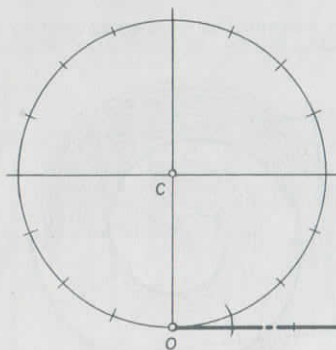
Retificar o arco OP maior que 90°
(processo D'OCAGNE)



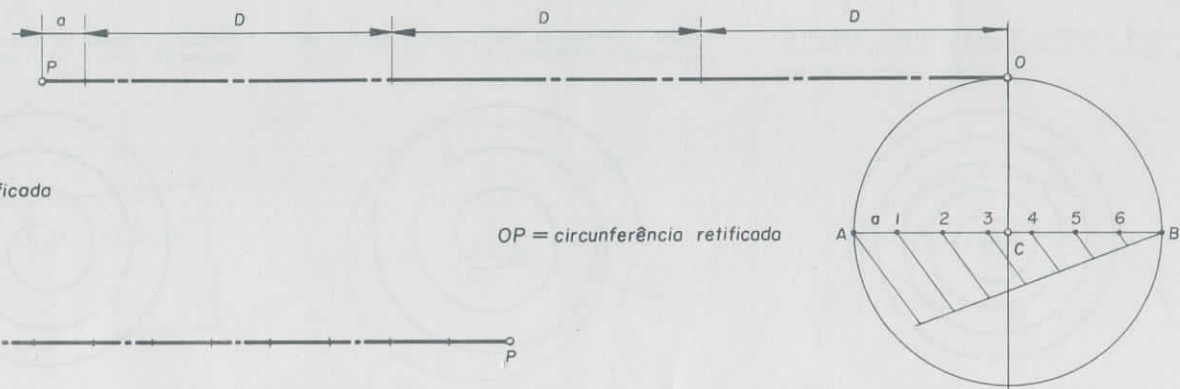
Retificar a semicircunferência OP de centro C e raio R .
(processo Kochansky)



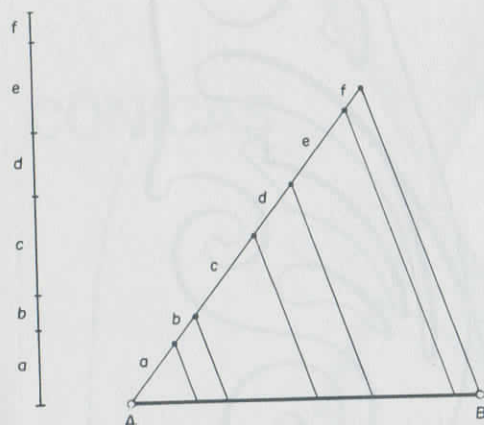
Retificar a circunferência de centro C .
(processo direto, aproximado)



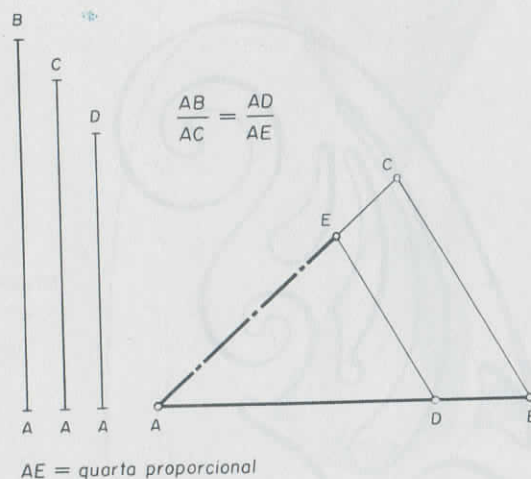
Retificar a circunferência de centro C e diâmetro D .
(processo de Arquimedes)



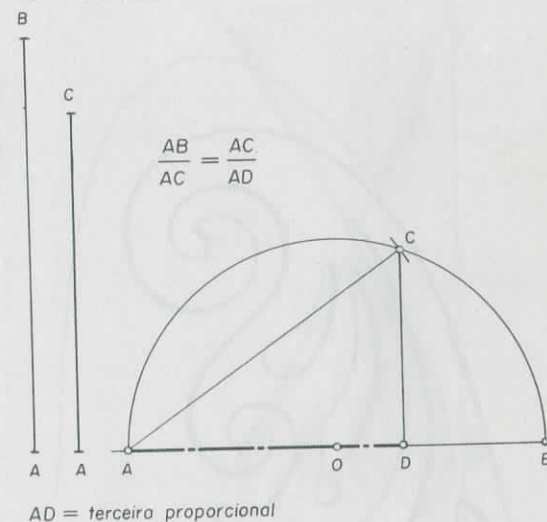
Dividir o segmento AB em partes proporcionais a : a, b, c, d, e, f.



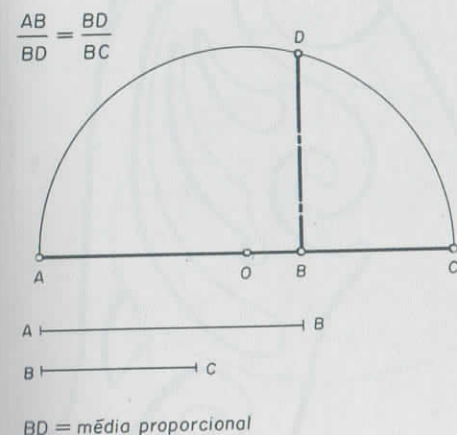
Achar a quarta proporcional dos segmentos AB, AC e AD.



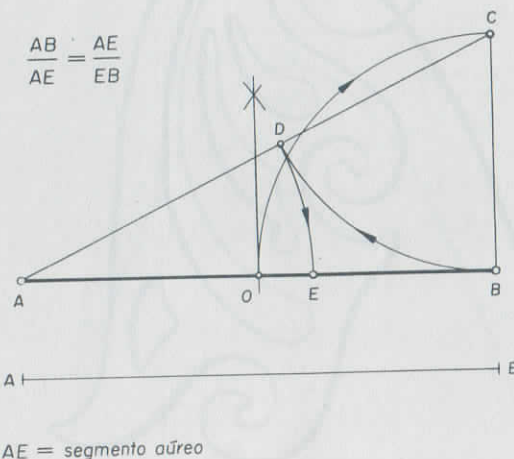
Achar a terceira proporcional entre os segmentos AB e AC.



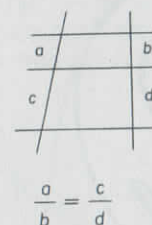
Achar a média proporcional dos segmentos AB e BC.



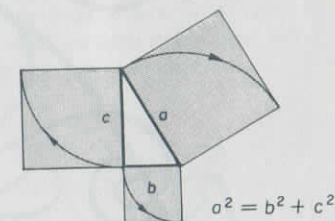
Dividir o segmento AB em média e extrema razão (secção aurea).



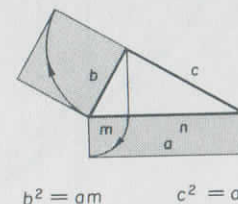
Teorema de Tales



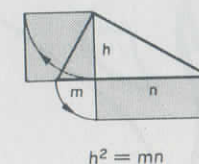
Teorema de Pitágoras

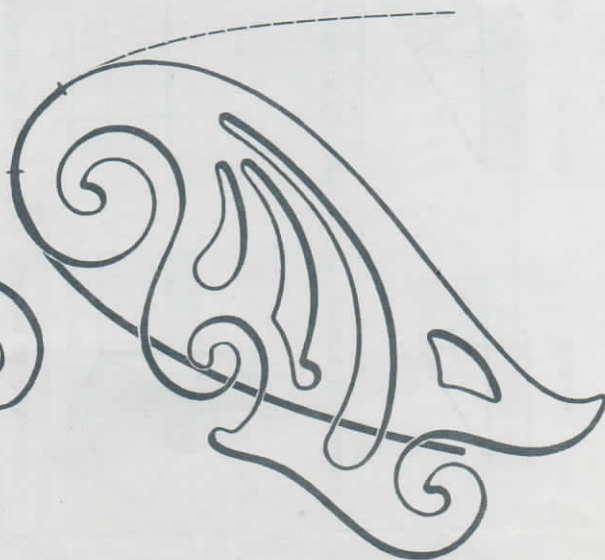


1º Teorema de Euclides

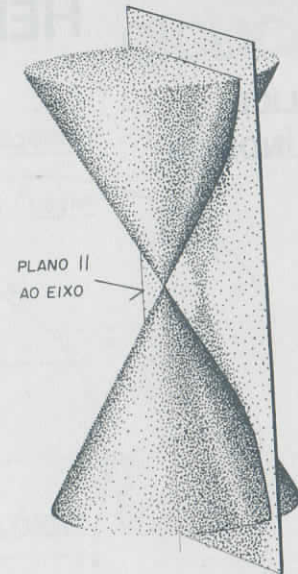
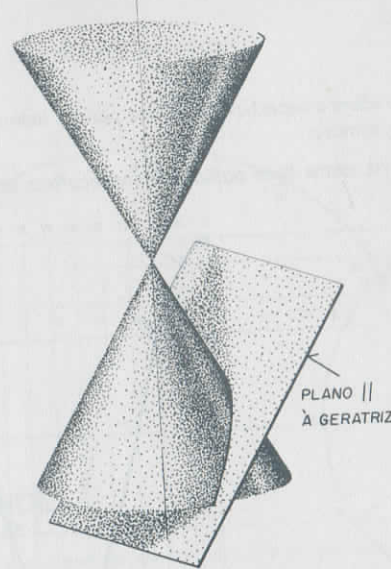
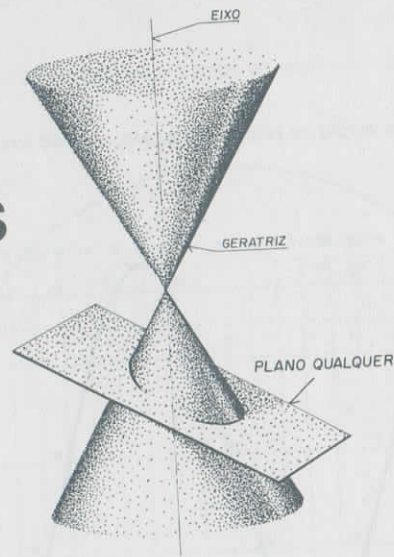


2º Teorema de Euclides



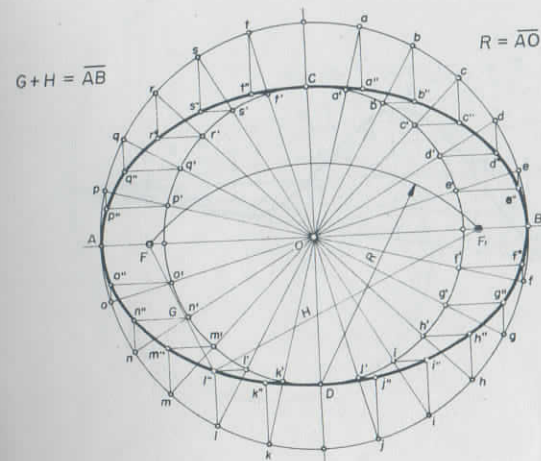


CÔNICAS



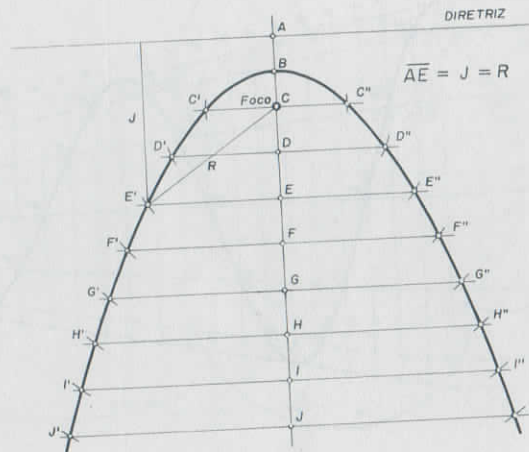
ELIPSE

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 .



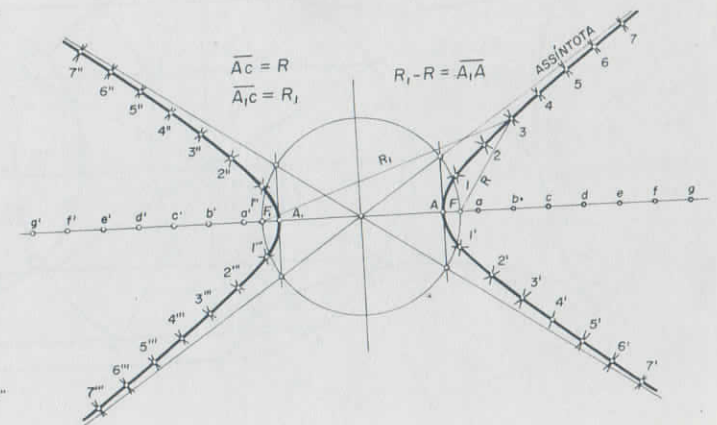
PARÁBOLA

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



HIPÉRBOLE

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

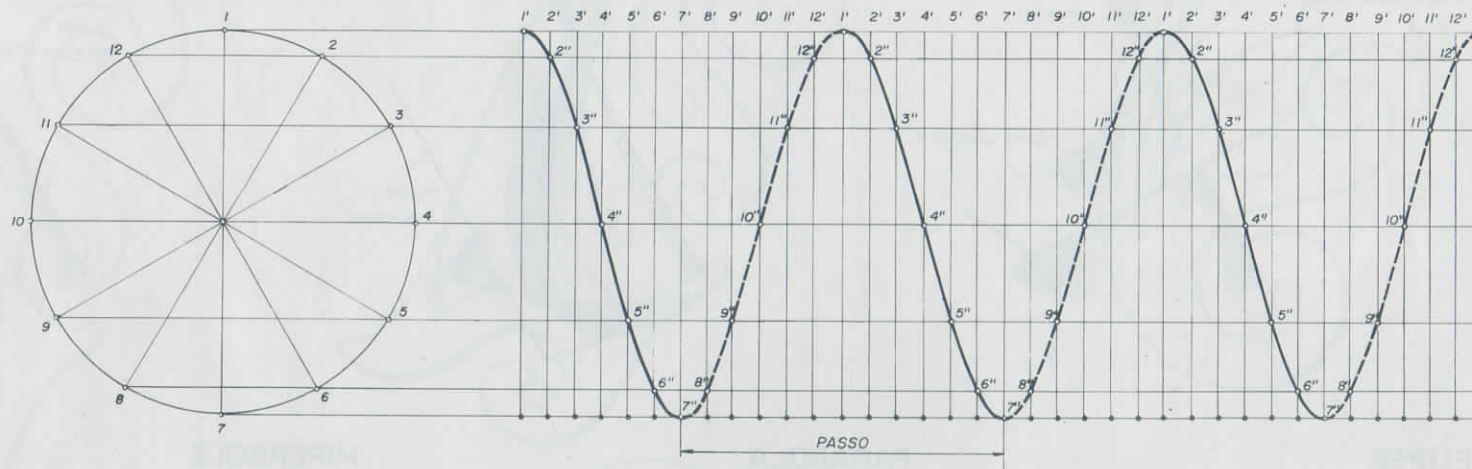


HÉLICES

HÉLICE CILÍNDRICA

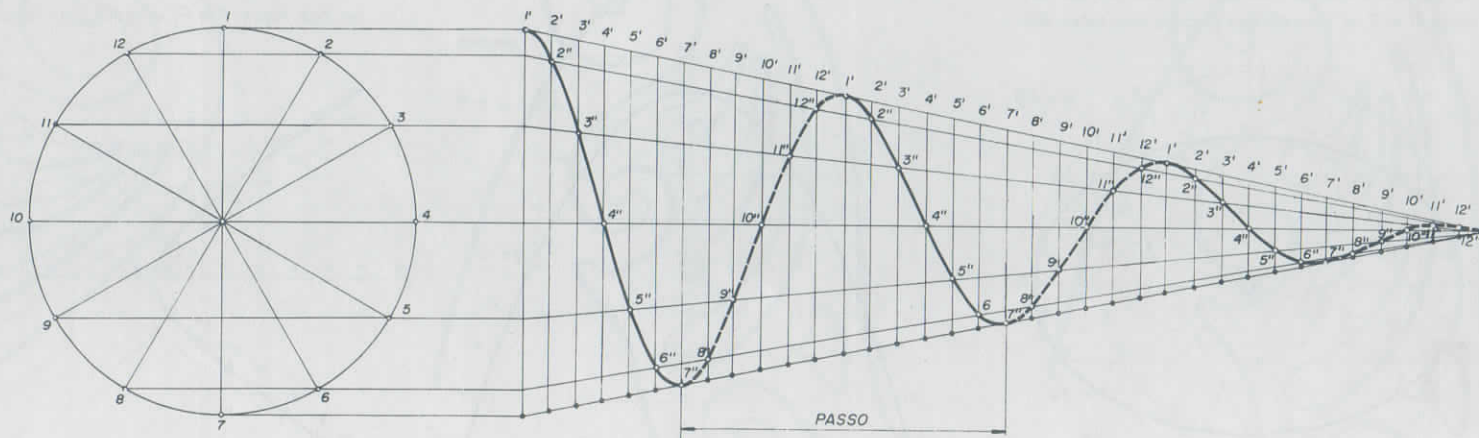
DEFINIÇÃO: é a curva formada sobre a superfície cilíndrica por um lado de um ângulo que se enrola no cilindro, enquanto o outro lado se enrola no círculo da base do cilindro.

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



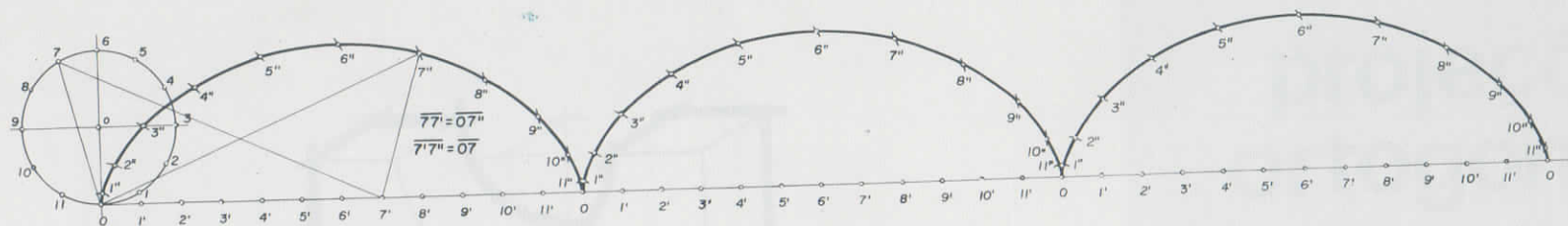
HÉLICE CÔNICA

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



CICLÓIDE

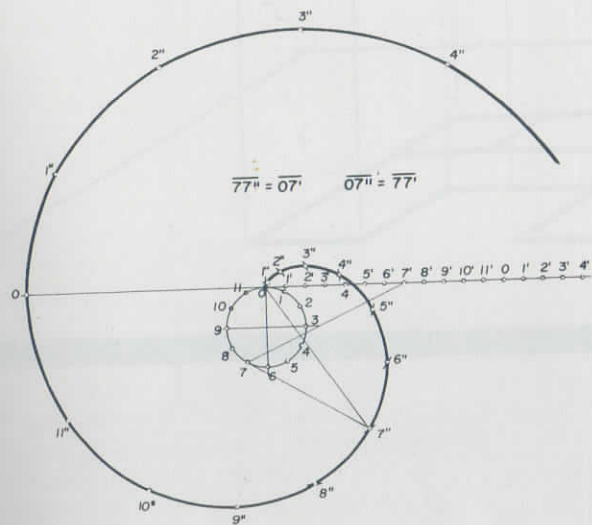
DEFINIÇÃO: é a curva gerada por um ponto de uma circunferência que rola sobre uma reta, sem escorregar.



CÍCLICAS

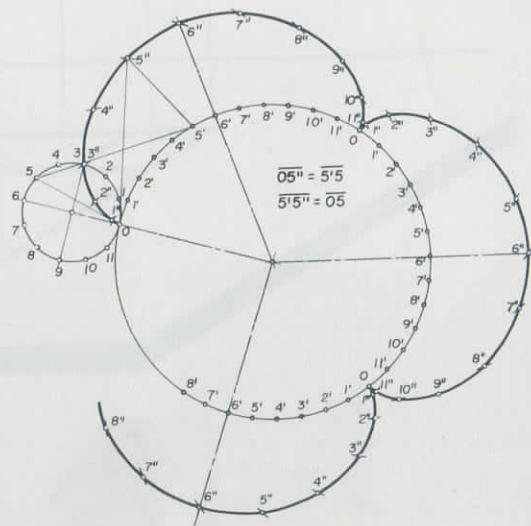
EVOLVENTE

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



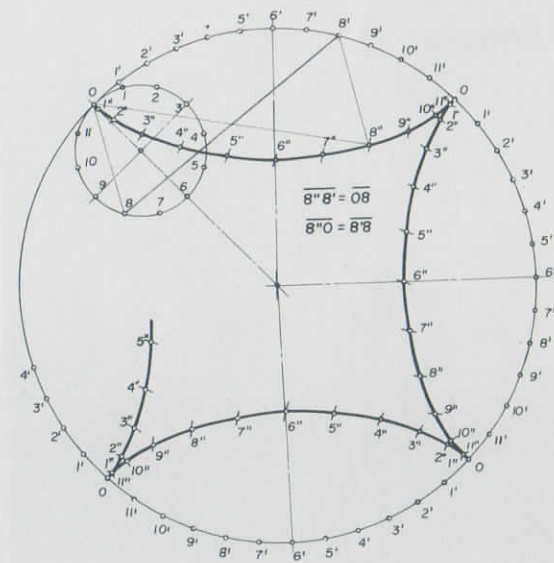
EPICICLÓIDE

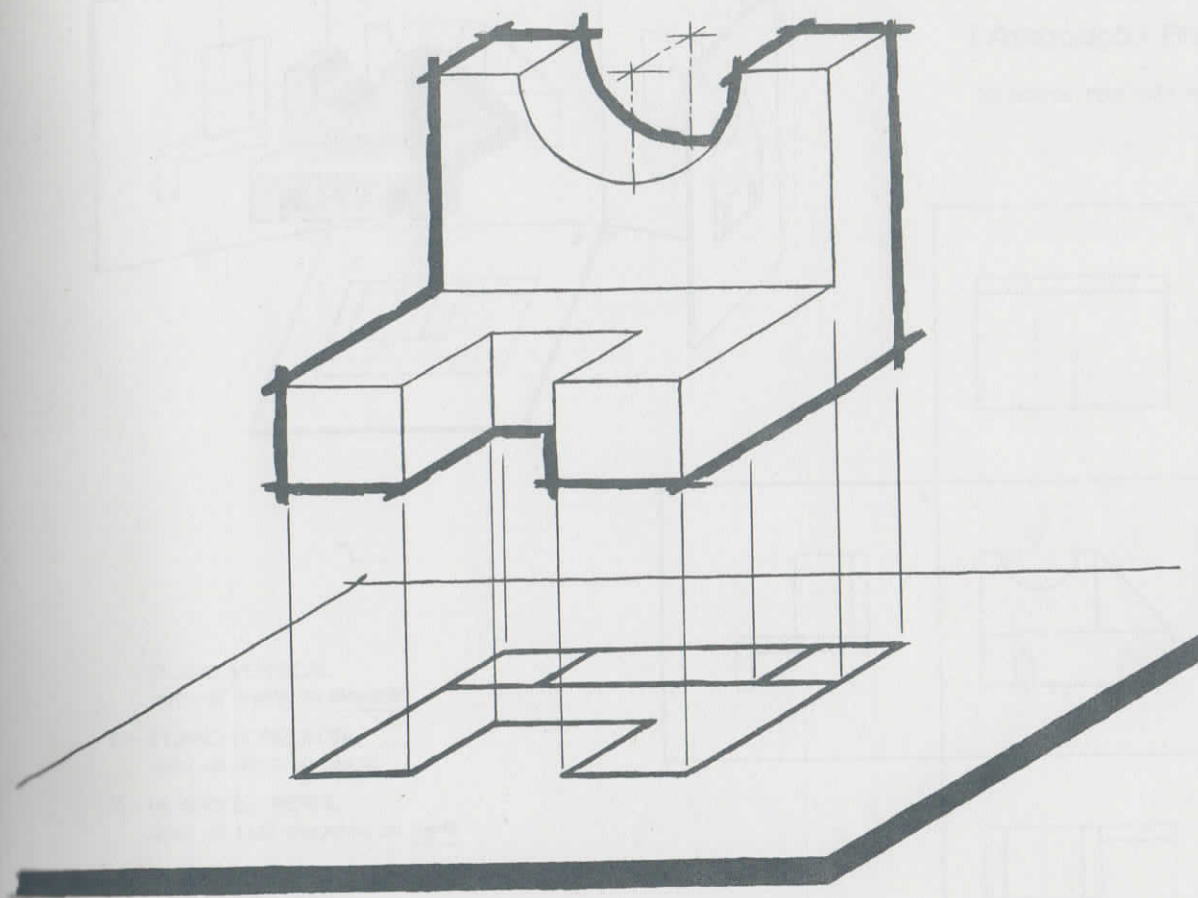
DEFINIÇÃO: é a curva gerada por um ponto de uma circunferência que rola exteriormente à outra, sem escorregar.



HIPOCICLÓIDE

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





3

projeções ortogonais

norma
americana

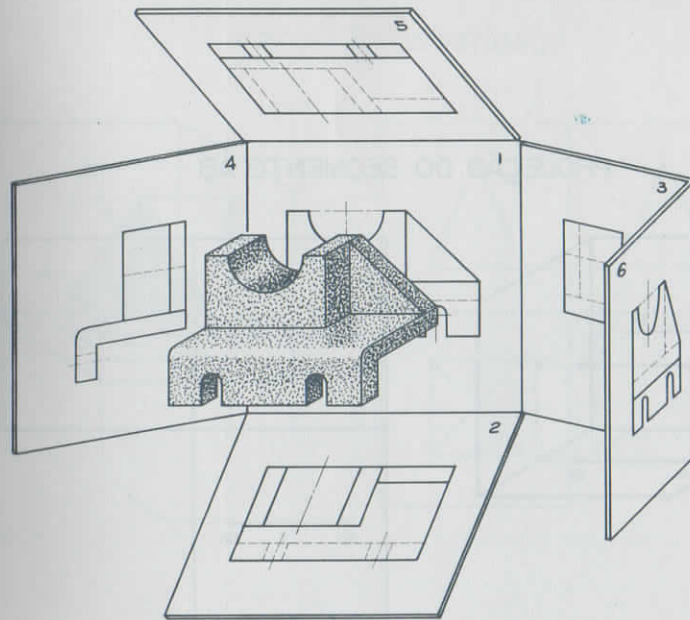
norma
européia

PROJEÇÃO ORTOGONAL

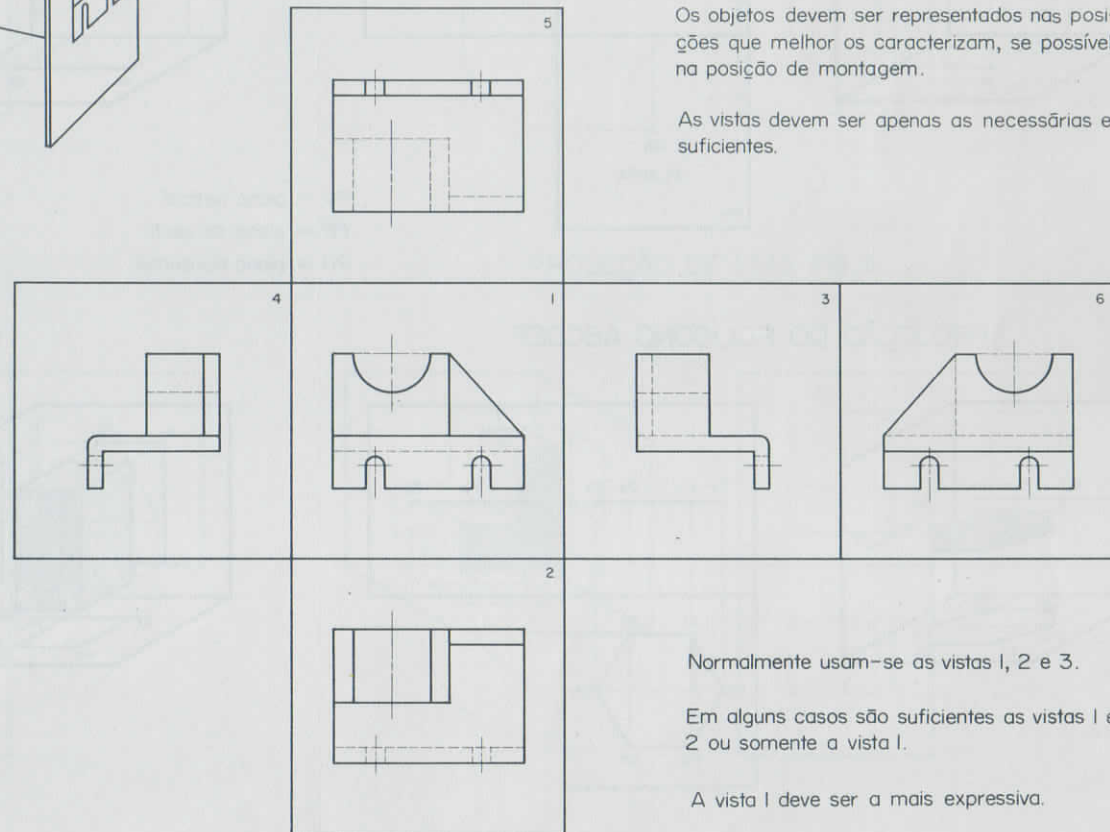
NORMA EUROPÉIA adotada pela ABNT

(Associação Brasileira de Normas Técnicas)

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



- 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



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.

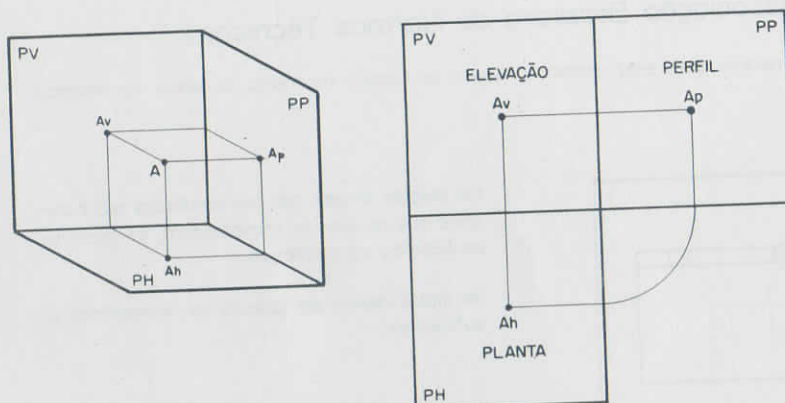
Normalmente usam-se as vistas 1, 2 e 3.

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

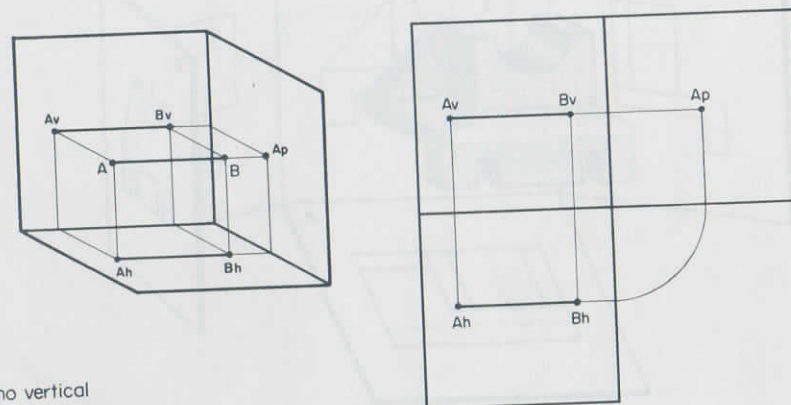
A vista 1 deve ser a mais expressiva.

