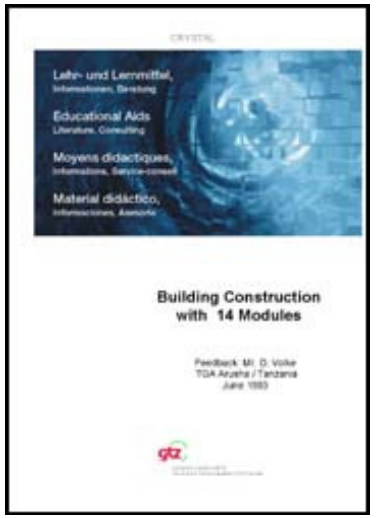

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Building Construction with 14 Modules (TCA; 1983; 618 pages)

1. ARCHITECTURAL DRAWING I

AD I		ARCH. DRWNG.	
compiled: D. VOLKE		--- LECTURE ---	
JUNE '83			
TCA	TECHNICAL COLLEGE ARUSHA CHUO CHA UFUNDI ARUSHA	CIVIL ENGINEER. DEPARTMENT	

REFERENCES:

1. "Draughtsmanship"

2. E. Neufert
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3. Dahmlos/Witte
"Bauzeichnen"

4. Landscheidt/Schlüter
"Bauzeichnungen"

5. E. Neizel "Fachzeichnen für das Baugewerbe 1"
- Grundzeichnen -

1.1 AIMS AND PURPOSE OF ARCHITECTURAL DRAWINGS

Architectural drawings are made as a MEANS of COMMUNICATION between

- the client
- the architect
- the engineer
- the building authority and
- the people, who are executing the construction work.

One can define architectural drawings as a LANGUAGE. Therefore the drawings should be:

- easily understandable

easily understandable

- clearly arranged
- unequivocal
- correct
- standardized and
- clean

in order to avoid mistakes and misunderstandings, which may become very expensive.

1.1.1 CONTENTS OF ARCHITECTURAL DRAWINGS

Architectural drawings should show

I. the ideas and imaginations of the designer (architect)

II. the type of the building or structure, which has to be in accordance with

- the rules of building construction
- the availability of building materials
- the financial possibilities of the client
- the regulations, bylaws and building rules of the local authority

1.2 Types of Architectural Drawings

Each type drawing has its special contents and has to save its own purpose.

There are different types of architectural drawings:

1. Sketch Drawings: show the solution of the job with the approximate measurements of the rooms and construction members as well as the arrangement of the buildings on the site. common scales 1:500, 1:200.

2. Design Drawings: Show the agreed solution of the job with the exact measurements of the rooms and construction members. For submission to obtain a Building Permit they have to be in accordance with the regulations of the Local Authority. common scales: 1:100 (1:200)

3. Working Drawings: Have to content all necessary specifications and measurements of the rooms and construction members in order to carry out the job properly.

They also have to specify the used building materials and structures. common scale: 1: 50

4. Detail Drawings: complete the Working Drawings for specific parts of the buildings in a bigger scale. common scales 1:20, 1:10, 1:5, 1:1

5. Special Drawings: give particulars about special constructions such as:

Reinforced concrete work, steel -and timber work, sanitary or electrical systems etc. For such drawings, other construction members are only shown as far as necessary to understand the drawing correctly.

Scales as necessary.

6. Accounting Drawings: give all necessary informations for the accounting.

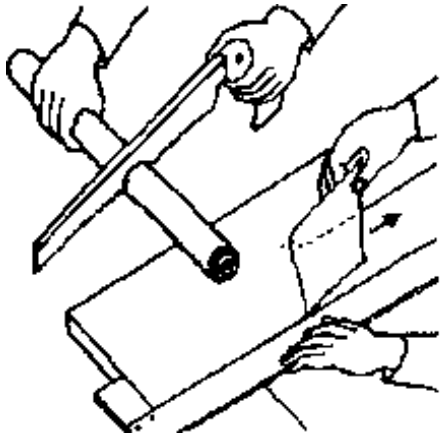
Scales as necessary.

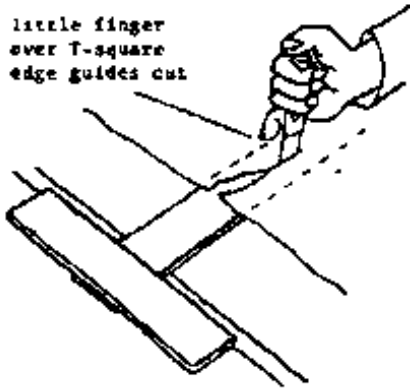
7. Stock-Taking Drawings: indicate all - for a certain purpose - necessary particulars and informations about an existing building

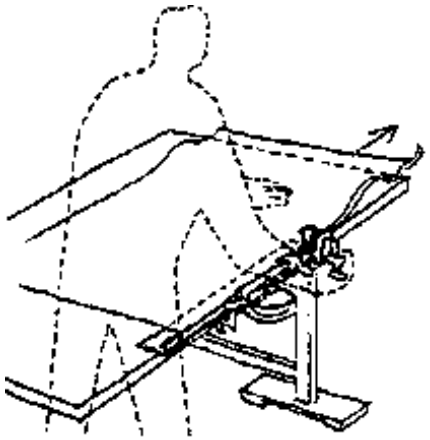
Scales as necessary.

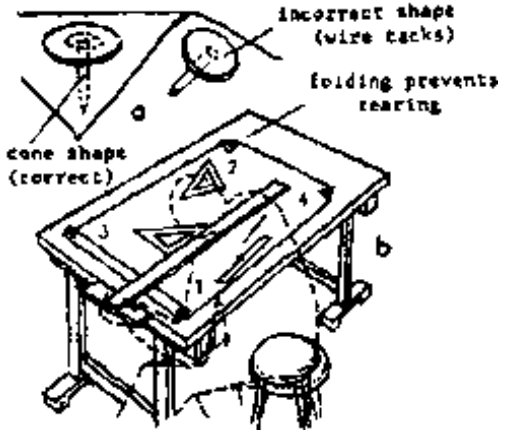
TYPE OF DRAWING	SCALE
1. Sketch Drawings	1:500, 1:200
2. Design Drawings	1:100, (1:200)
3. Working Drawings	1: 50
4. Detail Drawings	1: 20, 1:10, 1:5, 1:1
5. Special Drawings	as necessary
6. Accounting Drawings	as necessary
7. Stock-Taking Drawings	as necessary

1.2 DRAWING EQUIPMENT





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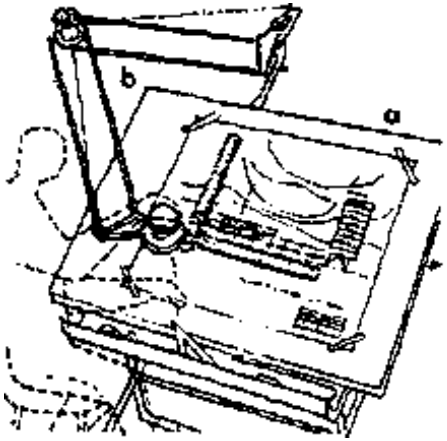
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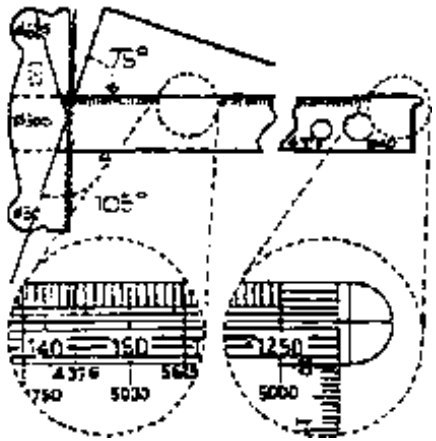
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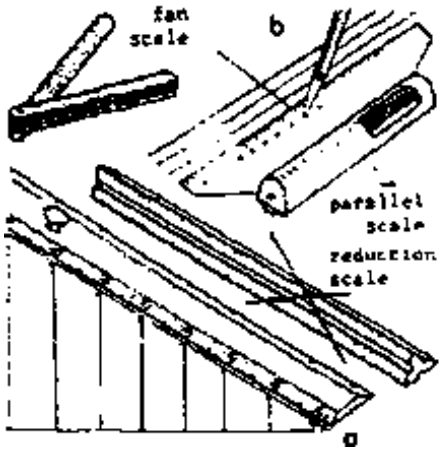
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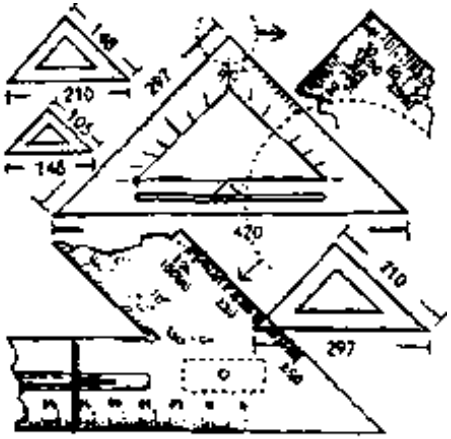
148
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420
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297

In the following, only the principle items of drawing equipment required by the draughtsman are mentioned.

The draughtsman, especially the beginner, is advised to purchase the best available instruments he can effort and he should handle and maintain them carefully. Well kept drawing equipment is the prior condition for making good drawings.

1.2.1 PENCILS

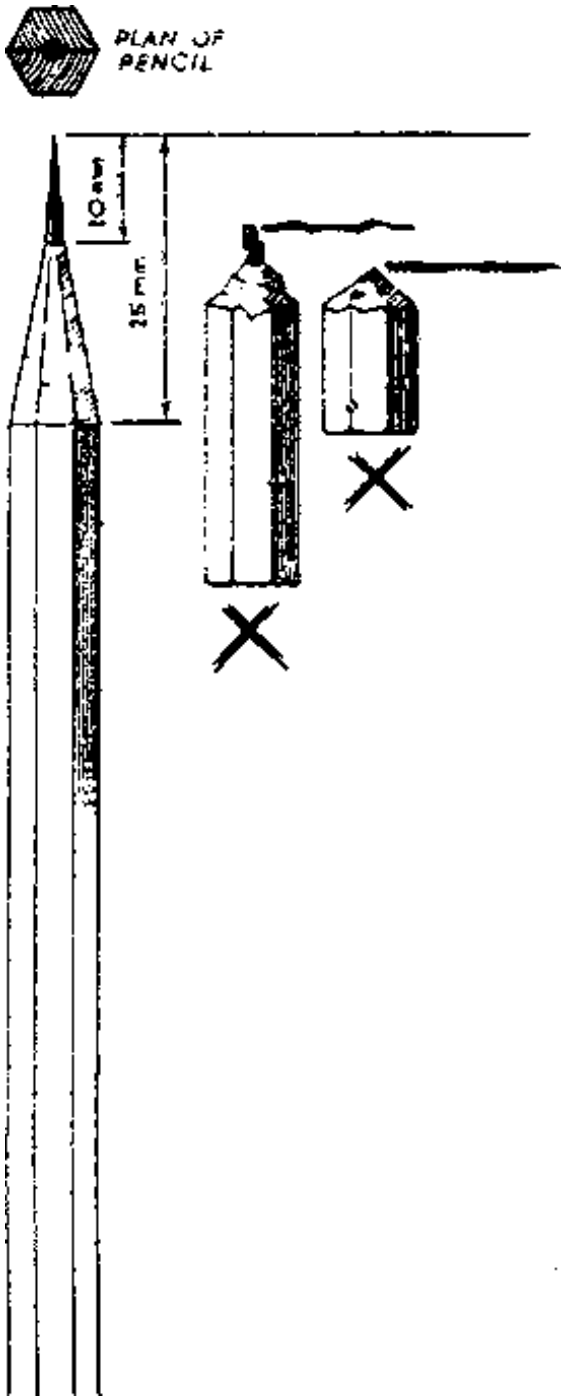
Ordinary drawing pencils are made of cedar wood with leads of compressed clay and graphite and are about 175 mm long. There are round and hexagonal types available. The hexagonal type is more easily held in the fingers and the pencil does not roll off the board or table. Always try to by the best pencils you can obtain because the leads of which are gritty or crumbly make good draughtsmanship impossible.

When a pencil has been reduced to about half its length by sharpening, the 'balance' tends to be destroyed and it becomes difficult to control. The short length should be put in a holder. In case you cannot find any holder, a stripe of paper can be rolled around the end an gummed, to increase the length and make the pencil more manageable.

Pencil points should be long, round and evenly tapering the exposed lead should be about 10 mm long, and the wood cut back a further 10-15 mm. The point must be round, and then, if the pencil is slowly revolved as lines are drawn, it will wear away evenly and remain sharp for some time.

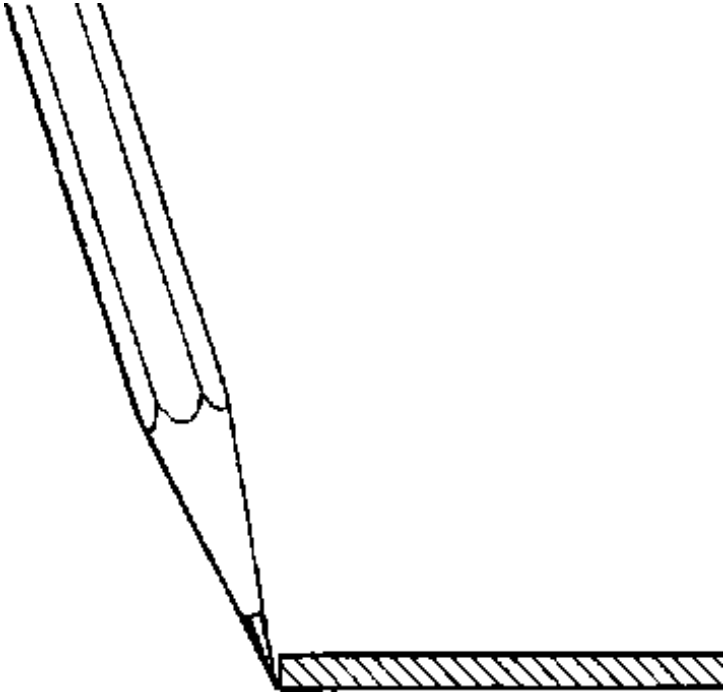
Clutch pencils are a popular alternative to the ordinary pencil of similar shape and size, consisting of a metal lead holder into which leads of varying degrees or various colours can be inserted. A push bottom operates the clutch and enables the lead to be withdrawn or fully protected as required. The main advantage of the clutch pencil is that balance is always constant, but it is heavier than the wooden

pencil.



PENCIL

There is a special type of clutch pencil for thinner leads (between 0.3 - 0.9 mm) which makes sharpening unnecessary.



Leads are made in varying degrees of hardness and softness, ranging from 9 H, the hardest, to 6 B, the softest. The extreme grades are very little used. Most drawings can be carried out by using

2 H

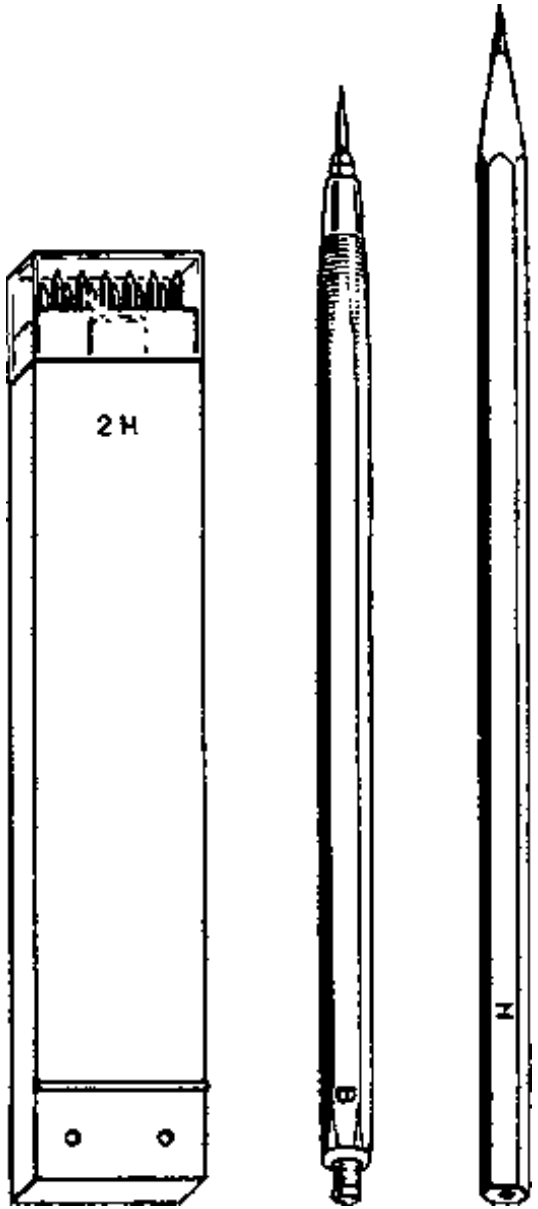
H (-hard)

F (-firm)

HB

B (-back)

2 B



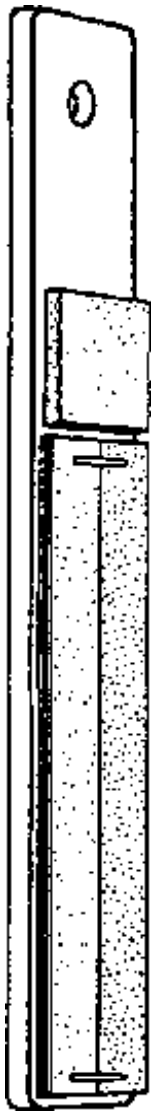
Setting out lines and fine work may be done in H, rogh sketching in B. Beginners should not use pencils harder than H on cartridge and similar drawing papers. It is a common error to resort a hard pencil

because the point lasts longer and the line is less likely to smudge, properly used HB pencil will keep its point just as long and will give a much better line whilst pomitting greater freedom of wrist action. Hard pencils bite into the paper and make harsh wiry lines. Smudging is due to carelessness and the student should learn to avoid rubbing the lines of his drawing.