EXEMPLOS

PROJEÇÃO DO PONTO A

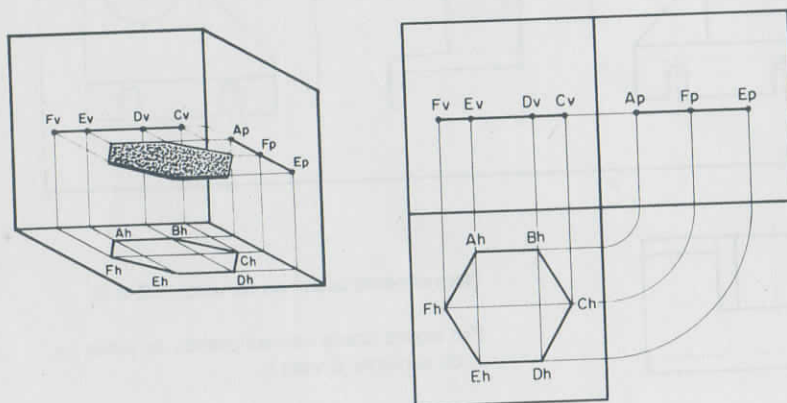


PROJEÇÃO DO SEGMENTO AB

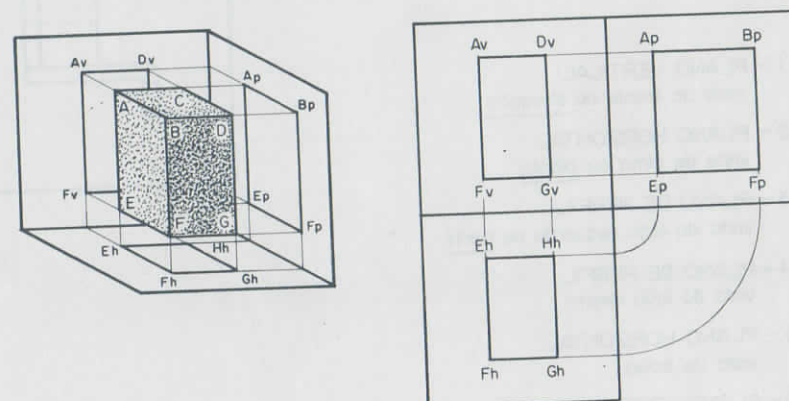


PV = plano vertical
PP = plano de perfil
PH = plano horizontal

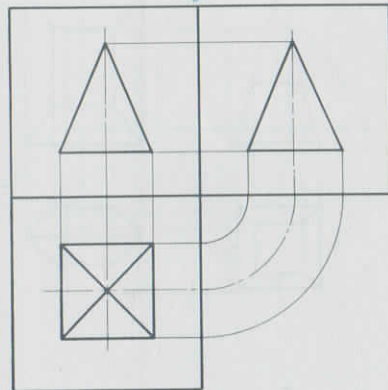
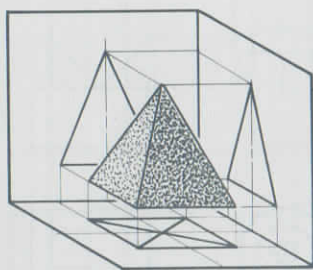
PROJEÇÃO DO POLÍGONO ABCDEF



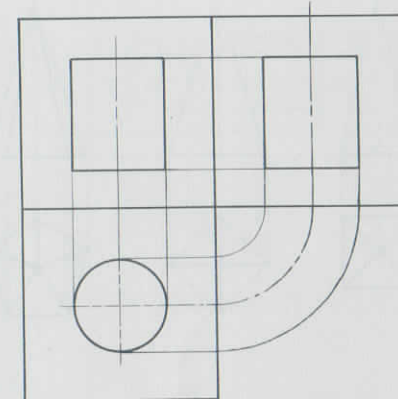
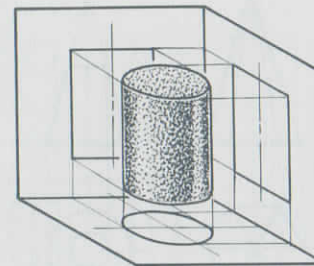
PROJEÇÃO DO PRISMA



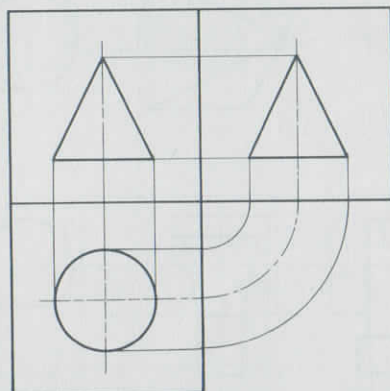
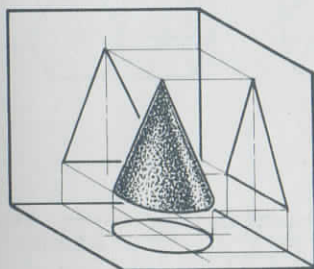
PROJEÇÃO DA PIRÂMIDE



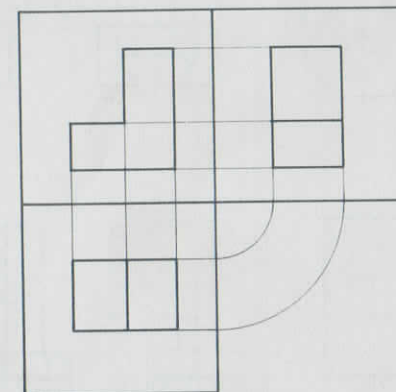
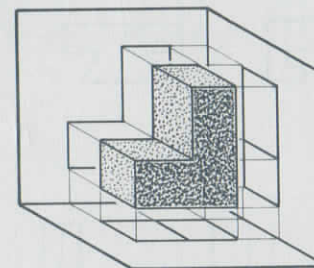
PROJEÇÃO DO CILINDRO



PROJEÇÃO DO CONE

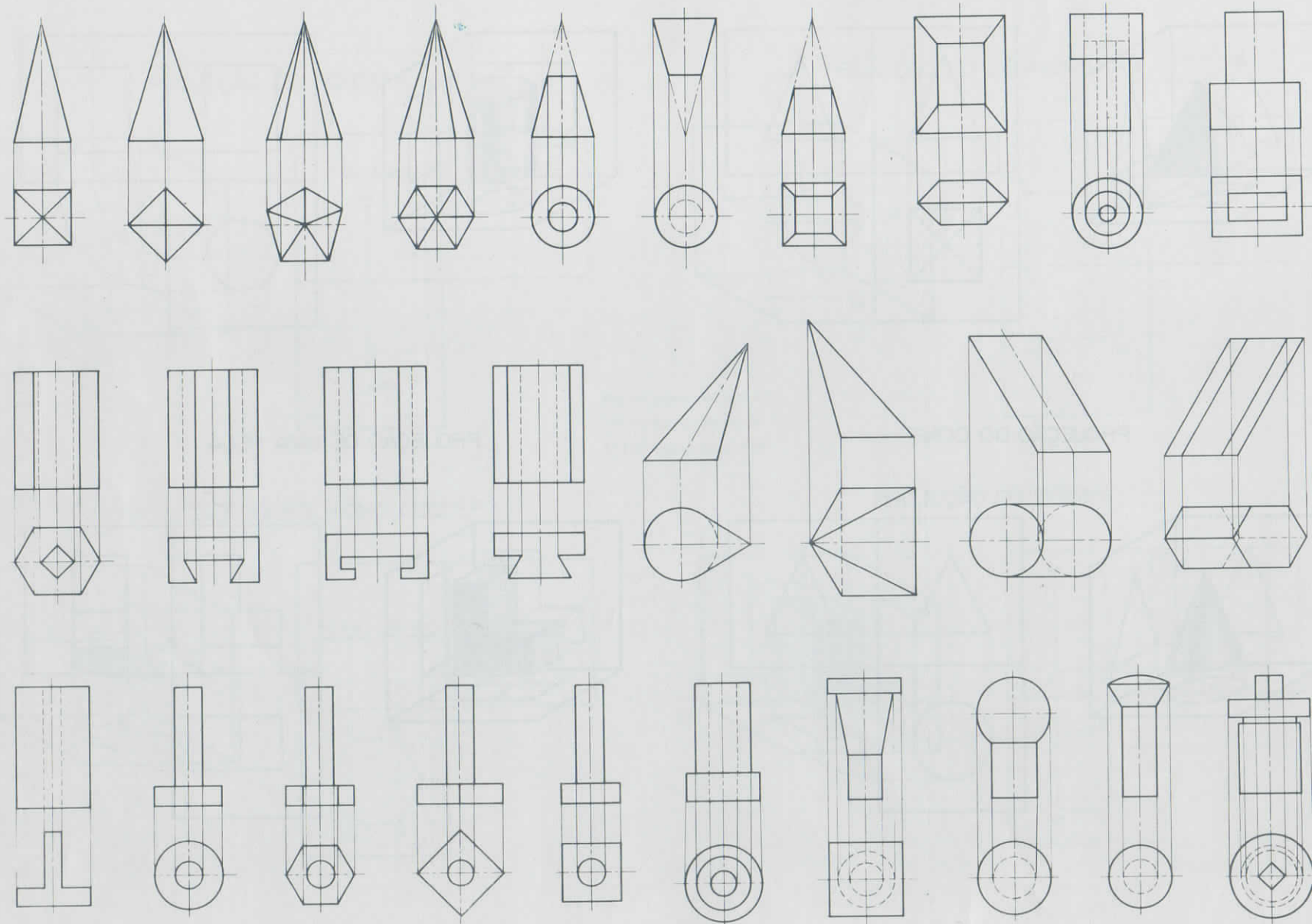


PROJEÇÃO DE UMA PEÇA



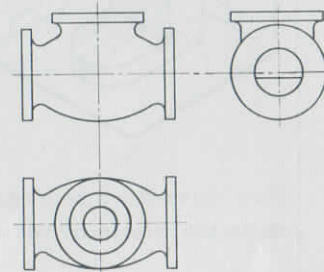
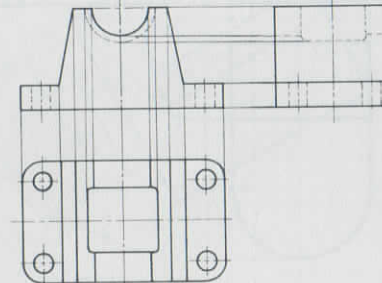
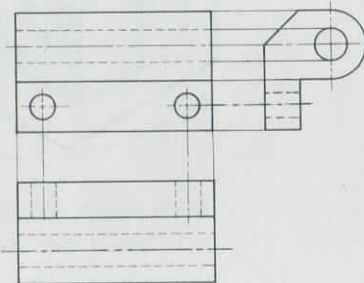
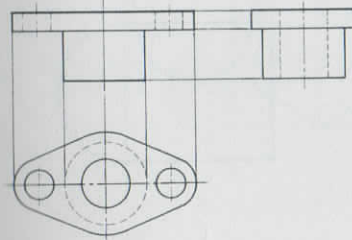
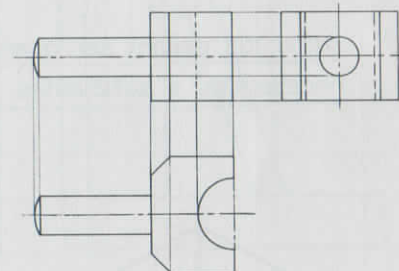
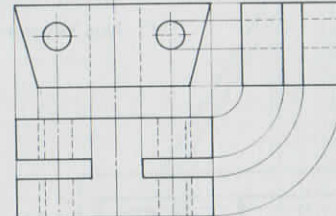
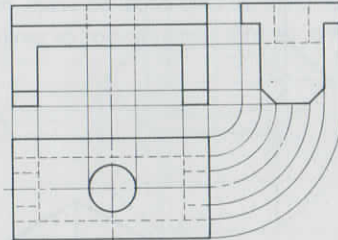
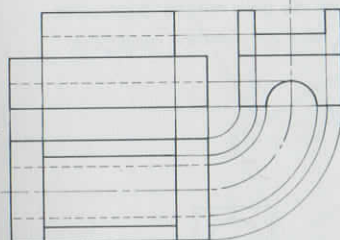
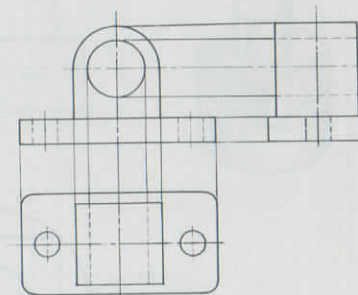
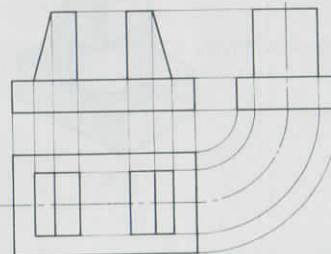
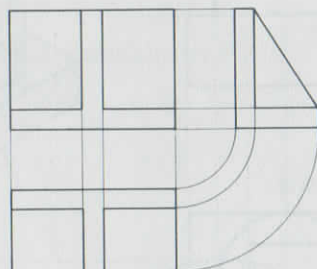
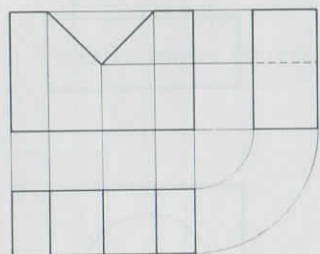
REPRESENTAÇÃO EM DUAS VISTAS

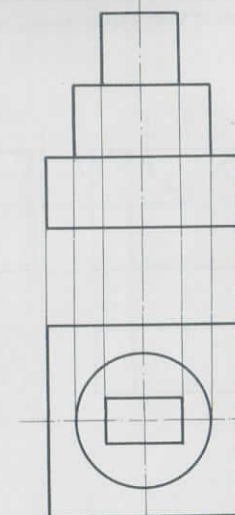
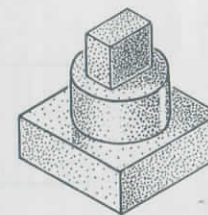
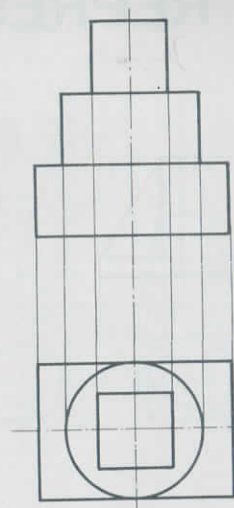
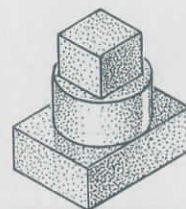
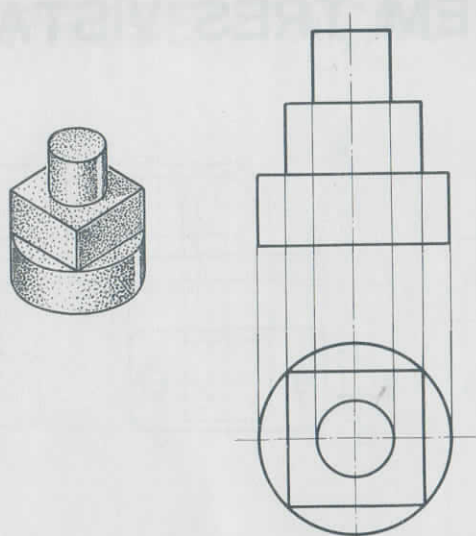
Alguns destes exemplos podem ser representados com uma vista apenas, se forem observadas as "Normas e Convenções."



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

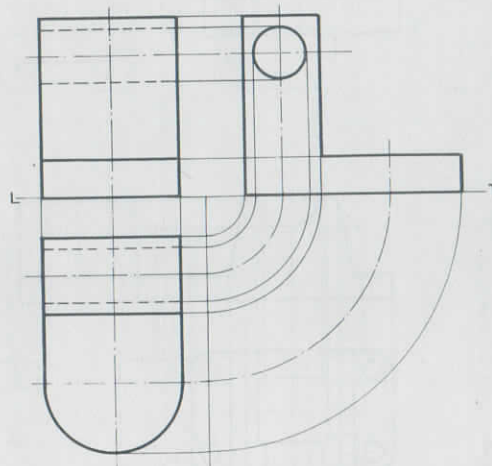
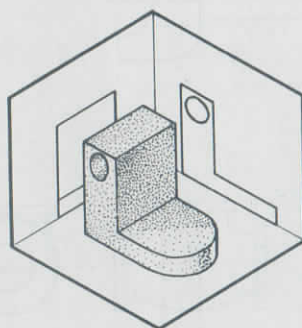
REPRESENTAÇÃO EM TRES VISTAS



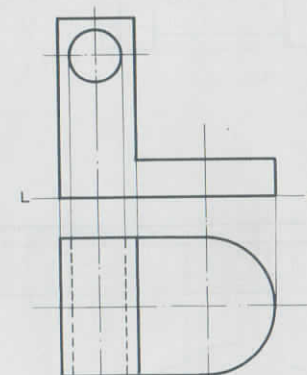
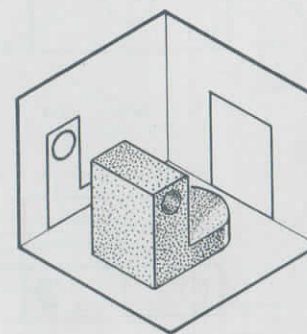


As vistas devem ser apenas as necessárias e suficientes.

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.



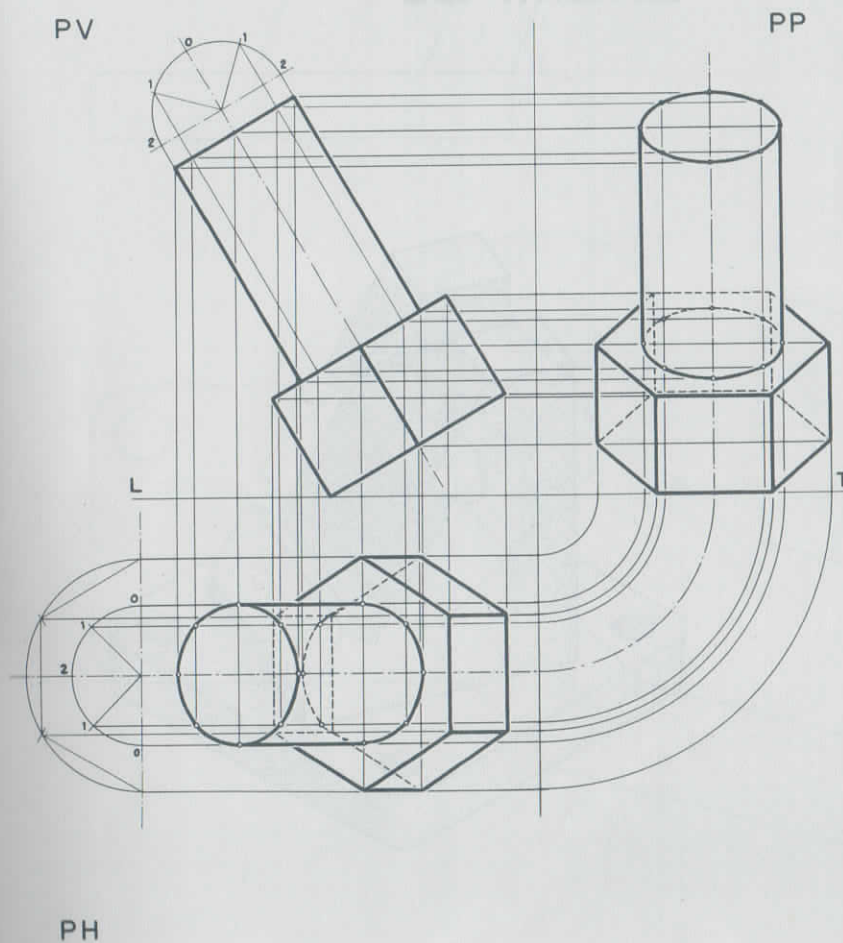
Para representar a peça nesta posição, são necessárias três vistas.



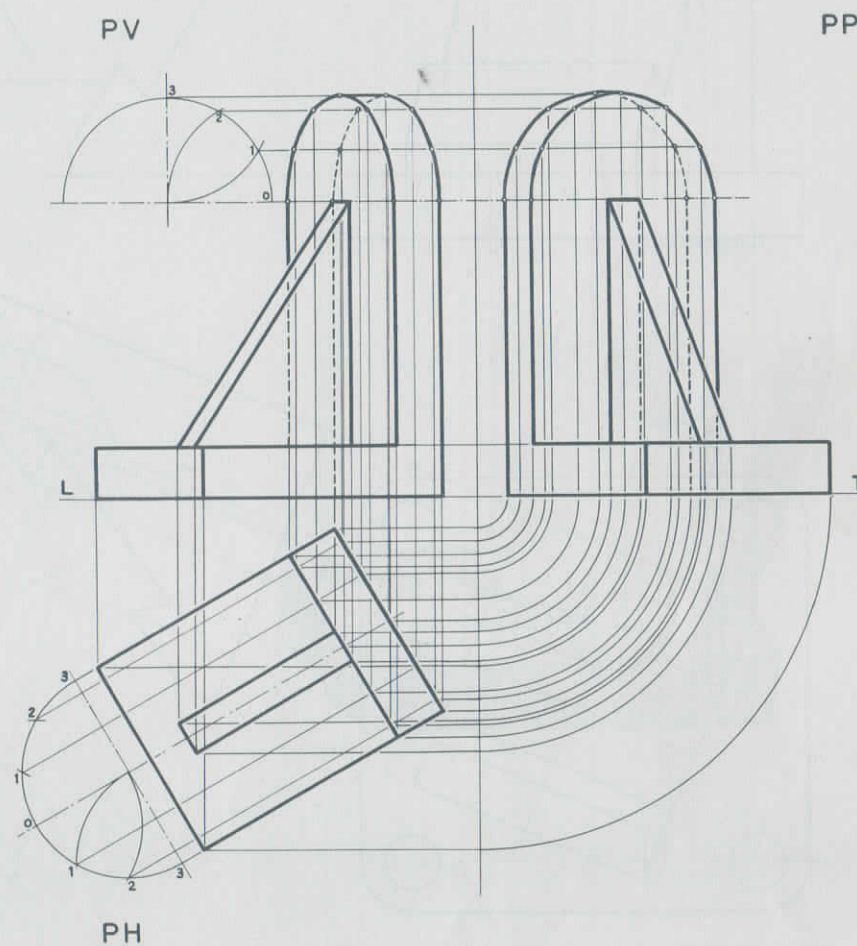
Nesta posição são suficientes apenas duas vistas.

ELEMENTOS INCLINADOS C/ OS PLANOS DE PROJEÇÃO

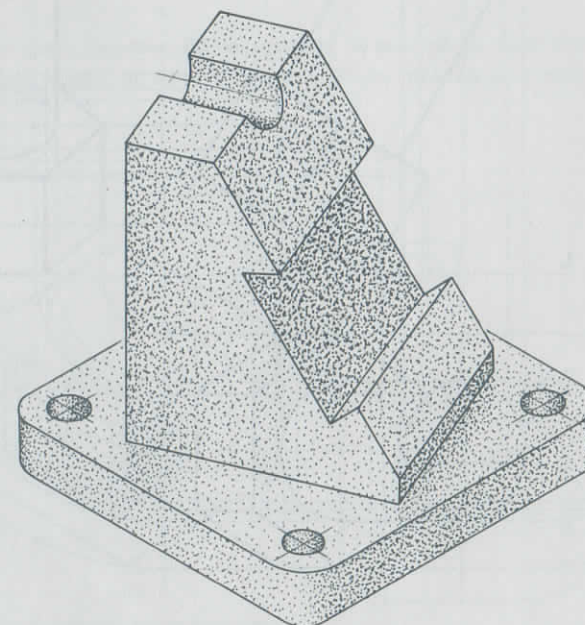
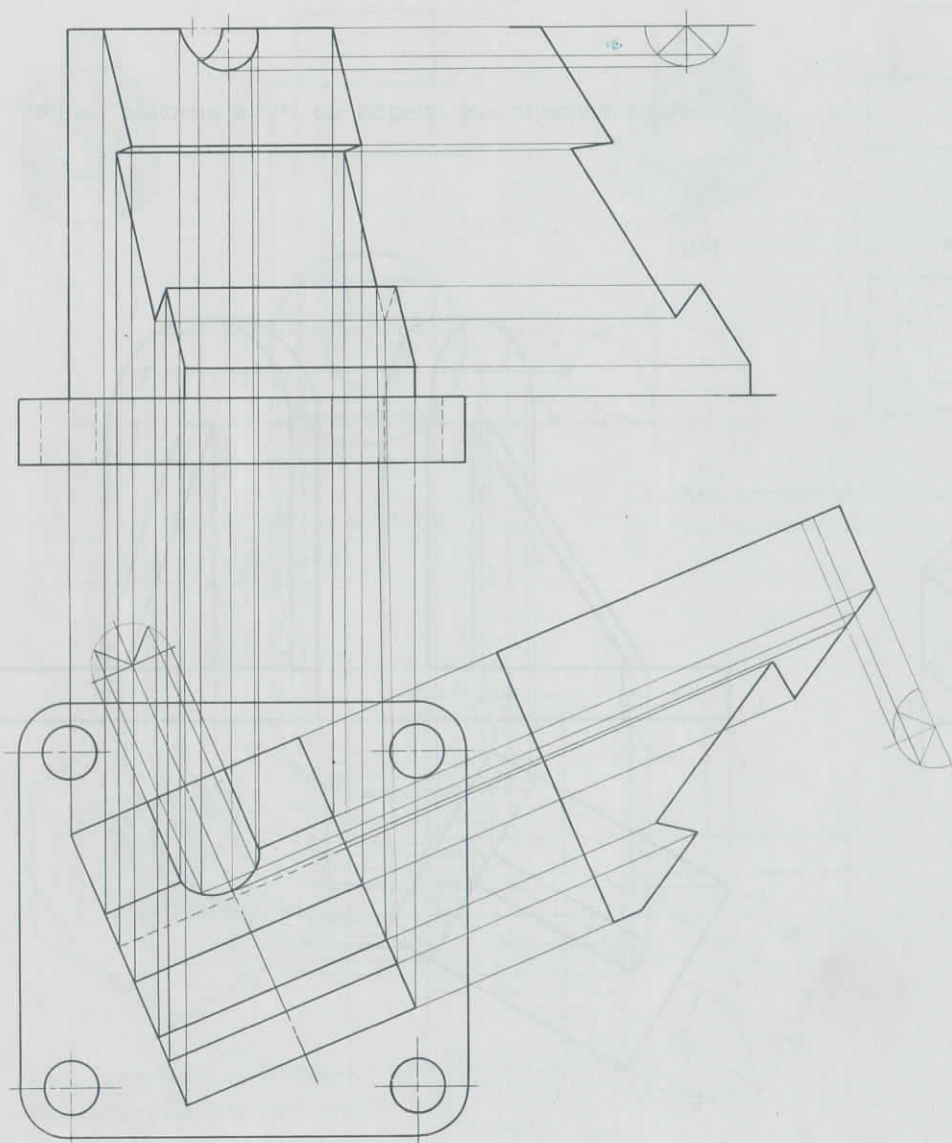
Peça inclinada em relação ao PH e paralela ao PV.

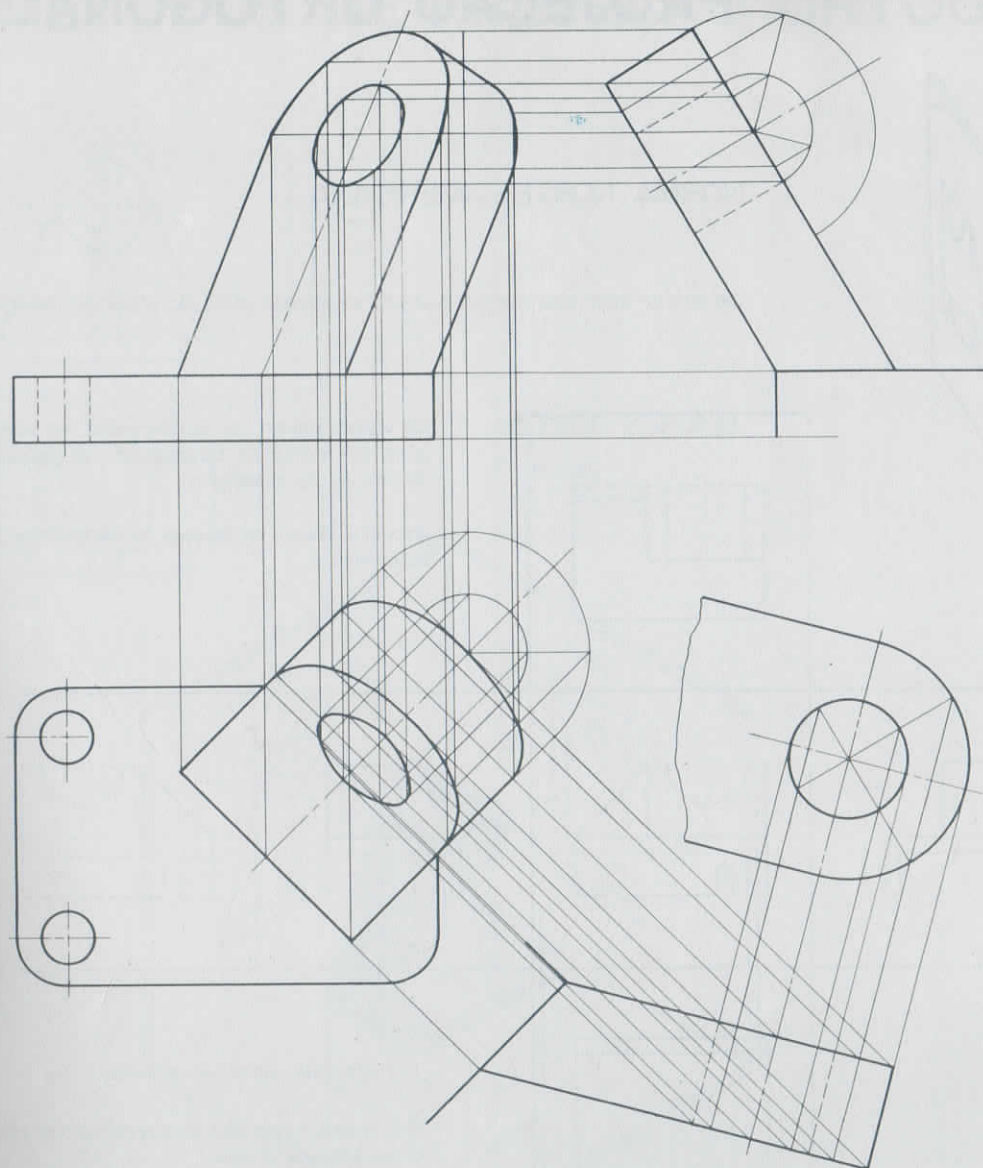


Peça inclinada em relação ao PV e paralela ao PH.

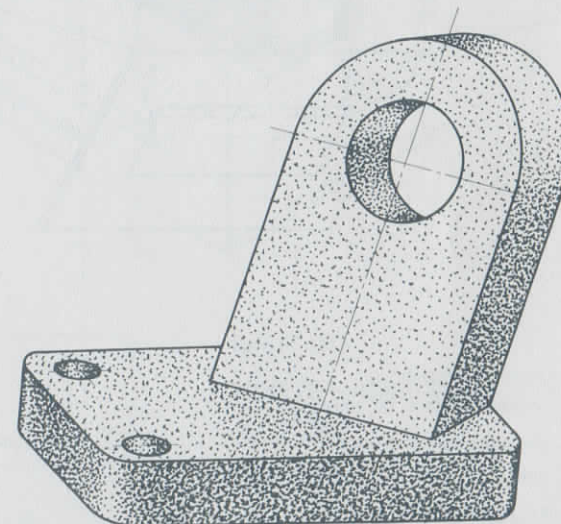


EXEMPLO





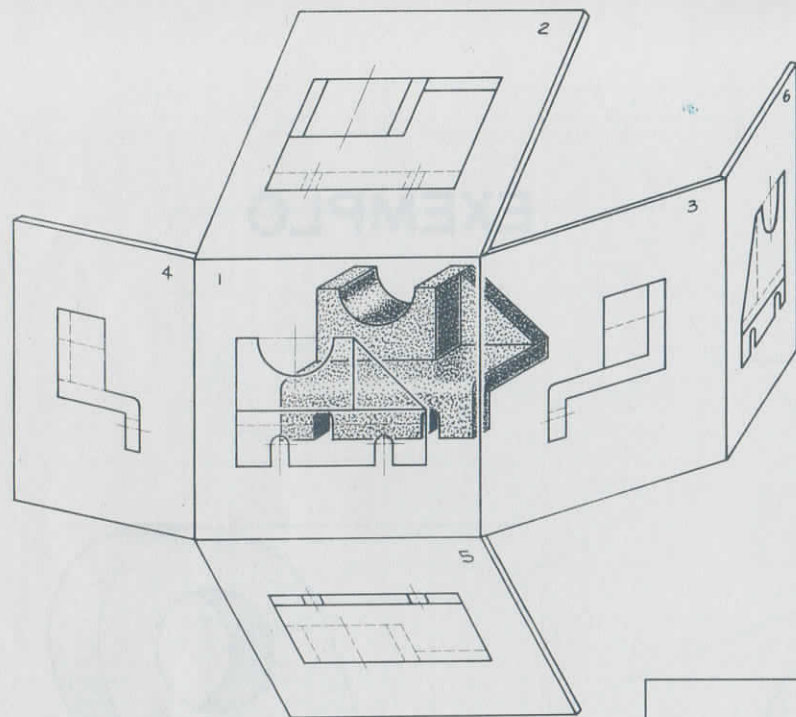
EXEMPLO



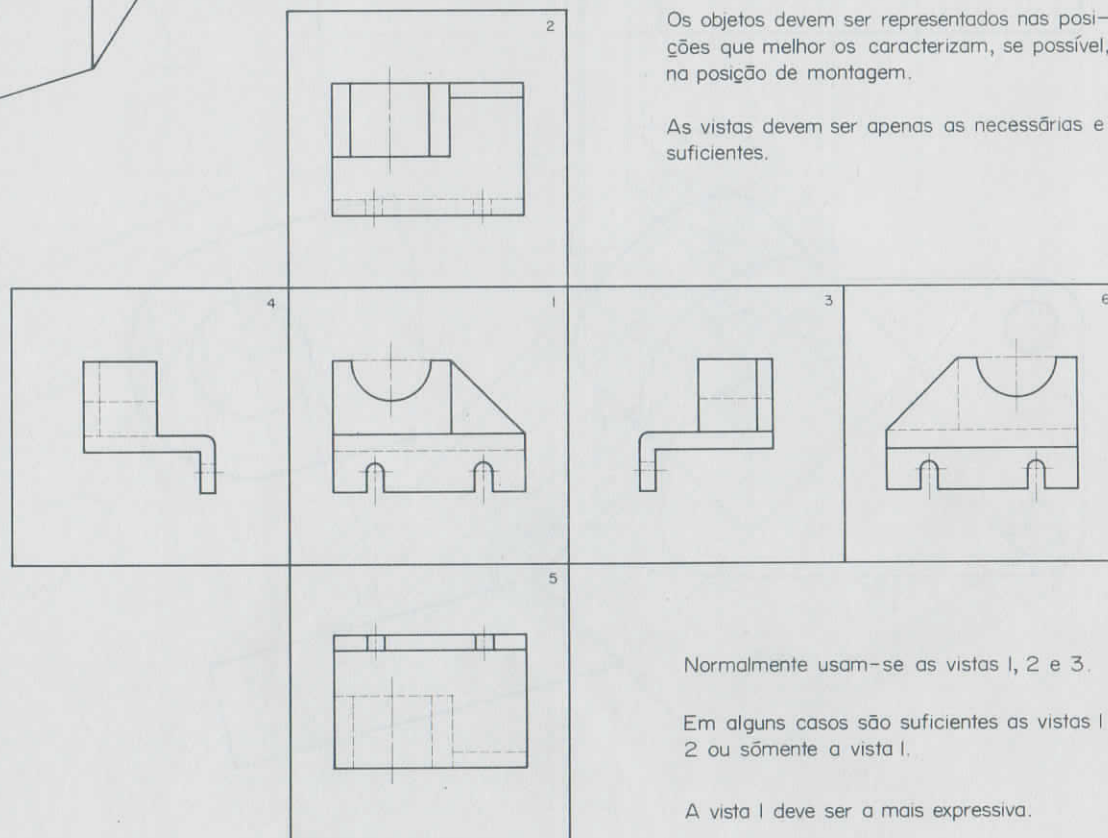
PROJEÇÃO ORTOGONAL

NORMA NORTE-AMERICANA

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



- 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



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

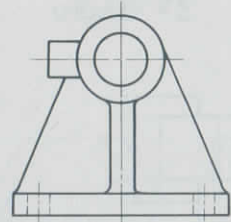
As vistas devem ser apenas as necessárias e suficientes.

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

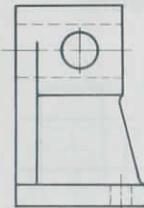
Em alguns casos são suficientes as vistas 1 e 2 ou somente a vista 1.

A vista 1 deve ser a mais expressiva.

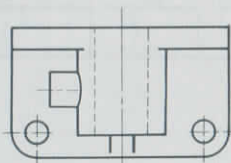
MÉTODOS DE PROJEÇÃO ORTOGONAL



elevação



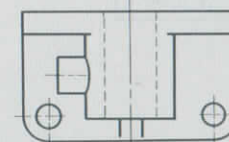
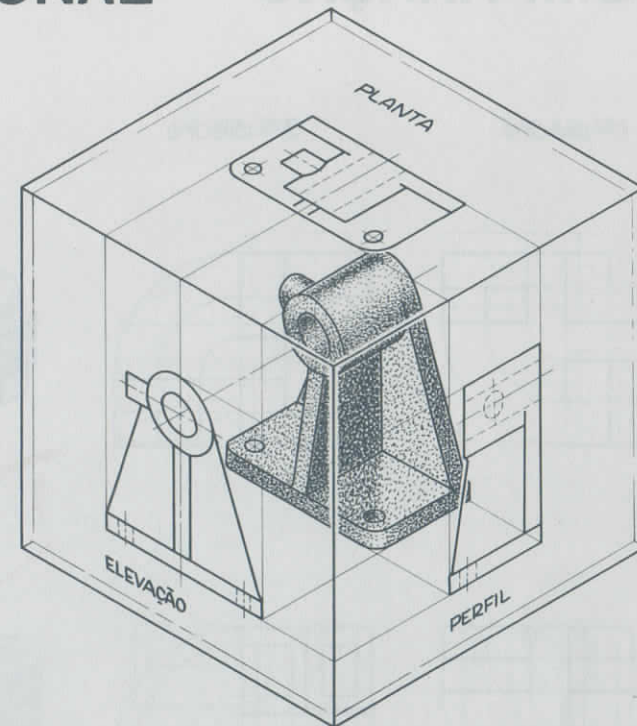
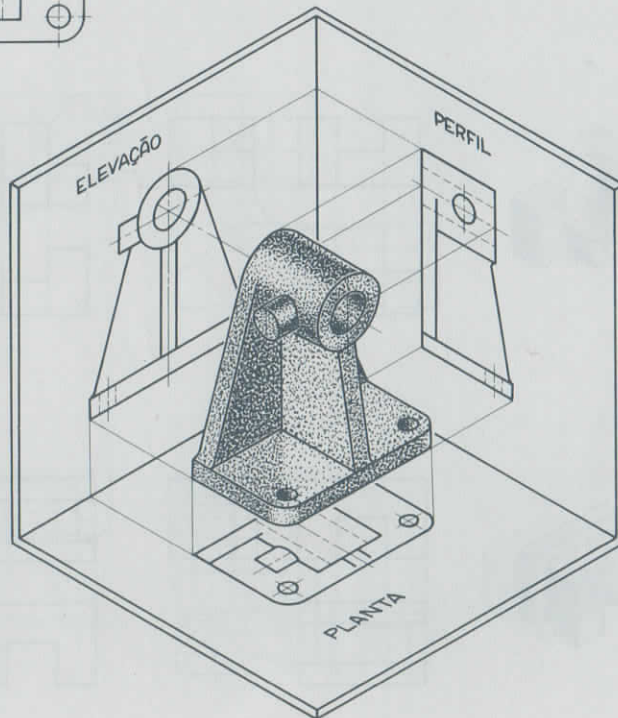
perfil



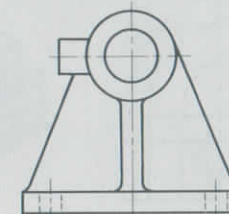
planta

MÉTODO EUROPEU

1º diedro



planta

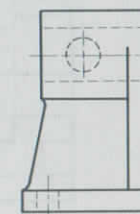


elevação

MÉTODO

NORTE - AMERICANO

3º diedro



perfil

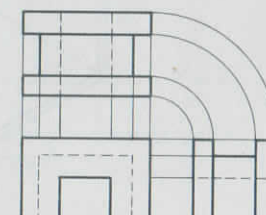
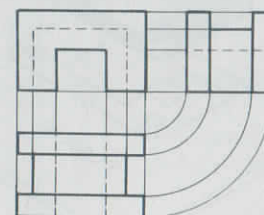
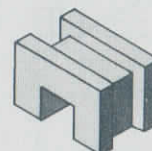
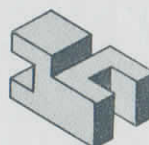
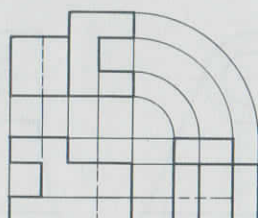
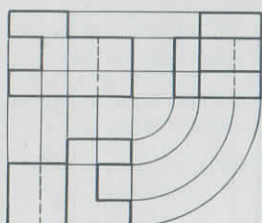
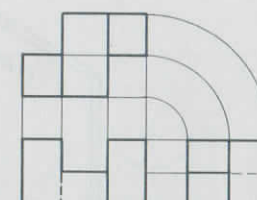
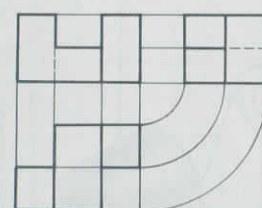
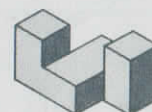
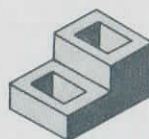
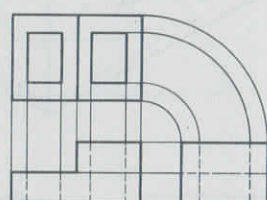
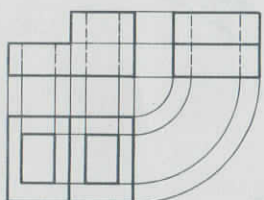
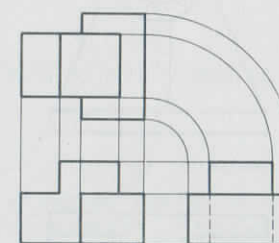
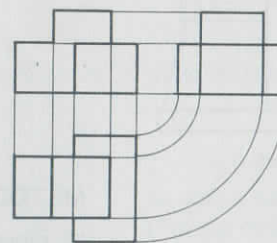
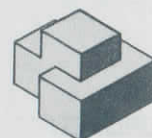
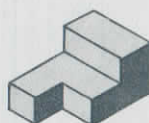
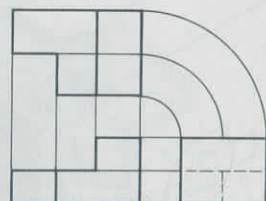
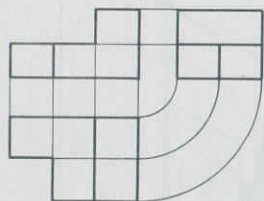
COMPARAÇÃO

1º diedro

3º diedro

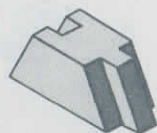
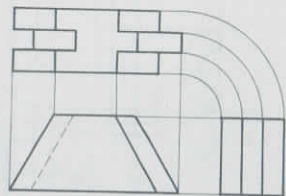
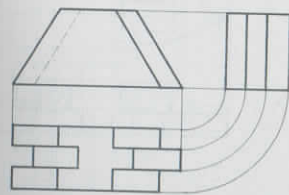
1º diedro

3º diedro



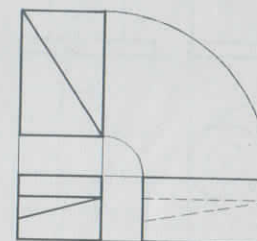
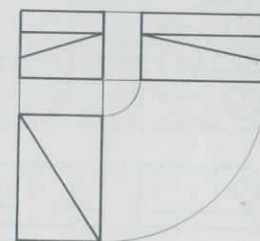
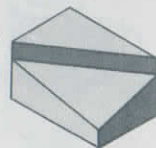
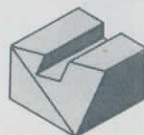
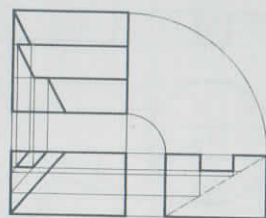
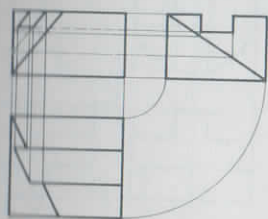
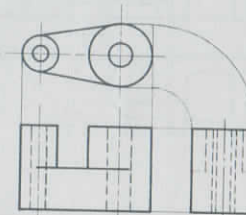
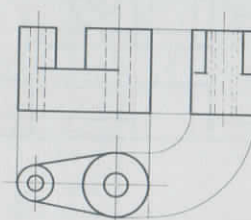
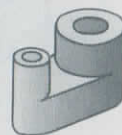
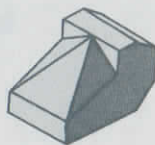
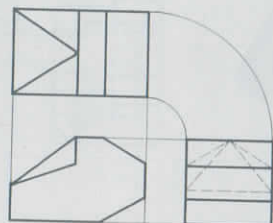
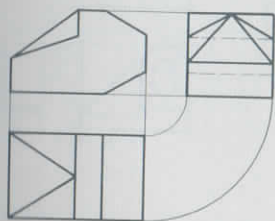
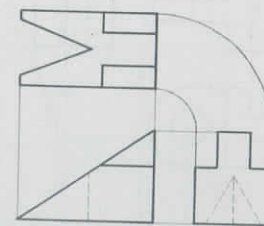
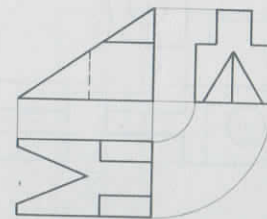
1º diedro

3º diedro



1º diedro

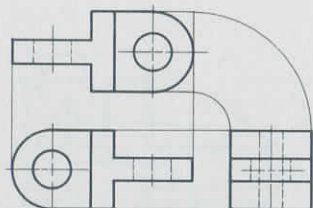
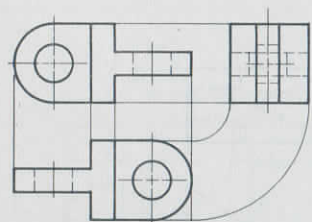
3º diedro



COMPARAÇÃO

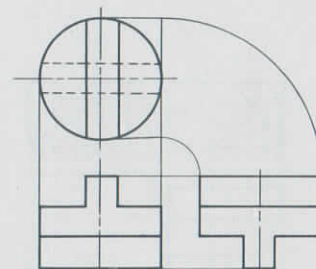
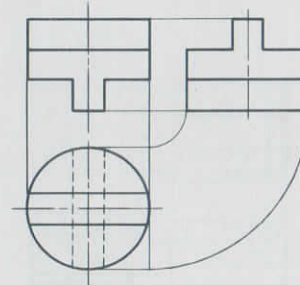
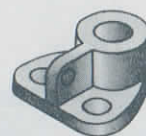
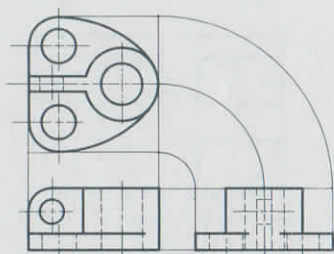
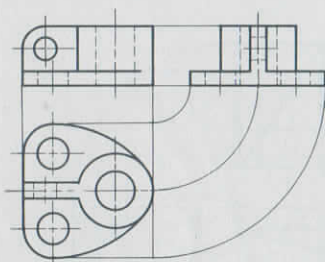
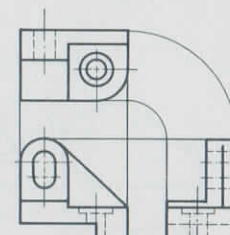
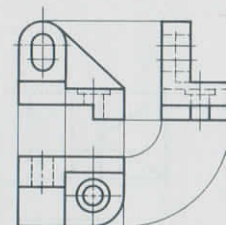
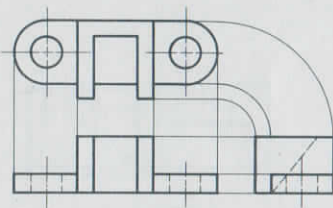
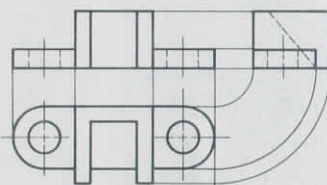
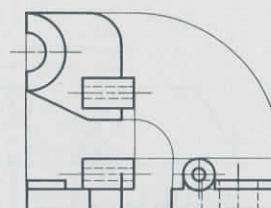
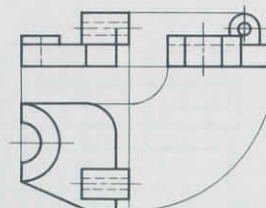
1º diedro

3º diedro



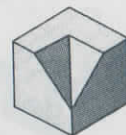
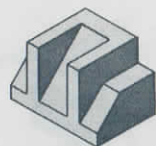
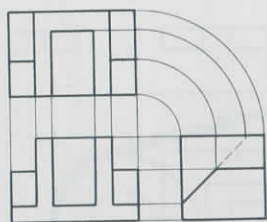
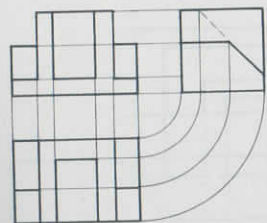
1º diedro

3º diedro



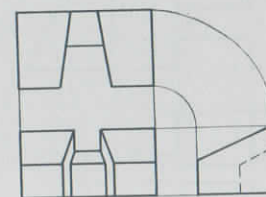
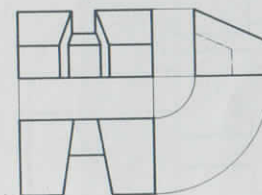
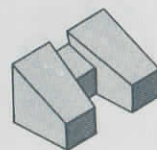
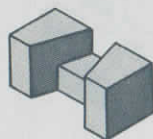
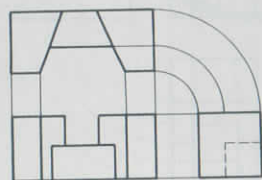
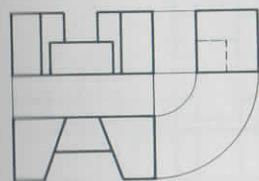
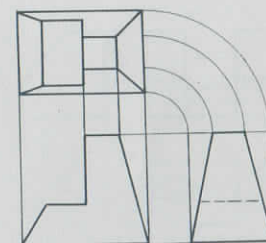
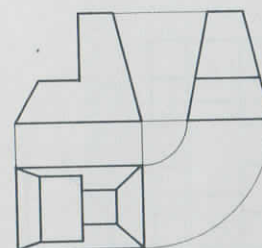
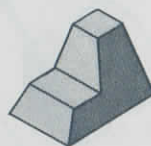
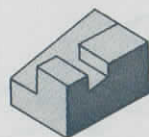
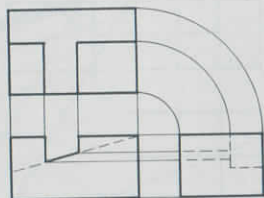
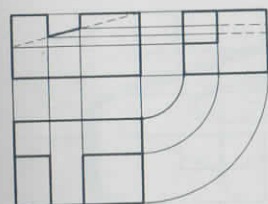
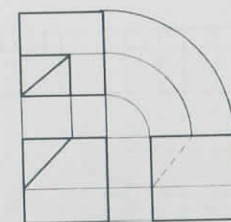
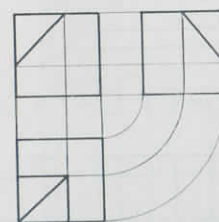
1º diedro

3º diedro



1º diedro

3º diedro

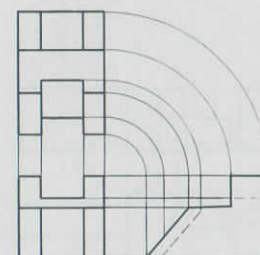
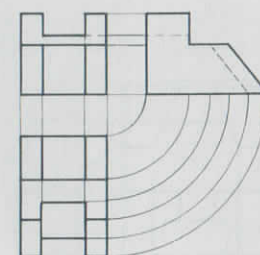
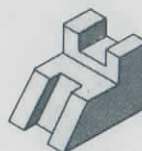
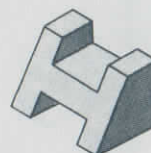
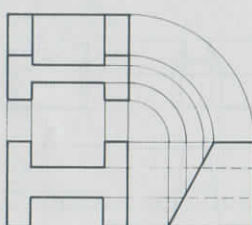
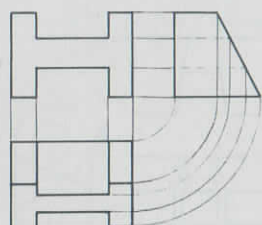
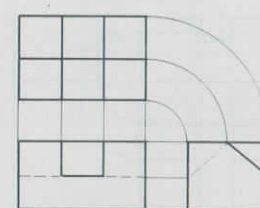
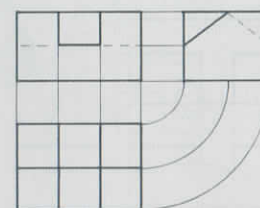
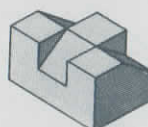
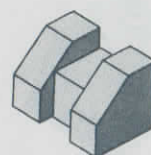
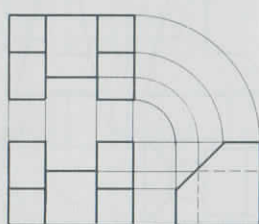
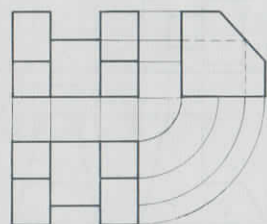
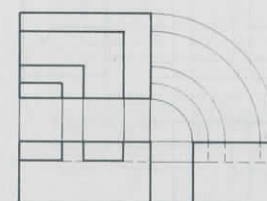
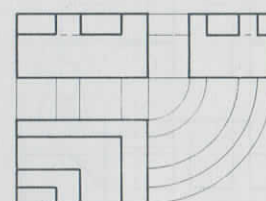
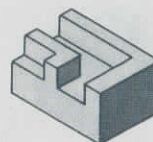
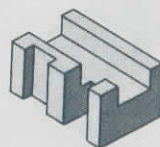
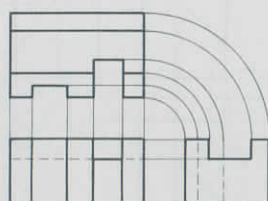
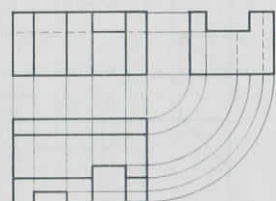


1º diedro

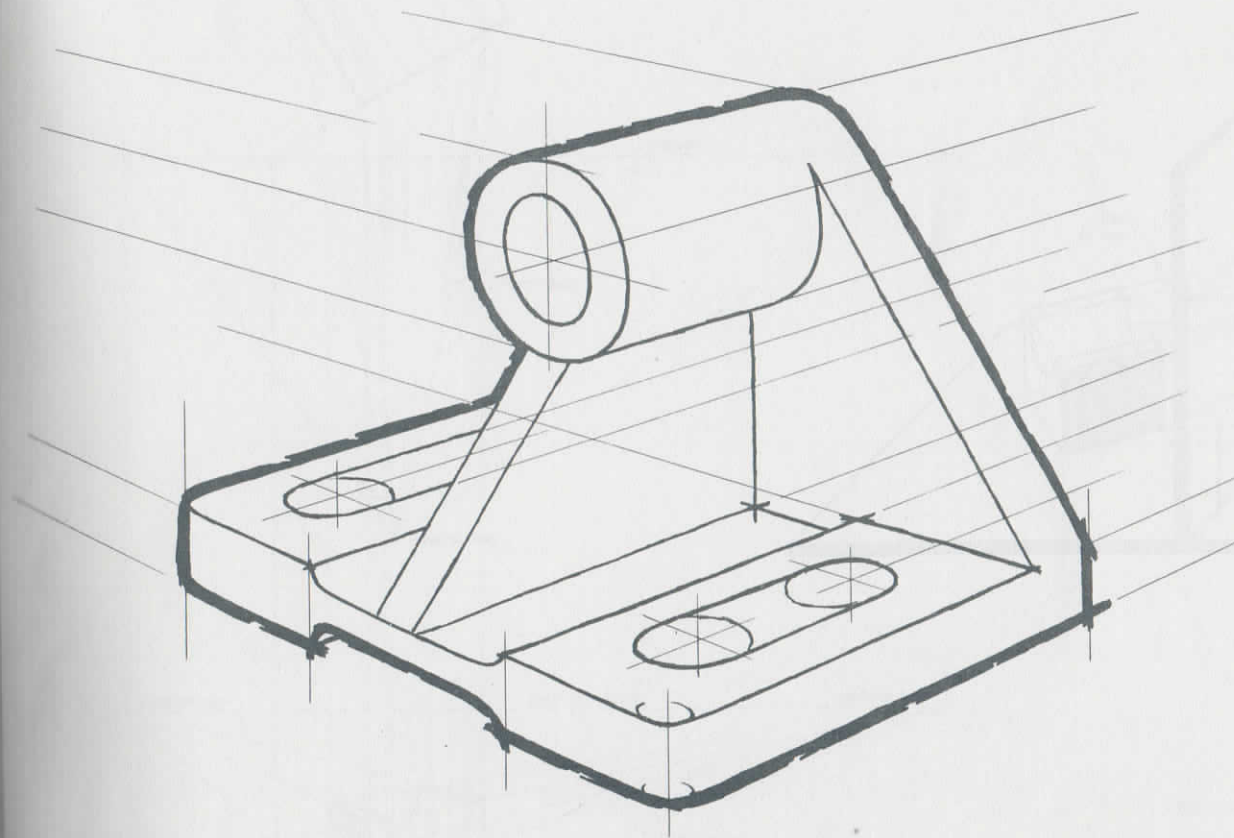
3º diedro

1º diedro

3º diedro



PERSPECTIVA EXATA



4 perspectiva

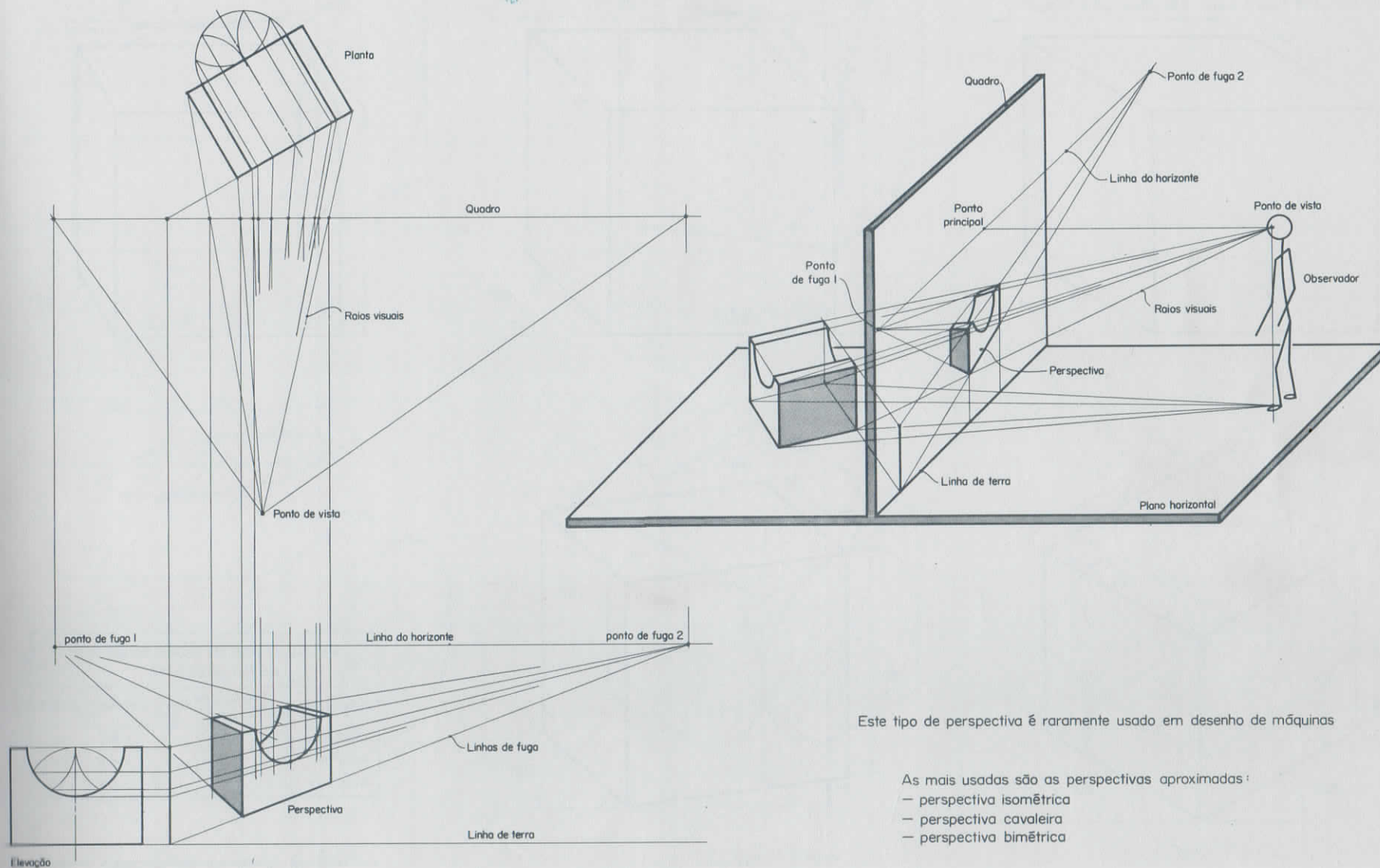
exata

cavaleira

bimétrica

isométrica

PERSPECTIVA EXATA

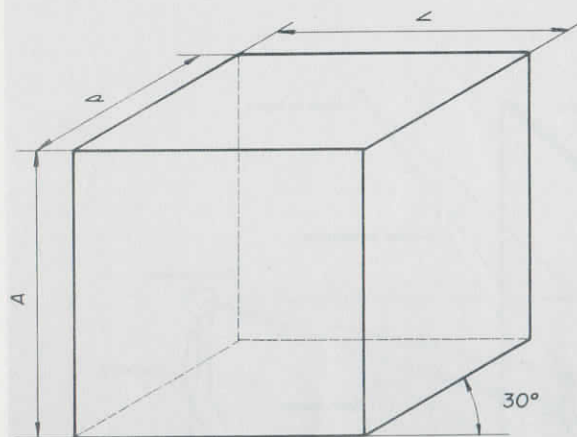


Este tipo de perspectiva é raramente usado em desenho de máquinas

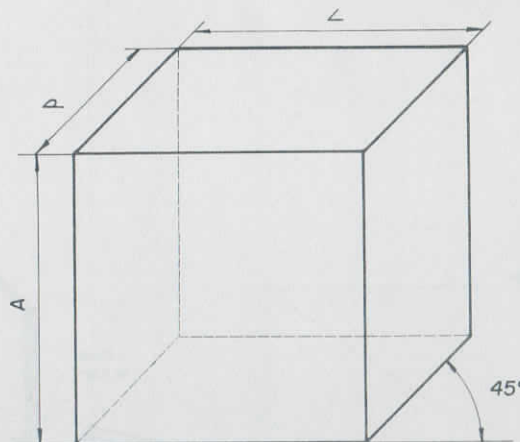
As mais usadas são as perspectivas aproximadas:

- perspectiva isométrica
- perspectiva cavaleira
- perspectiva bimétrica

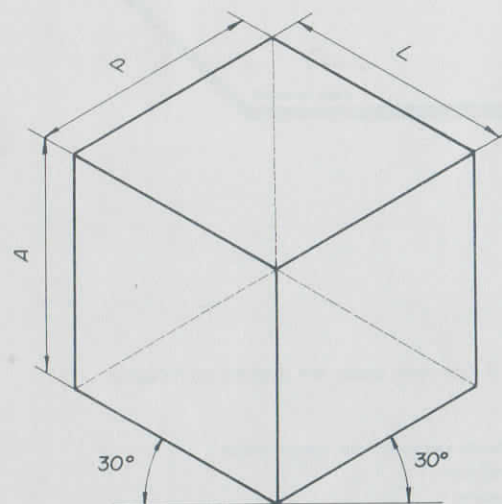
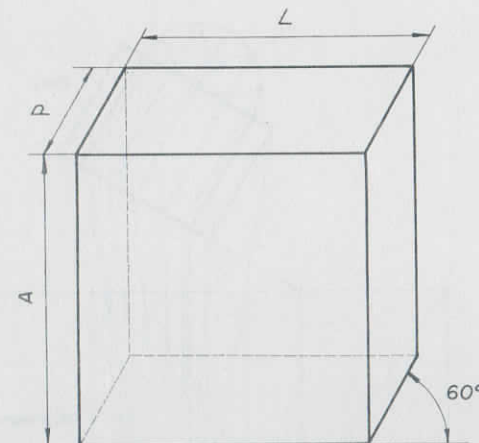
cavaleira à 30°



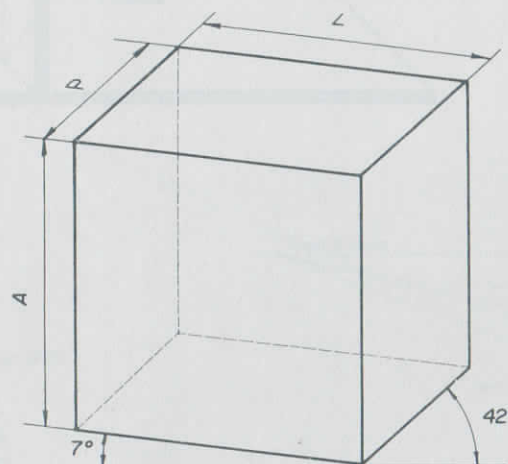
cavaleira à 45°



cavaleira à 60°



isométrica



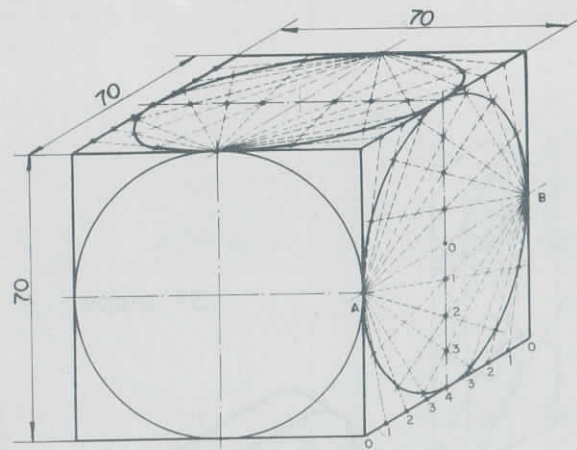
bimétrica

RELAÇÃO DAS MEDIDAS REAIS COM AS DO DESENHO

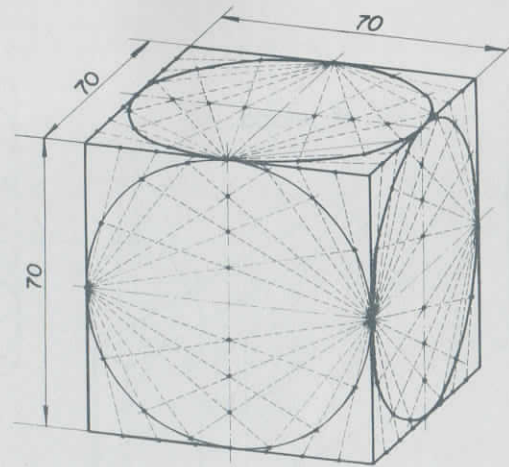
PERSPEC.	CAVALEIRA			ISOMÉT.	BIMÉT.
	30°	45°	60°		
LARGURA	1:1	1:1	1:1	1: 4/5	1:1
ALTURA	1:1	1:1	1:1	1: 4/5	1:1
PROFUND.	1: 2/3	1: 1/2	1: 1/3	1: 4/5	1: 1/2

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

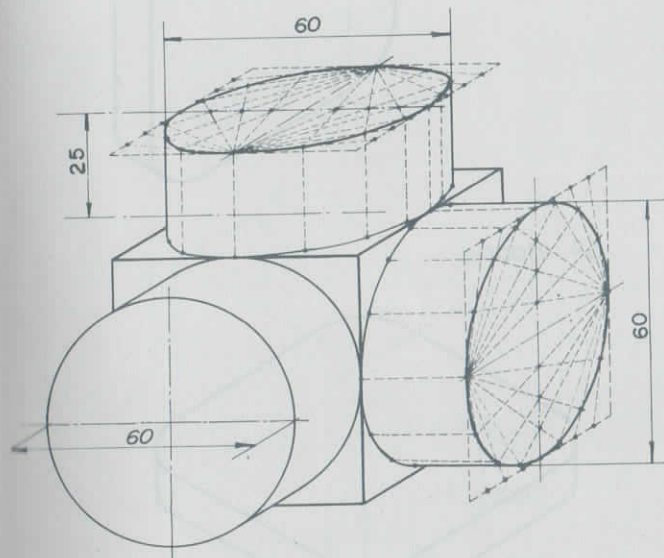
PERSPECTIVA DE CIRCUNFERÊNCIAS



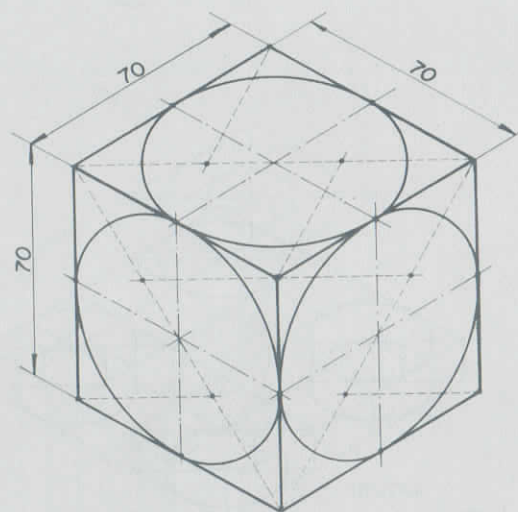
CAVALEIRA A 30°



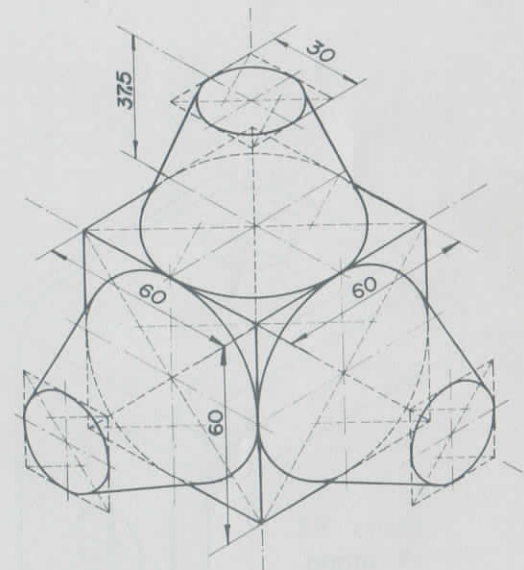
BIMÉTRICA



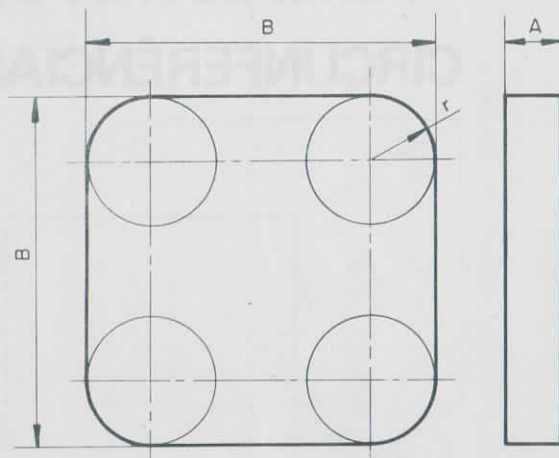
CAVALEIRA A 30°



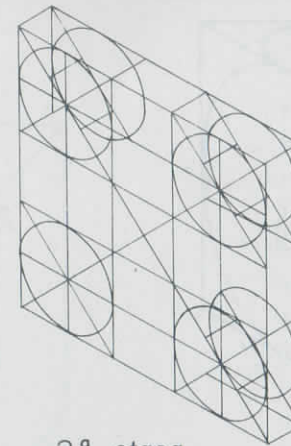
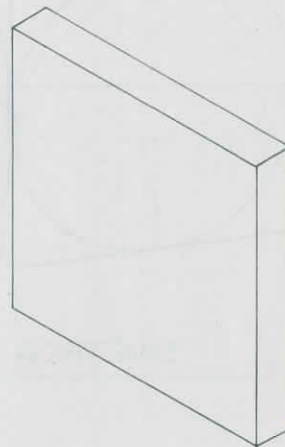
ISOMÉTRICA



ISOMÉTRICA

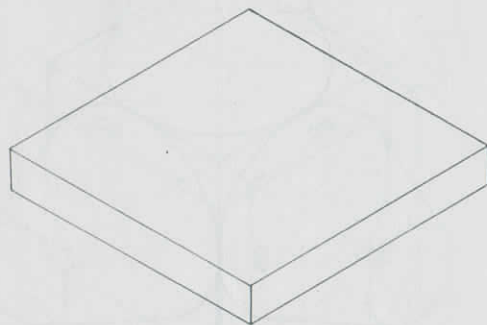
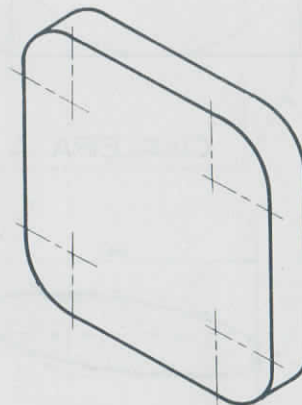


1ª etapa

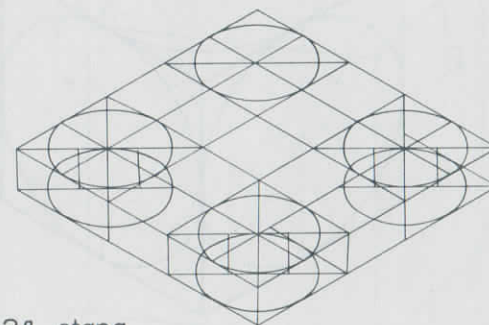


2ª etapa

3ª etapa

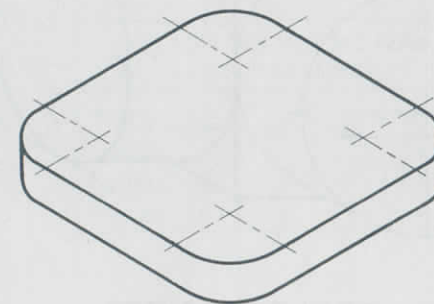


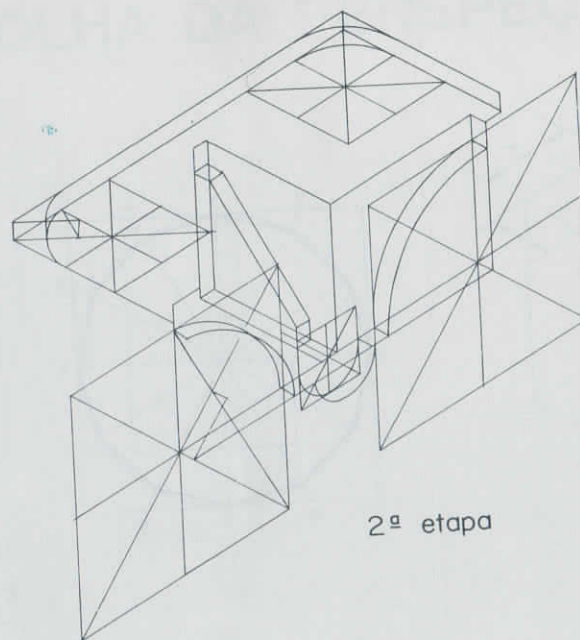
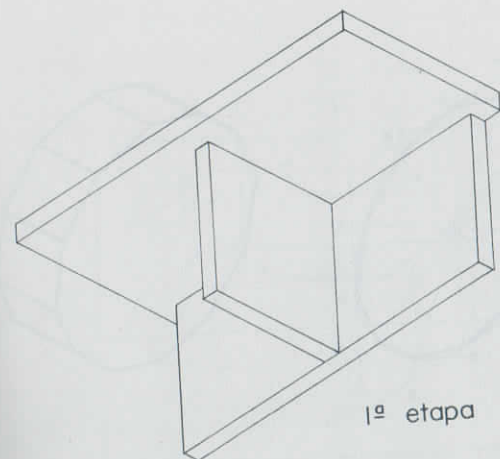
1ª etapa