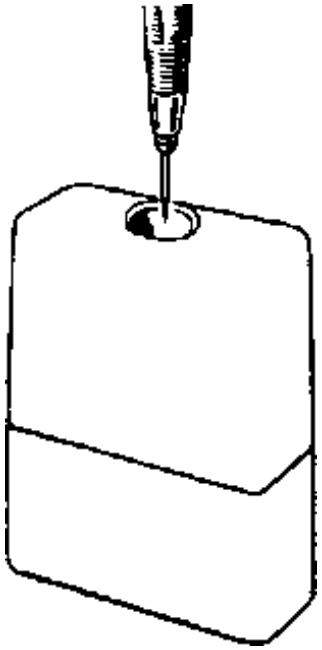
PENKNIFE

Sharpening: The best way of sharpening an ordinary pencil is by means of a penknife. The pencil is held in the left hand, below table-level and pointing downwards so that chips and lead dust cannot fall on the drawing paper. And with the penknife in the right hand inclined cuts are made firmly and regularly to remove the wood ground the point. The final sharpening is done with the penknife blade held more or less at right - angles to the lead - this reduces the risk of a sudden cut going right through the point.

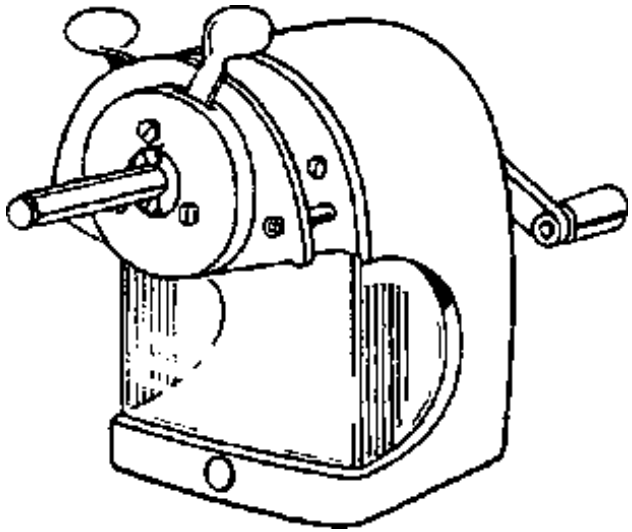
Pencils should not be sharpened with the lead held against a thumb - a sure way to make hands and clothes dirty -nor should safety - razor blades be used - they are much too sharp and difficult to control.



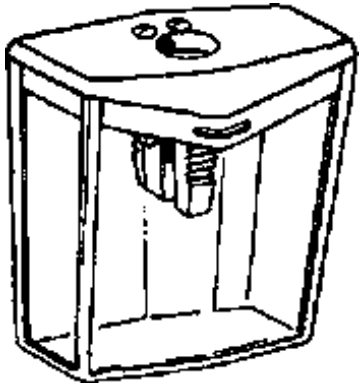
Sand paper pads: should never be used They are not only too coarse to produce anything like a good point, but they make an intolerable amount of dust which is rapidly transferred to fingers, clothes, and drawing papers.



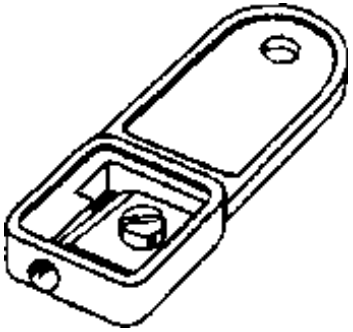
Mechanical pencil sharpeners which can be screwed either to the table or wall are generally efficient and save a certain amount of labour, although the points usually need a final touch of the penknife.



The small sharpeners that can be held in the fingers are quite useful, although care must be taken that lead dust and shavings fall into the waste basket or otherwise safely disposed of.

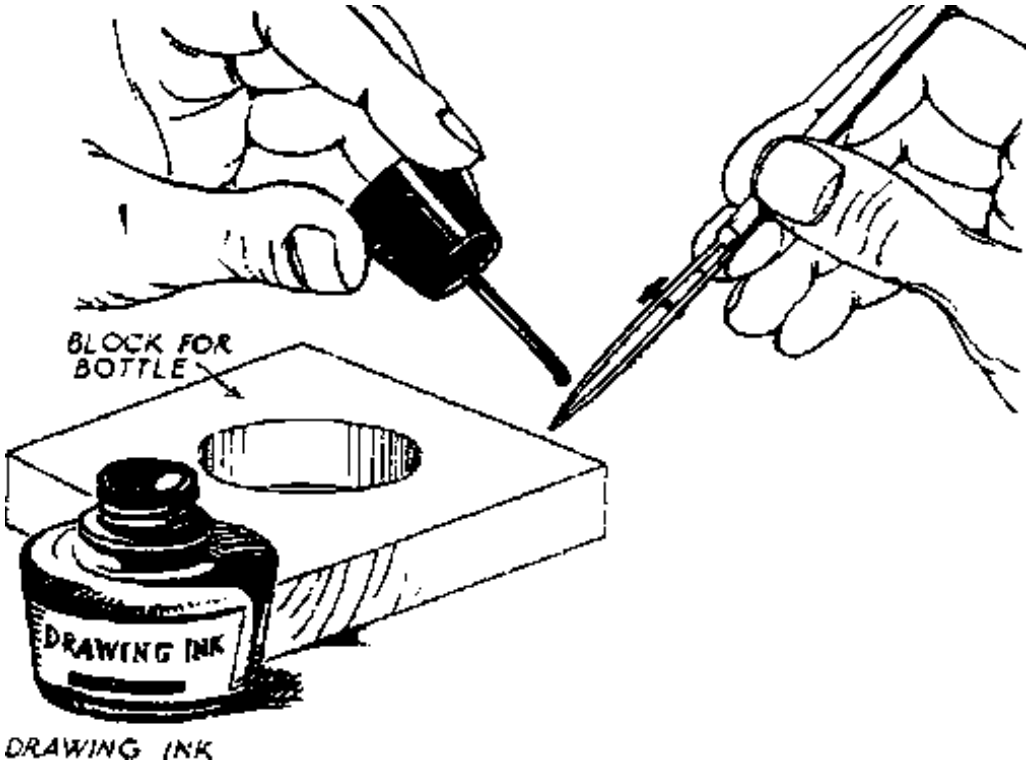


It must be realised that pencils require frequent sharpening when in continous use, and the beginner should start with a good stock and not be surprised if they wear out quickly.



Sharpening a clutch pencil, small lead pointers are often used, although its use is a potential source of black dust on fingers and paper; it is better to use a special pointing machine.

1.2.2 DRAWING PENS



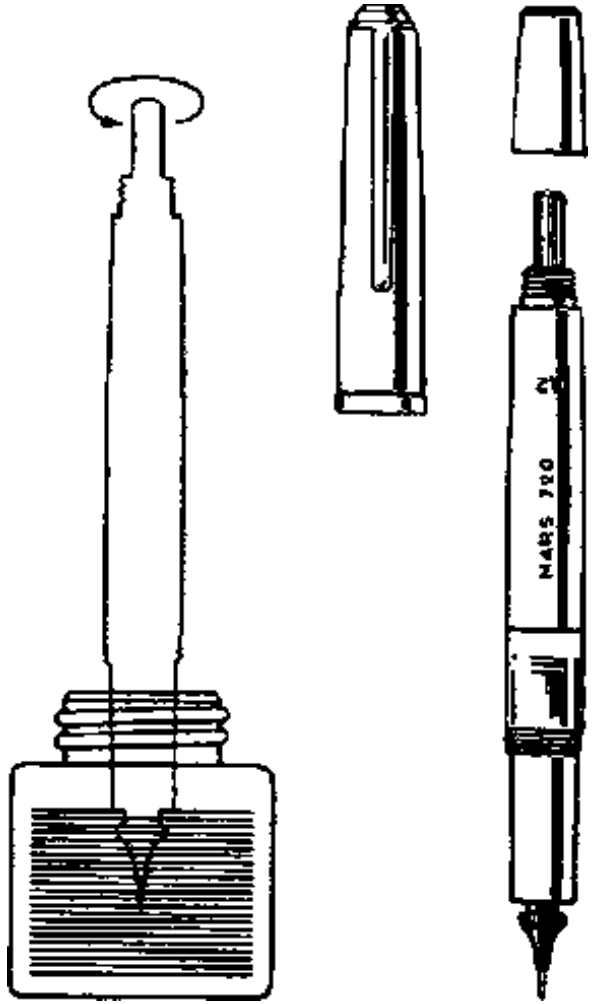
DRAWING INK

DRAWING PENS: Straight lines in ink are ruled in conjunction with the T-square and set-square (with the drawing board equipment or with a drafting machine) by means of special drawing pens. There are three types of drawing pens

- **Ruling pens**
- **Graphos**
- **Rapidographs**

The old type of Ruling pen has frequently to be filled either by means of the dropper from the ink bottle, or dipping an ordinary freehand pen into the bottle and transferring the ink to the blades. It is better not to put much ink between the blades. Practice will indicate how much is satisfactory. The thickness of the

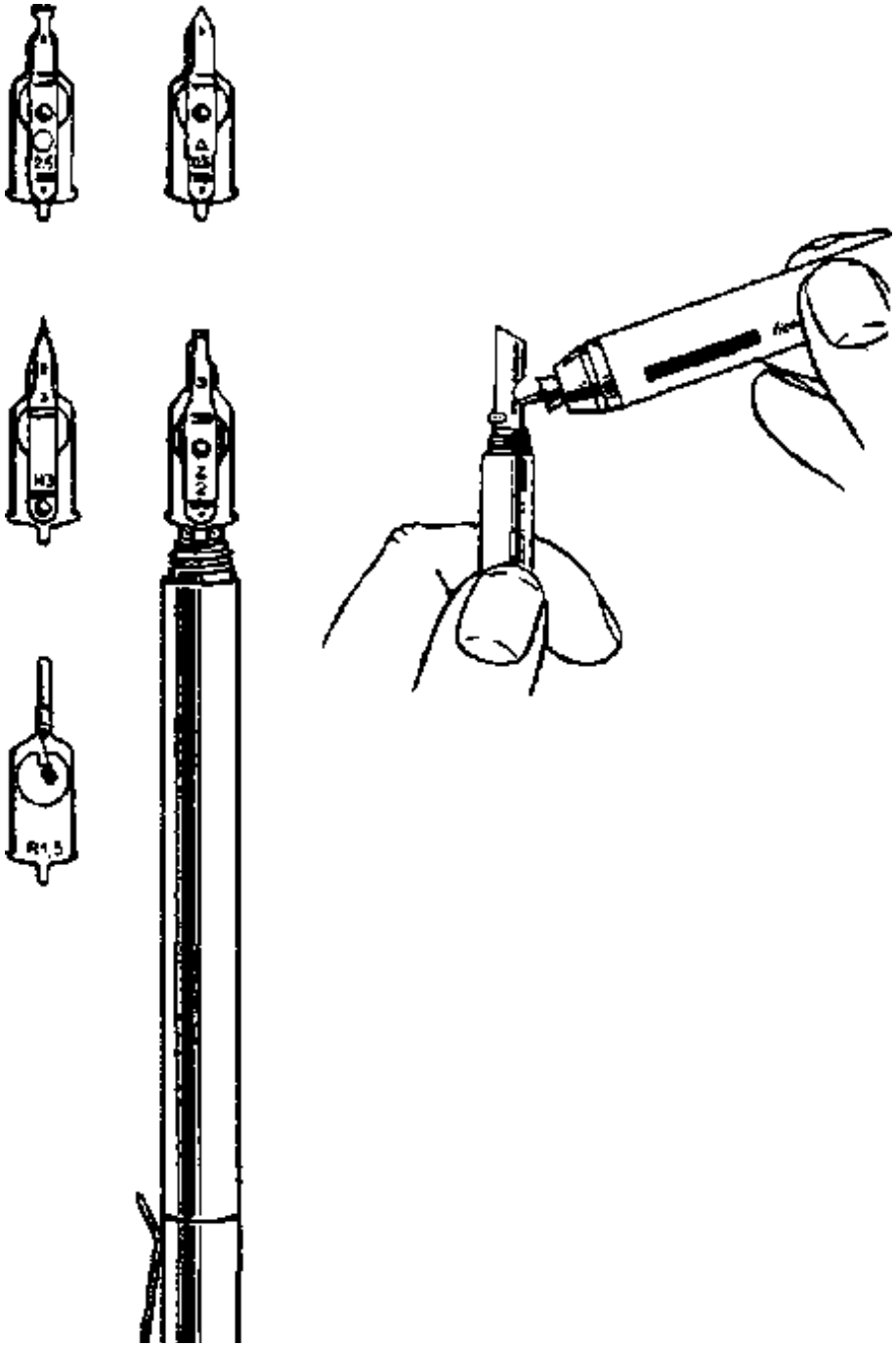
line required is obtained by means of the adjustment screw and by testing at the side of the drawing paper or on scrape of similar paper.



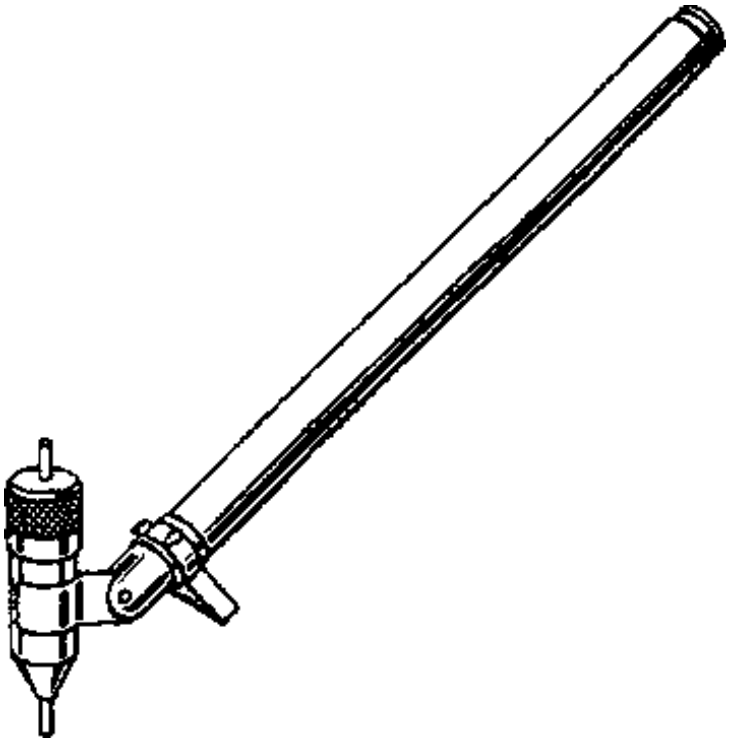
FOUNTAIN-PEN

Graphos and Rapodographs are based on the fountain-pen principle, with ink reservoirs, so that they can be used for long periods without refilling. Interchangeable nips or drawing elements are used for different thicknesses of lines. The most common set consists of 0,18, 0,25, 0,35, 0,7, 0,5 1,0, 1,4, (2,0) mm. The pens are also be used for free-hand drawing of lines and for freehand and stencil lettering. The

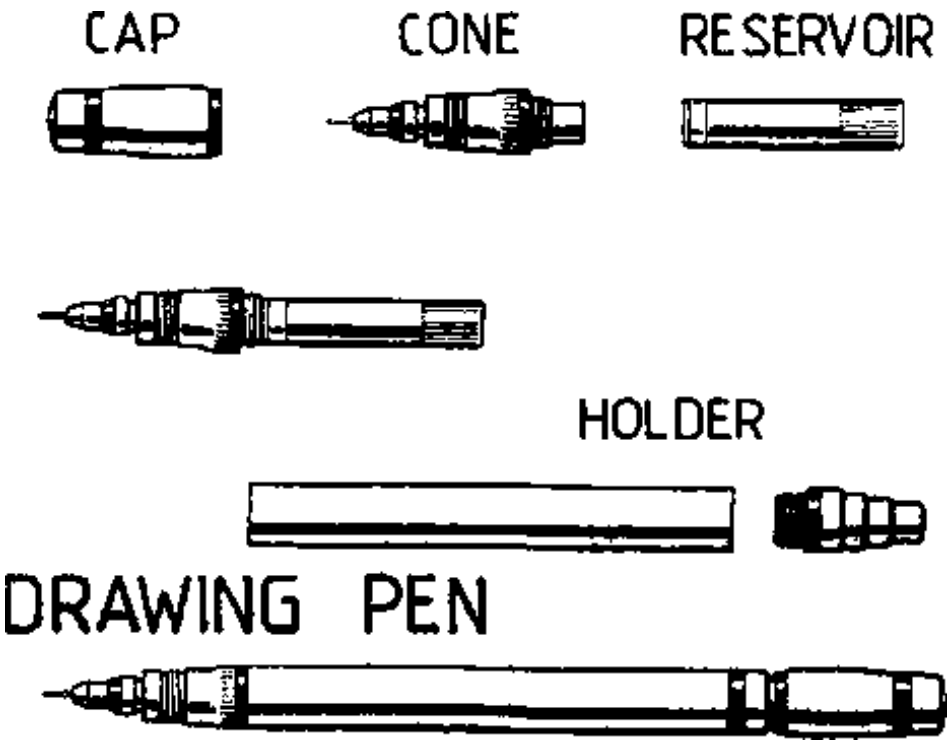
graphos pen has special nibs for freehand lettering.