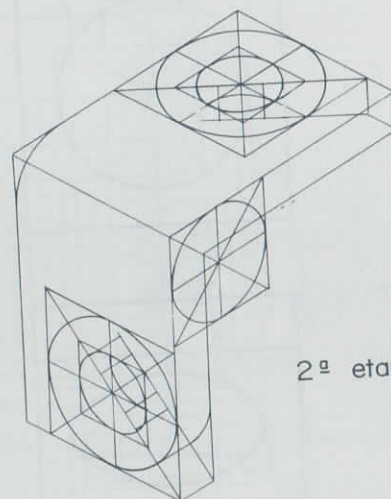
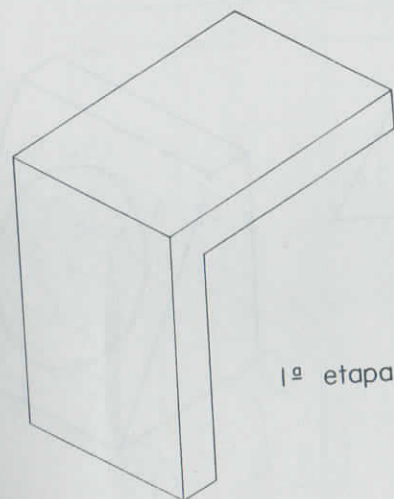
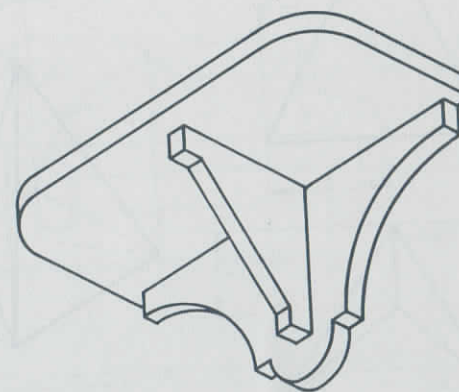
2ª etapa

3ª etapa

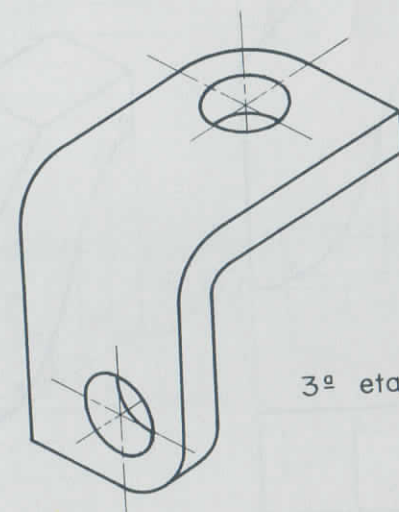




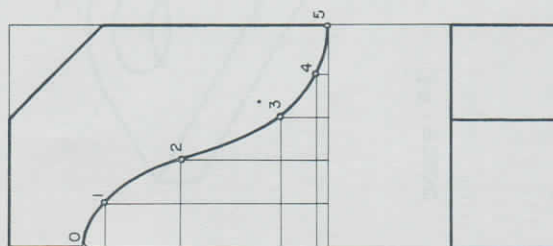
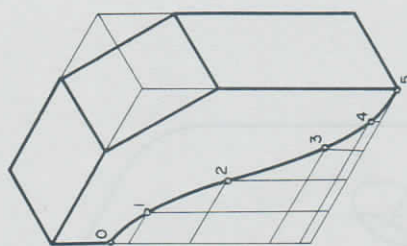
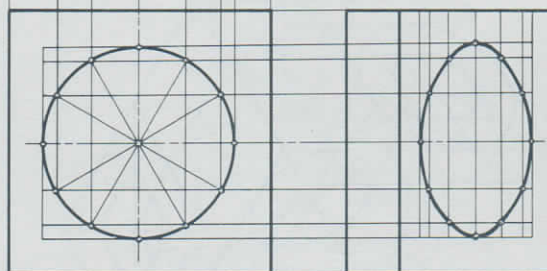
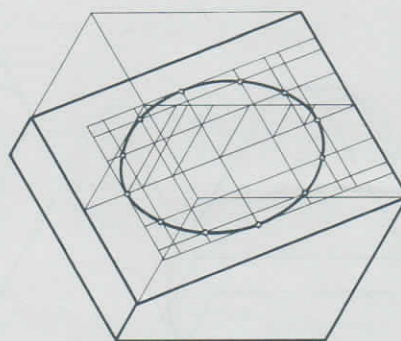
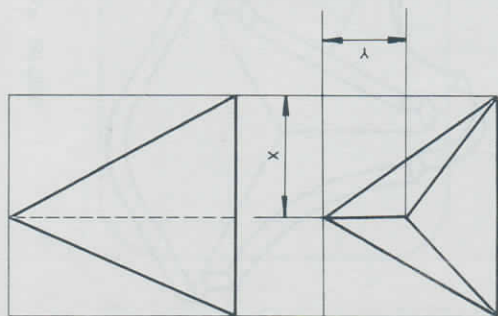
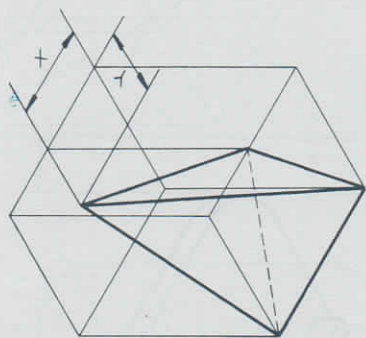
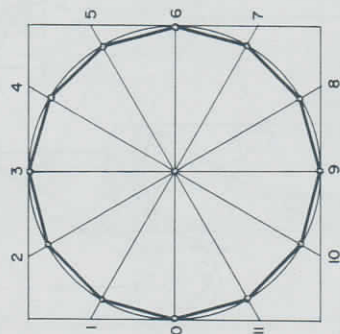
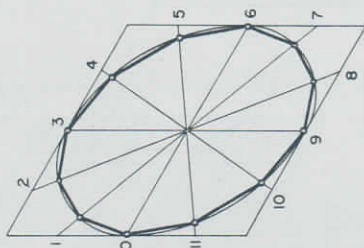
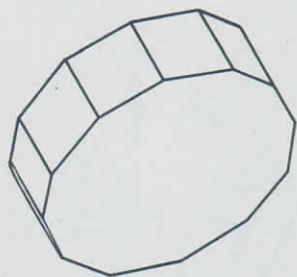
3ª etapa



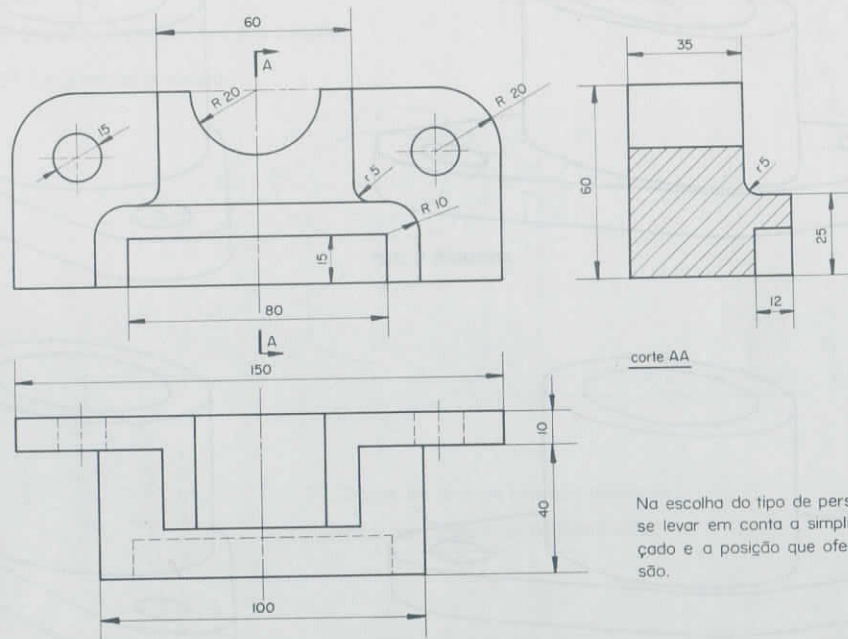
2ª etapa



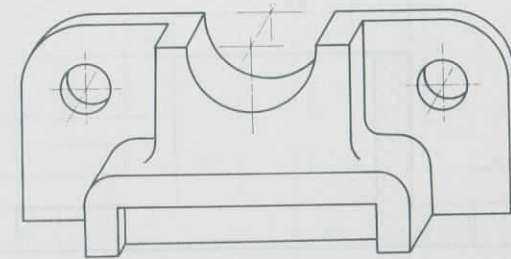
3ª etapa



ESCOLHA DA PERSPECTIVA

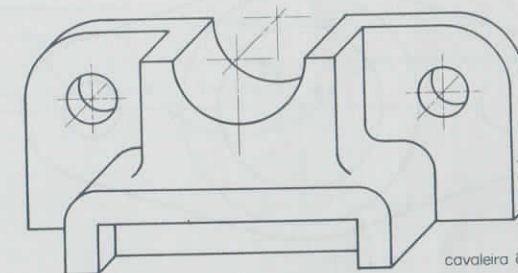


Na escolha do tipo de perspectiva deve-se levar em conta a simplicidade no traçado e a posição que oferece melhor visão.



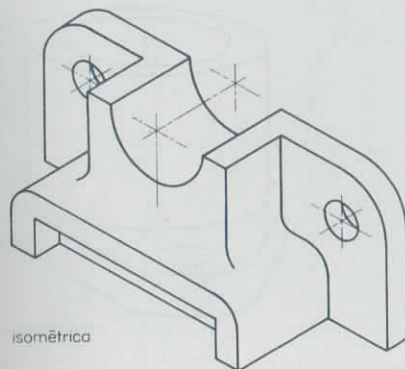
Solução fácil, porém, pouco expressiva

cavaleira a 60°



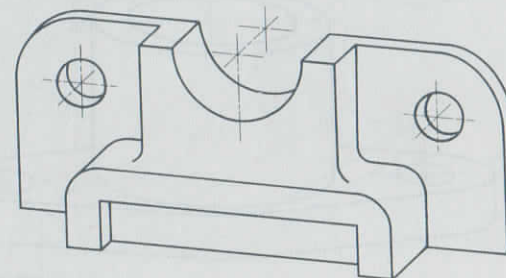
Solução fácil e bastante expressiva

cavaleira a 45°



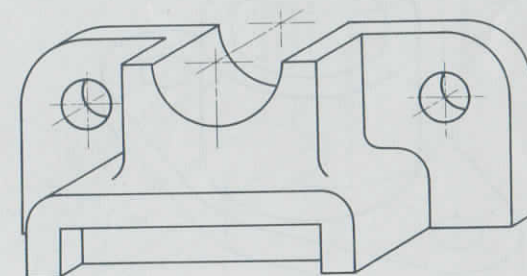
isométrica

Solução mais ou menos trabalhosa, porém, muito expressiva.



bimétrica

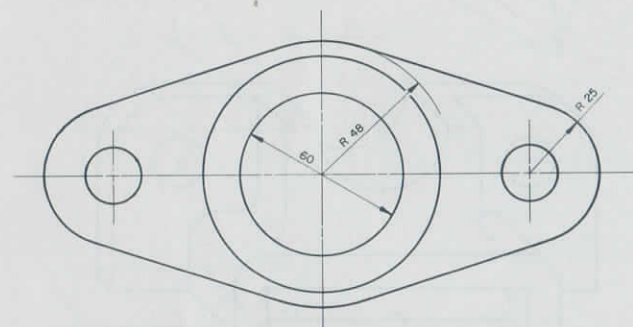
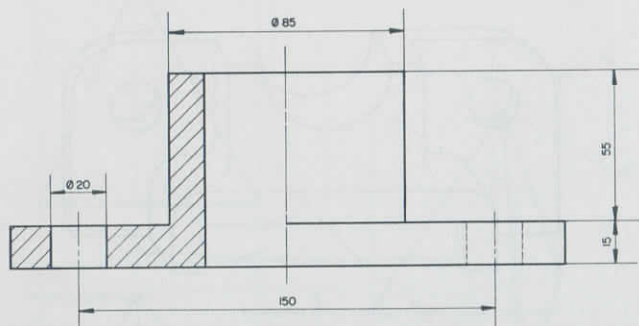
Solução muito trabalhosa e não expressiva



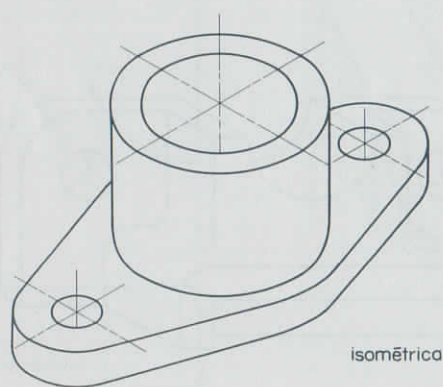
cavaleira a 30°

Solução fácil e mais ou menos expressiva

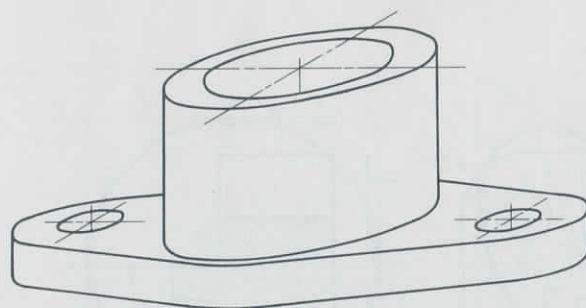
ESCOLHA DA POSIÇÃO



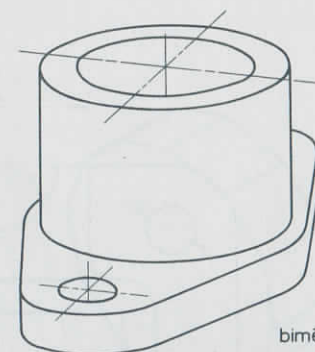
Os objetos devem ser representados nas posições que melhor os caracterizam.



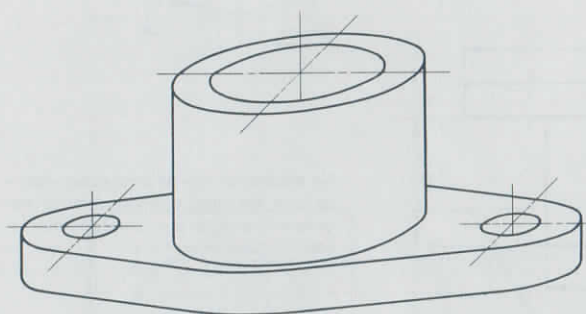
MELHOR SOLUÇÃO (simples e expressiva)



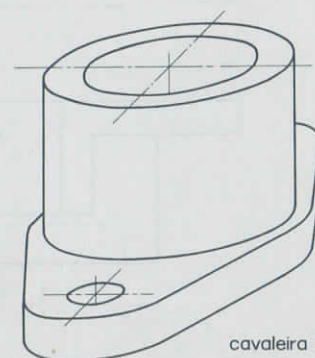
cavaleira a 30°



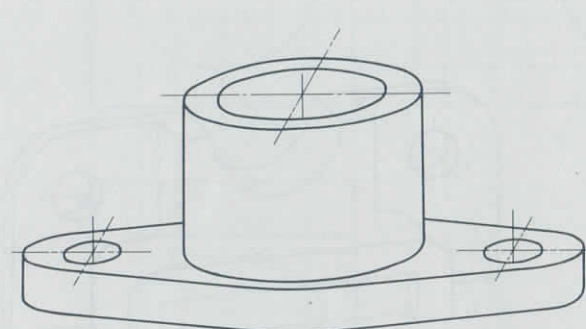
bimétrica



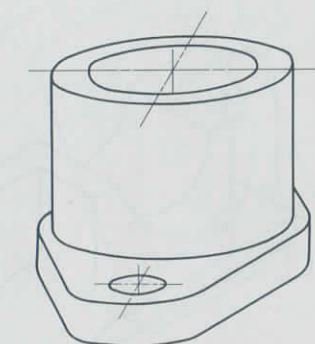
cavaleira a 45°



cavaleira a 45°



cavaleira a 60°



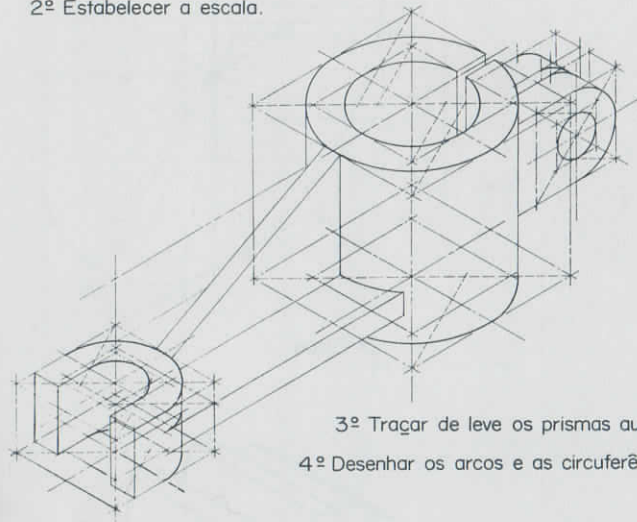
cavaleira a 60°

SOLUÇÕES NÃO RECOMENDÁVEIS (trabalhosas e com efeito de distorção)

SEQUÊNCIA DO TRAÇADO

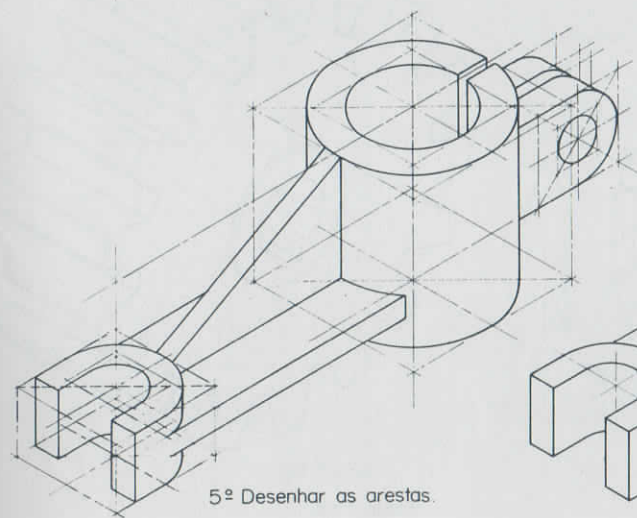
1º Escolher a perspectiva e a posição.

2º Estabelecer a escala.

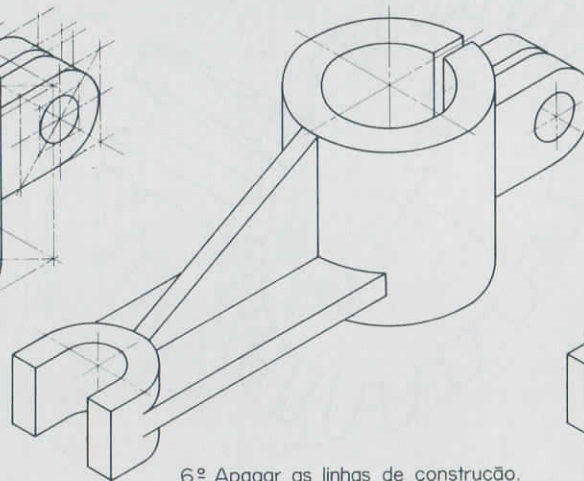


3º Traçar de leve os prismas auxiliares.

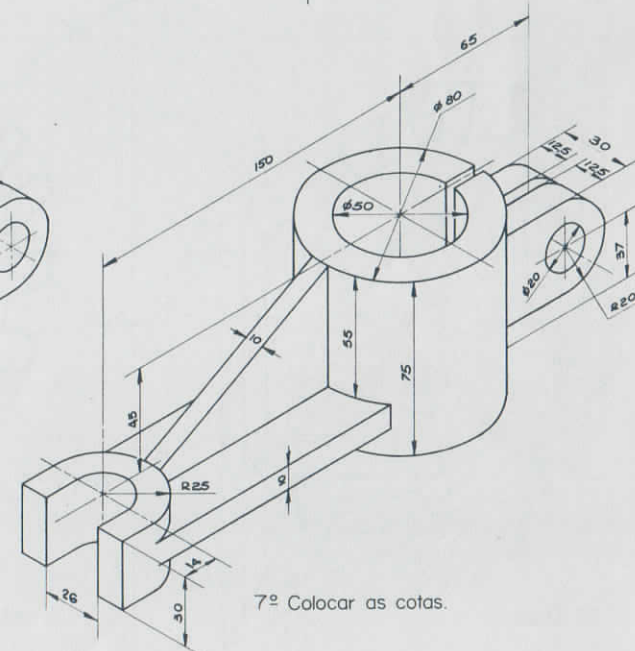
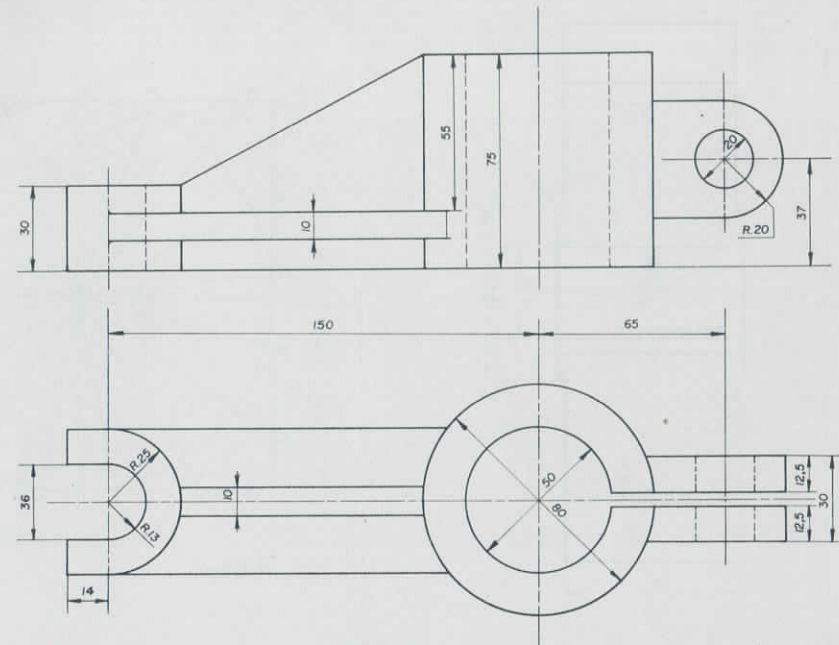
4º Desenhar os arcos e as circunferências.



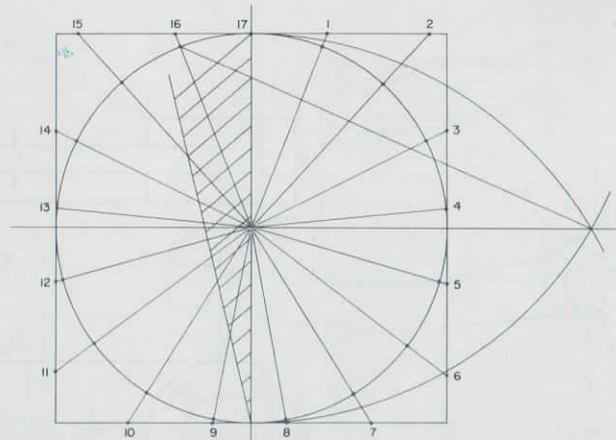
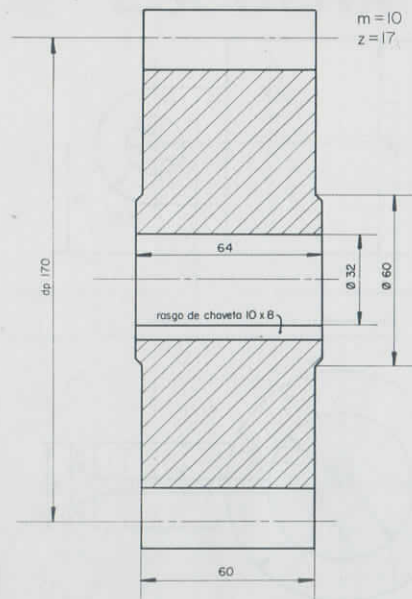
5º Desenhar as arestas.



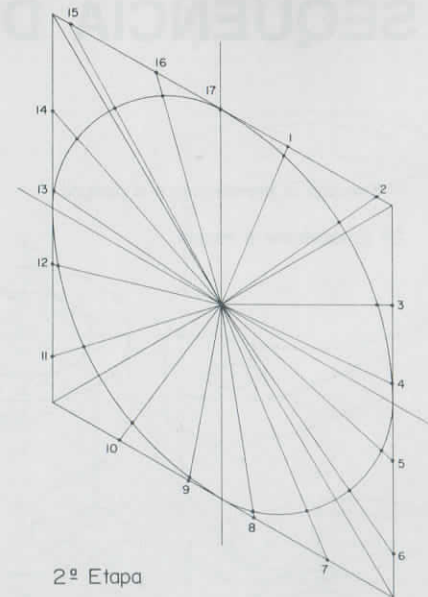
6º Apagar as linhas de construção.



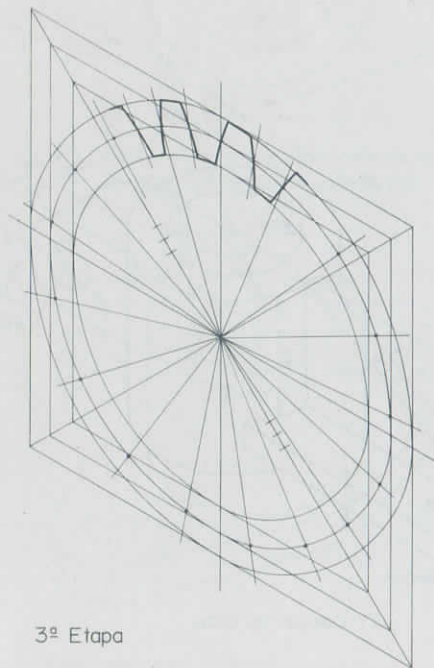
7º Colocar as cotas.



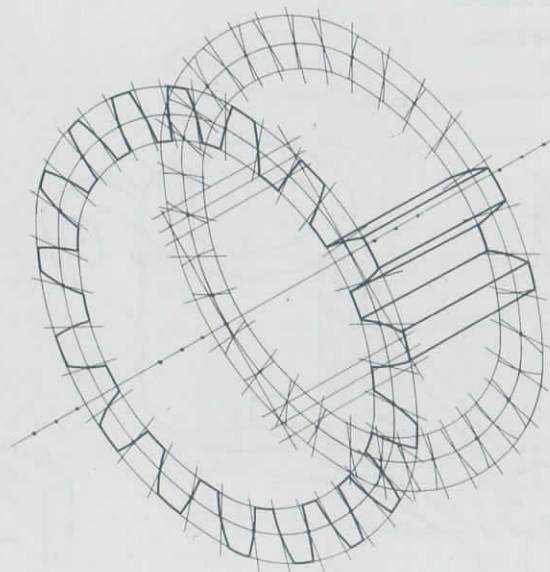
1ª Etapa



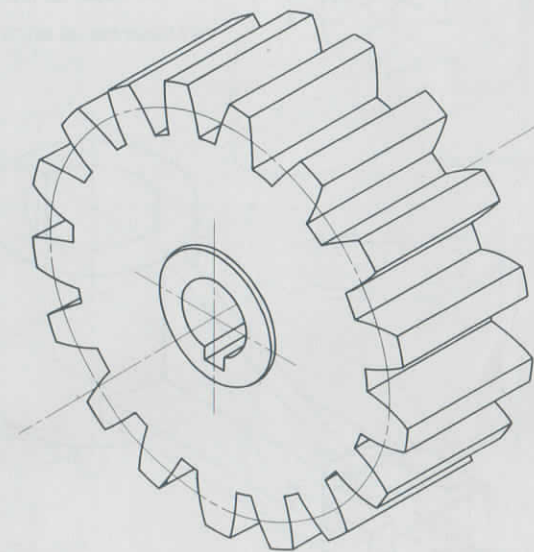
2ª Etapa



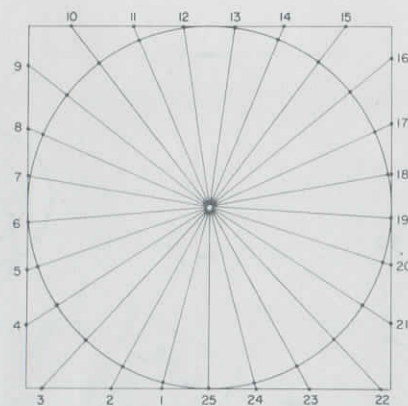
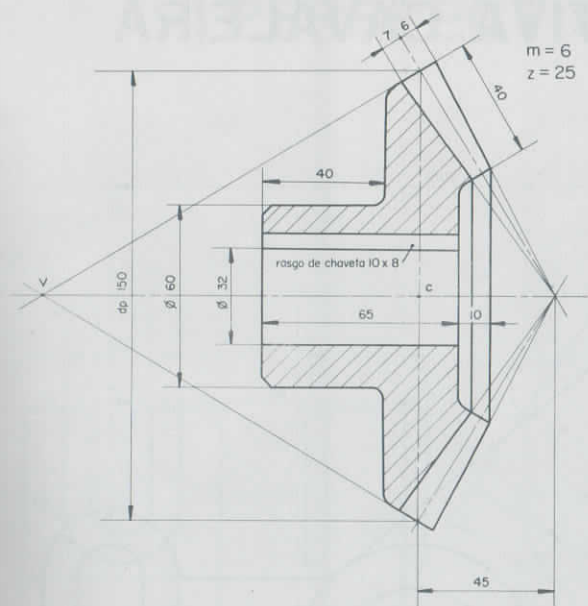
3ª Etapa



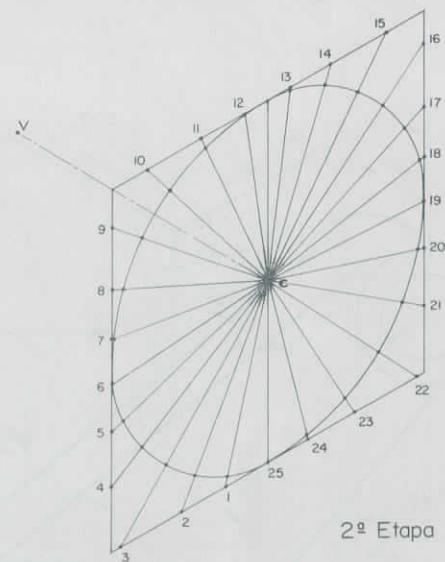
4ª Etapa



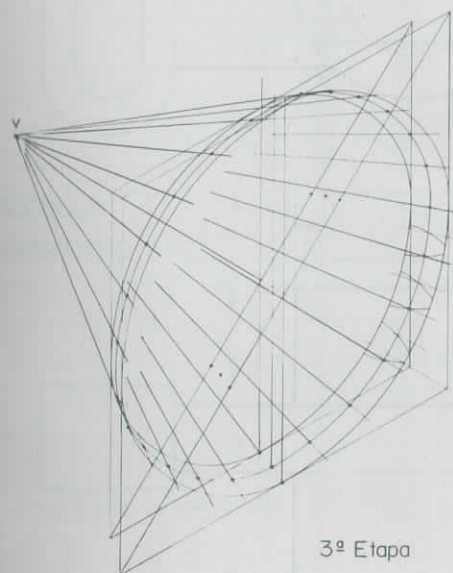
Etapa final



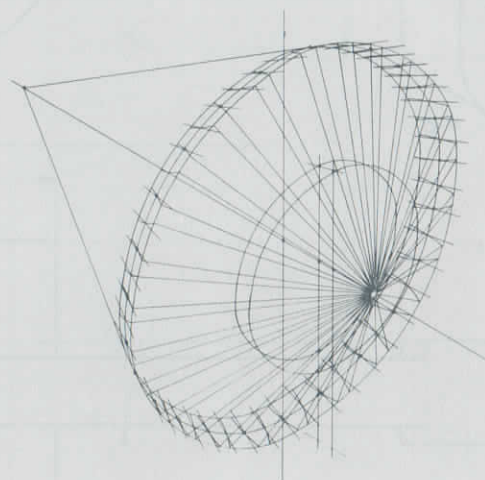
1ª Etapa



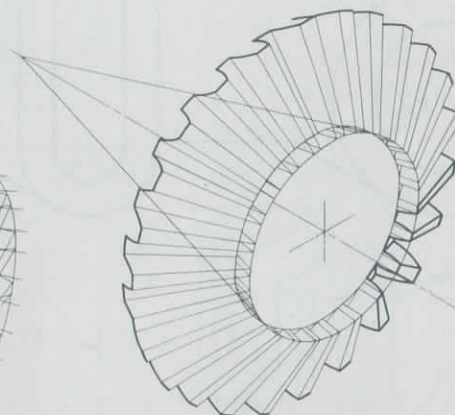
2ª Etapa



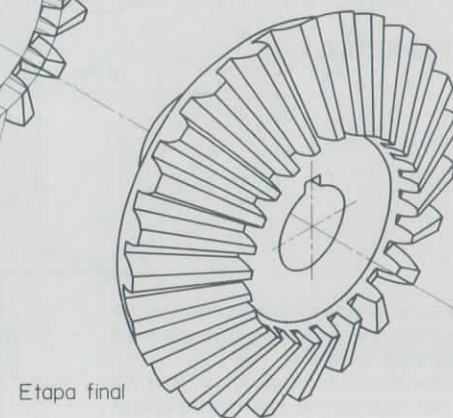
3ª Etapa



4ª Etapa

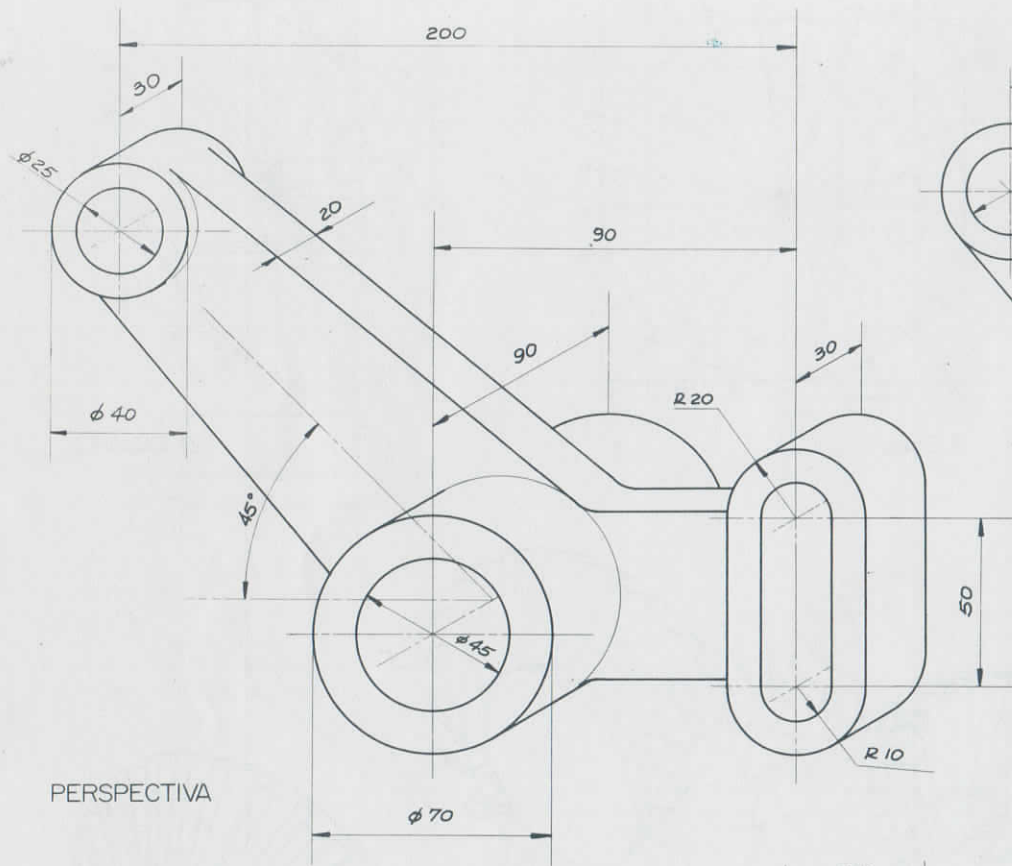


5ª Etapa

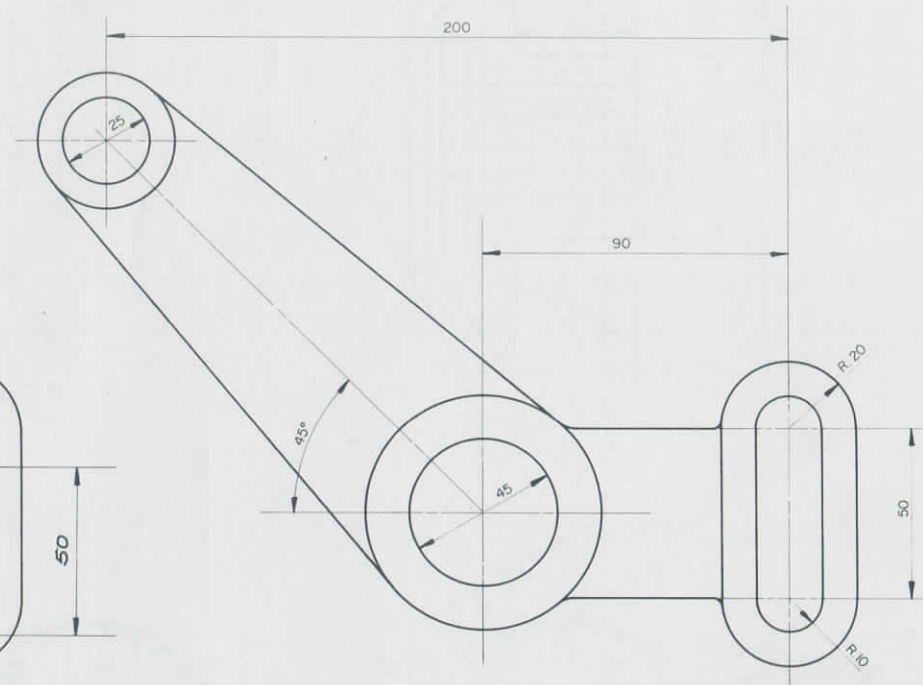


Etapa final

PERSPECTIVA CAVALEIRA

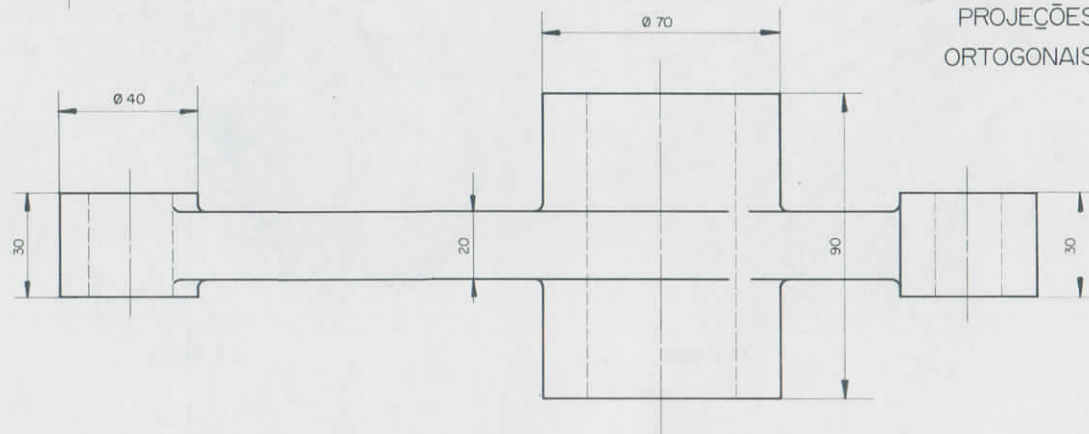
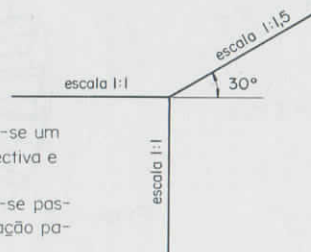