GRAPHOS



LETTERING NIB with HOLDER


CAP
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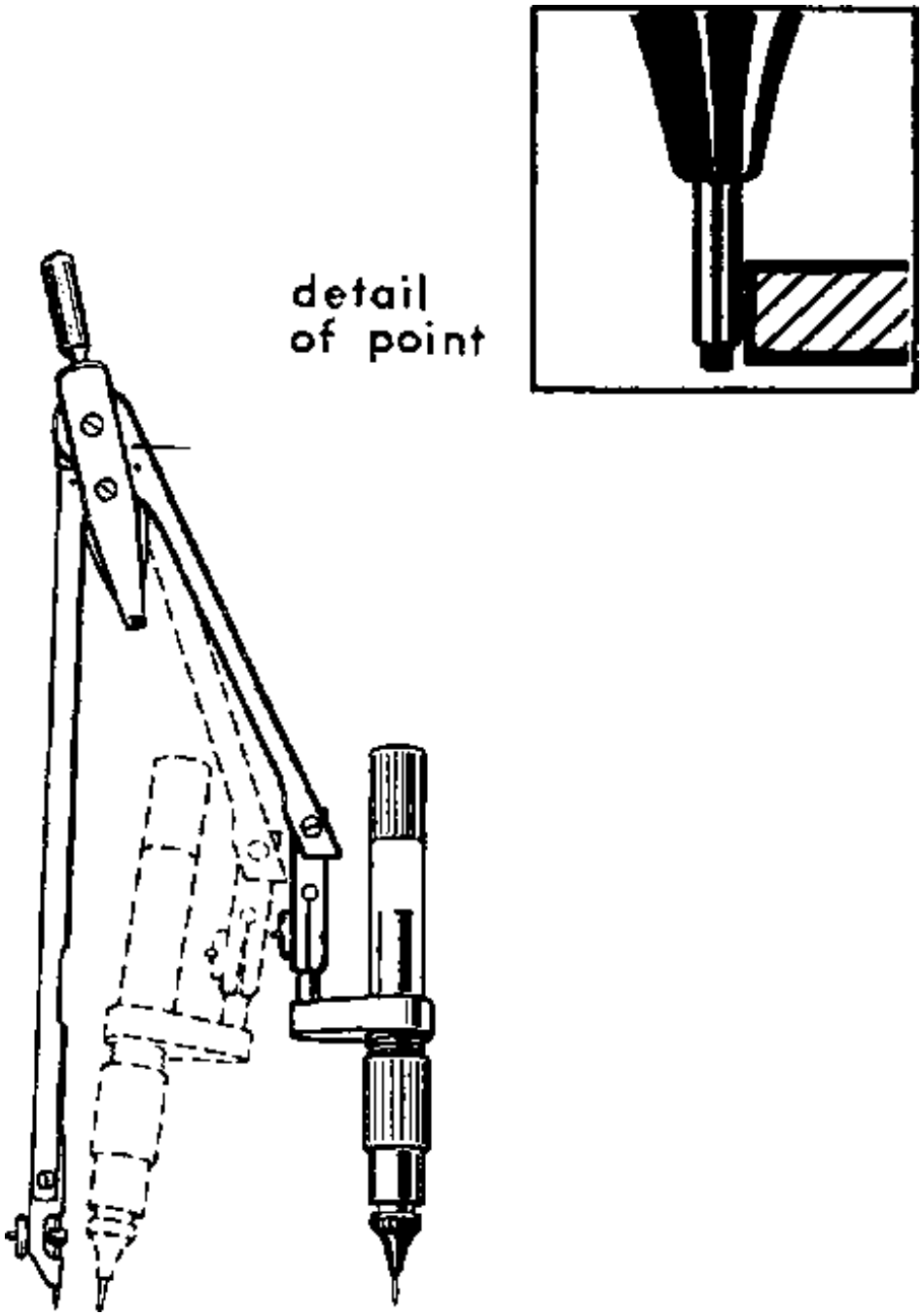
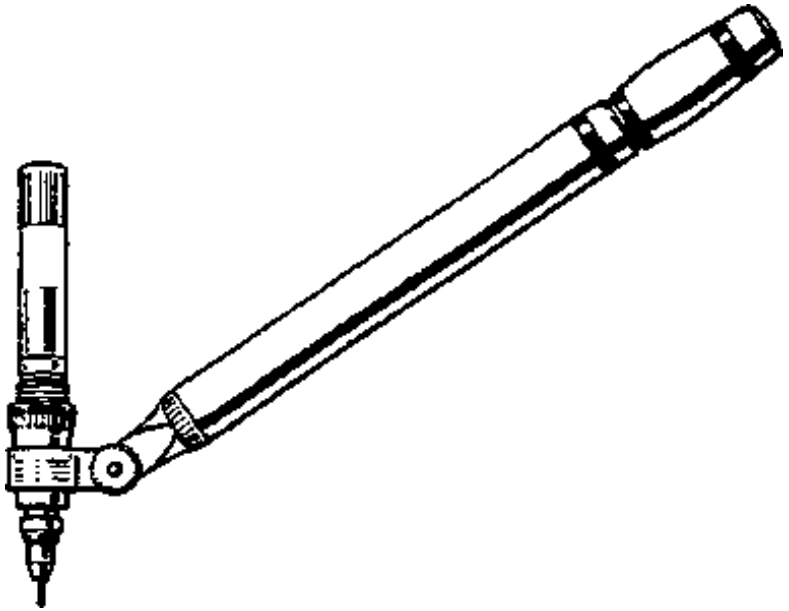
DRAWING PEN


detail
of point

Instruction for use and care come with the pens and it is very important to follow these instructions, especially in regard to cleaning. Keep the pens always clean and do not allow them to become clogged or encrusted with ink, so that undue time has to be wasted in making them work. All kinds of Drawing Pens should be held perfectly upright against the edge of T - square or set - square, and should be drawn smoothly with even pressure from left to right or in upwards direction.



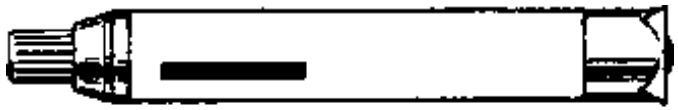
Drawing ink: Water proof black ink is used for line drawing. It can be taken from small glass bottles with dropper or pipette for filling ruling pens and other instruments, from plastic bottles for Rapidographs and similar pens, or from special cartridges for graphos pens etc.

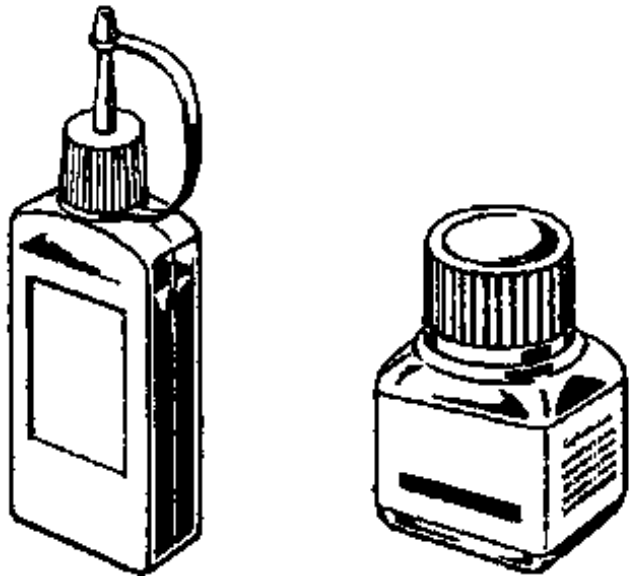
Not all inks are suitable for the drawing pens described earlier or for the use on all kinds of film and the maker's recommendations should be followed.

Containers should always kept closed (except when pens or instruments are being filled) to keep out dust and to lessen the risk of accidental spills.

In warm weather it may be found that the ink will run more freely if it is slightly diluted with clean,

preferably distilled water. Bottles should not be shaken once they are in use. Inks should never be mixed and dirty pens must not be used: Chemical action may be set up and the ink becomes lumpy.



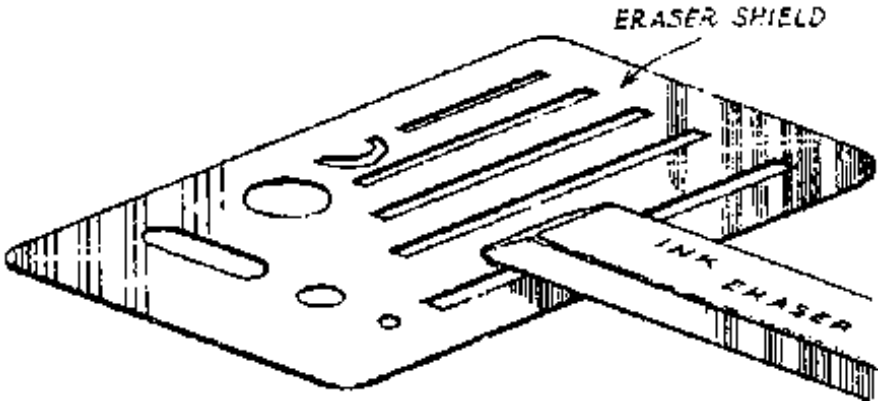


Drawing inks are obtainable in different colours.

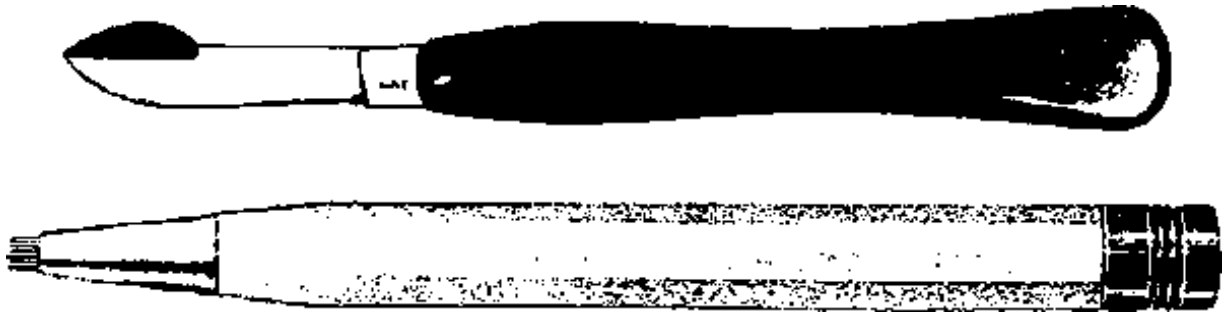
Erasers: Alterations, corrections, and the removal of unwanted lines are best made by rubbing with a soft rubber or vinyl eraser. Erasers should be large enough to be easily gripped, but very large rubbers

soft rubber or vinyl eraser. Erasers should be large enough to be easily gripped, but very large rubbers last too long and, as the outside surface becomes hard and useless in time, it is probably better to keep to small sizes. When the surface of the eraser is affected, it can be cut away or, if not too bad, rubbed clean on an old scrap of paper.

For a large area of paper the so called gum eraser is probably quicker and more gentle to the surface. For removing soft pencil shading, which are smeared by on ordinary eraser, a special putty rubber must be used.



So called 'glass erasers' are generally efficient. They consist of a holder (metal or plastic) into which bristles of glass are inserted. A screw bottom operates a mechanism which enables the glass bristles to be withdrawn or fully protected as required. The main advantage of the glass eraser is that glass bristles are gentle to the surface of tracing paper, but they have to be handled carefully to avoid small particles sticking in your hand, which is quite painful.



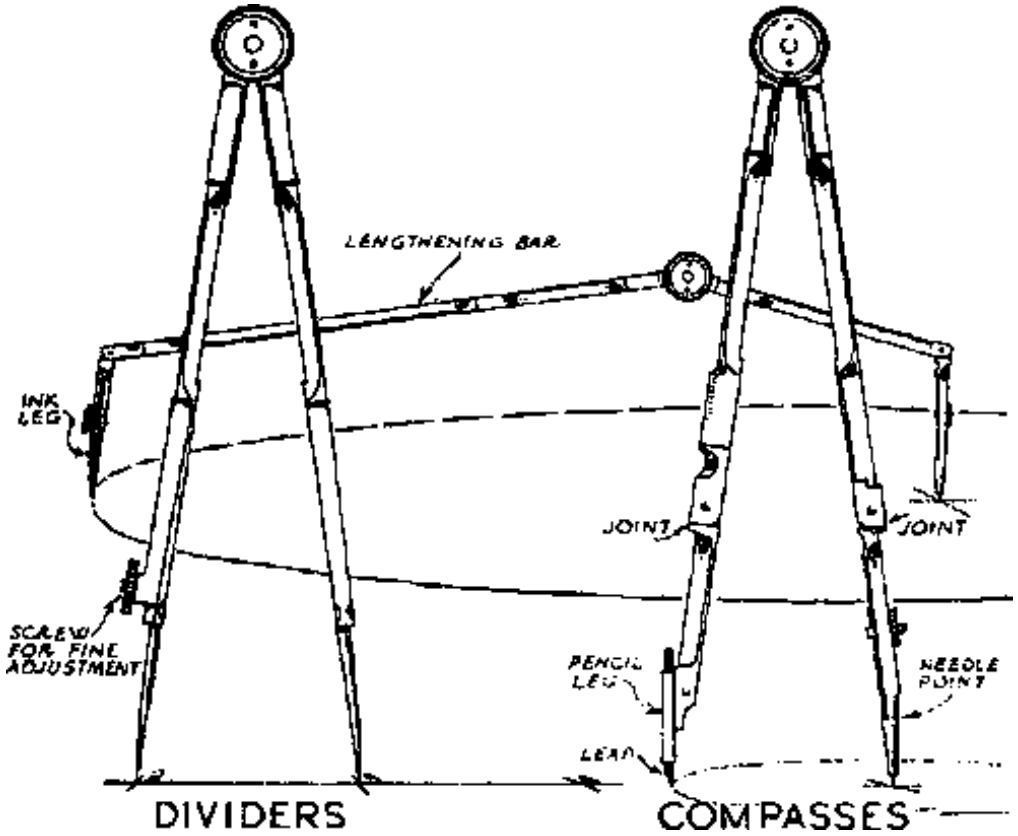
Ink lines on drawing paper are removed by hard erasers. As usually only a small portion of an ink drawing has to be removed and the surrounding lives disturbed as little as possible, the rubbing can be don through a thin metal or celluloid rubbing shield, which has openings to suit areas to be erased. Lines on tracing paper are best removed by scraping gently backwards and forwards with a safety razor blade held vertically between finger and thumb.

Electrically operated erasers are sometimes installed in large drawing offices. The machine is suspended over the drawing table and is drawn down to the surface of the paper and a small motor rotates rapidly a piece of pencil rubber or ink eraser.

The small particles of rubber which result from rubbing out should be carefully removed from the surface of the paper by blowing or by lightly flicking with a clean, smooth DUSTER.

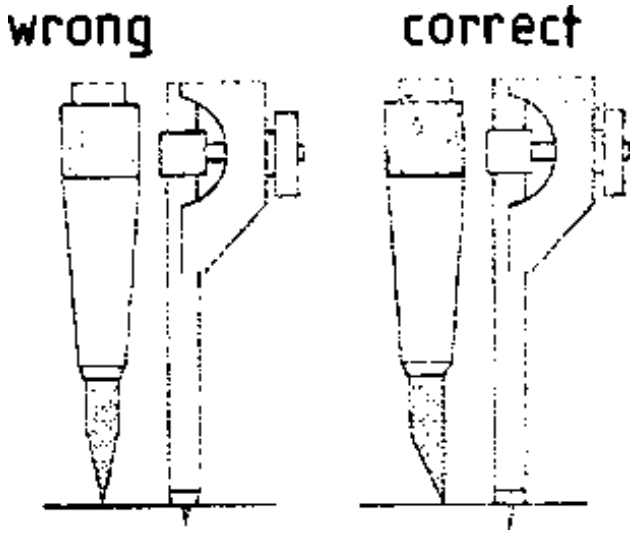
1.2.3 COMPASSES

The fig. shows a common pattern of compasses, which are used for drawing circles and arcs. One leg terminates in a needle point and the other leg can be fitted with pencil or pen. An additional needle pointed leg can also be obtained for converting this instrument into a pair of dividers. For large circles and arcs a lengthening bar is valuable. Both legs of the compasses are jointed so that they can be bent to keep the point more or less perpendicular to the paper.

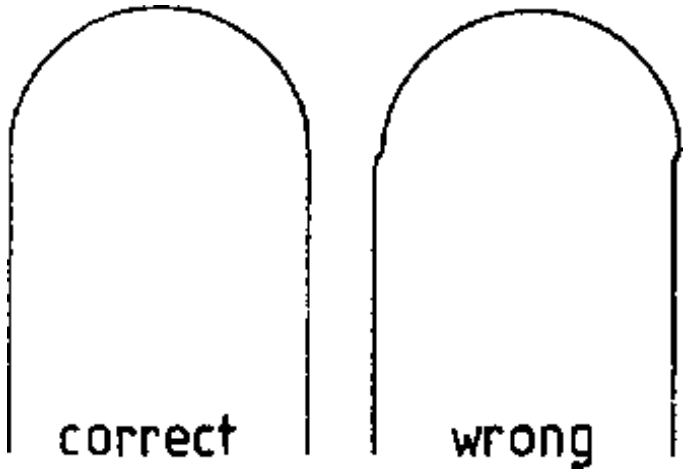


Needle points are removable and are usually shouldered at one end - this end is best for use in drawing circles, as the point does not penetrate the paper too far. The instrument should be held at the top and pressure must be only sufficient to keep the centre from slipping and to maintain a smooth, even line for the curve. The two points of the compasses must be carefully adjusted. The pencil lead should be the

same grade as the ordinary pencil being used on the same drawing. A 12 mm length can be out from the bottom of the pencil for the purpose.



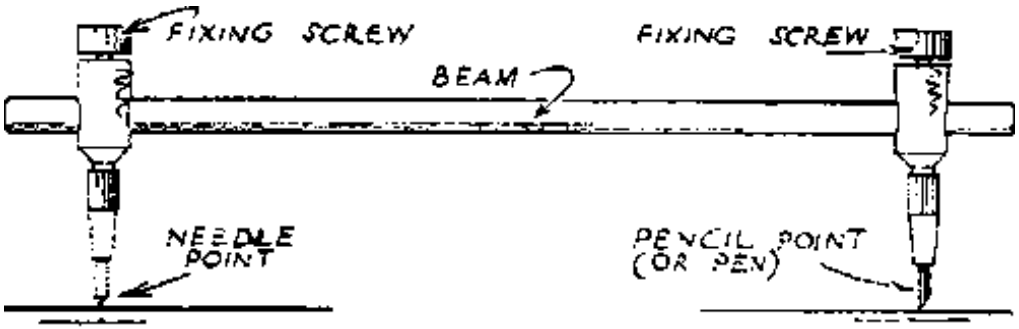
It should be sharpened to a fine chisel point and arranged tangential to the circumference, although for small circles a round point is probably better.