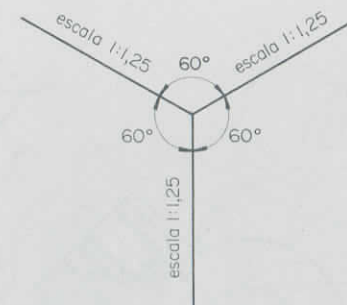
PERSPECTIVA



PROJEÇÕES
ORTOGONAIS

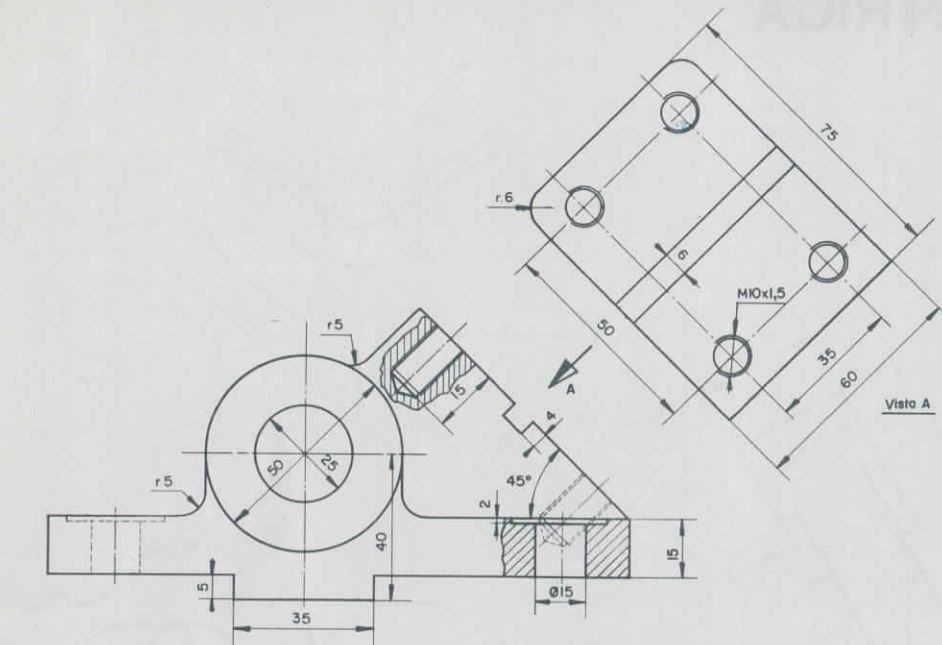
Usando-se as escalas indicadas obtêm-se um bom efeito dimensional entre a perspectiva e as projeções ortogonais.
Considerando-se estas escalas, pode-se passar reciprocamente de uma representação para outra.



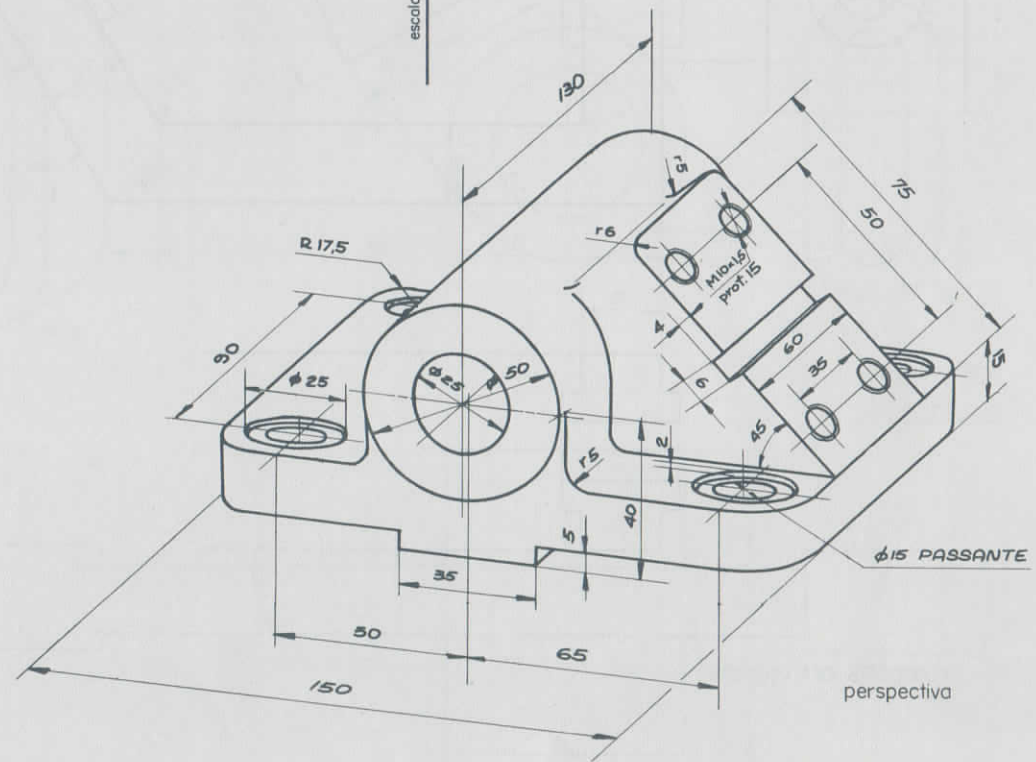
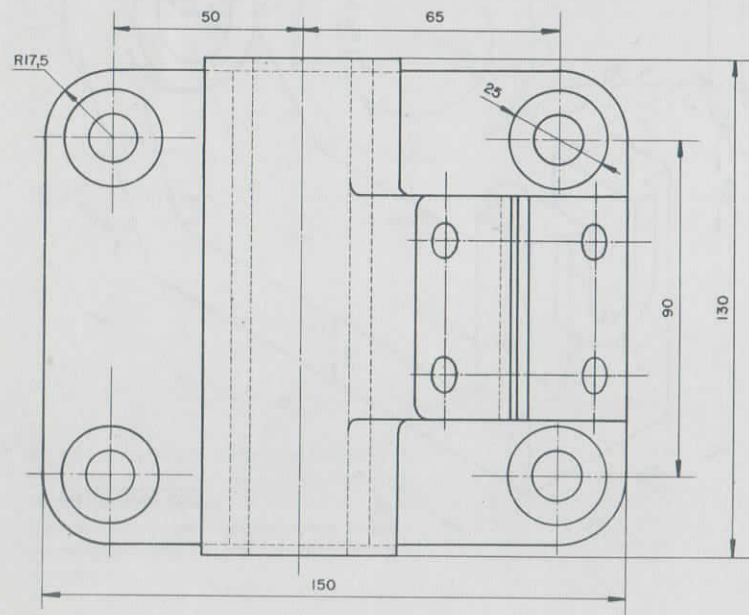


A perspective drawing of a mechanical part. The part has a base plate with a width of 50 and a length of 140. On the left side, there is a U-shaped feature with a height of 25 and a width of 30. The base plate has a thickness of 20. On the right side, there is a vertical plate with a width of 30 and a height of 60. The vertical plate has a circular hole with a diameter of $\phi 40$ and a center-to-center distance of 25 from the top edge. The vertical plate is connected to the base plate by a sloped section with a height of 20 and a radius of $r5$. The sloped section has a 60° angle. The base plate has a width of 50 and a length of 140. The word "perspectiva" is written at the bottom right.

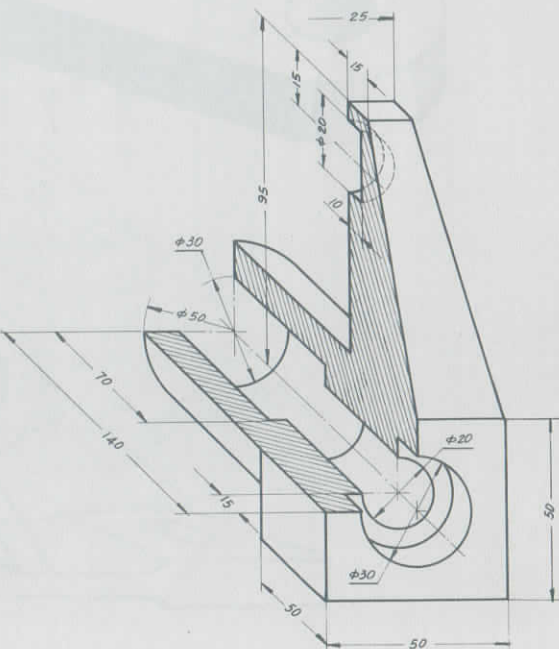
PERSPECTIVA BIMÉTRICA



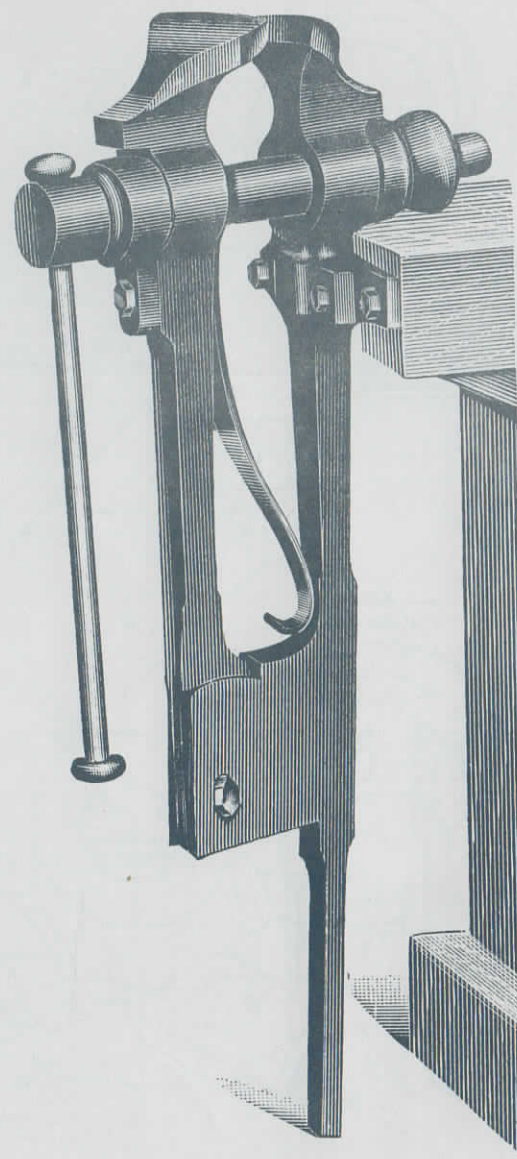
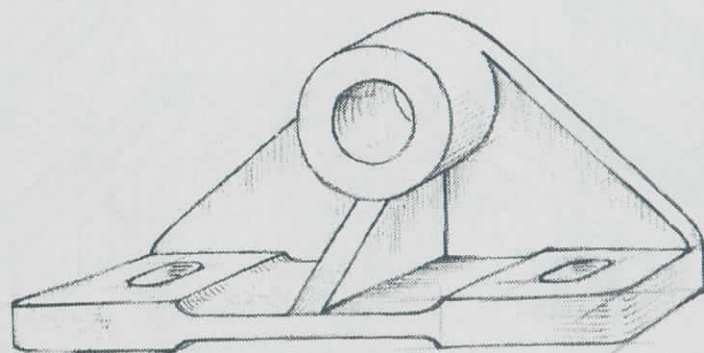
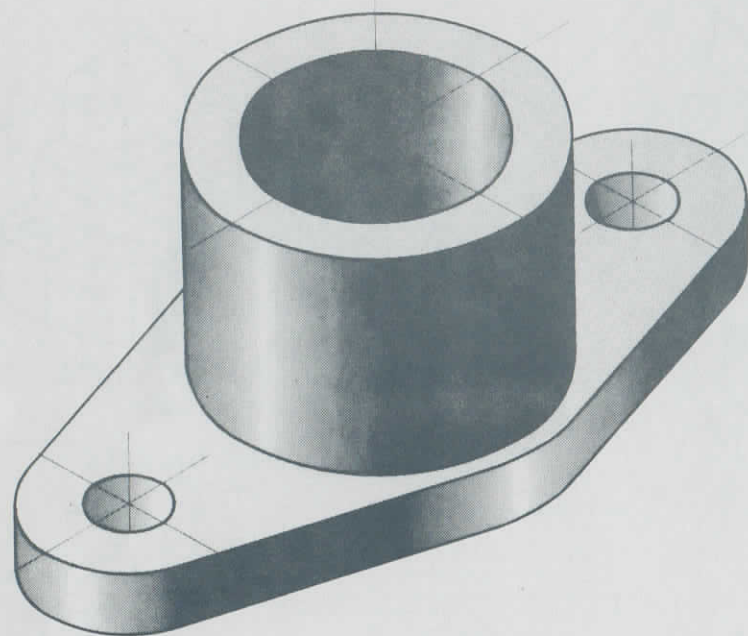
projeções ortogonais

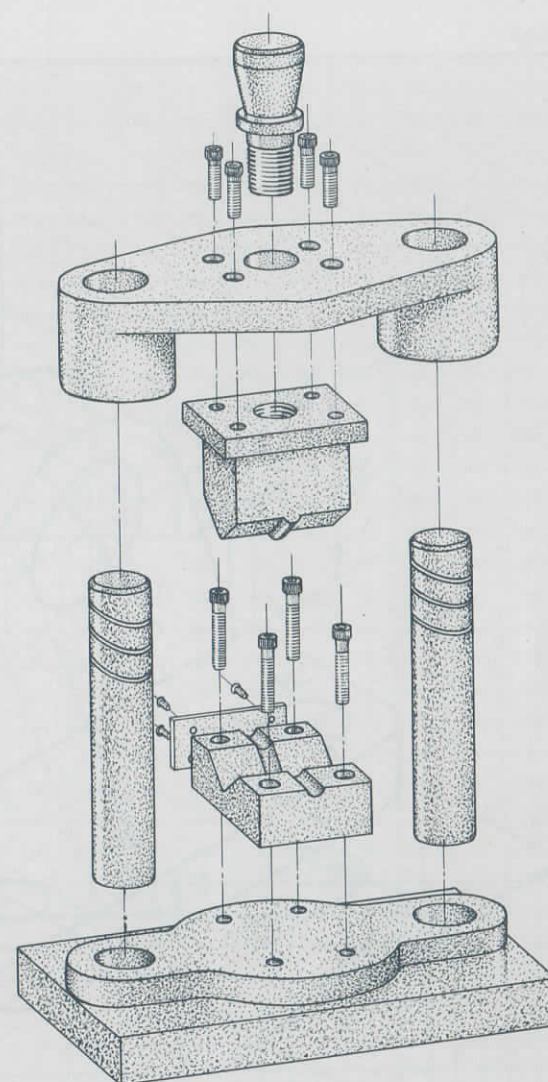
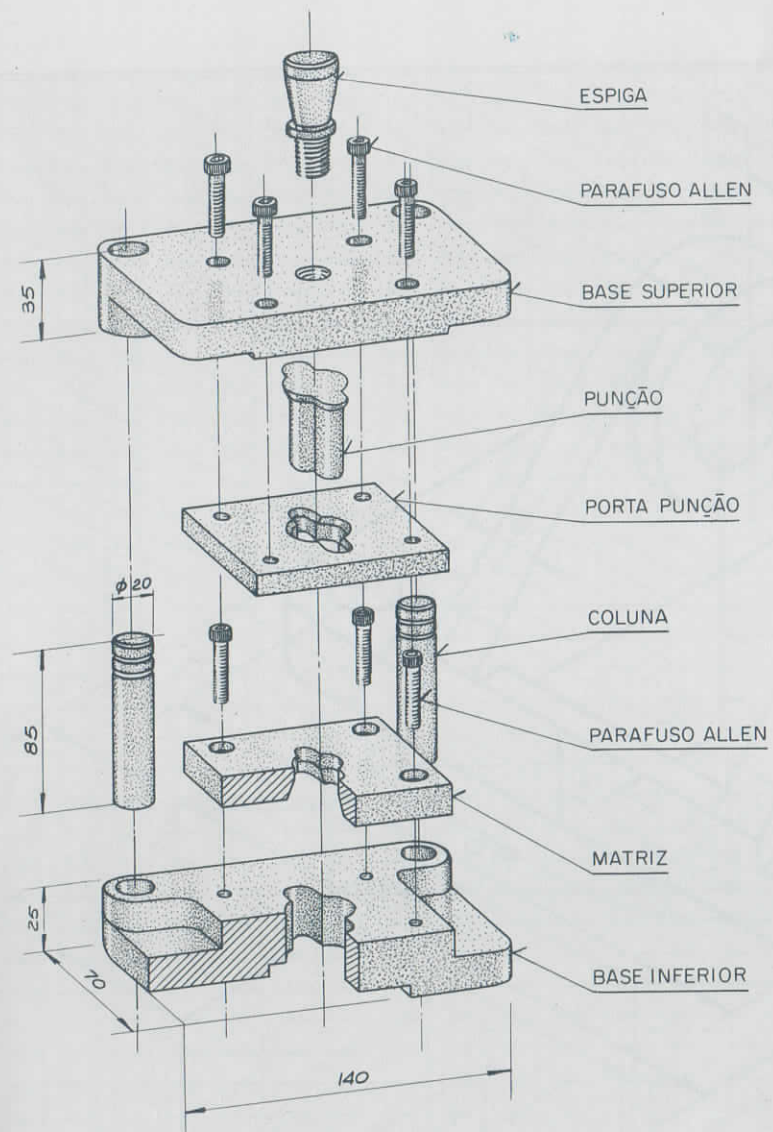


perspectiva



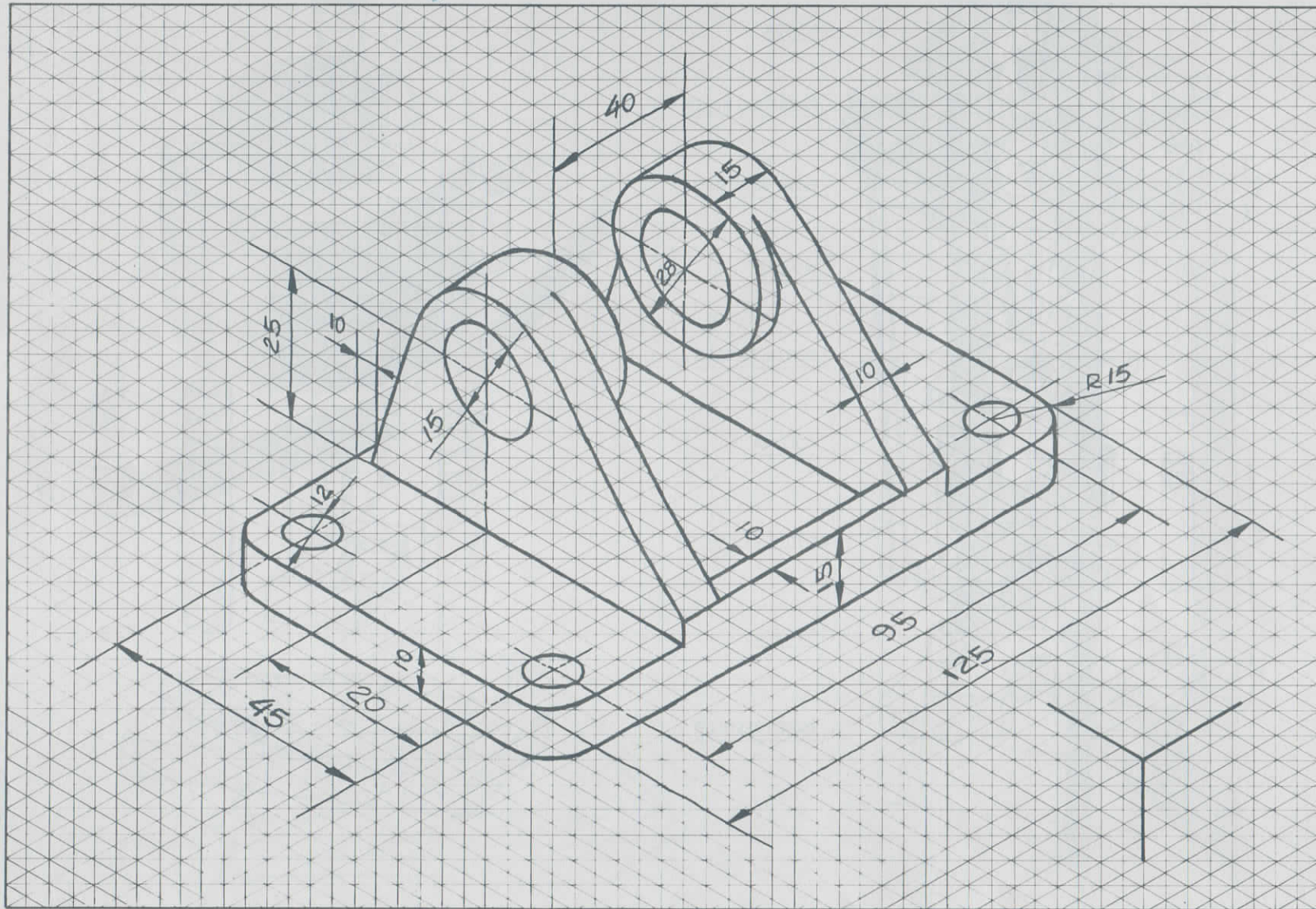
PERSPECTIVA SOMBREADA





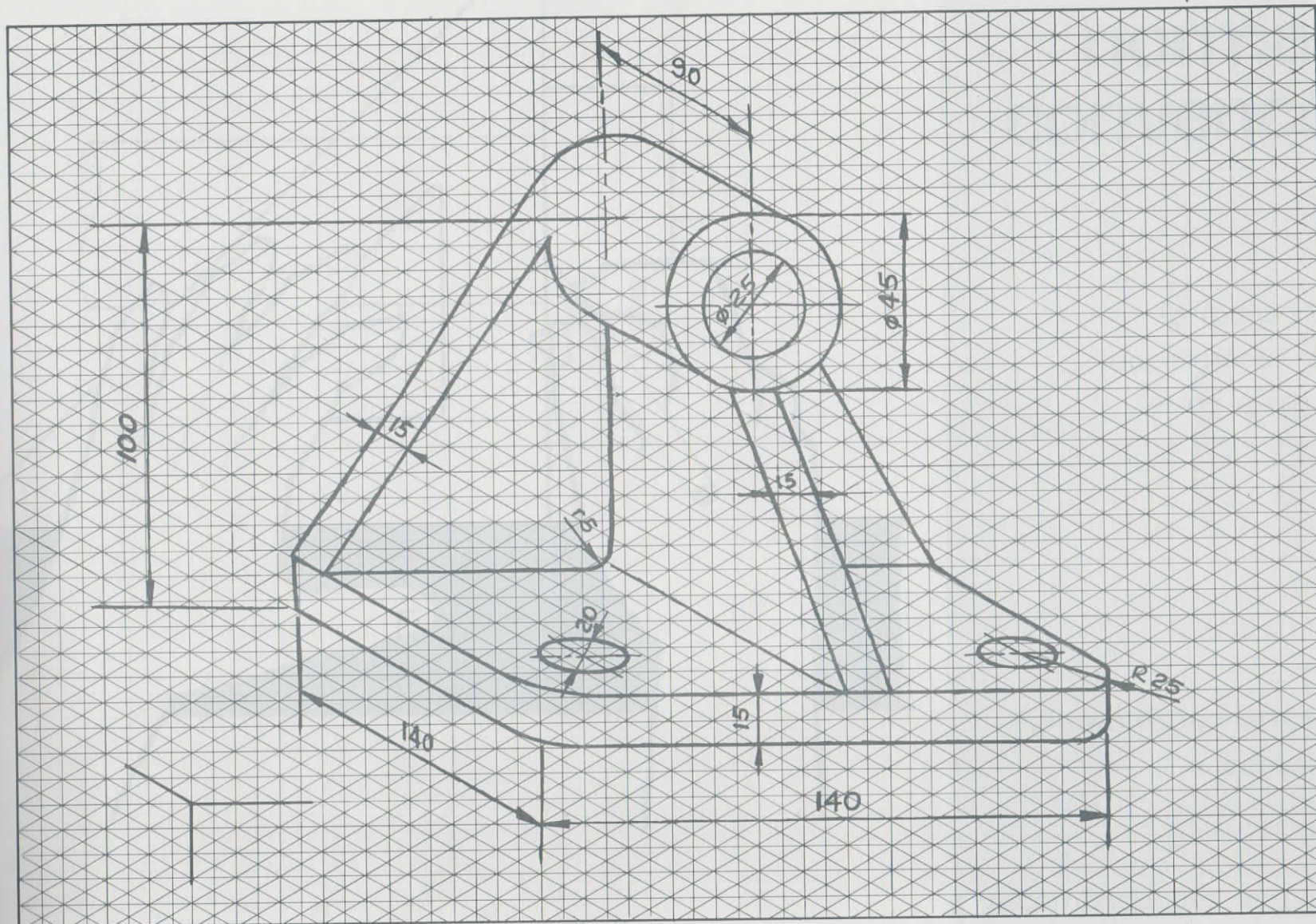
CROQUIS EM PERSPECTIVA ISOMÉTRICA

Papel isométrico



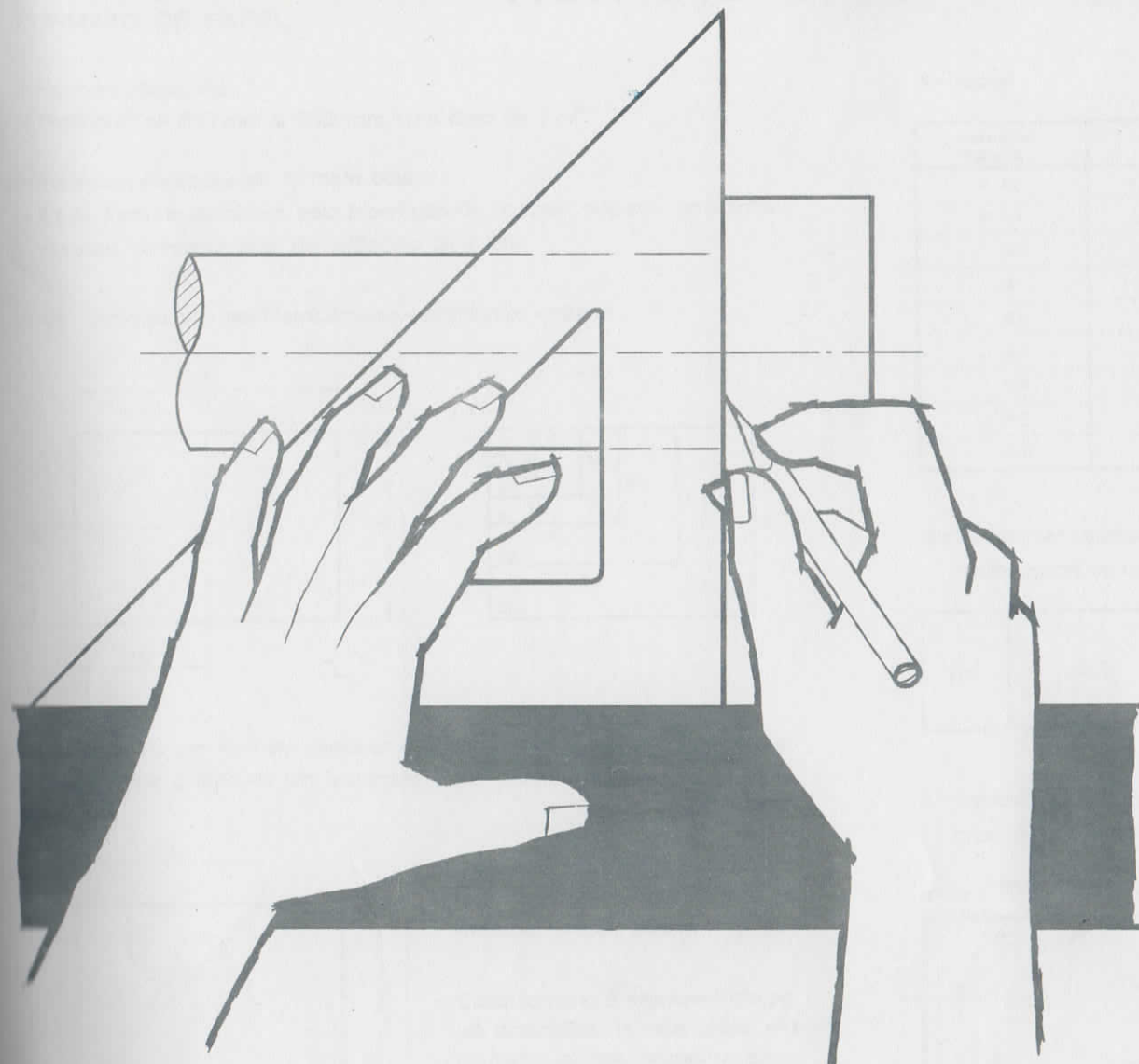
CROQUIS EM PERSPECTIVA CAVALEIRA

Papel isométrico



5

normas e convencões



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

NORMAS E CONVENÇÕES

FORMATO DE PAPEL

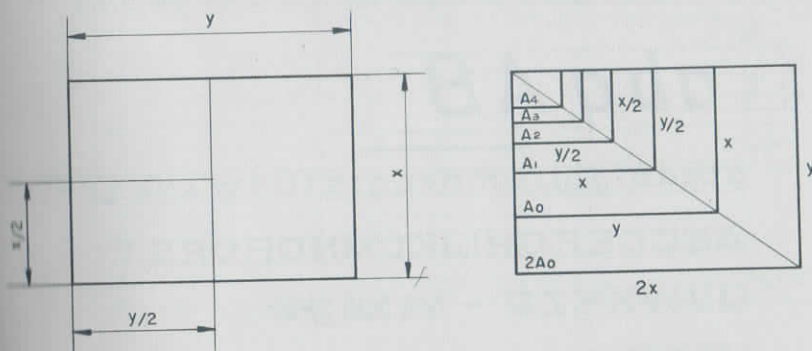
1-Formato básico A₀ :

-Retângulo de 841 mm x 1189 mm com área de 1 m²

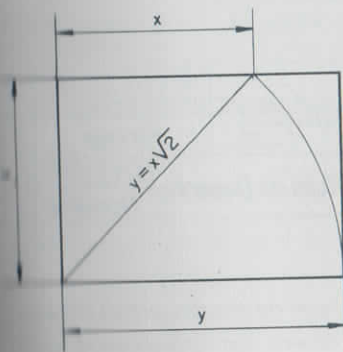
2-Formatos derivados do formato básico :

-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 m²).

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

Ex.: 210 mm x 297 mm ou A4

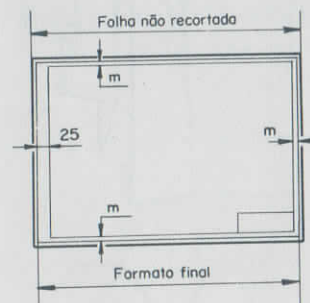
3- Tabela

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

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

A4	A3	A3
----	----	----

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

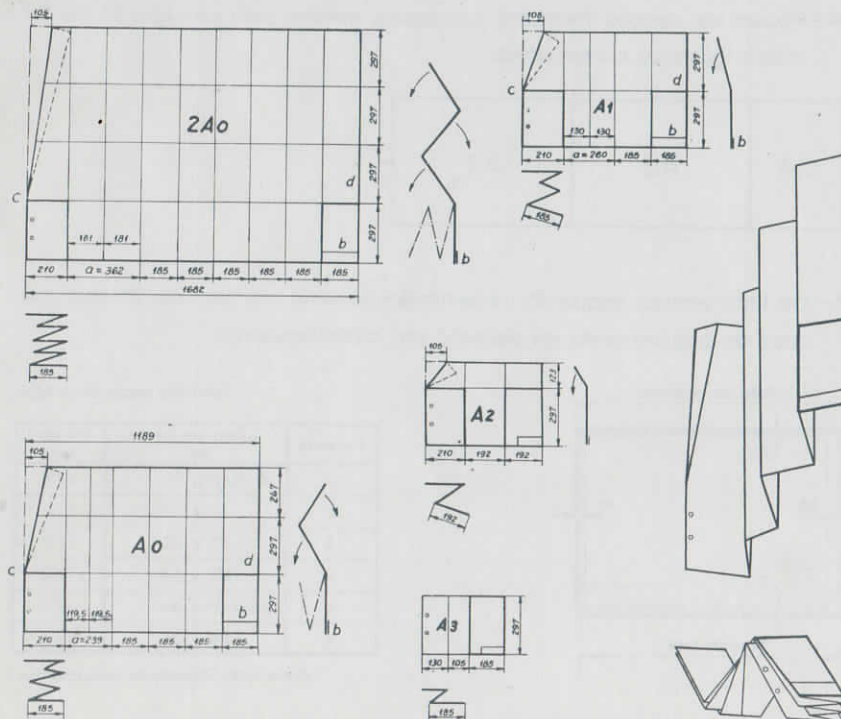
(American Standards Association)

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.

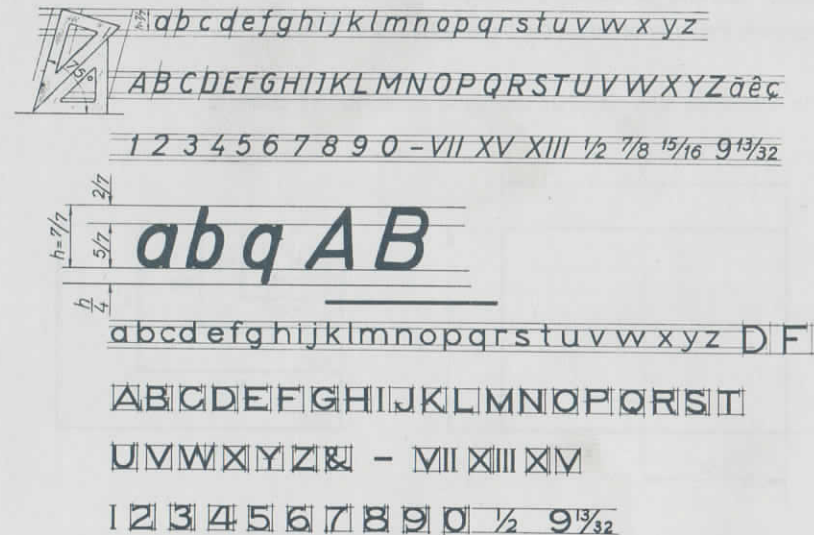
O dobramento das folhas pode ser efetuado da seguinte maneira:

- Efetua-se o dobramento a partir do lado *d* em dobras verticais de 185 mm; a parte final *g* 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.



LETRAS 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	L	H
A0, A1 e A2	175	50
A2, A3 e A4	120	35
A4 e A5	90	25

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

Peca	Denominação e observações	Quant.	Material e dimensões
Des.	Data	Nome	Assinatura do chefe responsável
Cap.			
Visto			
Escala	Título do Desenho		
	em substituição de substituído por		
	Firma		
	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	_____
	2	_____
MÉDIA	3	_____
	4	_____
	5	_____
	6	_____
FINA	7	_____
	8	_____

Arestas e contornos visíveis, circunferências de cabeça das engrenagens, cabeça de filetes de rosca...

Fundo de filetes de rosca, circunferência de pé das engrenagens...

Seções rebatidas, peças colocadas diante do objeto representado, peças contíguas para pos-las em relação, posições variáveis ou extremas no deslocamento; excesso para usinagem...

Arestas e contornos invisíveis...

Linhas de ruptura...

Linhas de chamada, cotas, hachuras...

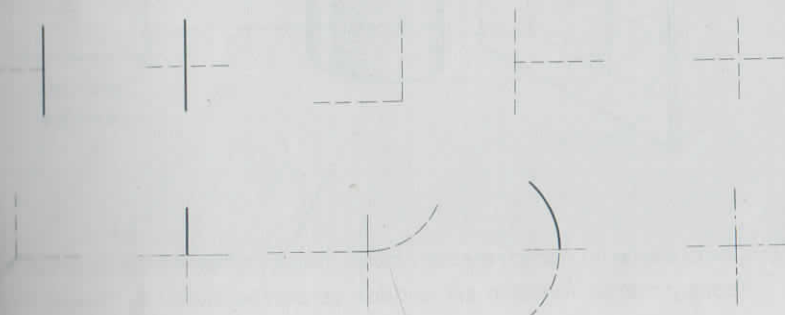
Hachuras

Eixos de simetria; linhas de centro e demais linhas básicas.

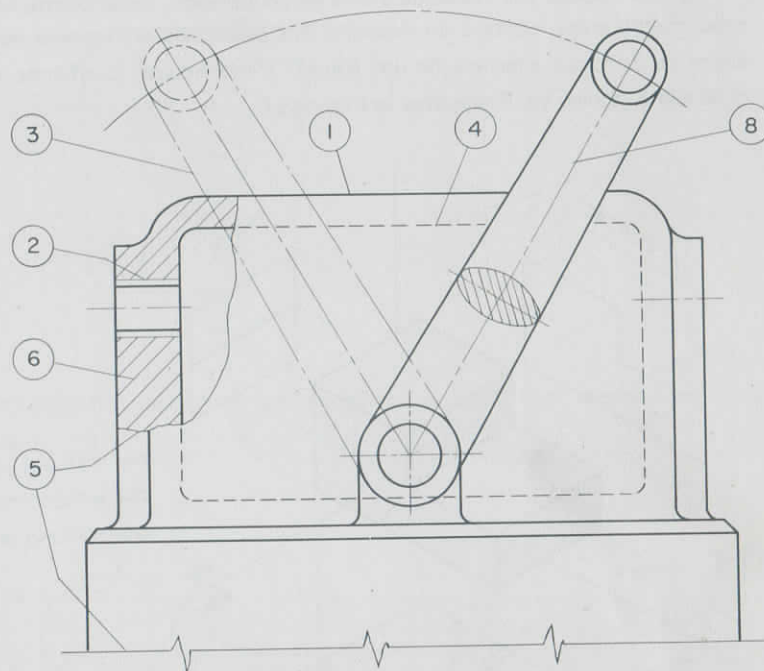
Quando necessário podem ser utilizados outros tipos de linhas.

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

11 - 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.

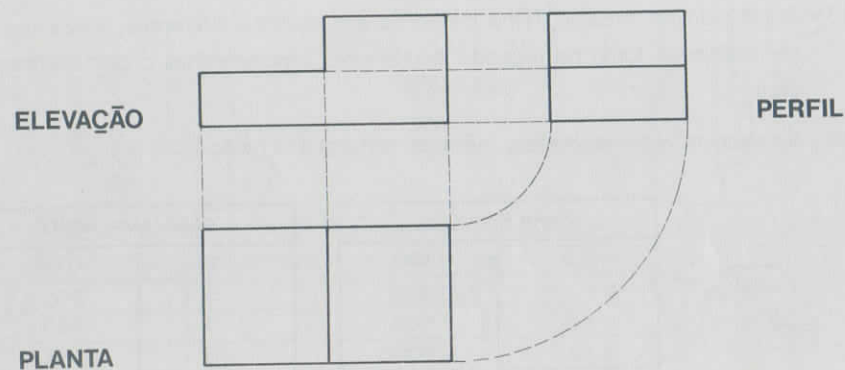
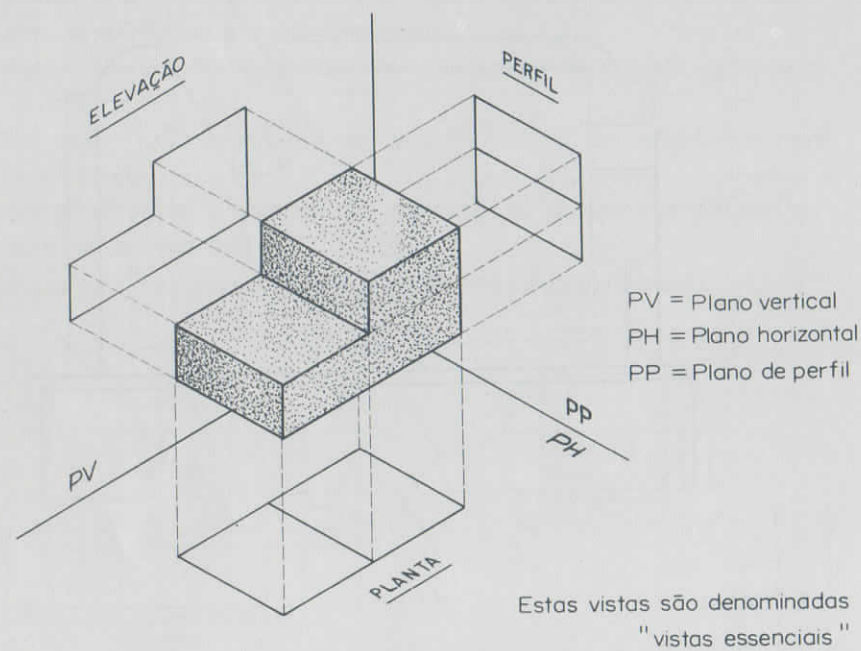
14 - As escalas recomendadas, além da natural (1:1), são :

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

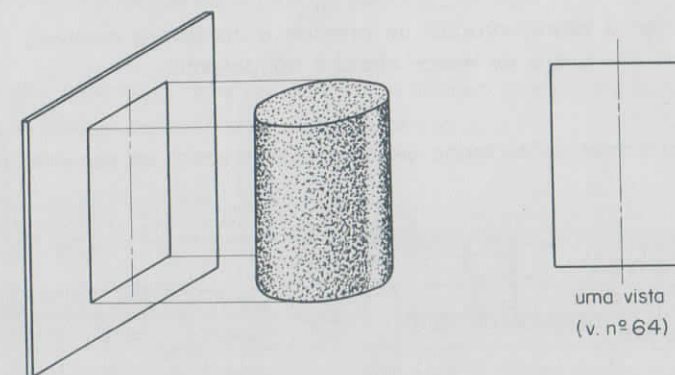
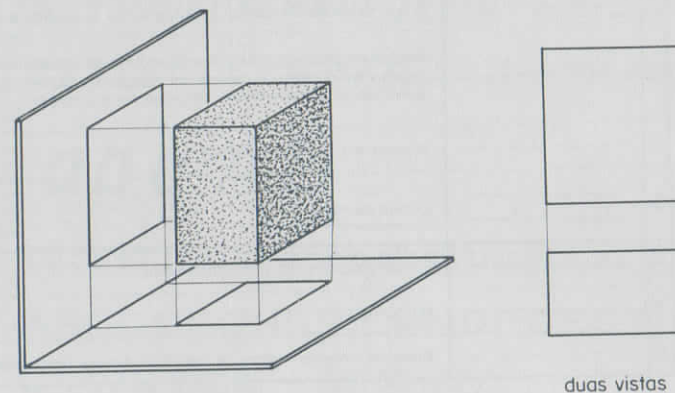
- 15 – As representações por meio de vistas serão obtidas, essencialmente, pelo rebatimento sobre o plano do desenho das projeções ortogonais da peça sobre as 3 faces internas de um triedro triretangular, conforme mostra o desenho abaixo (v. Projeções ortogonais).



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

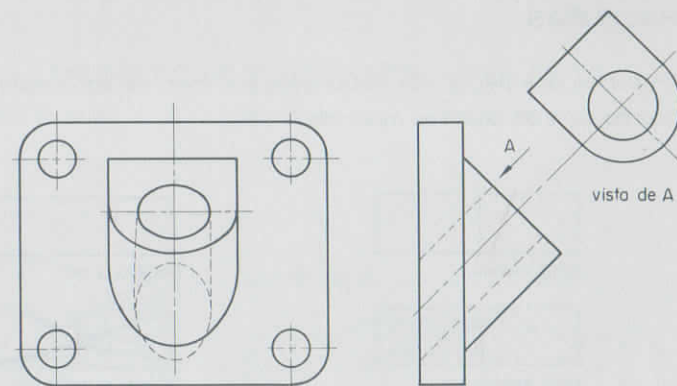
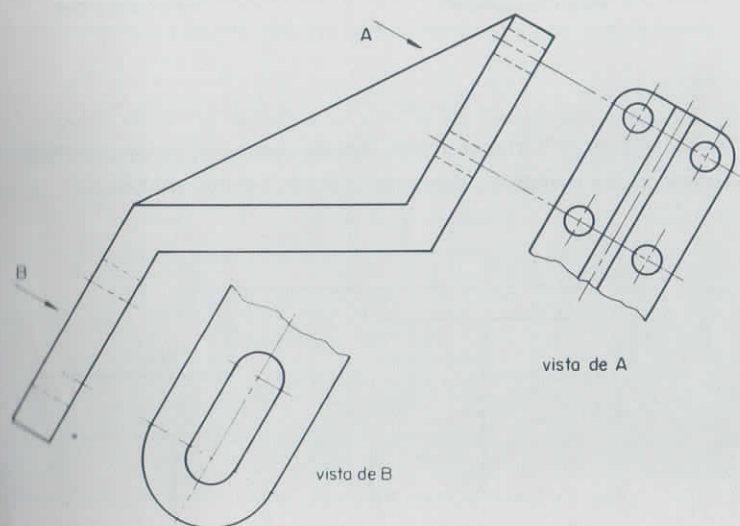
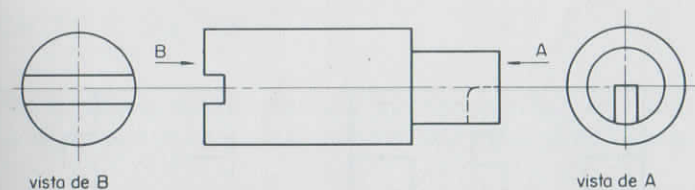
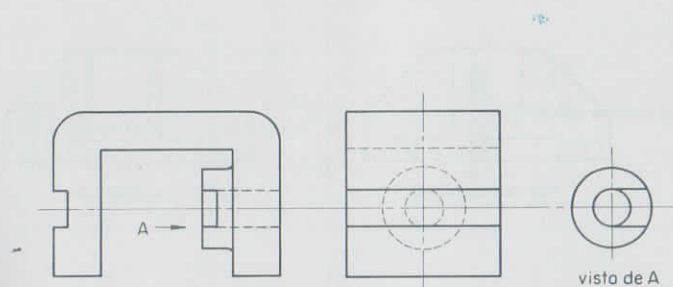
- 17 – As peças devem ser representadas na posição que melhor as caracteriza; em geral, na sua posição de montagem, podendo todavia, para desenho de detalhe, adotar-se qualquer posição conveniente.

- 18 – É permitida a representação das peças com menos das tres vistas essenciais quando isso não afetar a sua clareza.

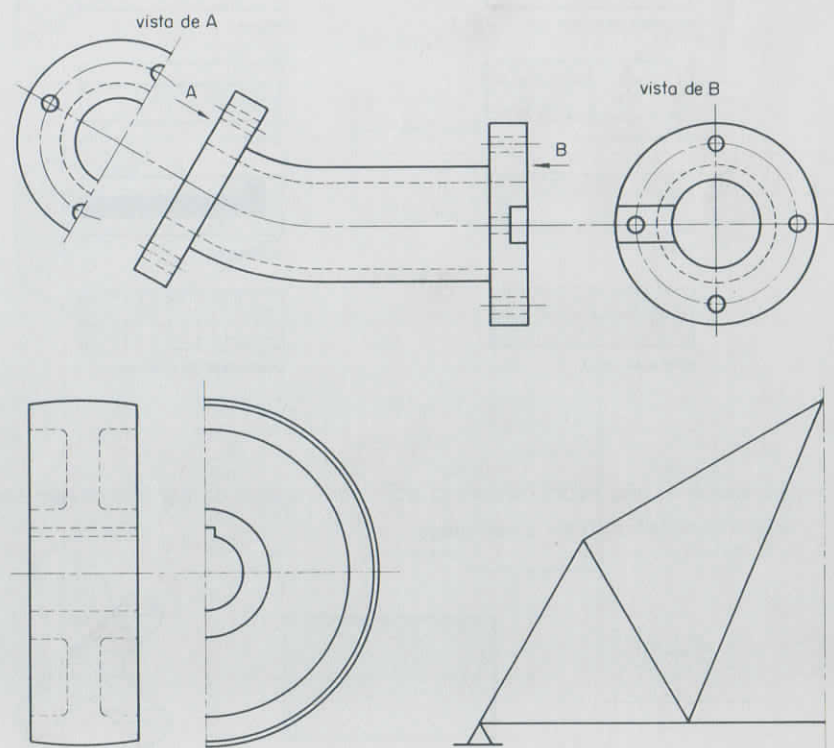


- 19 – Como elemento complementar, para melhor compreensão da peça representada, poderão também ser usadas as perspectivas (v. Perspectiva).

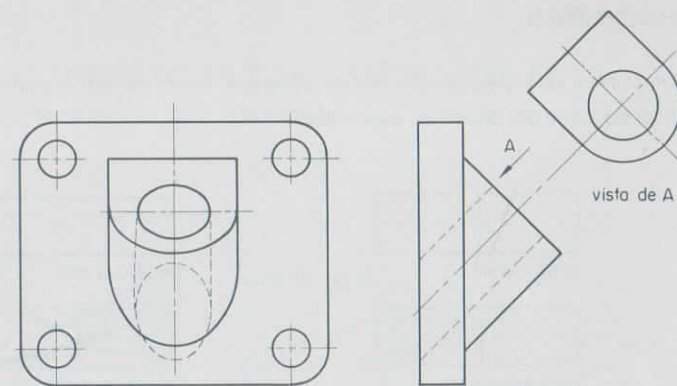
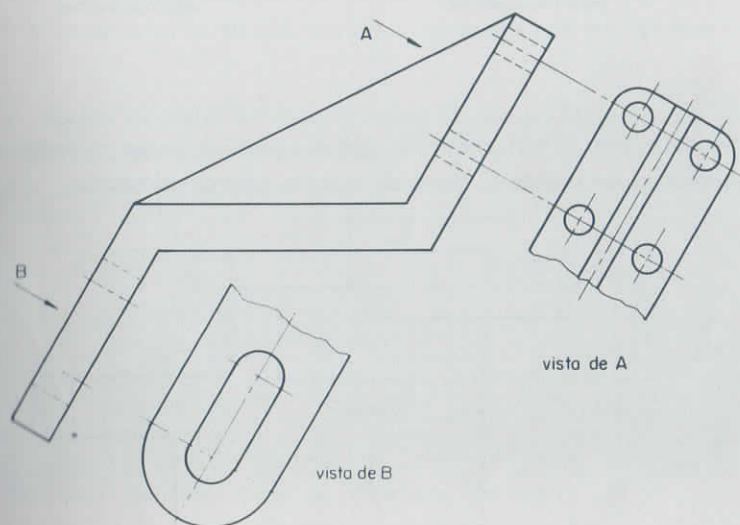
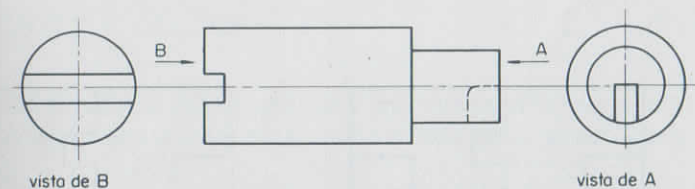
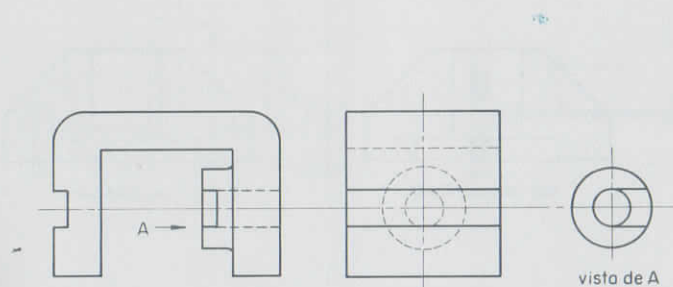
20 – Além das tres vistas essenciais, outras poderão ser usadas bem como rebatimentos parciais, vistas auxiliares, etc., quando isso for necessário. Estas vistas deverão ser denominadas e assinaladas por letras e flechas



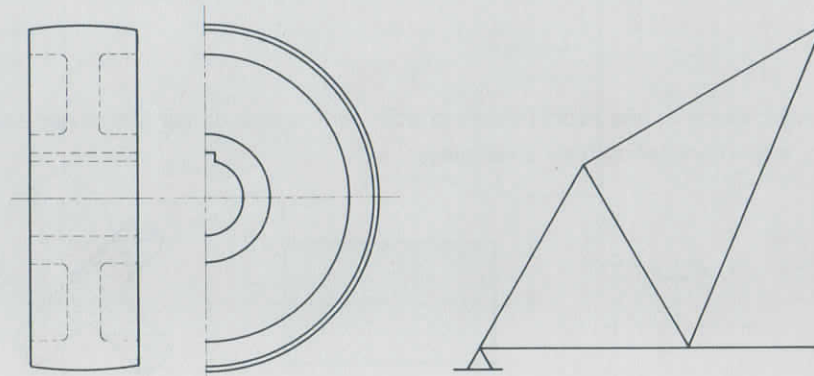
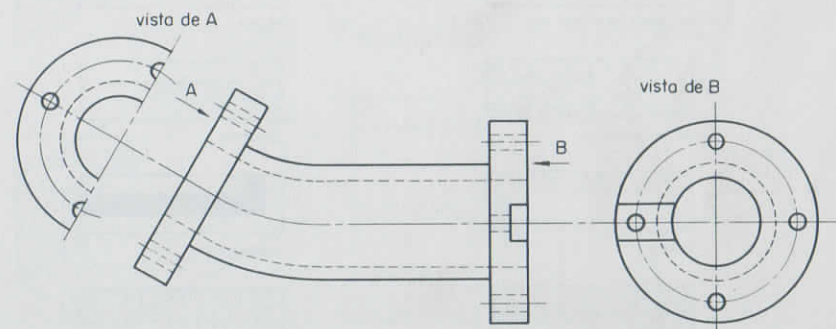
21 – Para ganhar espaço as vistas simétricas podem ser desenhadas em meia vista.



20 – Além das tres 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



FERRO BATIDO E AÇO



BRONZE, LATÃO, COBRE



ALUMÍNIO, METAIS LEVES



METAL BRANCO



TERRA



BORRACHA, FIBRA



MADEIRA DE FACE



MADEIRA DE TOPO



CONCRETO



PEDRA



LÍQUIDOS

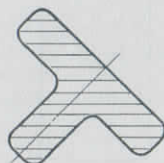


GUARNIÇÃO

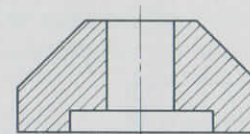


ENROLAMENTOS ELÉTRICOS

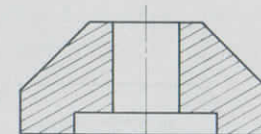
23 – As hachuras são habitualmente a 45° com o eixo da peça e devem ser feitas com linhas finas e paralelas.



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

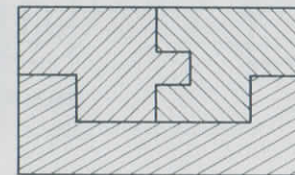


não aconselhável

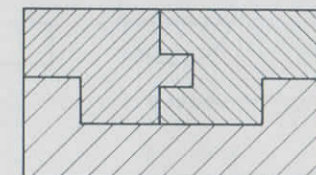


aconselhável

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

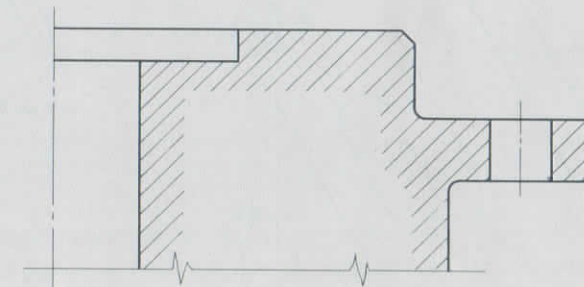


menos aconselhável

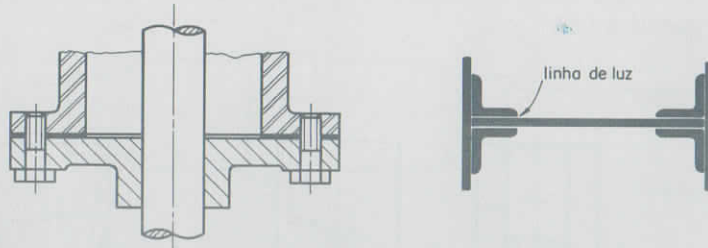


mais aconselhável

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.

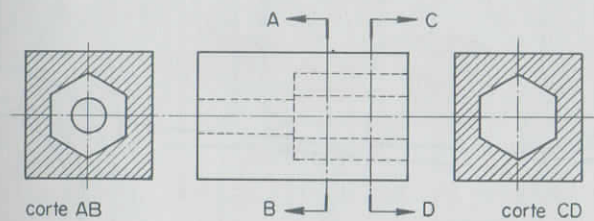
CORTES E SEÇÕES

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.



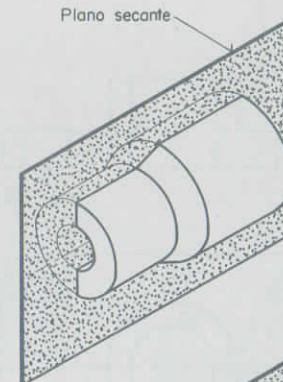
Nos casos evidentes, pode-se omitir esta indicação.

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

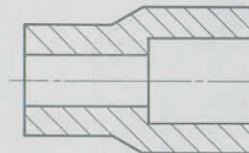
corte total

meio corte

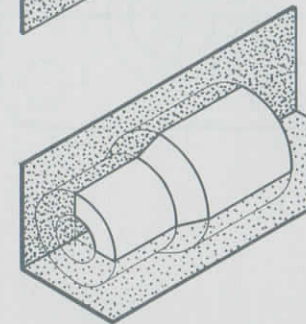
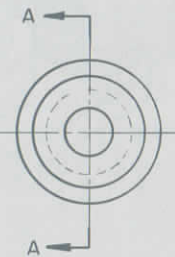
corte parcial



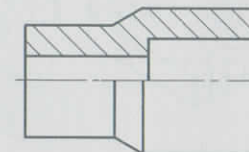
CORTE TOTAL



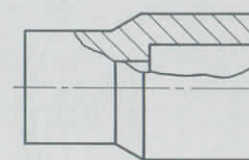
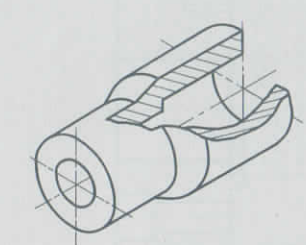
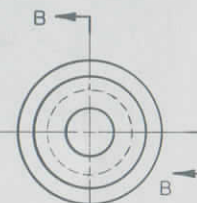
corte AA



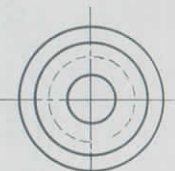
MEIO CORTE



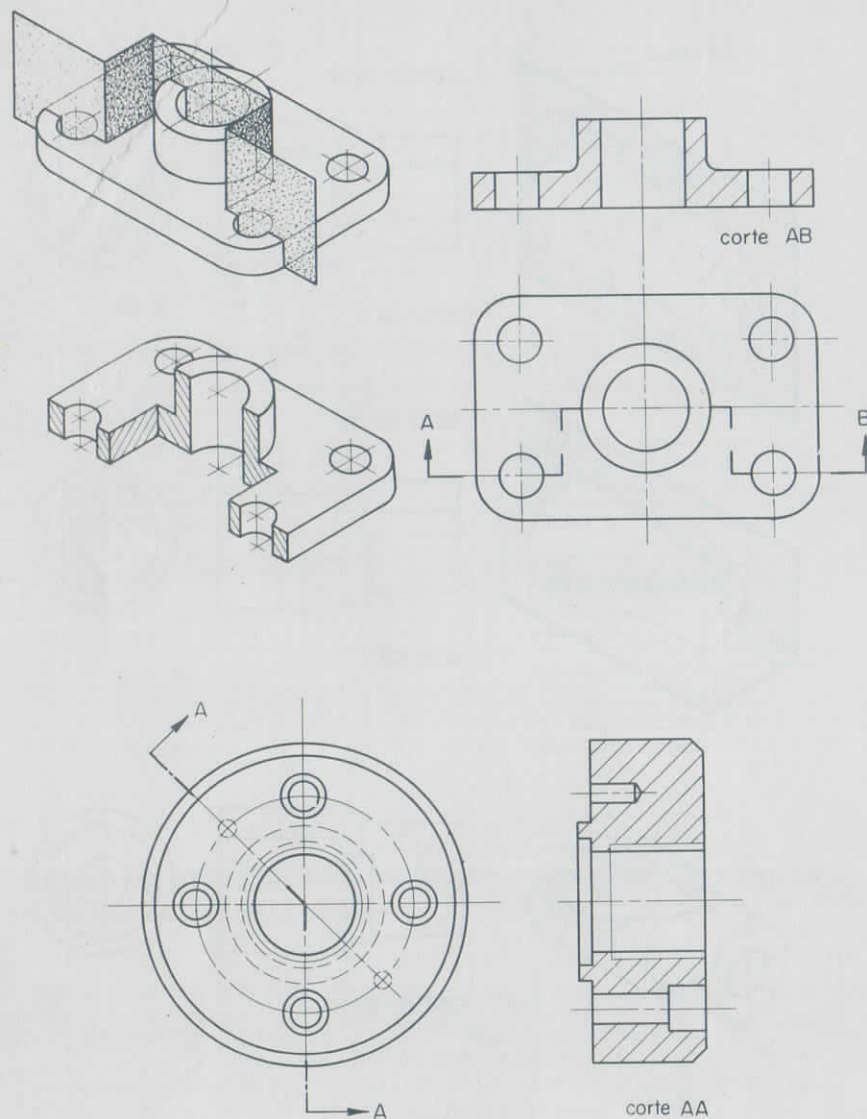
corte BB



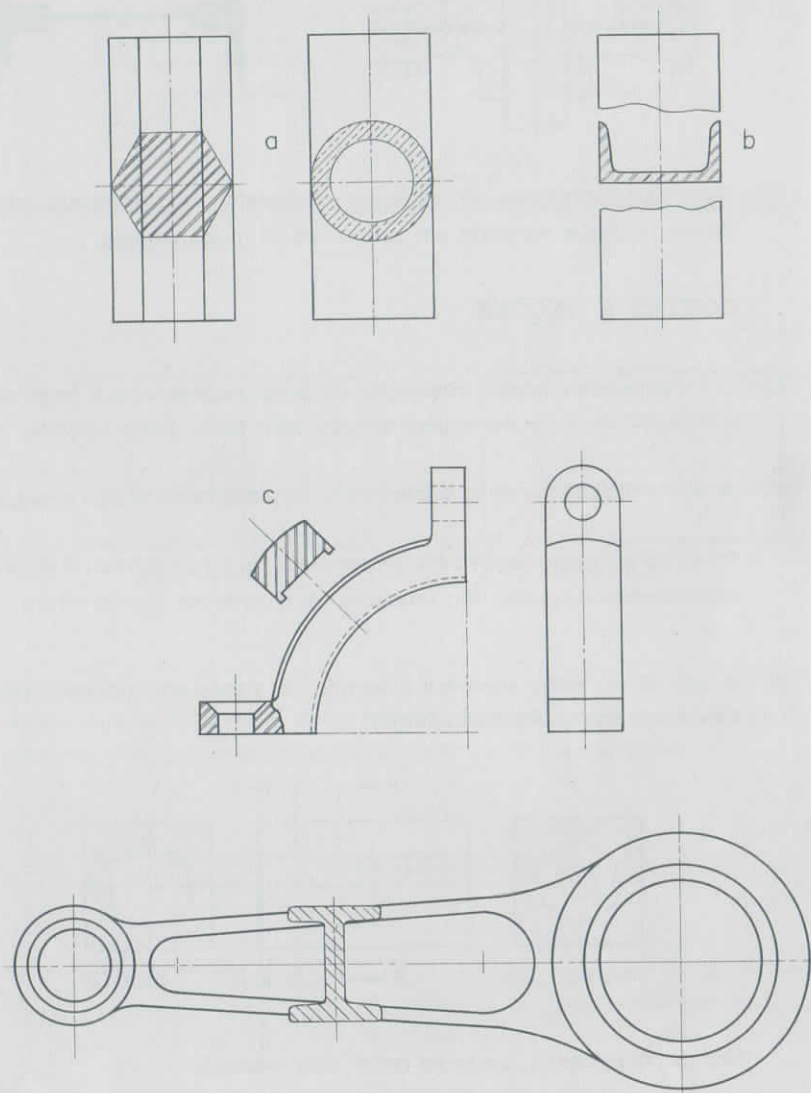
CORTE PARCIAL



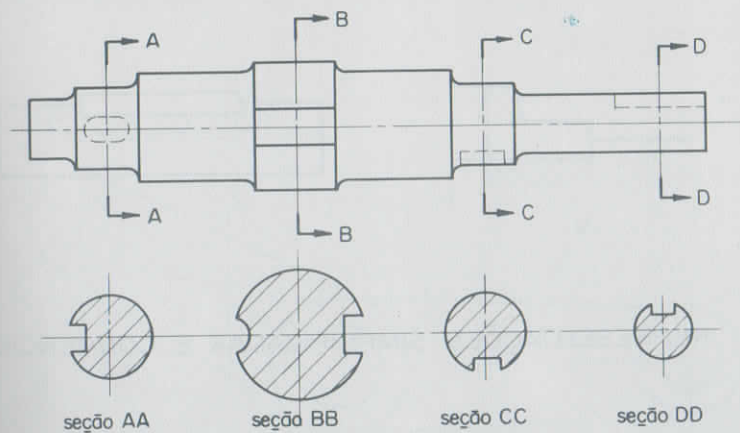
33 – Conforme a conveniência, um corte pode ser efetuado por uma associação de vários planos, constituindo um corte composto.



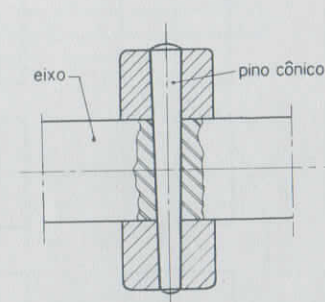
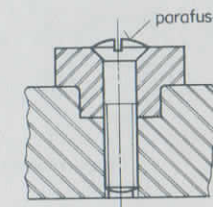
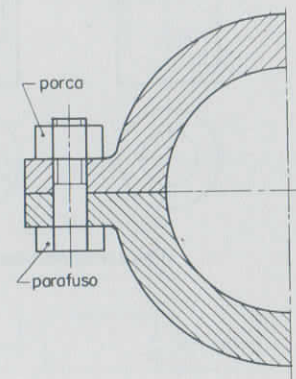
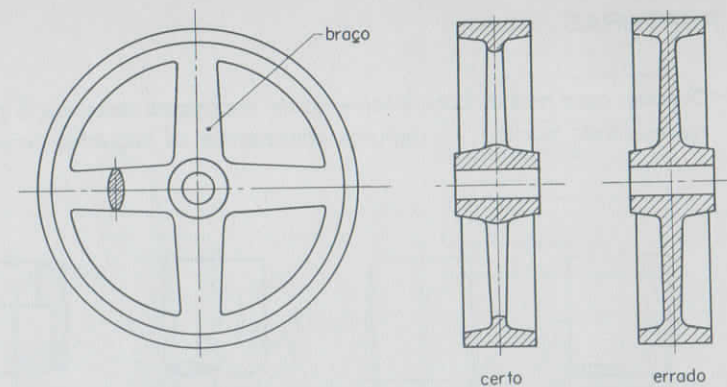
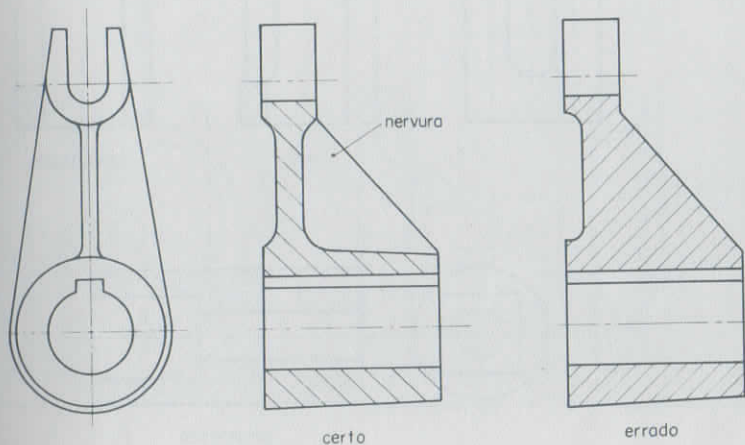
34 – Os cortes ou seções mostrando detalhes ao longo de uma peça, podem ser rebatidos dentro do contorno da vista, sem interrupção do traço da vista (a), com interrupção (b), ou ainda, removidos para fora desse contorno (c).