Pens are capable of adjustment in the manner of ruling pens. The thickness of the ink line should be

tested at the side of the paper before the required curve is drawn.

Special compass/pen attachments are available for use with the Rapidographs and with small pump compasses for drawing small circles.



Beam compasses

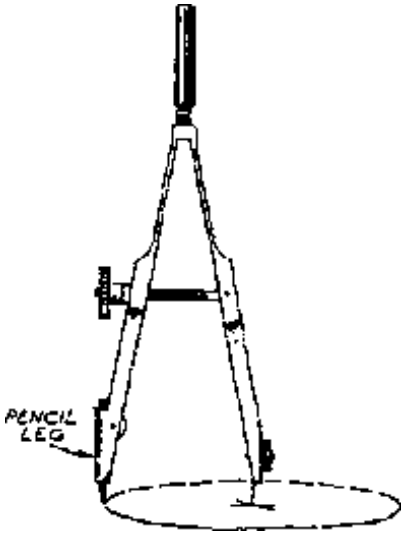
For drawing larger circles than are possible with ordinary compasses and the lengthening bar, beam compasses can be used. They consist of a centre point and a fitting, with interchangeable pencil and pen legs, which are screwed to a bar to give the radius required.

Dividers

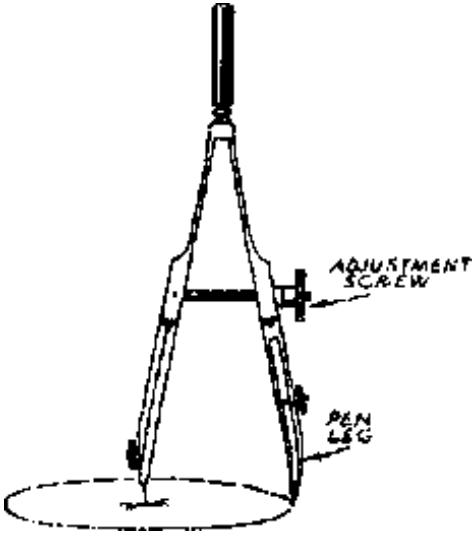
The fig. illustrates a pair of dividers used for dividing lines into equal units by trial and error and for multiplying or transferring distances. A convenient size is about 140 mm long. A spring screw attachment to one leg for fine adjustment is an advantage. This hinge should move easily but should not be loose.

Spring bows and pump compasses. Small dividers and pencil and pen compasses for accurate and fine work are called spring bows. Adjustment is made by means of a screw either at the side, or in the middle at the instrument. There are a number of variations of theses instruments including precision - made pump compasses and rapid adjustment compasses. It should be mentiones, however, that for general work small circles and arcs are drawn through templates.

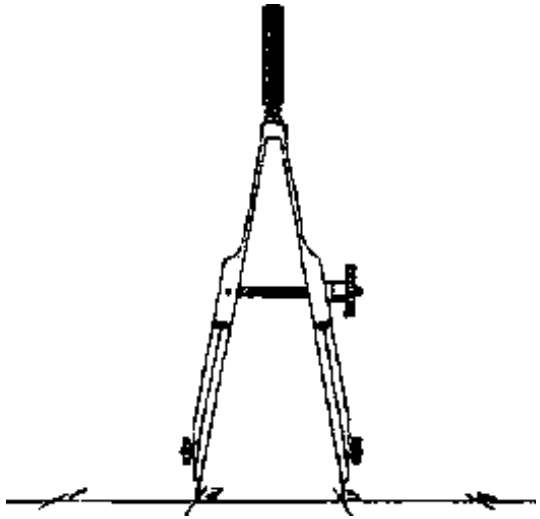
SPRING BOWS



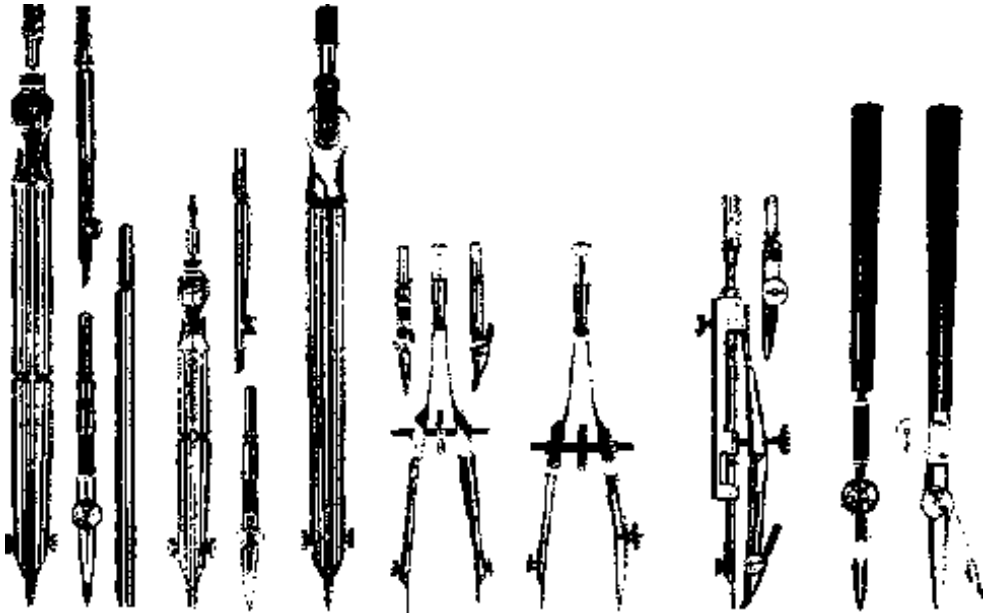
PENCIL BOWS



INK BOWS



DIVIDERS



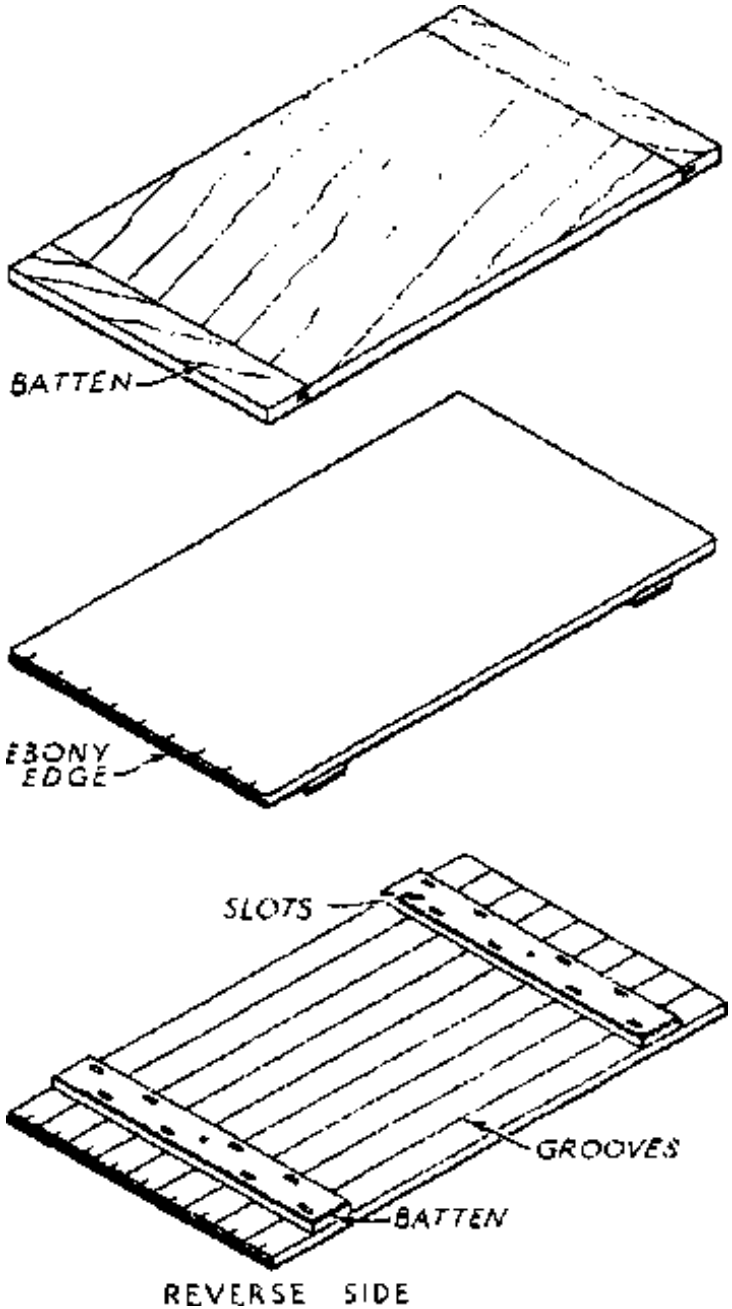
1.2.4 DRAWING BOARDS

Drawing boards are made in sizes to correspond with standard sizes of drawing sheets. The most suitable for general use are:

A 1 : 920 × 650 mm

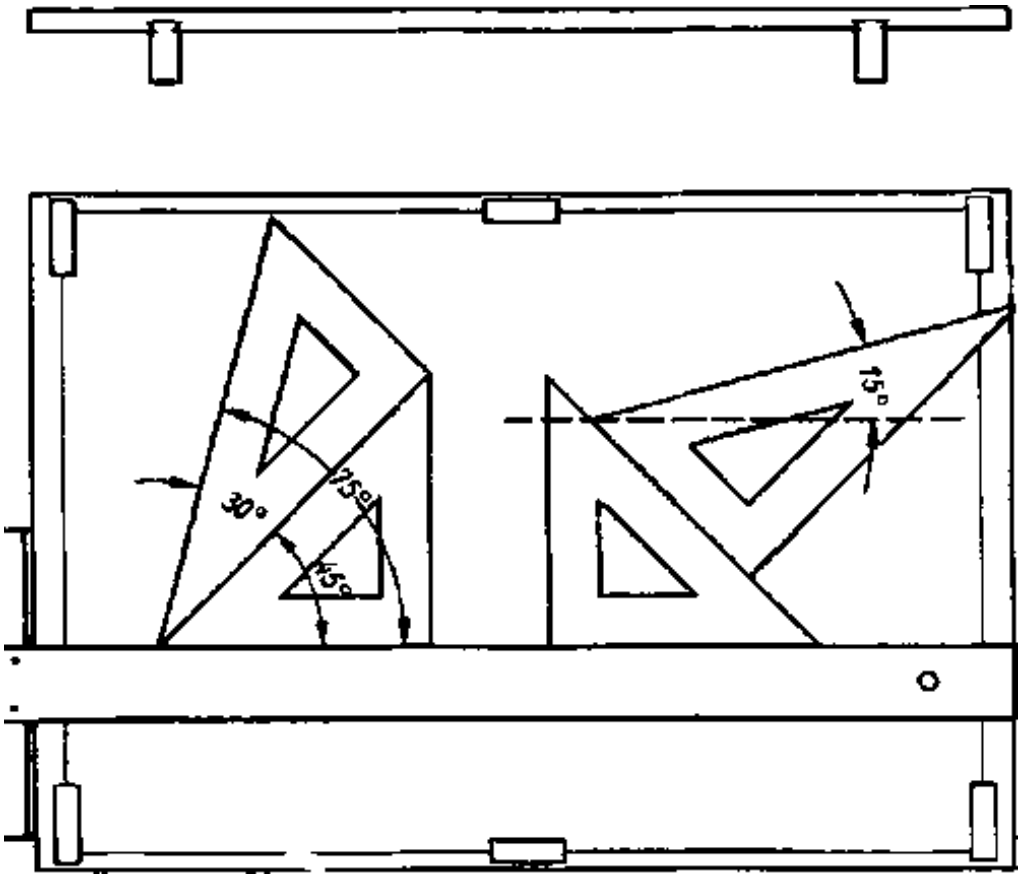
A 0 : 1270 × 920 mm

The fig. illustrates three types of drawing boards. Types A and B, not bigger than size A 1, are suitable for the student as they are light for carrying about and are relatively inexpensive. Such boards can be obtained with metal edges. Type C, which is best for office use, is usually made from spruce and has beech battens secured by screws in elongated washers to allow for expansion and contraction. The back of the board is grooved to resist warping. Small drawing boards accepting paper up to A 3 size are now becoming generally available. They are precision made with smooth plastic surface, are light and easily transportable and are often supplied with a carrying case. They are provided with positive sliding drawing heads or rules operating rather linke T-squares for drawing horizontal lines and with matching set squares multipurpose design. Alternatively, they can be fitted with miniature drafting machines. They usually have devices for holding drawing paper in position as pins or staples cannot be used and adhesive tapes tend to spoil the board.



DRAWING BOARDS

It is important with all types of drawing boards that the faces are perfectly flat and smooth and that they will not twist or buckle with normal use. Edges should be at right-angles to one another. Wooden boards should have a firm even grain, free from knots and should be soft enough to take drawing pins or staples easily and allow the removal without difficulty. Boards with composition surfaces can have paper attached by means of spring clip or strips of drafting table.



1.2.5 T-SQUARES

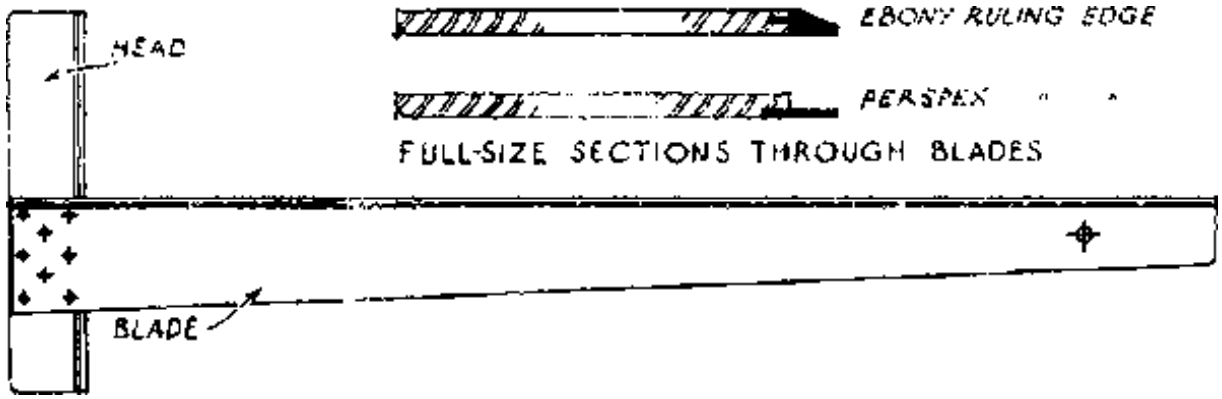
Are used in conduction with the board for drawing horizontal lines. The head of the T-square being held against the left hand side of the board by the right handed person (reverse T-squares are made for the

against the left hand side of the board by the right handed person (reverse T-squares are made for the left handed draughtsmen). Sizes correspond to the lengths of the drawing boards:

A 1 920 mm blade

A 0 1270 mm blade

T-squares are best when made of mahagony with ebony or clear plastic ruling edges or of clear or coloured plastics. For lightness blades have to be made of thin strips of wood (plastics), but this renders them liable to fracture. Therefore: Dont leave them lying about in bridge positions or leaning against walls.



T-SQUARE

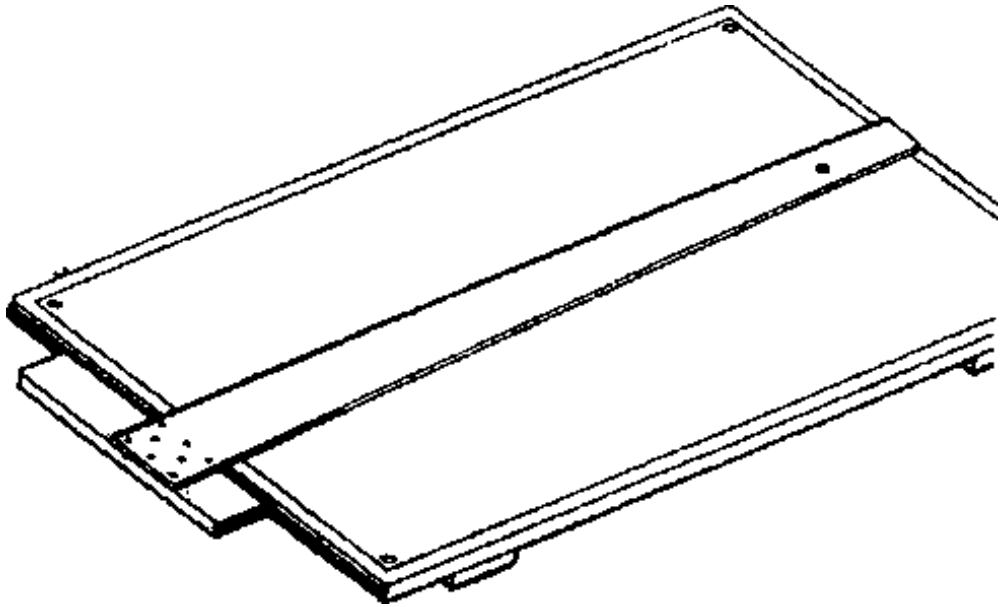
They should either be left flat or hang on pegs.

- Dont use a T-square as a hammer to knock in drawing pins, a loosing of the fixing between head and blade will be the result.

- Dont use the blade as a straight edge in cutting paper in order to avoid indentations along the ruling edge.