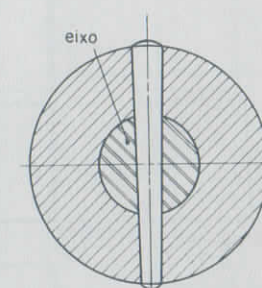
35 – Várias seções sucessivas podem ser indicadas no desenho.



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



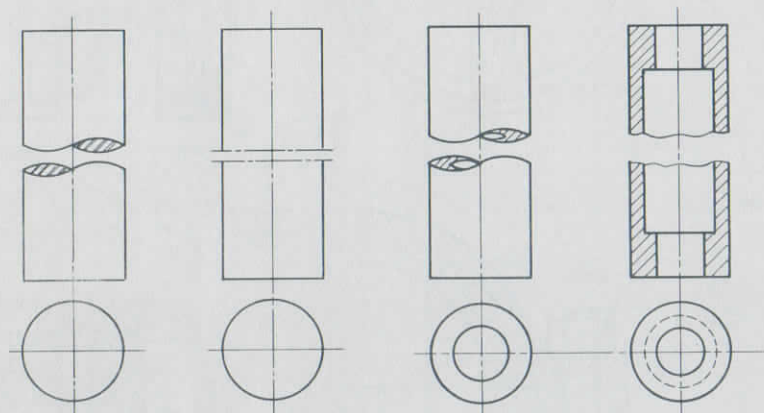
O eixo foi cortado somente para por em evidência a posição do pino.



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

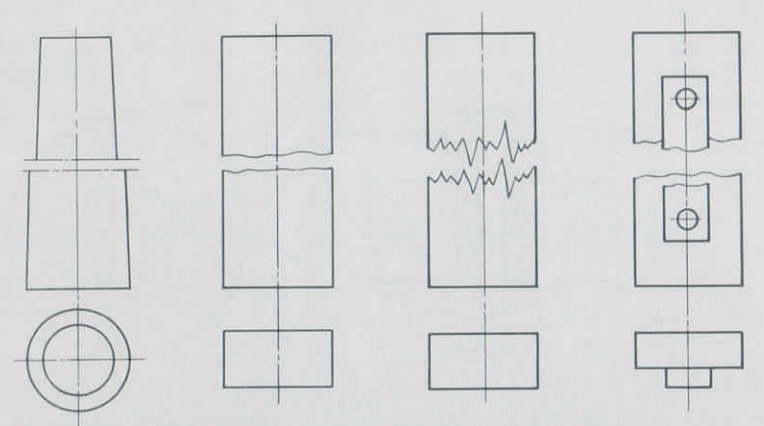
RUPTURAS

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



Peças redondas cheias

Peças redondas ocas



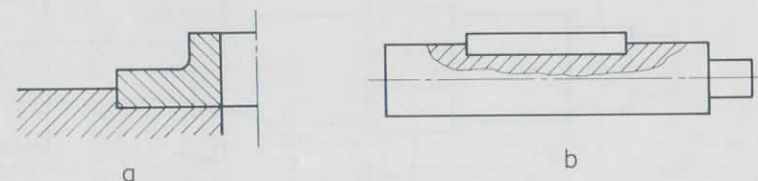
Peça cônica

Peça prismática

Peça de madeira

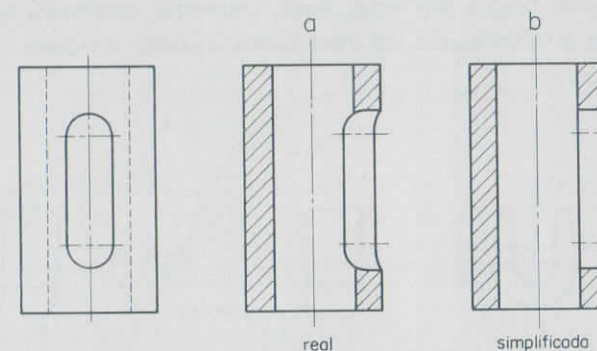
Peças superpostas

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



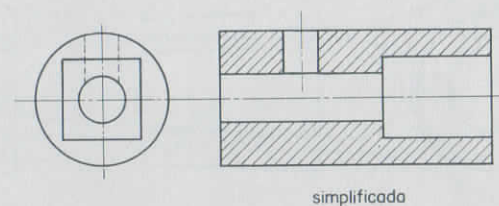
REPRESENTAÇÕES SIMPLIFICADAS E CONVENCIONAIS

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



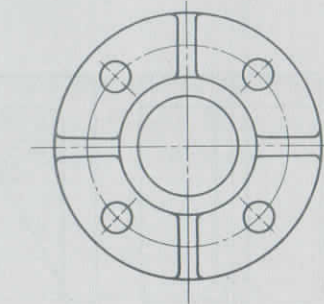
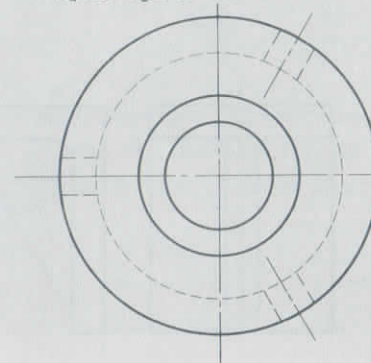
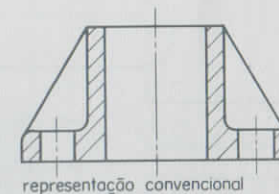
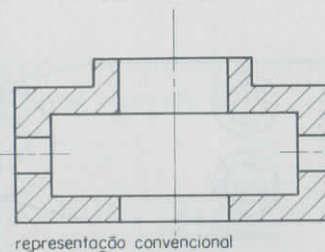
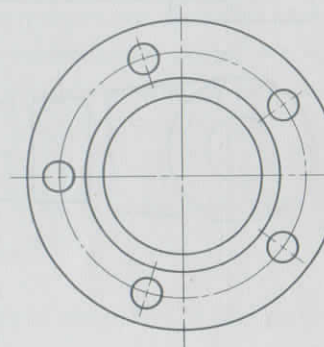
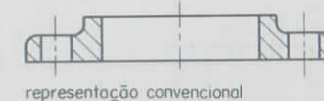
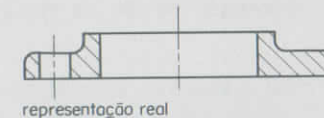
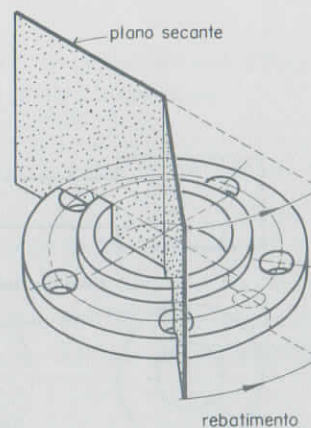
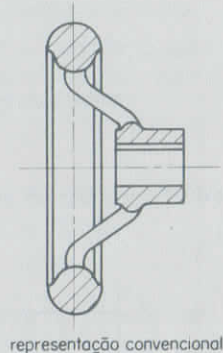
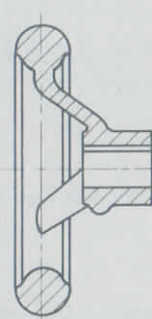
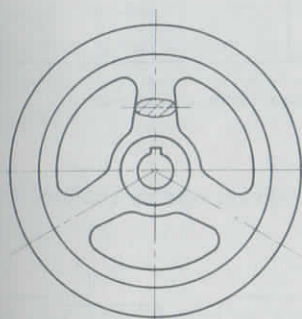
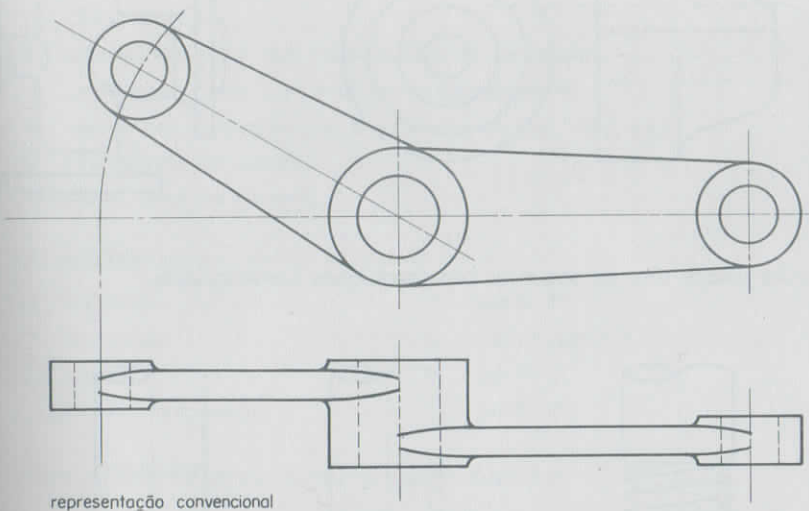
real

simplificada

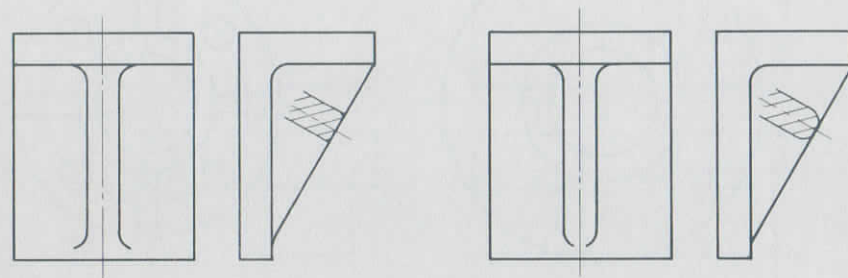
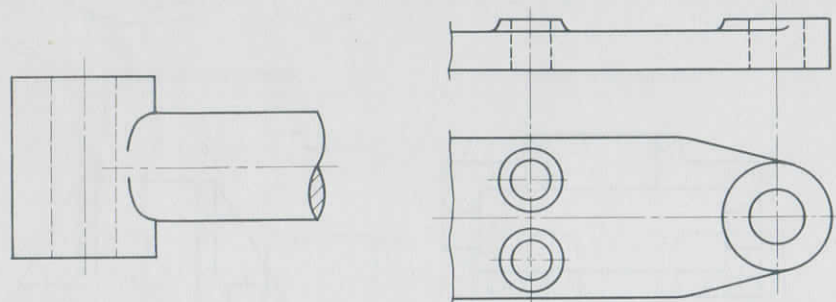
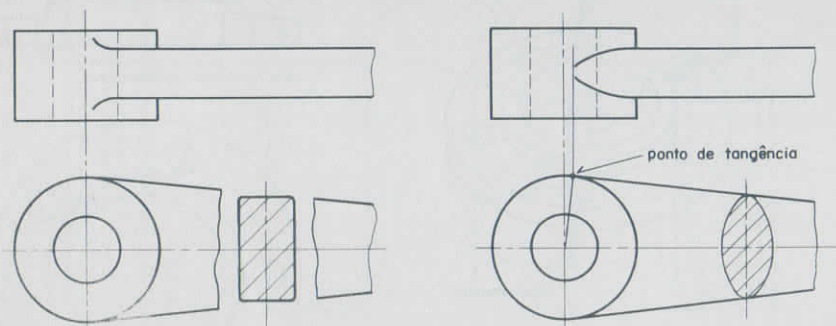


simplificada

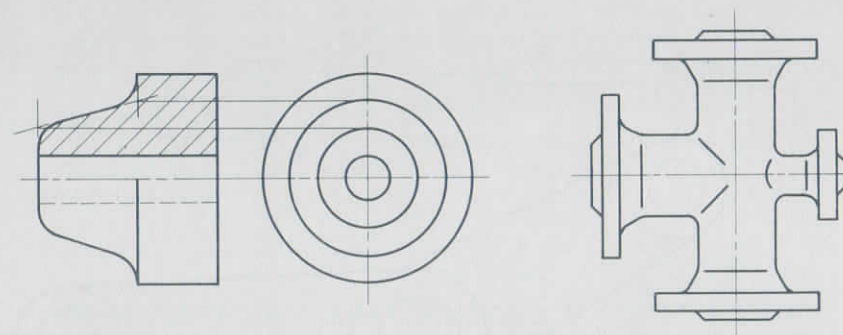
40 — A fim de evitar o encurtamento que resultaria da verdadeira projeção de detalhes inclinados, faz-se a rotação de tais detalhes, de modo a projetá-los sem deformação.



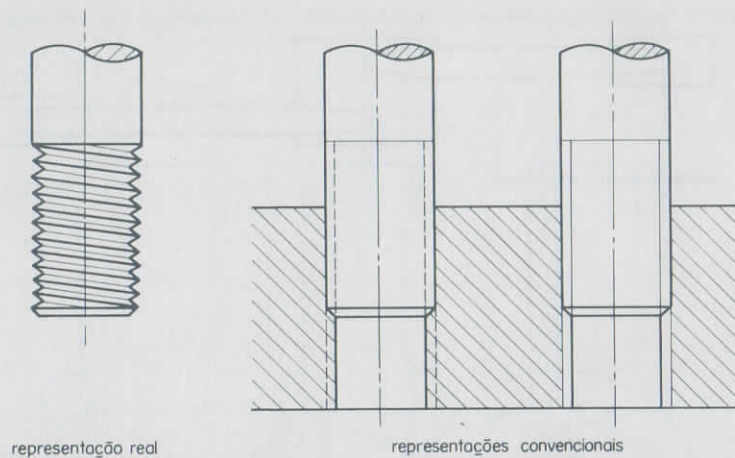
41 – Quando a intersecção de duas superfícies se fizer por uma concordância, empregar-se-ão as seguintes representações convencionais:



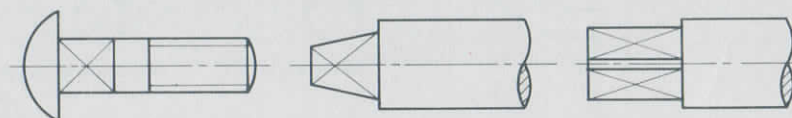
42 – Quando não ficar definida a forma da peça devido às concordâncias das superfícies que o delimitam, desenharem-se-ão linhas fictícias de intersecção.



43 – As roscas têm as seguintes 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

- | | |
|------------------|------------------|
| O redondo | T perfil T |
| ◻ quadrado | I perfil duplo T |
| ▭ chato | C perfil U |
| L JL cantoneiras | ↘ 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 cotação 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.

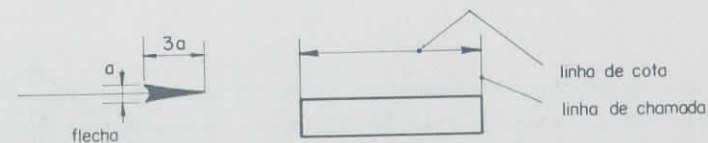
51 – Deve-se evitar a repetição de cotas.

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.

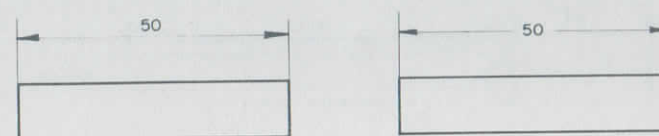
53 – As linhas de cota são representadas por traço fino, limitadas pelas linhas de chamada.

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

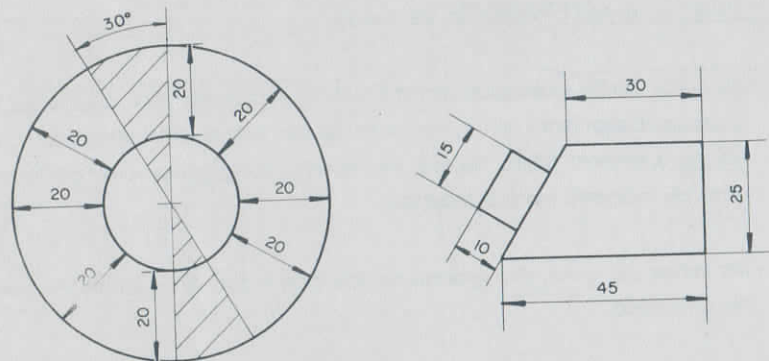
55 – As linhas de cota são terminadas em suas extremidades por flechas, conforme indicação abaixo.



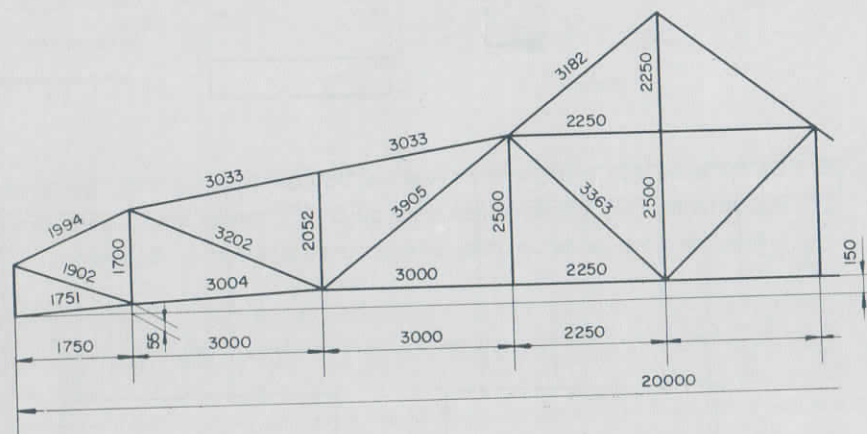
56 – Os números que exprimem os valores da cota são escritos, geralmente, equidistantes dos extremos da linha de cota e acima dela. Eventualmente, a linha de cota pode ser interrompida para colocar o algarismo.



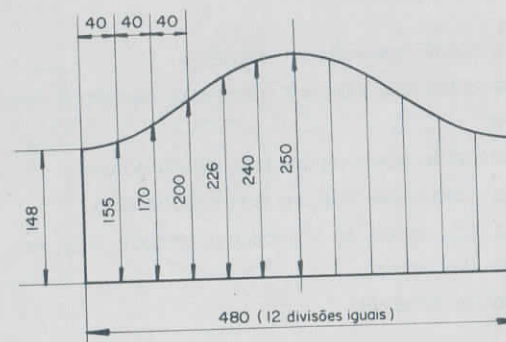
57—Os algarismos são escritos segundo a direção das linhas de cota, evitando-se que estas linhas tenham uma direção compreendida dentro do ângulo de 30° hachurado, para que a leitura seja efetuada sem necessidade de virar o desenho. Dessa forma a leitura será efetuada de frente ou do lado direito do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



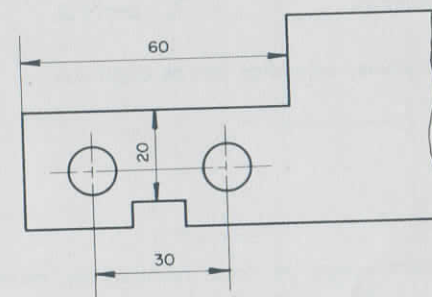
58—Não se deve usar como linhas de cota, eixos, linhas de centro, arestas e contornos de objeto, com exceção de desenhos esquemáticos como estruturas.



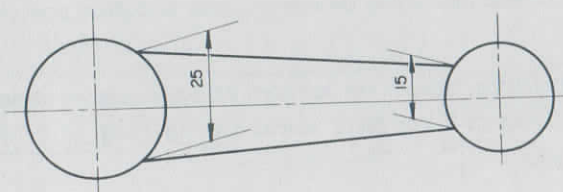
59—Em casos especiais as linhas de chamada e as linhas de centro podem servir de linhas de cota.



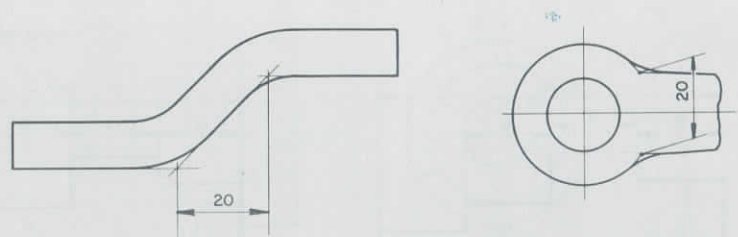
60—As linhas de centro, eixos, arestas e contornos de peças podem substituir quando conveniente, as linhas de chamada.



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

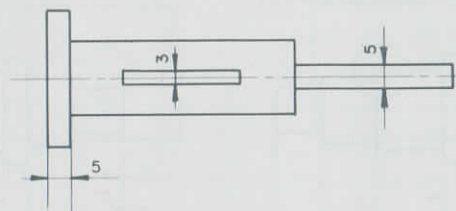


62—Quando houver necessidade, a cota pode ser referida às linhas de construção.

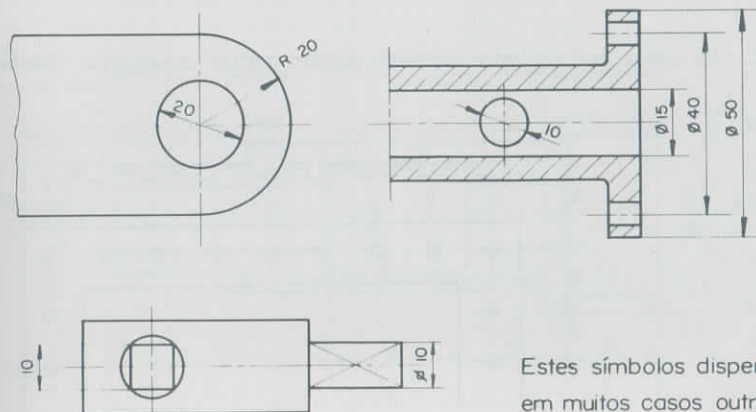


Não cotar as partes representadas com linhas invisíveis.

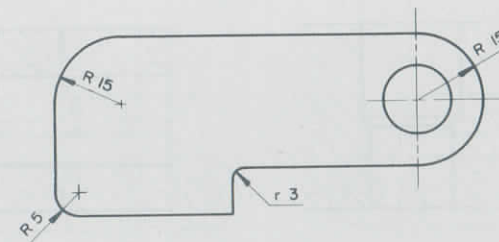
63—Na falta de espaço deve-se desenhar as flechas externamente para atender os requisitos de melhor clareza.



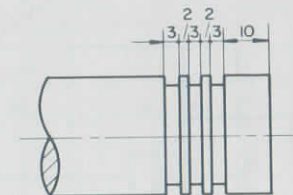
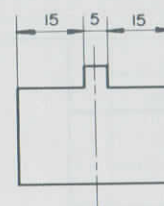
64—Quando na vista cotada for evidente que se trata de diâmetro ou quadrado, o respectivo símbolo pode ser dispensado.



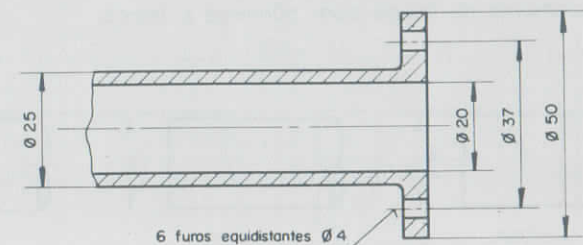
65—As linhas de cotas de raios de arcos e de arredondamentos não levam flechas na extremidade que está no centro do arco.



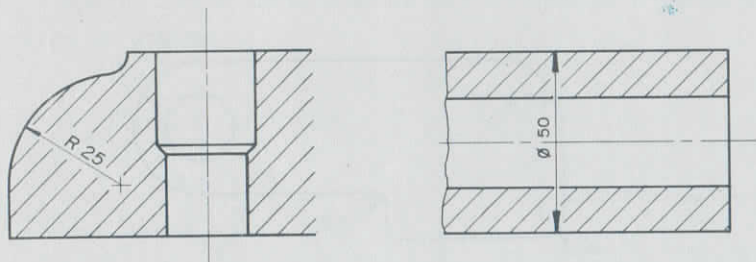
66—Na impossibilidade de colocar flechas usar as indicações abaixo:



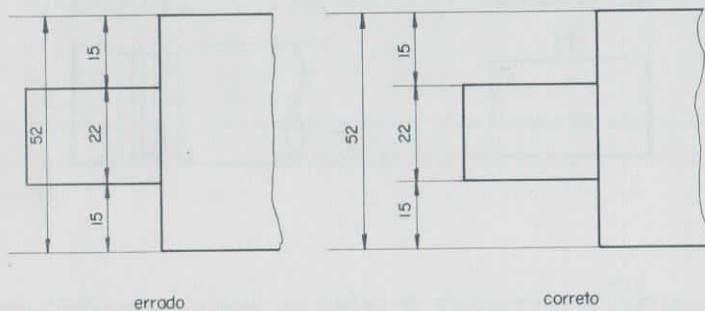
67—Quando houver necessidade de referir no desenho informação escrita ou simbólica pertencente a um detalhe da peça procede-se conforme indicação abaixo:



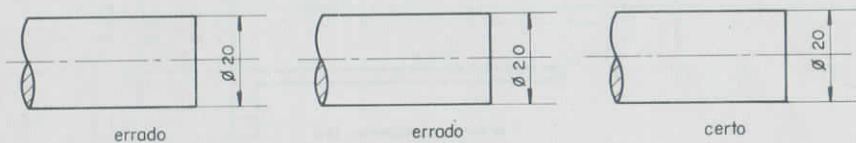
68—Quando uma cota for escrita no interior de uma seção as hachuras devem ser interrompidas.



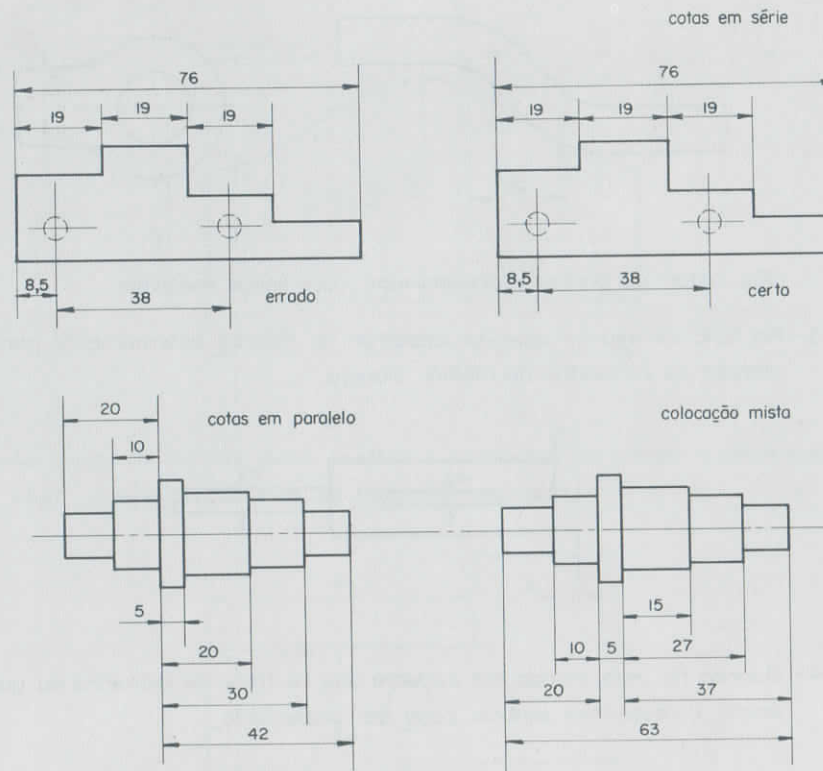
69—Deve-se evitar, se possível, que linhas de cota se cruzem entre si ou com linhas de desenho.



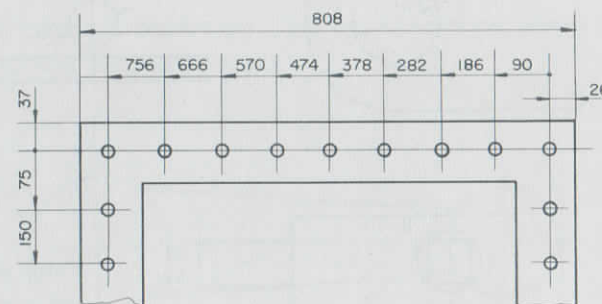
70—A colocação das cotas deve atender aos requisitos de maior clareza, compreensão e facilidade de execução do desenho, evitando qualquer cruzamento de linhas com números e letras.



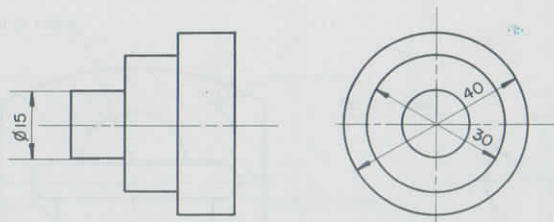
71—Cotas que tenham a mesma direção são dispostas em série e quando admitirem origem comum, em paralelo. É permitida a combinação das duas modalidades.



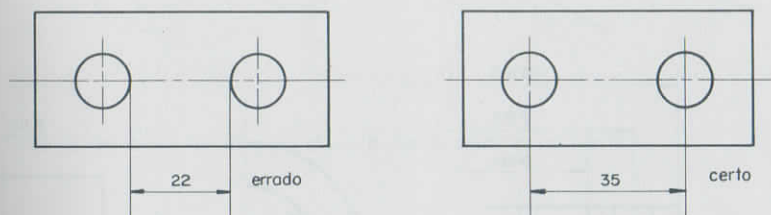
72—As cotas em paralelo também podem tomar a seguinte disposição.



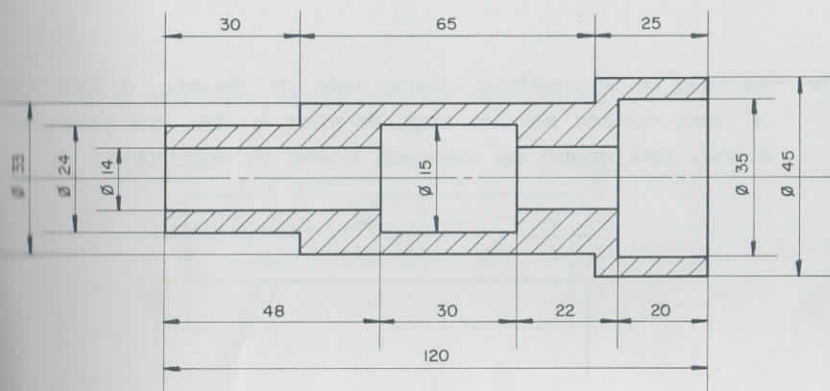
73 – Evitar colocar mais que duas cotas que passam pelo centro da circunferência.



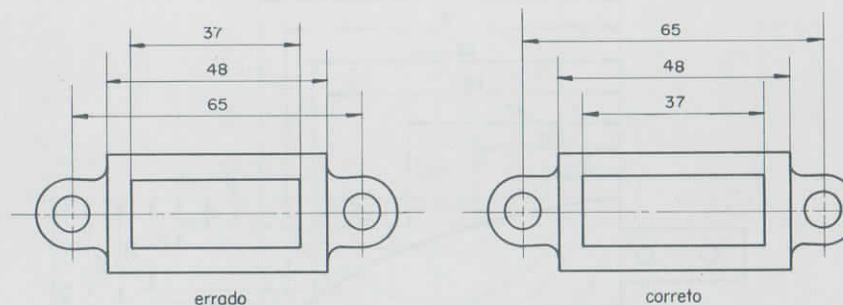
74 – Indicar a distância entre os centros dos furos e não entre as paredes.



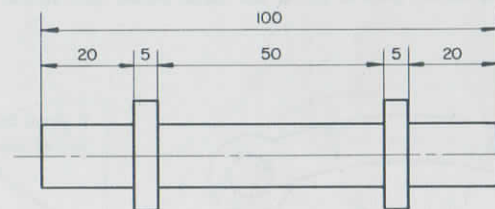
75 – É aconselhável separar as cotas internas das externas.



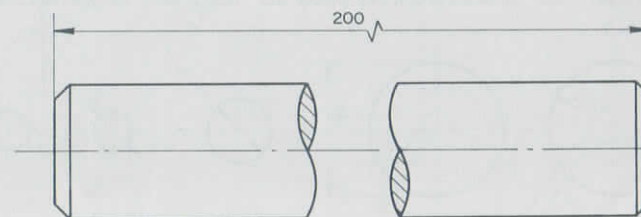
76 – As cotas maiores são colocadas por fora das menores, a fim de evitar cruzamentos.



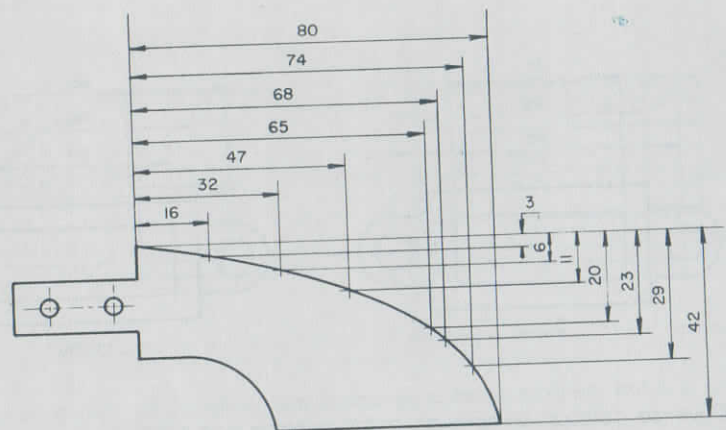
77 – Deve-se colocar sempre as cotas parciais e a total.



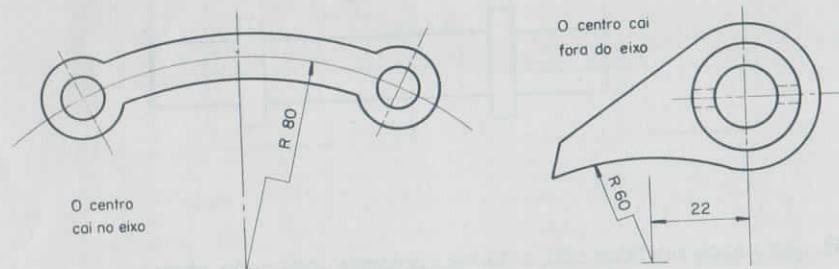
78 – As peças partidas são cotadas conforme indicação abaixo.



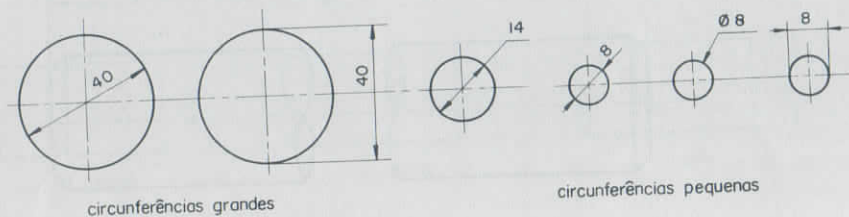
79 - Contornos irregulares podem ser cotados conforme indicação abaixo.