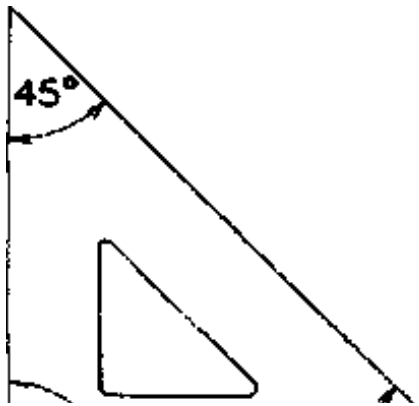
- It is important to keep the underside of the blade smooth and clean, and this is best achieved

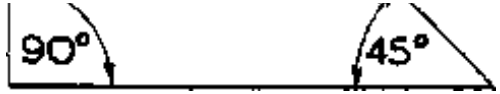
by wiping it periodically with a soft cloth with a few drops of petrol or similar spirit. Water can be used, but is less effective and may cause warping.



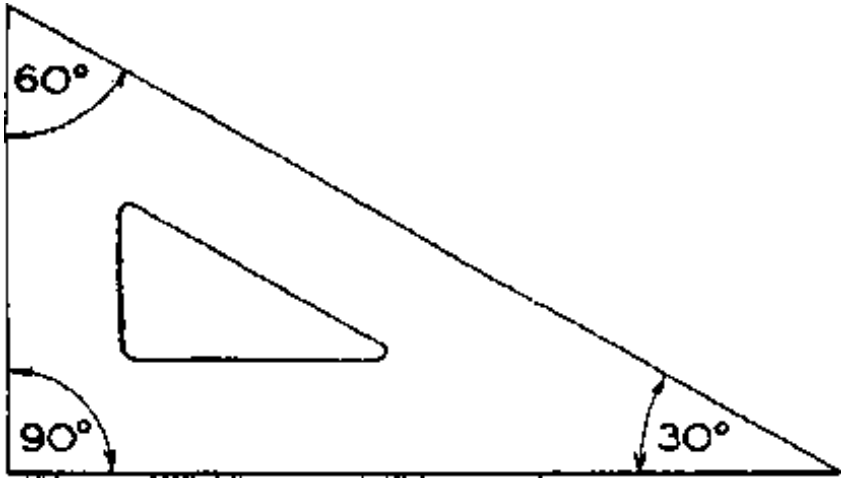
1.2.6 SET SQUARES

Set-squares are used for drawing vertical and inclined lines. They are triangles of clear plastic about, 2 mm thick, and there are three basic kinds as illustrated:

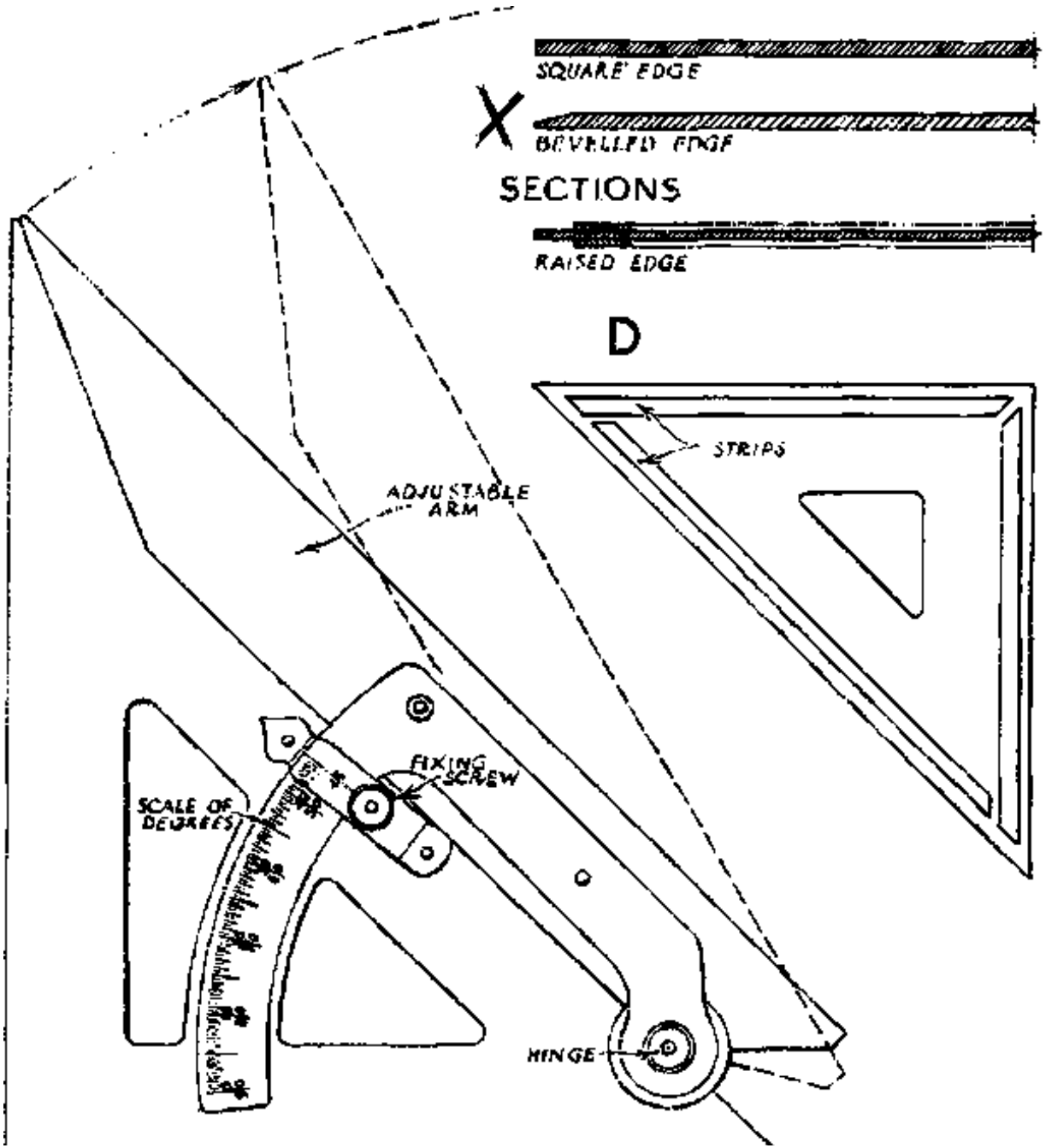




A - 45 degrees SET-SQUARE



B - 60 - 30 degree SET-SQUARE


SQUARE EDGE
BEVELLED EDGE
SECTIONS
RAISED EDGE
D
STRIPS
ADJUSTABLE ARM
FIXING SCREW
SCALE OF DEGREES
HINGE

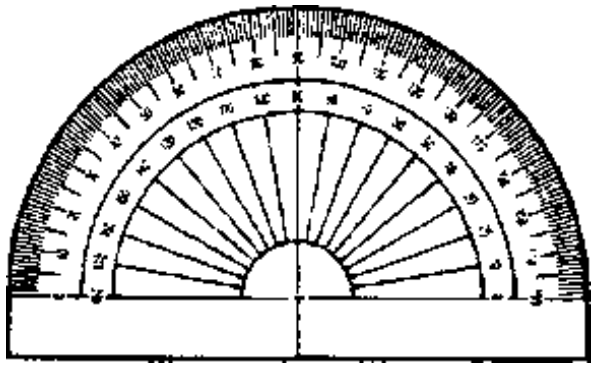
C - Adjustable SET-SQUARE

For general use the length of the longest side should be about 250-300 mm and the edges should be square.

Set squares to be protected from damage. Dents are caused by hard knocks and cutting with a razor blade, etc, along the edge can easily ruin them. They should be kept clean, because dirty set squares quickly transfer the dirt to the drawing.

1.2.7 PROTRACTORS

A protractor is used for measuring or for setting out angles. It is a semicircular (or circular) piece of metal or clear plastic with the arc divided into degrees, reading both to left and right, and with the centre and diameter indicated. The protractor is placed so, that the centre coincides with the apex of the angle and the diameter lies along one line the position of the other line on the scale giving the reading.



The most convenient sizes have diameters from 100 mm to 150 mm. The transparent protractor is to be preferred.

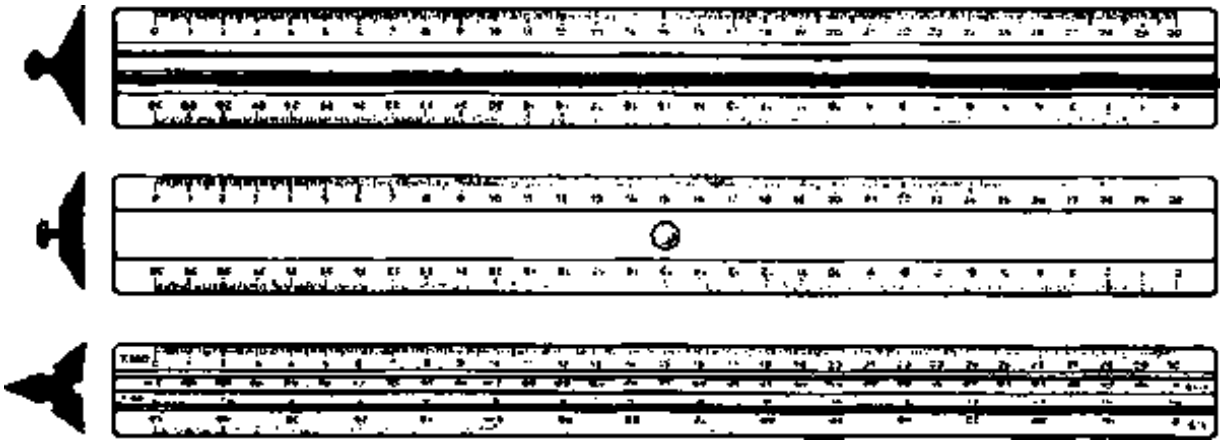
1.2.8 SCALES

Scales are thin narrow strips of plastic or boxwood with divisions along each edge. These divisions are

in various recognized proportions to actual distances and dimensions, and can be used for making new drawings 'to scale' of for measuring, by 'scaling' existing drawings. There are scales available for metric drawings as well as for drawings in which drawings are related to feet and inches.

Now commonly used by architects and draughtsmen are three edge scales with divisions along each edge in the proportion of 1:1 or 1:10/1:100, 1: 200, 1:5/1:50, 1:250/1:2500 and others.

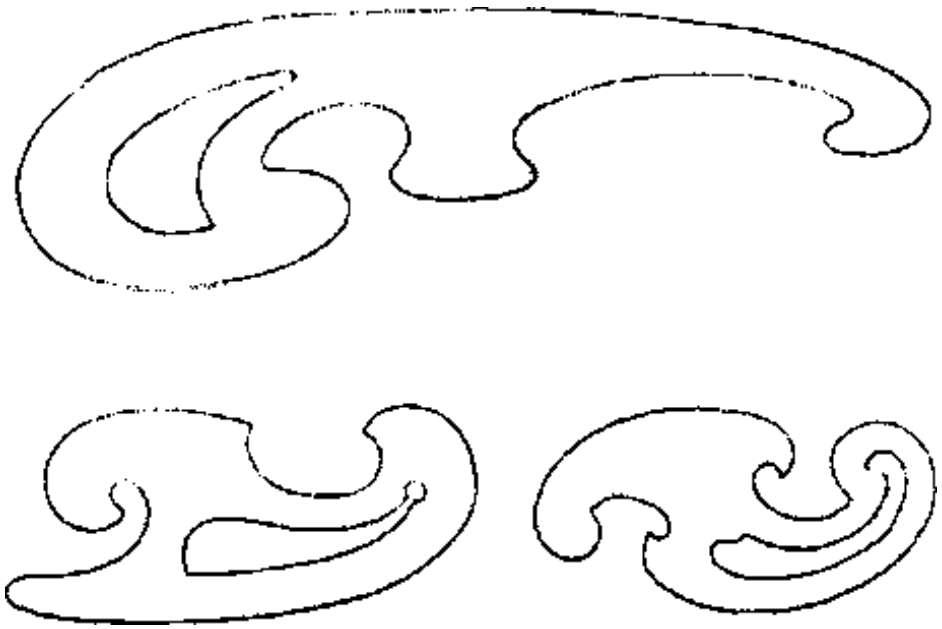
Scales are usually 300 mm long. They never should be used for ruling lines or for any other purpose for which they are not intended, the edges are soon chipped and broken.



1.2.9 FRENCH CURVES

French curves are made of clear (or coloured) plastic like set-squares. They can be used for drawing irregular or complex curved lines which cannot be conveniently made up of arcs of circles. Many shapes are available, but one is usually sufficient for architectural drawing. They are not essential, and with practice curved lines can be drawn freehand more rapidly and often with better effected. Long slow curves can be drawn by a series of blended straight lines with acceptable accuracy.

Another device is the flexible ruler consisting of a length of pliable plastic which can be bent to any required curve. Patience is needed to get the correct curvature, but once set the ruler is particularly useful for repetition work.



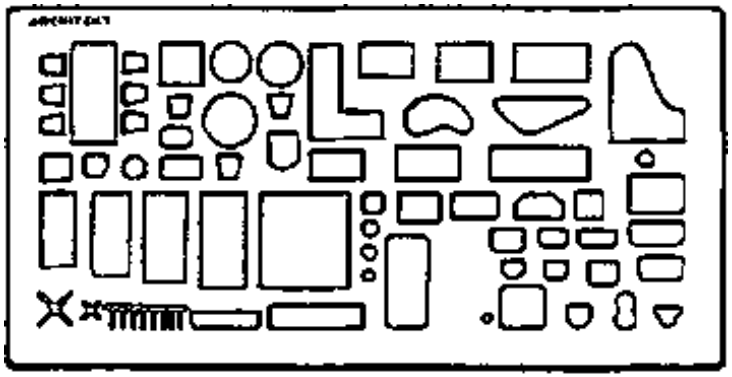
1.2.10 TEMPLATES

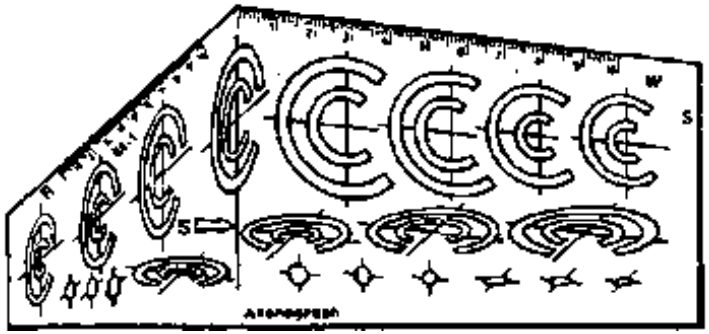
Small circles and ellipses, or parts there of, can often be more easily drawn with the help of plastic templates, which are available for figures of various metric and imperial sizes. There are also special templates available such as Symbol templates for:

- **Electrical installation**
- **Plumbing work**
- **Furnitures in different scales (1:200, 1:100, 1:50) etc.**

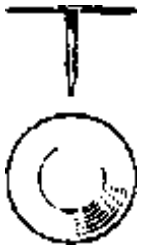
The main advantage of these templates is saving time.

Lettering guides, stencil-lettering, transfer-lettering. These are described later under LETTERING.





1.2.11 DRAWING PINS AND OTHER FIXINGS



DRAWING PIN

Small, flat - headed pins are best for fixing the paper to the board in most cases. They should be well made of brass with sharp round points. The type with the point stamped out of the head is of little use.

As the heads should hold the paper, the pins must be pressed well into the board. Four pins, one at each corner, should be sufficient if put in about 10 mm from the edge of the sheet. Whenever a drawing is repined the previous pin-holes, unless enlarged or torn, should be used again. Pins can usually be taken out easily by finger and thumb-nail but the blade of an old penknife can be inserted under the head to rise it up in the case of a stubborn one.

Other means of holding the paper to the board are spring steel clips, staples, and drafting tape. Clips are not always secure and sometimes get in the way of border lines, etc. Staples (the smallest size is best) are quick and convenient for fastening the paper and do not interfere the running of T - square and set square, but are a nuisance to get out. Drafting tape tends to be an in-tidy and rather messy fixing method except for short term use. For holding one piece of tracing paper over another, especially where the piece is relatively small and pins cannot be used because they would damage the sheet below as well as get in the way of T-square and set-square, transparent self adhesive tape, such as sellotape, is most suitable as it can be placed away on completion without effecting the paper.

1.2.12 MINOR ITEMS OF EQUIPMENT

In addition to the essential equipment already described the following should be readily available for use as the need arises:

- A good pair of scissors. Cutting knives for thick card and a lighter knife, of which there are many kinds, for thin cardboards and paper. In this connection, a metal ruler or straight edge is useful.

- A piece of cotton-cloth often washed or soft toilet paper for cleaning drawing pens etc.

- A handy scratch pad for notes, memos, rough calculations, testing pens, etc.

- Provisions for the safe-keeping or transporting of drawings.

- Soap, towels and a hand wash basin with water.

1.2.13 PRINTING PAPERS

Printing papers are used for making copies of drawings by photocopying processes. Copies are usually referred to as 'Prints'.

There are different types of photocopying processes (semi-dry dyeline or dry developed by ammonia gas). They all require a transparent or translucent negative e.g. a drawing or tracing media. This is passed in contact with diazo paper sensitive to ultra-violet light, through a machine in which it moves around a special tubular lamp emitting such light.

Where no machine is available the so called 'sun-print' method can be used. A timber or metal frame in accordance with the size of the drawing, covered with glass, the negative, printing paper, and sun: thats all you need for that method. For developing the same method is used as with a printing machine depending on the type of printing paper.

Dyeline prints can be made on different type of papers e.g. on airmail paper, which is very flimsy and

Dyeline prints can be made on different type of papers e.g. on airmail paper, which is very flimsy and difficult too.

1.2.14 TRACING PAPER, CLOTH AND FILM

These materials are specially treated paper and linen, and polyester film of transparent or semi-transparent nature; when placed over an original drawing they allow the lines underneath to be clearly seen and so copied or traced. The tracings thus made can then be used as negatives for the making of any number of further copies by the photo-printing processes. Drawings can of course be made directly on the materials in question. Almost all production drawings are negatives of one kind or another.

Tracing paper is most economical if purchased in rolls, but for final drawings it is increasingly the practice in offices and in schools of architecture to use pre-cut sheets in the A-sizes, often with printed border lines, title blocks, and sometimes modular or other grids, etc. Tracing paper can be roughly classified into three categories. thin, medium and stout, and two surfaces: smooth and rough. Different makes vary, however, so that it is difficult to particularise as to the most suitable; personal preference plays some part in selection. Thin papers are usually good enough for preliminary sketches but are too flimsy for final negatives.

Smooth surfaces are best for pencil drawings, as the rough kinds wear down the leads and tend to smudge and smear. For roughing out design and many other uses rolls in short widths are handy.

Tracing cloth is nearly always supplied in rolls, although short lengts can be purchased. The material is usually tinted blue, but white is also available. It is much more expensive than tracing paper, and is used mainly for master negatives in ink, but to a lesser extent than formerly as it is being superseded by film. Film is also expensive but has superior transparency and is stated to be stretch-proof and waterproof. It should be used in accordance with the manufacturers recommendations, for example in regard to type of backing sheets, preparation before inking, and use of erasers.

1.2.15 BACKING SHEETS

1.2.15 BACKING SHEETS

Drawing boards should be covered with backing sheets, over which the actual drawing paper or tracing media is placed to provide a firm, even working surfaces. This is particularly important if boards have become pitted, scored, damaged or worn.

Thick white cartridge paper is a satisfactory material, cheap enough to be discarded as it becomes soiled drawing pins can be used. Other and harder materials for backing sheets of a semi-permanent nature are thick, flexible plastic sheets usually with a green surface and cellulose-acetate sheets, which can be printed to standard lay-outs and grids.

In connection with backing sheets, a useful device to minimise the marking of drawings by rubbing of the T-square is the fixing of a strip of folded drawing or tracing paper -three or four thicknesses are sufficient - about 20 mm wide along the left-hand edge of the board. Fixing by drawing pins or staples at the ends only is best.

Drawing boards with an integral plastic surface do not normally require backing sheets, but for working on tracing paper a white under sheet is an advantage.

1.2.16 DRAWING PAPERS

There are two main classifications of drawing papers: 1) machine-made papers, such as cartridge, which are used for exercises and line drawings, and 2) handmade or mouldmade papers used for rendered drawings. Mention is made of other types of paper, where necessary, in later chapters.

1.2.17 CARTRIDGE

This is sold in rolls and A-size sheets, including pads of 30 sheets up to A2 size, as well as in the old standard sizes of antiquarian, double elephant, and imperial

standard sizes of antiquarian, double elephant, and imperial.

The paper is made in three thicknesses: 'thin', 'medium', and 'stout'. The thin is usually too flimsy to be of much value, it is also obtainable in rolls either unmounted or mounted on cotton or holland. The rolls can be conveniently cut into the various standard sheets or used for extra large drawings, and are probably more economical for the busy office.

Unmounted cartridge paper has right and wrong sides which can be distinguished by examination - the wrong side has a slightly but regularly pitted surface, and the cut edge of the sheet is usually turned down towards the wrong side.

The surface is fairly satisfactory for pencil drawing and the 'stout' quality will take ink moderately well, but it is not really suitable for colour washes except those of a most limited nature. White cartridge paper, which is usually of better quality, is to be preferred to that which is cream in colour.

1.2.18 HANDMADE AND MOULDMADE PAPERS

These are obtainable in sheets of standard sizes, and usually in three surfaces: HP (hot pressed) - smooth; NOT - medium; R - rough. The firstnamed is the kind most used for pencil and ink drawings and various types of renderings, particularly work in wash. All the papers can be 'stretched' and some can be obtained already mounted on stiff card or board. Water colour paper is also sold in pads.

1.2.19 PLASTIC-COATED CARD

For particularly fine pencil line and pen and ink drawings some draughtsmen prefer an extremely smooth plastic-coated card, such as CS 10. Great care is needed, however, in working with the medium as ink lines are easily smudged. Any removal of lines must be made by gently rubbing with a soft eraser.

handle, on medium paper, which is normal and suitable for general use on stout paper which is the best

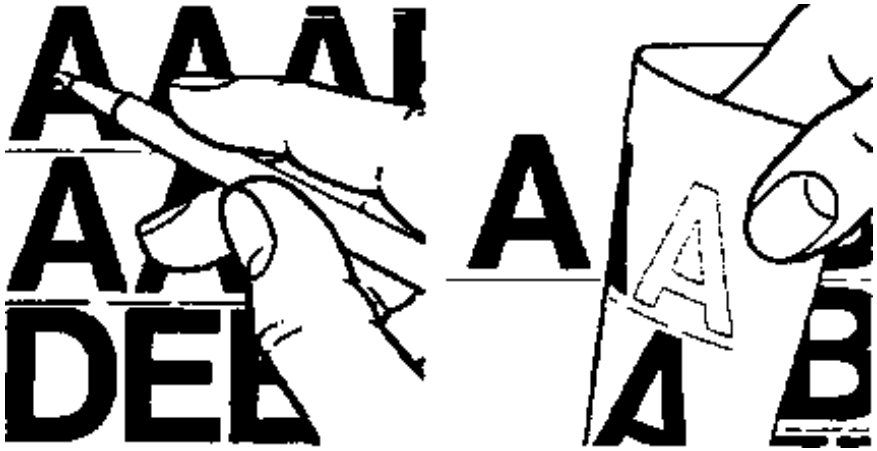
for mounting, colouring and presentation and cotton-backed paper.

Master copies or new negatives, from which further copies can be made, can also be produced on tracing paper, tracing cloth and polyester-based materials. Such copies are used for the adding of specialist information, as a basic for the preparation of working drawings and for supplying remote sites with means of obtaining local reproductions. All dyeline prints tend to fade on long exposure to daylight.

Mention may be made here of other methods such as:

- true - to - scale (TTS)
- photostats
- microfiling of drawings
- various kinds of ordinary office copies: thermographic, electrographic and diffusion transfer. Although these types of copies are developed for the copying of typed or printed documents they are excellent for the rapid copying of small drawings - or large drawings in parts which can be subsequently joined. For paper sizes (up to A 1) the dyeline process should be used.

1.3 LETTERING



Little progress can be made in draughtsmanship without attention being paid to lettering. Almost every

drawing has to be titled and many of them, particularly working or production drawings, require descriptive words and notes in order that they can be clearly understood.

Therefore, it is important for the draughtsman, to acquire as quickly as possible the habit of using good lettering on all his work.

And as the study of lettering also affords excellent practice in drawing, it is particularly suitable that it should be dealt with at an earlystage in the training.

1.3.1 PRINCIPLE OF LETTERING

1. Legibility depends on

a shape or form of each individual letter
b spacing of letters and arrangement of words
c the size and positions of the lettering according to relative importance.

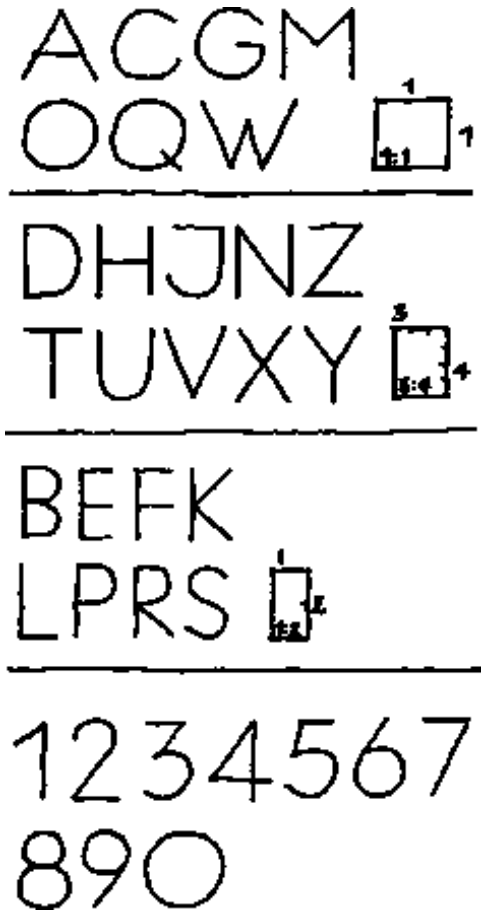
2. Suitability of shape to materials and method of execution, thus, lettering drawn in pencil on paper will differ in form to some extent from lettering incised in stone.

3. The Character must be appropriate to its purpose. The type of letters and general composition of the wording should be expressive of the quality or use of the drawing, e.g. decorative lettering is completely out of place on a working drawing, just as crude stencil lettering would be on a highly finished perspective drawing.

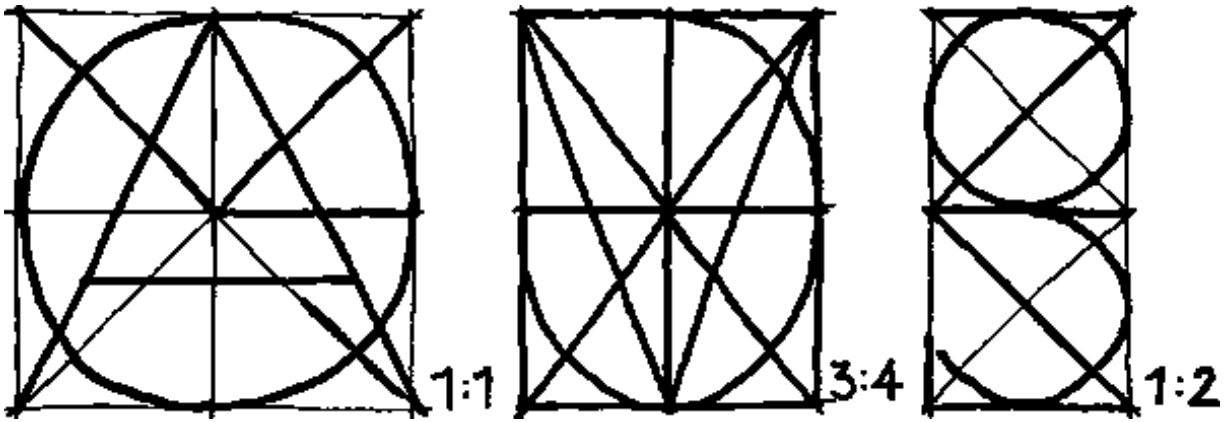
1.3.2 FREEHAND LETTERING

Absolutely sufficient for Architectural Drawings are 'block letters' with simple, vertical letters, represented with straight lines, circles or parts of circles. Important are the proportions of the letters

represented with straight lines, circles or parts of circles. Important are the proportions of the letters which are described in the following scheme.



In the following please find some explanations how to draw or to write capital block letters:



A take the area of a square. The horizontal stroke should be in the lower third. Other forms look too wide or too thin.

B Should be inwritten into two squares, which are on top of each other. The roundings are parts of a circle.

C consists of a three quarter (3/4) part of a circle

D has to be drawn in a full semi-circle

E again should be in written into two squares, which are on top of each other.

F is equal to E, without the horizontal bottom stroke. Both remains horizontal stroke should have the same length.

G has almost the shape of a circle. The horizontal stroke has to be drawn from the centre of the circle to the external line on the right hand side.

H is in-written in a rectangle with the proportions of 3:4. The horizontal line should be drawn right in the centre.

I is only a vertical line without any additions.

J is again in-written in a rectangle with the proportions of 3:4. The lower rounding consists almost of a semicircle.

K fits in an area of 2 squares, one on top of each other. The inclined strokes are drawn from the centre to the top and the bottom under 45.

L this horizontal stroke is half as long as the vertical line

M takes again the area of a square. It has to be taken care, that the lines at the left and the right are exactly vertical.

N is to be in-written in a rectangle with proportion of 3:4 three to four.

O has to be drawn as a full circle not oval or in the form of an ellipse.

P has a proportion of two to one, the upper part is drawn as a semi-circle with horizontal parts at the top and the centre of the vertical line.

Q is written like an 0 the inclined stroke has to be added under 45 in the right hand bottom corner.

R is similar to P from the centre of the letter an inclined stroke under 45° has to be added.

S is a difficult letter. It may help you to draw it, if you imagine that S is constructed out of two circles, one on top of each other, and which lines are not completely closed.

T fits in a rectangle with the proportion three to four.

U consists of a semi-circle at the bottom, the two ends extend in vertical lines.

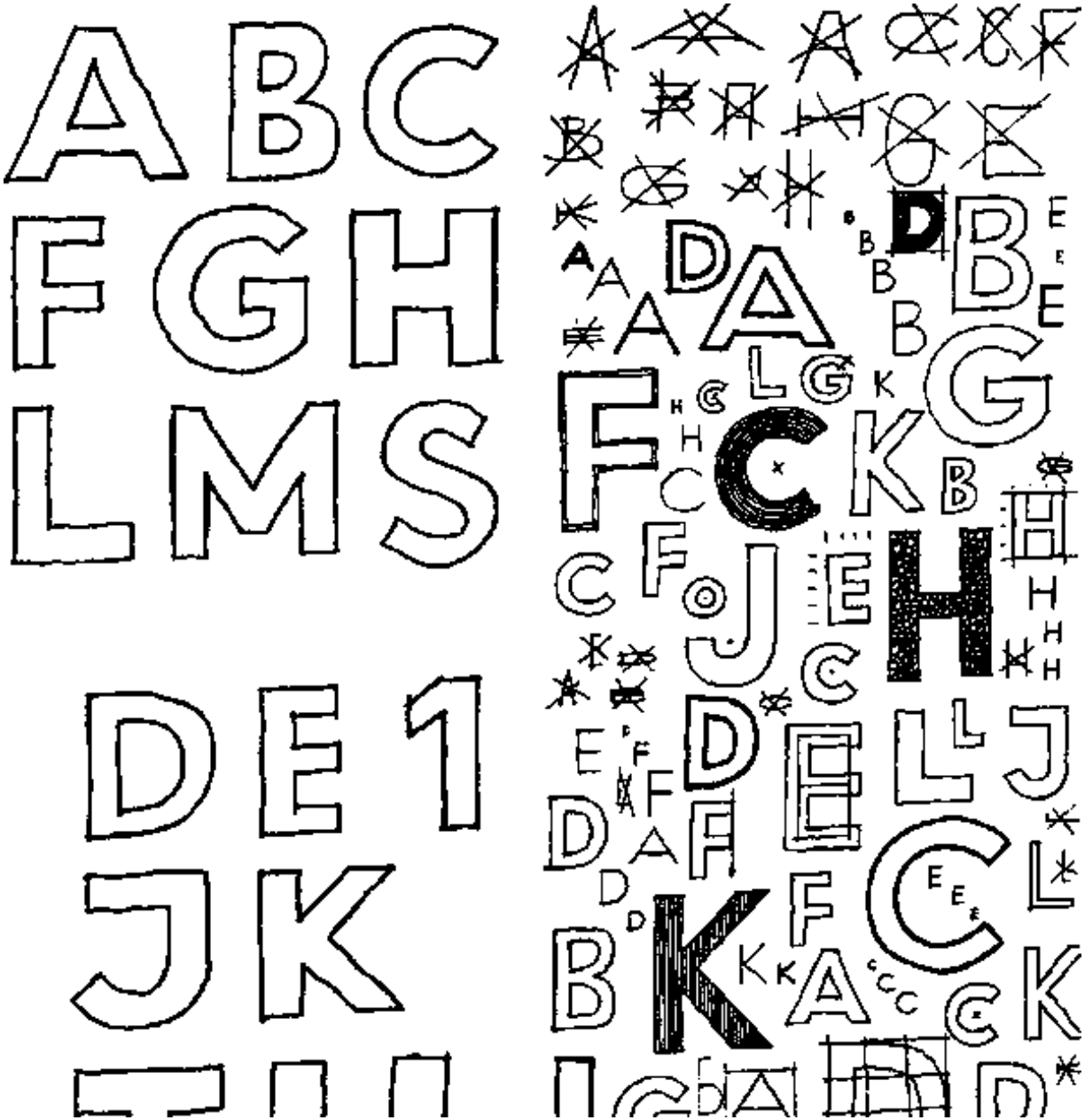
V again fits in a rectangle with proportions three to four.

W draw V twice next to each other, fitting in a square.

X all have to be drawn in a rectangle

Y with proportions of three to four.

Z


A B C
F G H
L M S
D E 1
J K

FREEHAND LETTERING

Writing numerals we have to follow the same rules, their elements are straight lines, circles and parts of circles.

1 The small inclined stroke should never be horizontal, otherwise it could be mixed up with 7.

2 Is in the upper part a semi-circle which continues as a inclined line under 45 downwards.

3 Is only in the lower part a semi circle the upper parts consists of an inclined stroke under 45° with a horizontal stroke on top.

4 ends at the top as a triangle

5 the upper stroke on the left hand side has to be drawn exactly vertical, other wise it might be mixed up with 3

6 should be drawn as full circles with + an tangential inclined stroke under 9 45° up or downwards.