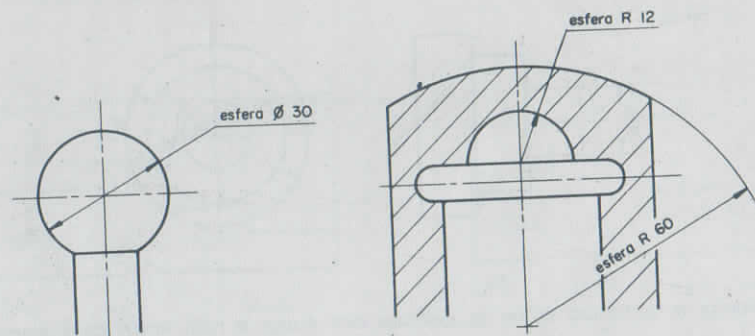
80 - Para os grandes raios a linha de cota pode ser quebrada em trechos paralelos.



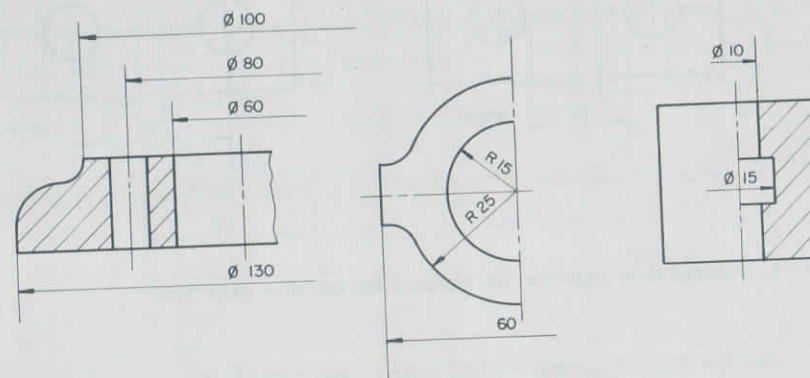
81 - A cotagem de circunferências pode ser feita das seguintes maneiras:



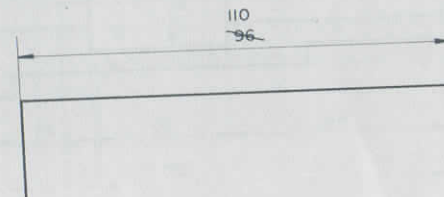
82 - Os elementos esféricos são cotados pelo diâmetro ou pelo raio, precedido da palavra "esfera".



83 - Cotas de peças simétricas podem ser interrompidas.



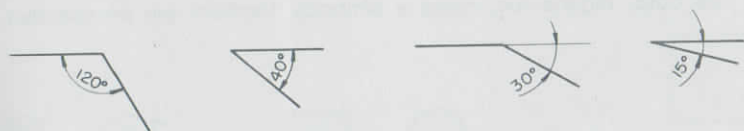
84 - No caso de se modificar alguma cota do desenho, a cota substituída será cortada por um traço, de modo, porém, que possa ser lida. A nova cota deverá ser colocada acima da substituída.



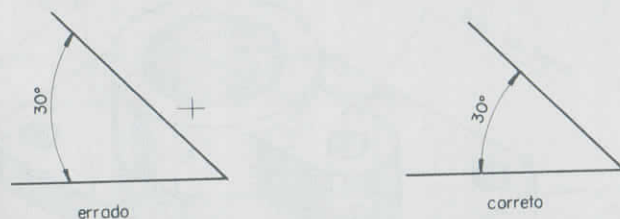
85—As cotagens de corda, desenvolvimento de arco e ângulo se diferenciam conforme indicações abaixo.



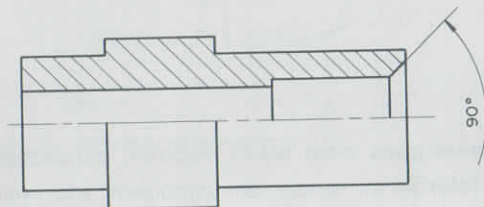
86—Conforme o espaço disponível no desenho, os ângulos podem ser cotados como indicam as figuras abaixo:



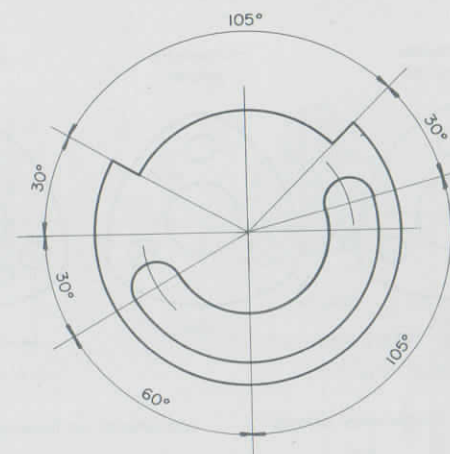
87—O arco de cota do ângulo deverá ter o centro no vértice.



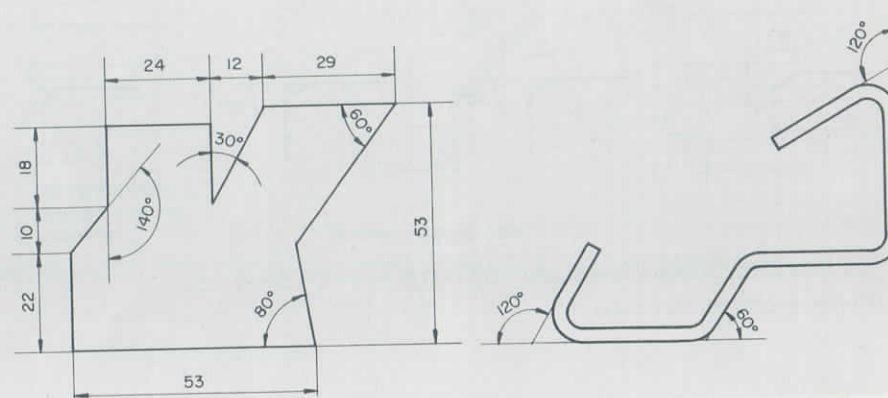
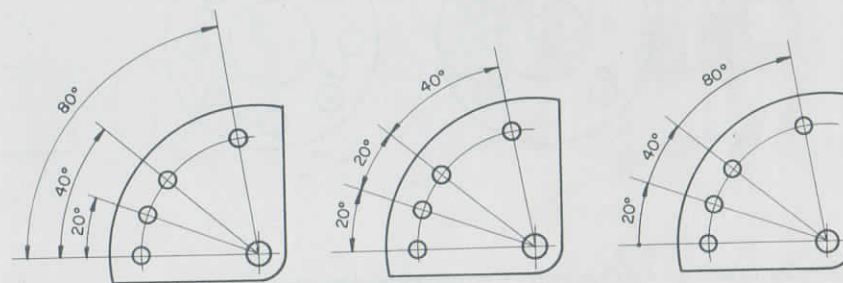
88—Em peças simétricas, a cota pode ser interrompida.



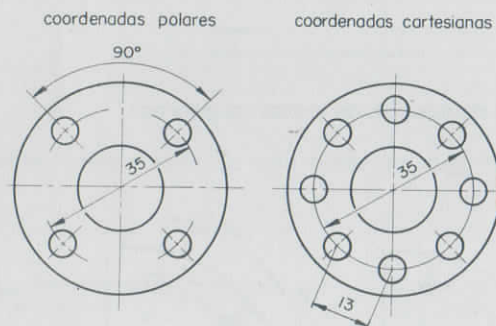
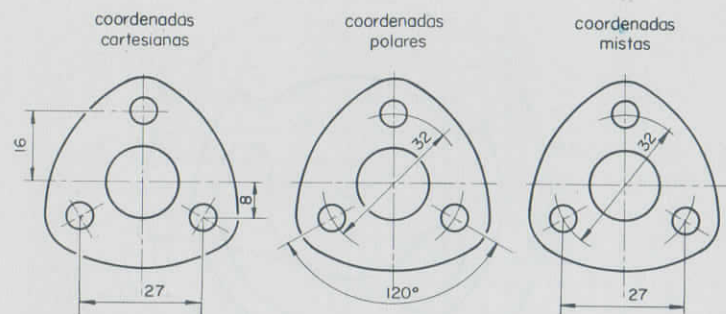
89—A colocação dos algarismos se efetuam da seguinte forma.



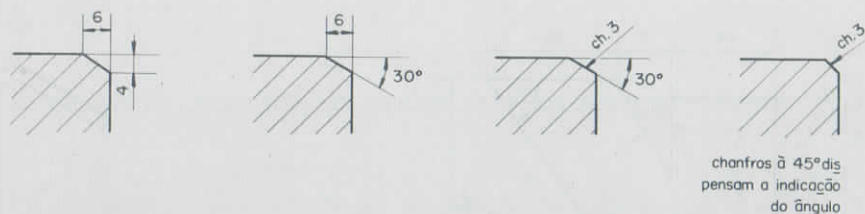
90—Exemplo de disposição de cotas angulares:



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

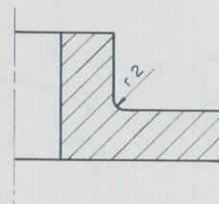


92 – Os chanfros (ch) podem ser cotados das seguintes maneiras :



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

93 – Os arredondamentos são cotados da seguinte maneira.

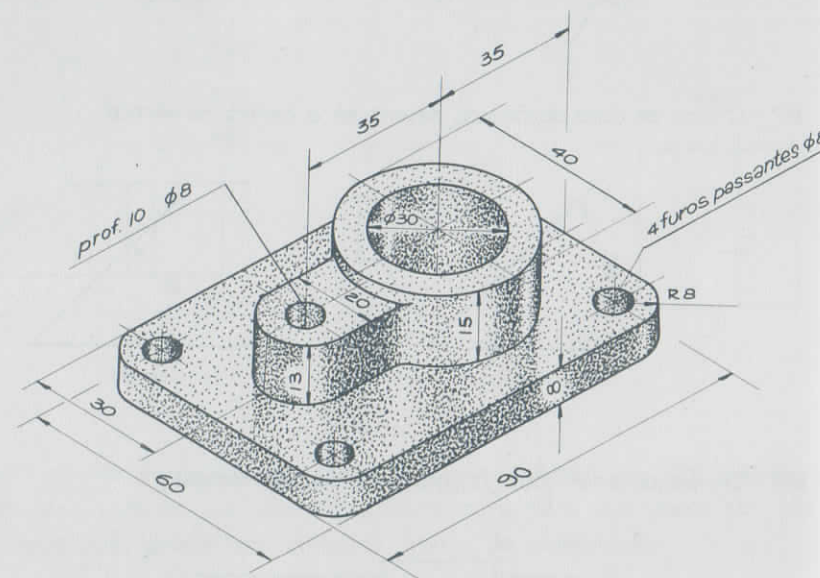


Os arredondamentos aconselháveis são os seguintes :

0,2 – 0,5 – 1 – 2 – 3 – 5 – 10

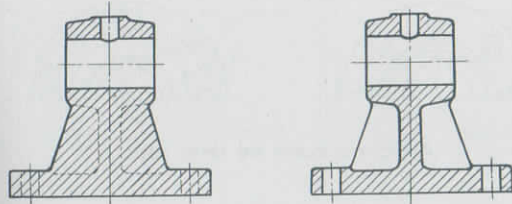
Evitar arredondamentos convexas.

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

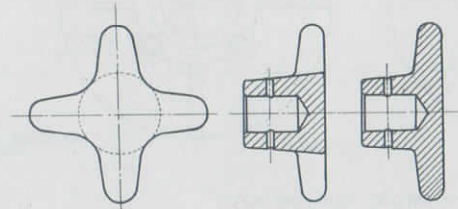


95 – Sinais e convenções para solda, rebites, canalizações, conicidade, inclinação, tolerância, sinais de usinagem, etc. estão indicadas em outros capítulos.

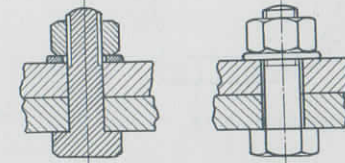
RECOMENDAÇÕES E CONSELHOS



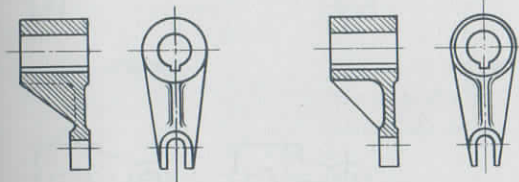
errado correto
Representação de um suporte com nervura.



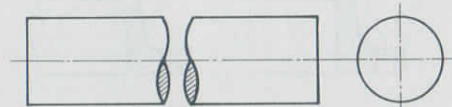
correto errado
Representação de um manípulo de comando



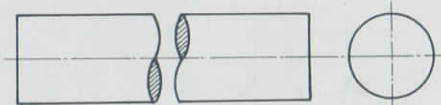
errado correto
Representação de uma união com parafuso passante



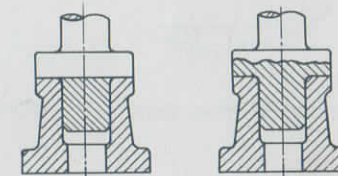
errado correto
Representação de um suporte com nervura.



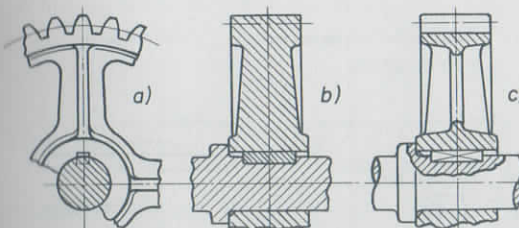
representação errada



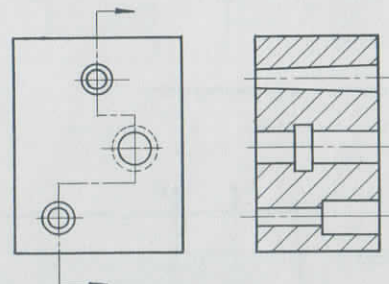
representação correta



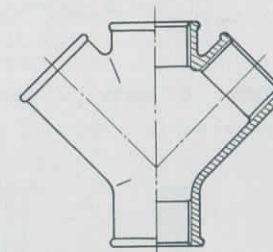
errado correto



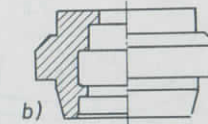
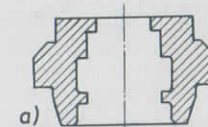
correto errado correto
Representação de uma engrenagem



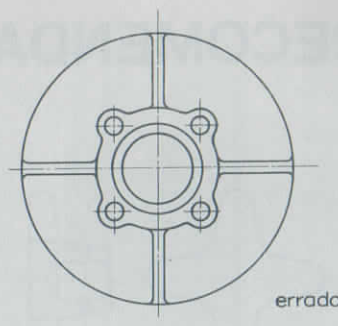
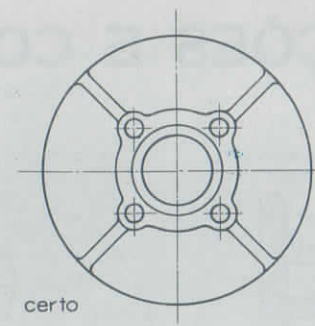
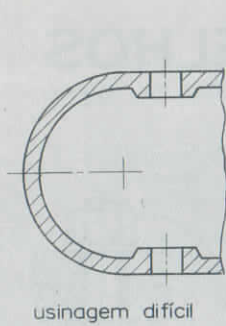
seção em vários planos



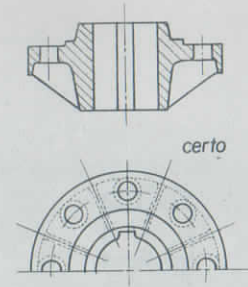
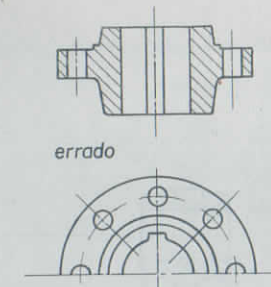
Representação em meio corte



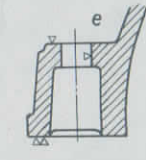
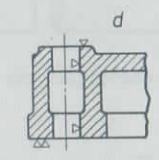
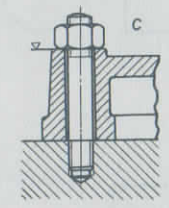
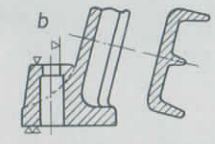
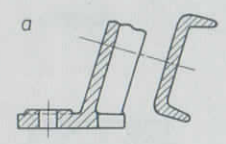
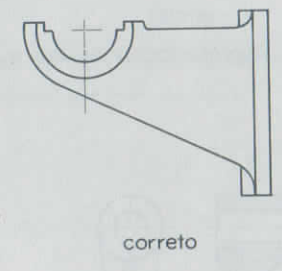
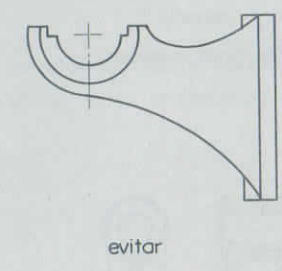
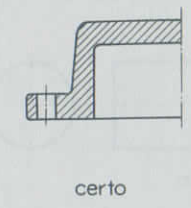
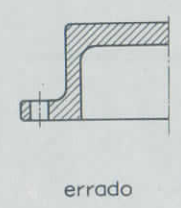
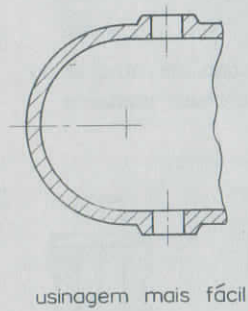
a) errado b) correto



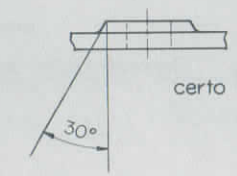
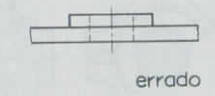
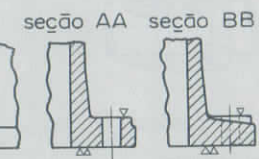
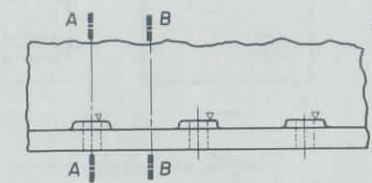
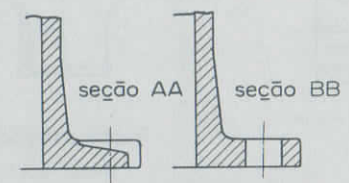
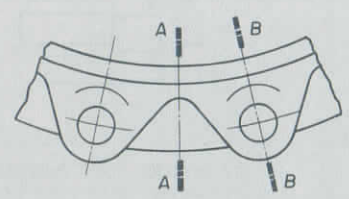
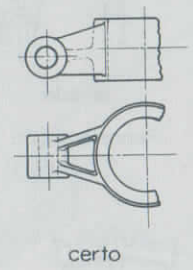
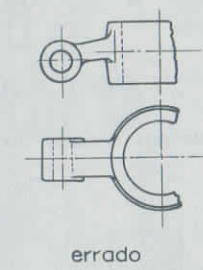
Disposição das nervuras



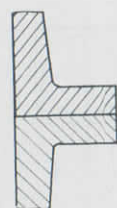
Alívio no cubo de uma roda



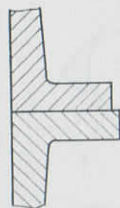
Base das máquinas: a) errado b) certo c) certo d) certo e) melhorado.



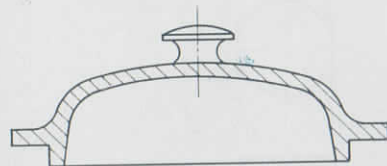
Reforçar os furos para parafusos de união, fixação ou chumbadores



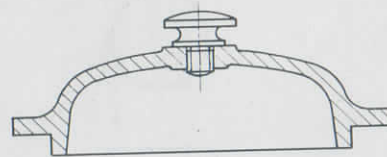
certo



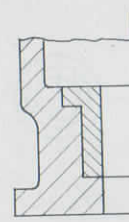
errado



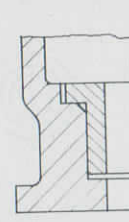
dificuldade na fundição



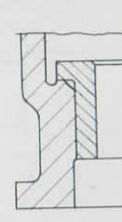
correto



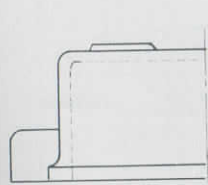
errado



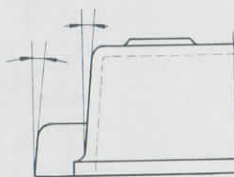
certo



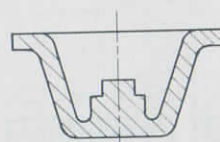
melhorado



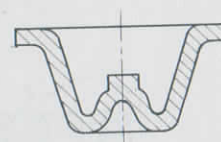
errado



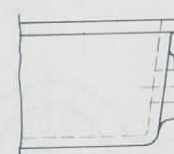
certo
para facilitar a
retirada do molde



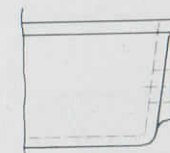
errado



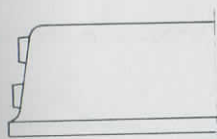
certo



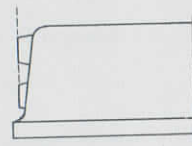
evitar



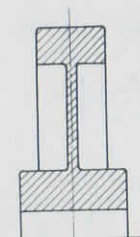
correto



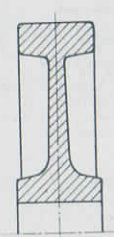
errado



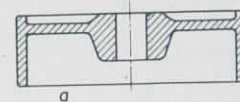
para facilitar o
acabamento



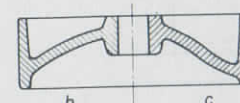
errado



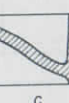
certo



a) errado



b) certo



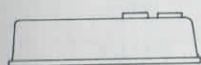
c) melhorado



errado



certo



evitar



para facilitar o acabamento



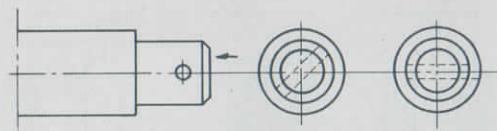
evitar



certo

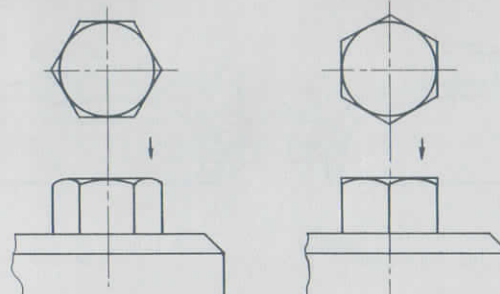
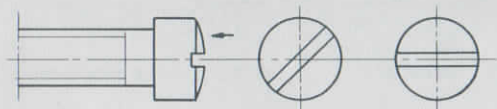


melhorado



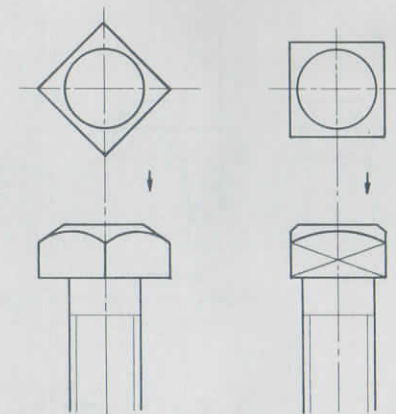
correto

evitar



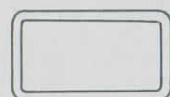
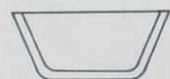
correto

evitar

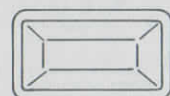


evitar

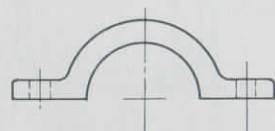
correto



evitar



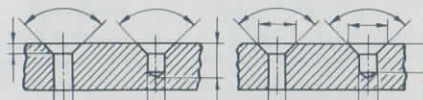
correto



evitar

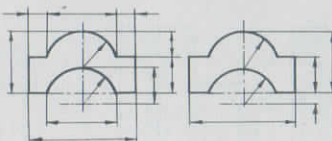


correto



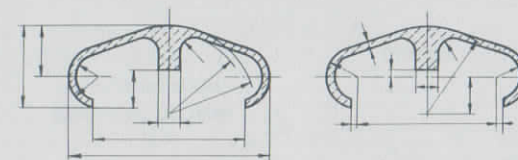
mais racional

pouco usado



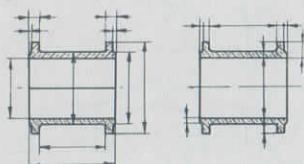
confuso

correto



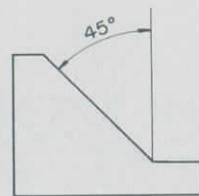
correto

errado e incompleto

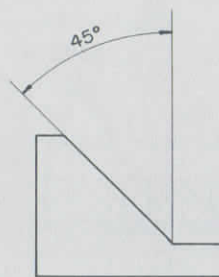


correto

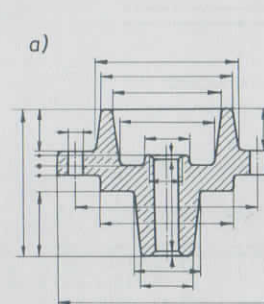
errado



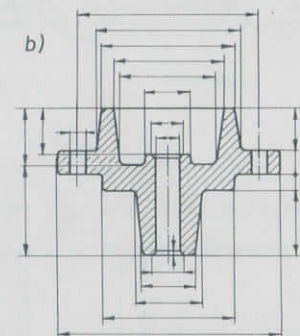
evitar



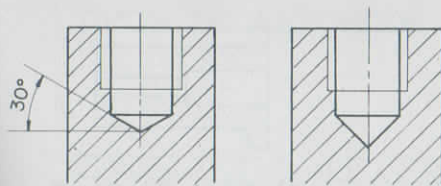
correto



disposição incorreta das
linhas de chamada e de
cota.

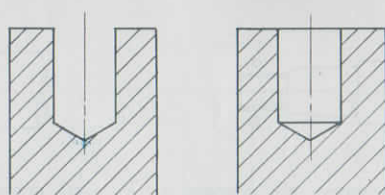


maneira correta
de cotar



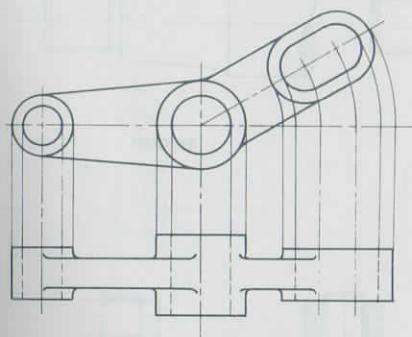
correto

errado

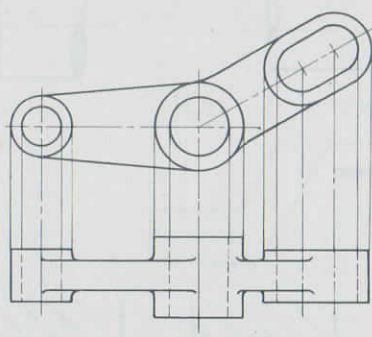


errado

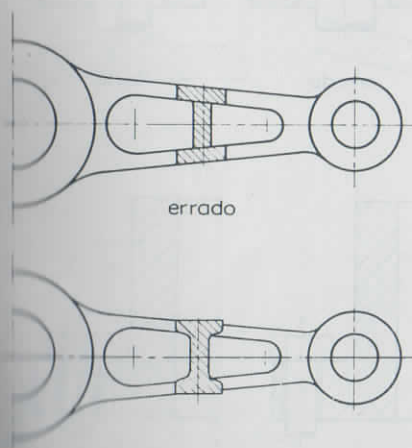
correto



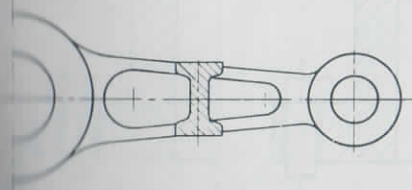
representação convencional



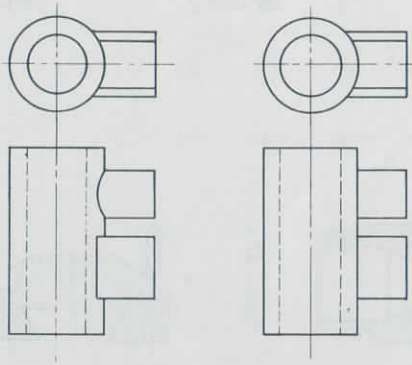
representação real



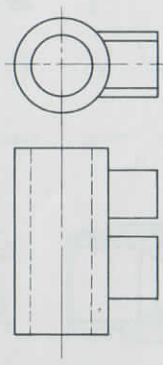
errado



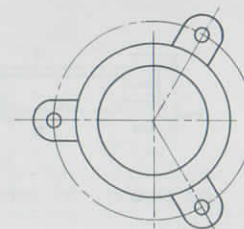
correto



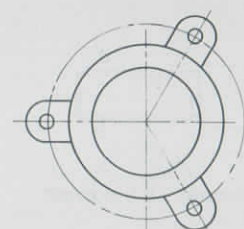
representação real



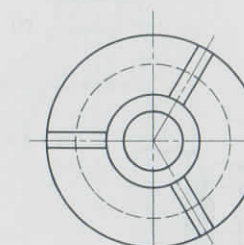
representação
simplificada



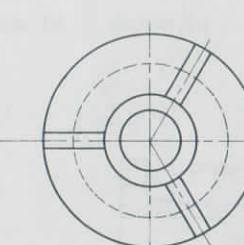
representação real



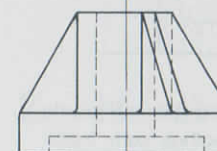
representação
convencional



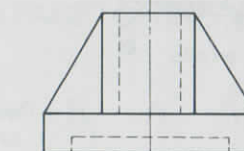
representação real



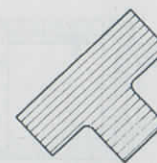
representação
convencional



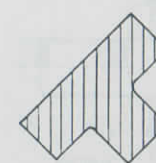
representação real



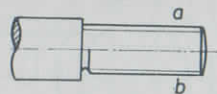
representação
convencional



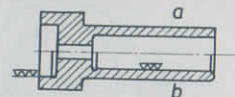
errado



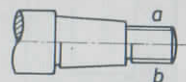
correto



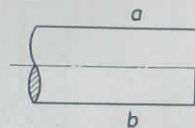
a) errado b) correto



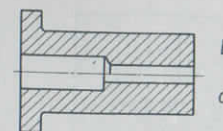
a) errado b) correto



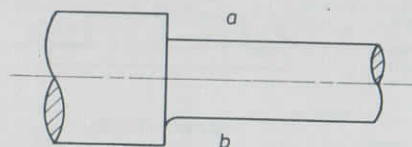
a) errado b) correto



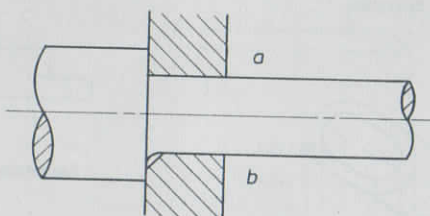
a) errado b) correto



a) errado b) correto



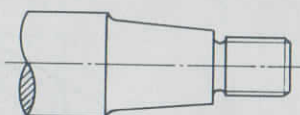
a) errado b) correto



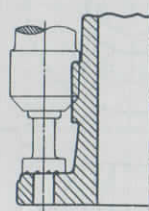
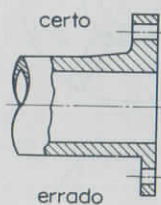
a) errado b) correto



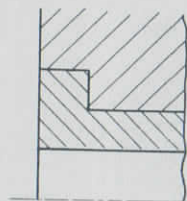
correto



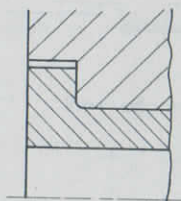
errado



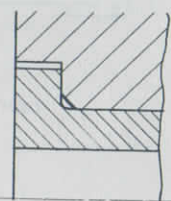
Deixar espaço suficiente
p/ trabalhos com fresa



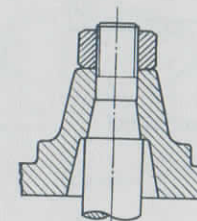
errado



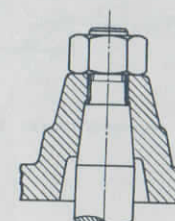
errado



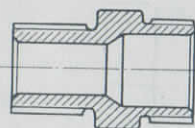
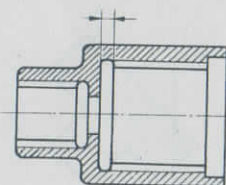
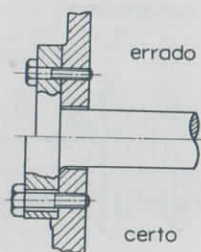
certo



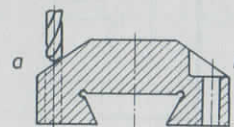
errado



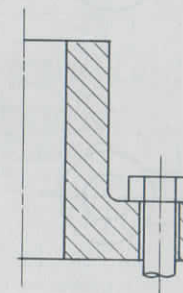
certo



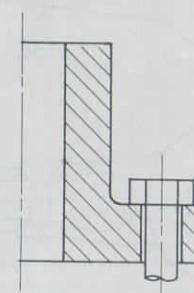
saída de roscas



a) errado b) correto

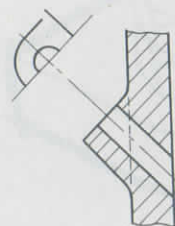
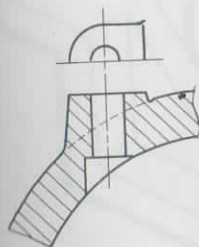
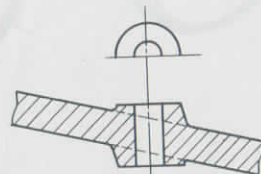
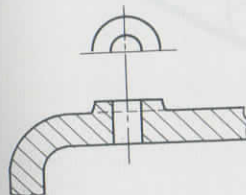
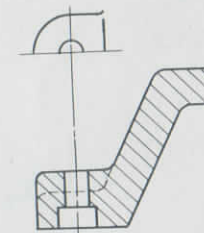
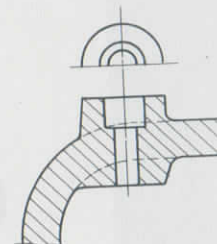
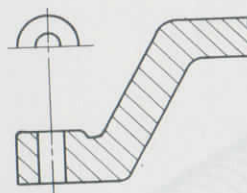
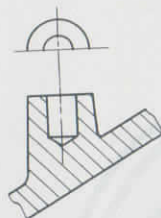
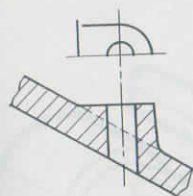
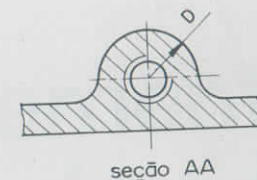
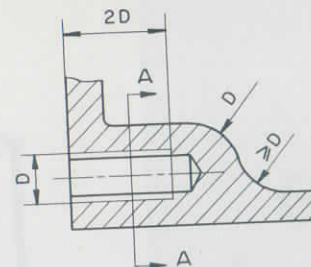
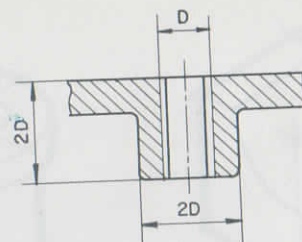
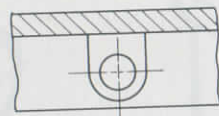
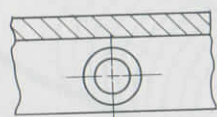


errado



correto

TIPOS DE REFORÇOS



ALFABETO GREGO

Α	Β	Γ	Δ	Ε	Ζ	Η	Θ	Ι	Κ	Λ	Μ
α	β	γ	δ	ε	ζ	η	θ	ι	κ	λ	μ
alfa	beta	gama	delta	épsilon	zeta	eta	teta	iota	capa	lâmbda	mu
Ν	Ξ	Ο	Π	Ρ	Σ	Τ	Υ	Φ	Χ	Ψ	Ω
ν	ξ	ο	π	ρ	σ	τ	υ	φ	χ	ψ	ω
nu	csi	ômicron	pi	ro	sigma	tau	úpsilon	fi	chi	psi	ômega