7 it is advisable to draw a short horizontal stroke

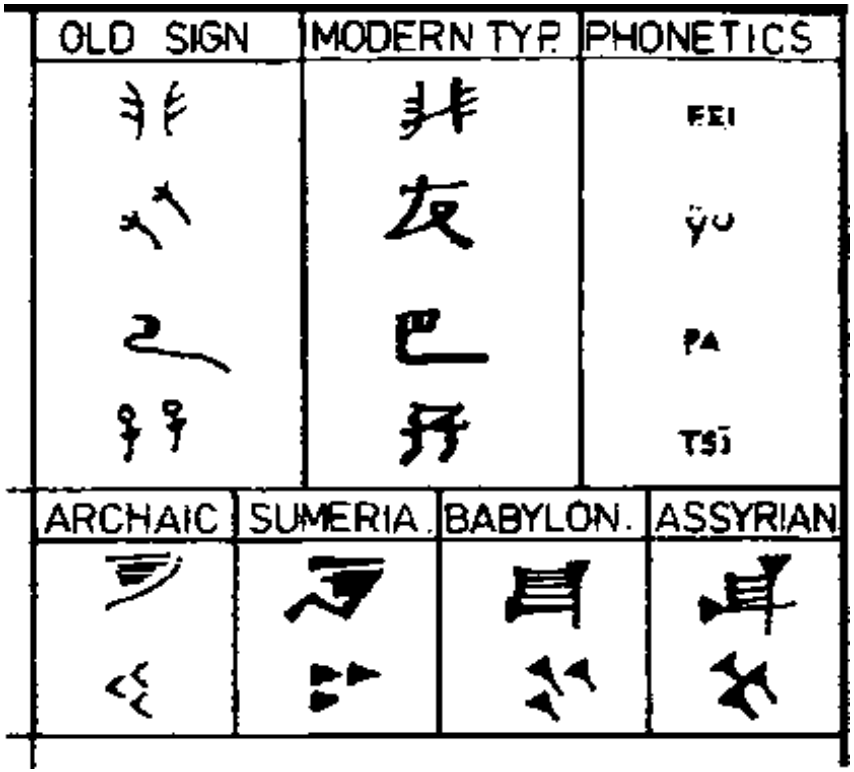
8 crossing the inclined line at the centre, in order to avoid a confusion with 3. consists of 2 full circles, one on top of each other

ROMAN

Practicing capital block lettering, always try avoid inclined letters or unnecessary decorations. The same passes for the numerals.

1.3.3 TYPES OF LETTERS

Writing is a sort of 'language of sings' and it serves the purpose of fixing informations. About 5000 years ago people in China, Mesopotamia and Egypt have started to write down their informations. As letters, they used signs and symbols. Later on these sings and symbols have been changed to letters and numerals of different types and even the types of letters and numerals have been modified up to the present day.

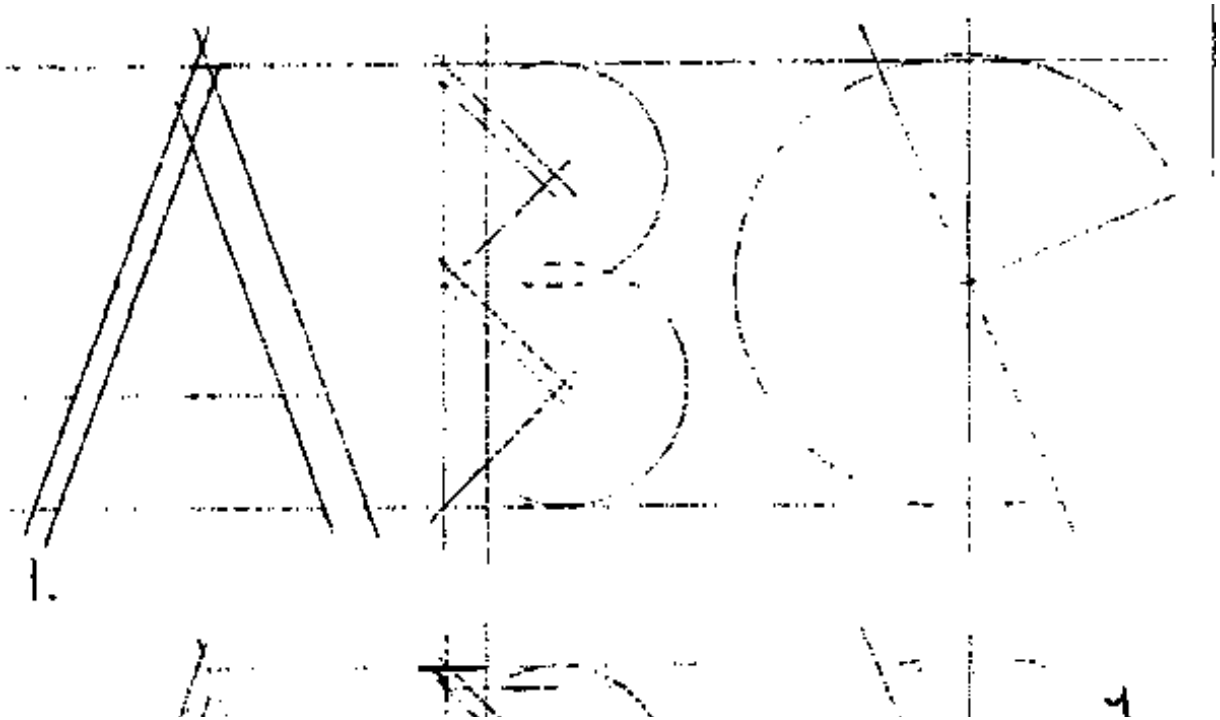


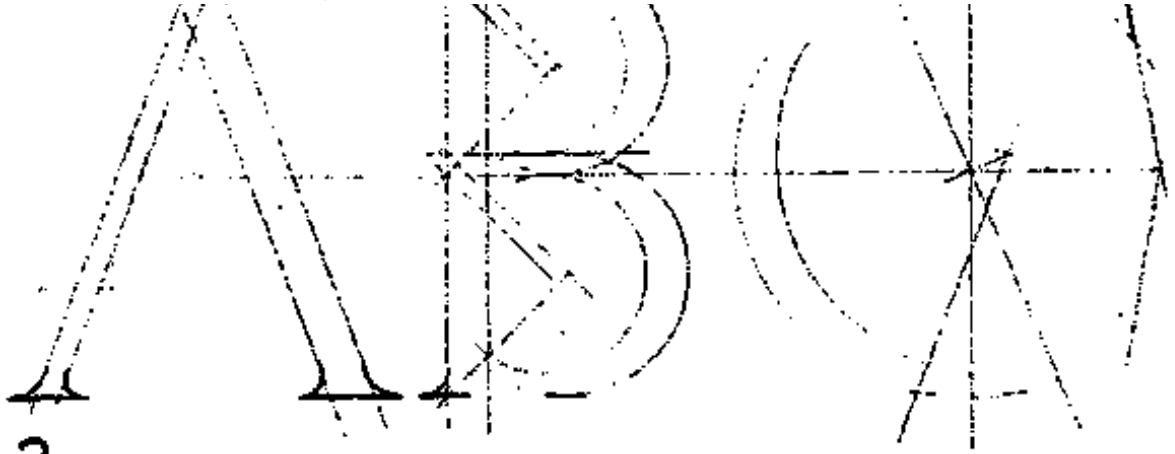
1.3.3.1 The Roman Alphabet

In architectural drawings the historical types of letters should not be used except for special purposes, e.g. as decorative lettering in perspective drawings or for titeling in stock-taking drawings of historical buildings. However, there is one alphabet in the history which should be studied carefully. Our modern lettering is derived from that of the ROMANS, and the generally accept as standard is the lettering which was carved on Trajan's Column, Rome, in the second century. A.D. The forms of these letters have now become familiar in printing types and flat letters, and the Roman alphabet will always be the basis of good lettering.

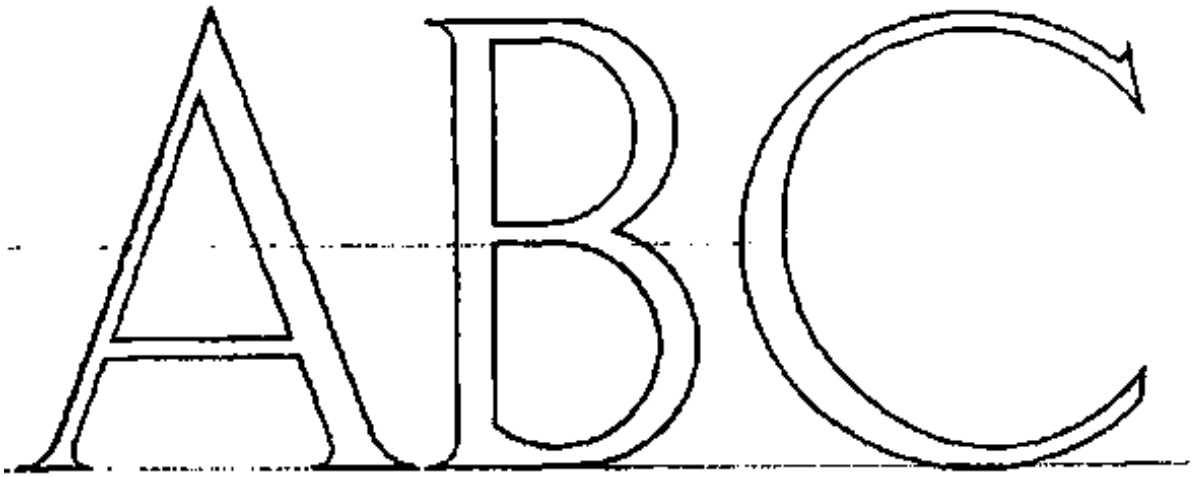
The construction of each letter is shown and should be understood:

STAGES IN SETTING UP ROMAN LETTERS





2.



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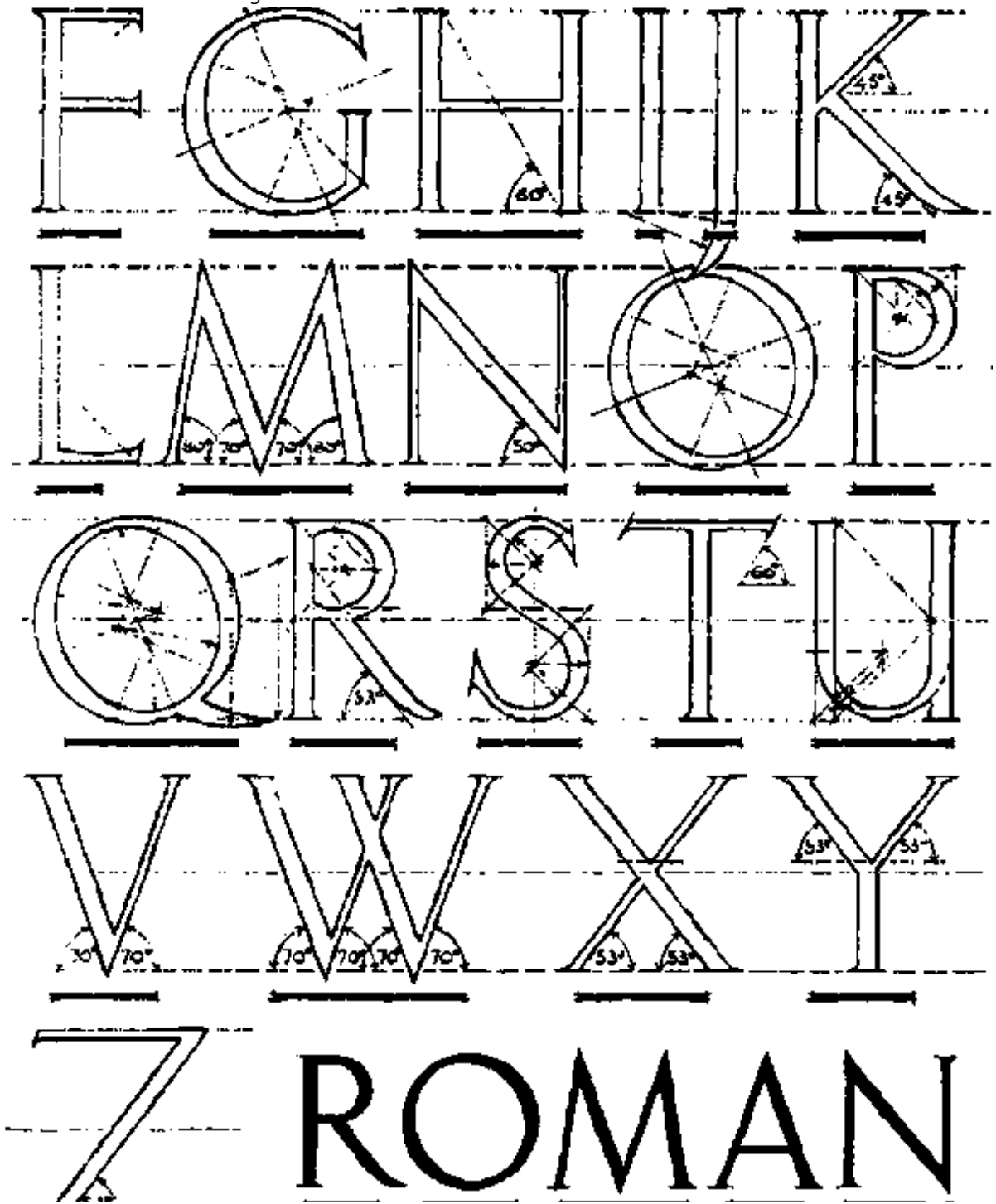
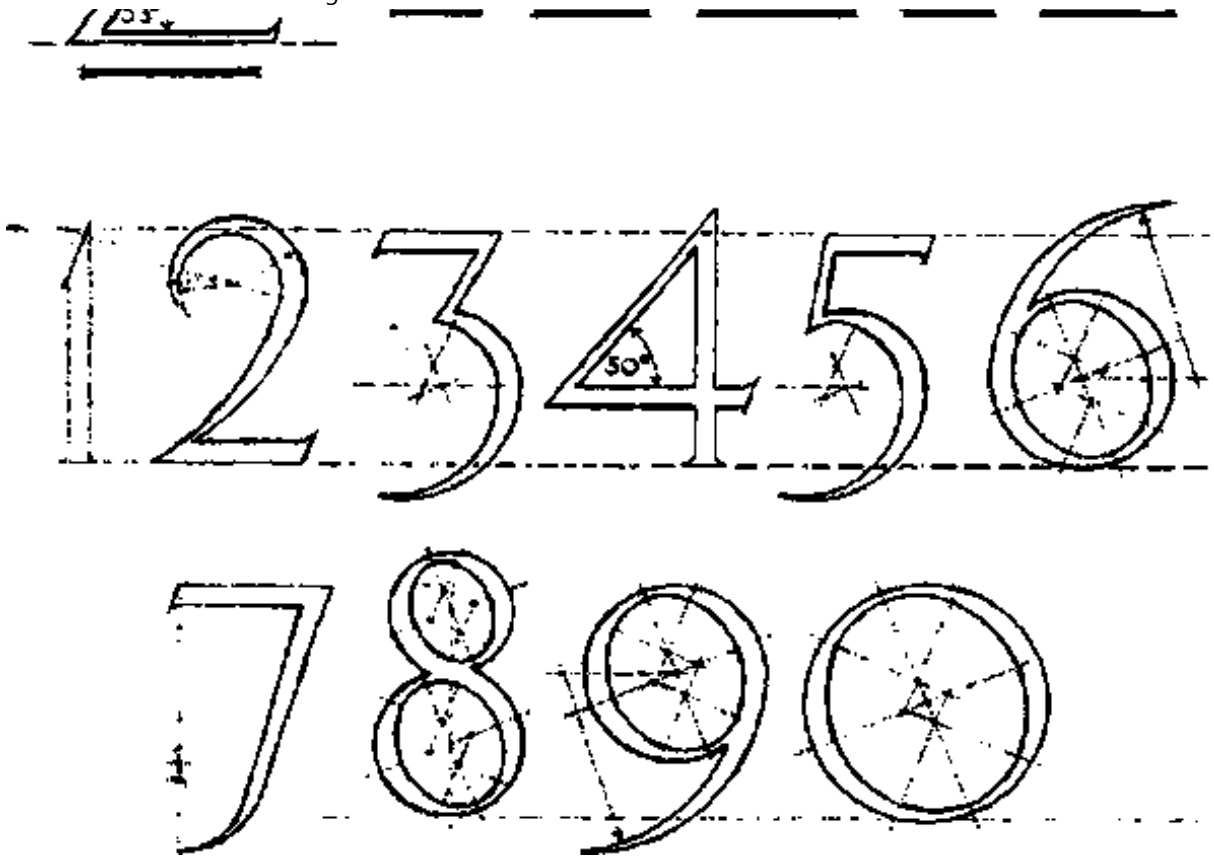

ROMAN



1.3.3.2 Sans Serif Letters

In more recent times, letters without serifs, known as 'sans serif alphabets' have been designed and are much used because of their simplicity, clarity and ease of execution. The fig. shows the setting-out of such an alphabet, suitable for the titling of drawings, etc.

1.3.3.3 Inclined Lettering

Sometime it is necessary to distinguish between two types of lettering, e.g. names of rooms on plan and notes regarding construction. While this might be effected by variations in size, it may be more

notes regarding construction. While this might be effected by variations in size, it may be more convenient to use upright lettering for the one and inclined lettering for the other.

The fig. shows inclined lettering sloping uniformly at an angle of about 75 degrees. The slope should not be exaggerated.

1.3.3.4 Script Lettering

The figure shows individually formed capitals, numerals and lower case letters which can be written in pencil or pen. If well executed it is an attractive way of labelling certain types of project presentation drawings.

1.3.3.5 Stencil Lettering

Stencil letters can be used for titling drawings and are a means of achieving uniformity at negligible cost when a number of drawings are similarly titled. The fig. shows an example and how a stencil is used. Special stencil ink can be used or indian ink or opaque colour, etc. The brush must be almost dry, and the plate must be held down perfectly flat and firmly for good results. The description 'stencil lettering' is also commonly applied to guided pen lettering.

1.3.3.6 Guided Pen Lettering

The figure shows examples of the letters produced by means of special pens and guides. Such lettering is used extensively for drawings of all kinds, particularly working drawings and details. Its popularity is due to its legibility, speed of execution, and the uniformity which it gives, especially when different draughtsmen are working on the same set of drawings.

Both upright and sloping guides are obtainable for capital, lower-case letters, and numerals in a variety of sizes with corresponding pens. Also drawing pens like 'graphos' or 'rapido-graphs' can be used.

Used carelessly, this lettering is as bad as the worst freehand and a certain amount of practice is necessary to obtain lettering which is pleasing in appearance as well as very legible.

A few hints are

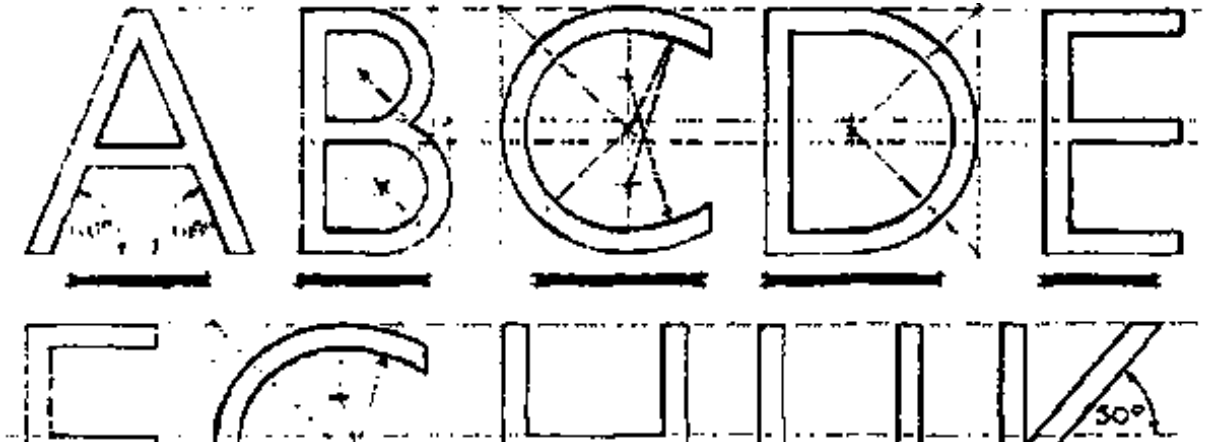
1) only a small quantity of ink should be put in the pen,

2) keep the pen perfectly upright in use,

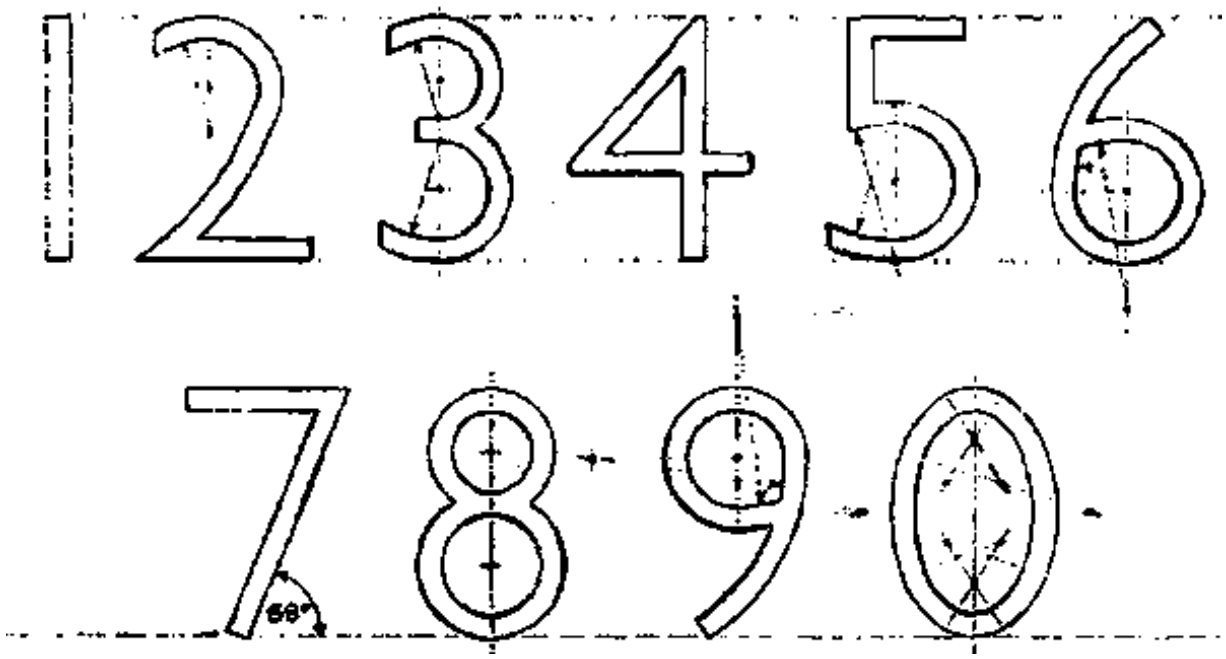
3) wash the pen out immediately after use and see that the wire is pushed well home

4) keep the guides clean, do not let the ink clog the letters. A special cleaning liquid can be obtained for pens and guides.

Always rule faint guide-lines for letters and consider the spacing before starting. Sometimes it may be advisable to make a trial setting-out.




45°
53°
53°
60°
50°
50°
68°
68°
68°
68°
53°
53°
53°
SANS SERIF



ABCDEFGHIJKLMNOPQ
RSTUVWXYZ 1234567890

ABCDEFGHIJKLMNOPQ
RSTUVWXYZ 1234567890
abcdefghijklmnopqrstuvwxyz

INCLINED LETTERING

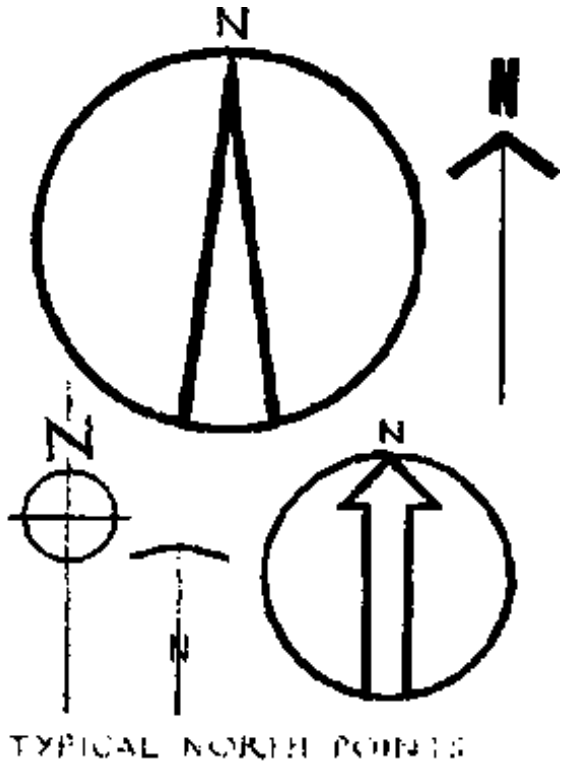
ABCDEFGHIJKLMNOPQ
RSTUVWXYZ 1234567890
abcdefghijklmnopqrstuvwxyz

SCRIPT LETTERING

GENERAL NOTES SHOULD NOT BE SCATTERED OVER THE DRAWING BUT SHOULD BE NEATLY ARRANGED IN PANELS OF REGULAR SHAPE

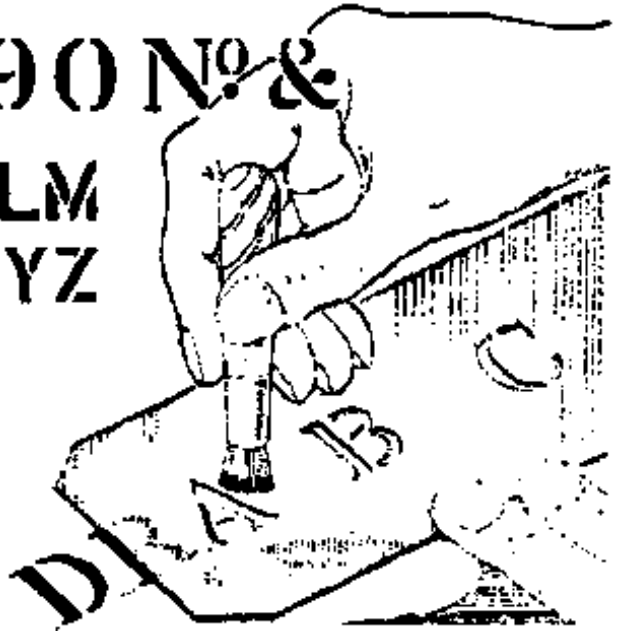
THEY SHOULD BE BROKEN INTO PARAGRAPHS FOR EASE IN READING

THE LETTERS AND WORDS SHOULD NOT BE CRAMPED NOR SO W I D E L Y SPACED AS TO BECOME ILLEGIBLE



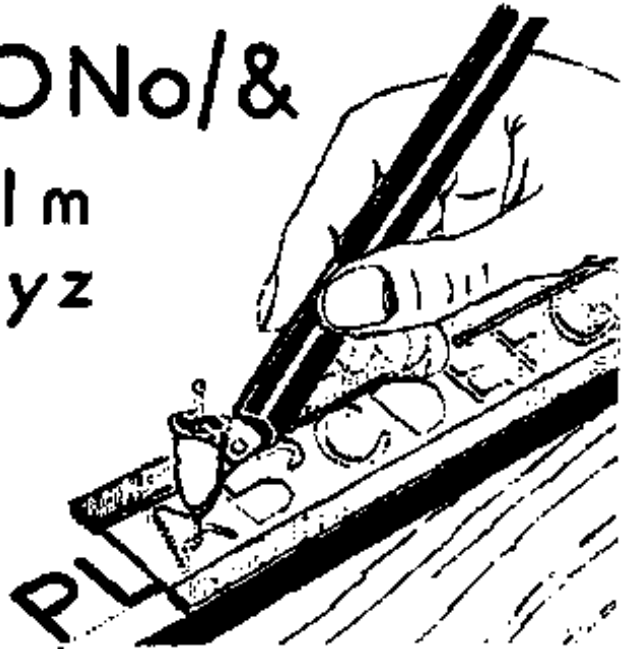
NOTES

ABCDEFGHIJKLM
NOPQRSTUVWXYZ
1234567890 Nº &
ABCDEFGHIJKLM
NOPQRSTUVWXYZ
1234567890 Nº &

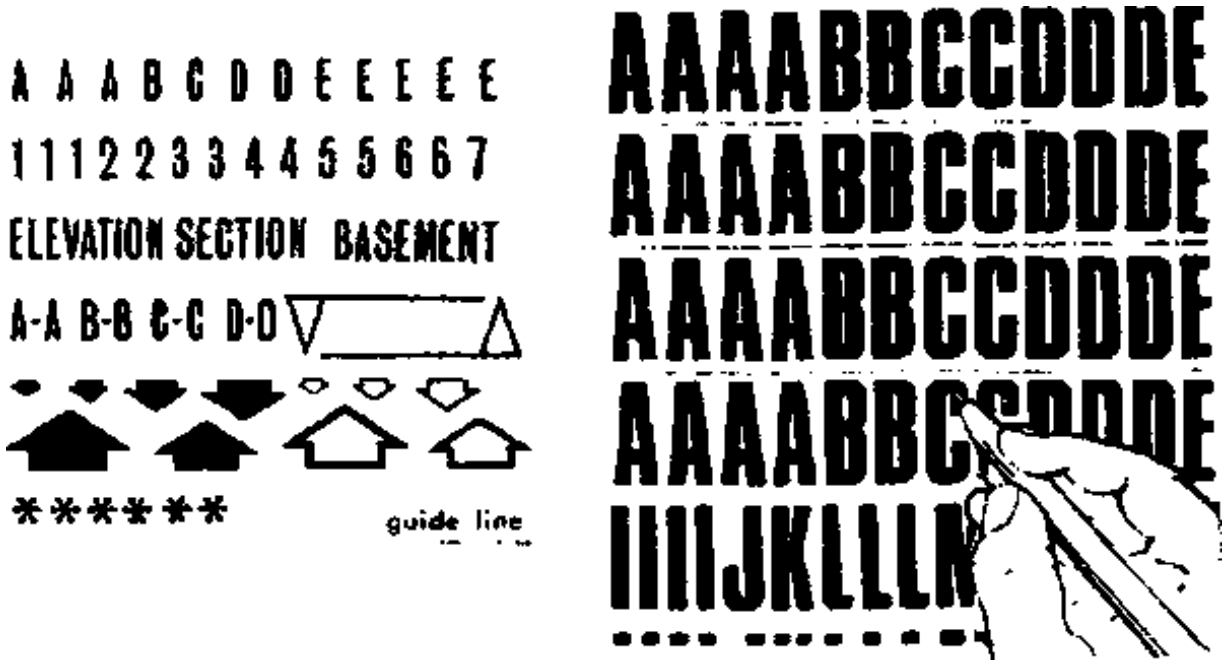


STENCIL LETTERING

ABCDEFGHIJKLMN
OPQRSTUVWXYZ
1234567890No/&
abcdefghijklm
nopqrstuvwxyz
1234567890No



GUIDED PEN LETTERING



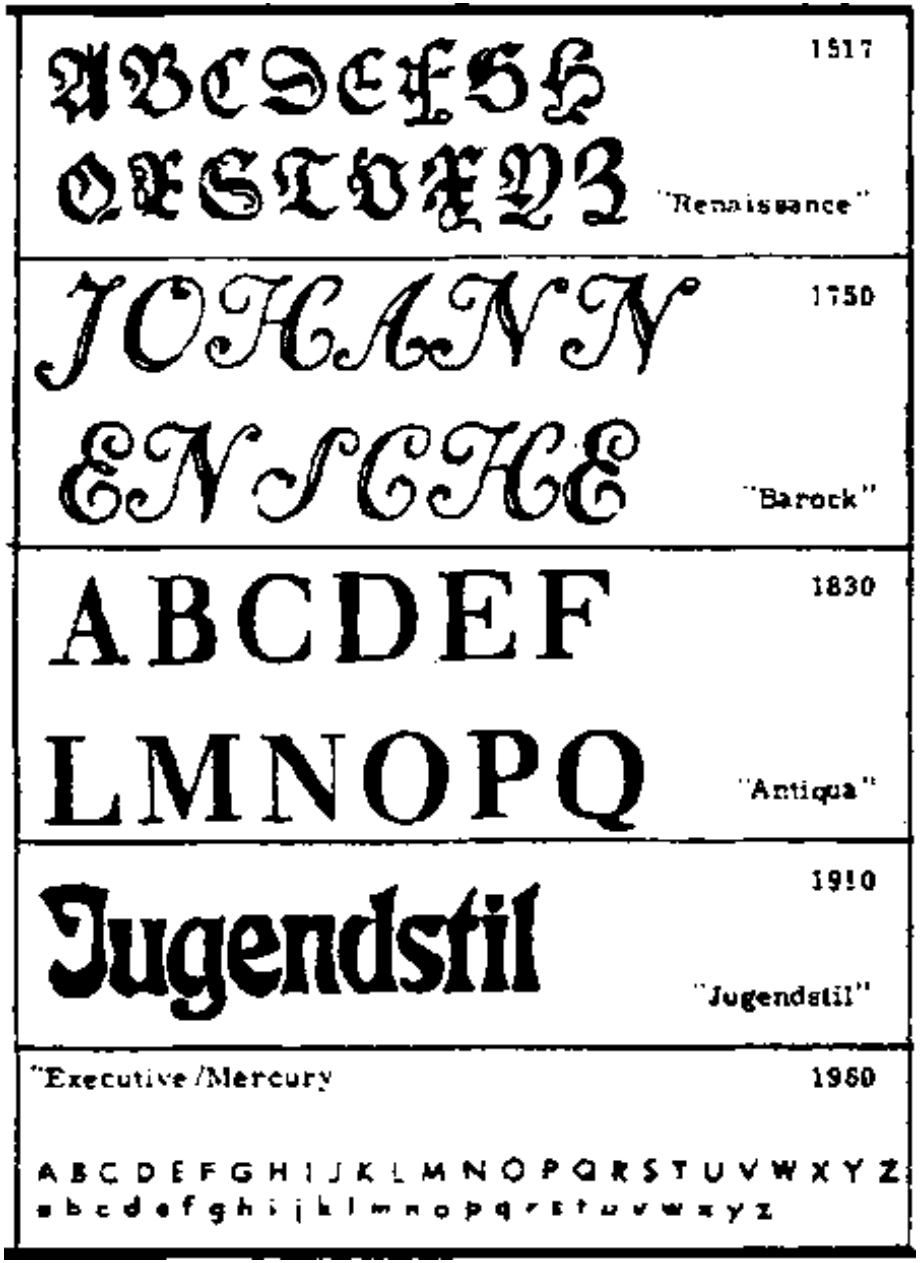
PRESSURE TRANSFER LETT.

1.3.3.7 Pressure-Transfer Lettering

This kind of lettering, also known as pressure sensitive, is extensively used on all kinds of architectural and planning drawings, particularly for titling and labelling. It is reasonably quick and most effective. It's only serious disadvantage is that it is rather expensive, especially as many letters of each sheet are never used.

The letters are printed on thin plastic sheets, usually 254 mm × 381 mm, although smaller sheets are available, in a variety of types of alphabets, numerals, punctuations, etc. and are protected by silicon-treated backing sheets. A typical example is illustrated. The characters can be applied to any smooth dry

treated backing sheets. A typical example is illustrated. The characters can be applied to any smooth dry surface in any desired arrangement. Having decided on the type and size of letters to be used and estimated the placing on the drawing - this requires some experience - the technique of application is to remove the backing sheet and to position the first letter, on a previously ruled guide line if there are to be a series of letters, and then to shade across the letter from top to bottom using a ball-point pen with moderate pressure. This action is continued until the letter appears lighter, which shows that it has been transferred to the surface of the paper. The lettering film is carefully peeled back until the letter is exposed, it is then moved to position the next letter and the transfer procedure is repeated. On completion of -a word, or every few letters, even after each letter of the larger sizes, the backing sheet should be laid over and additional firm pressure applied by the finger or the edge of a scale in order to obtain maximum adhesion. When application is made to tracing paper or film from which dyeline prints are to be obtained it may be necessary to spray the letters with a matt fixative or they will be damaged in the printing process. As the spray will also 'fix' any parts of the drawing on which it may fall, it is advisable to vonfine the area by masking.

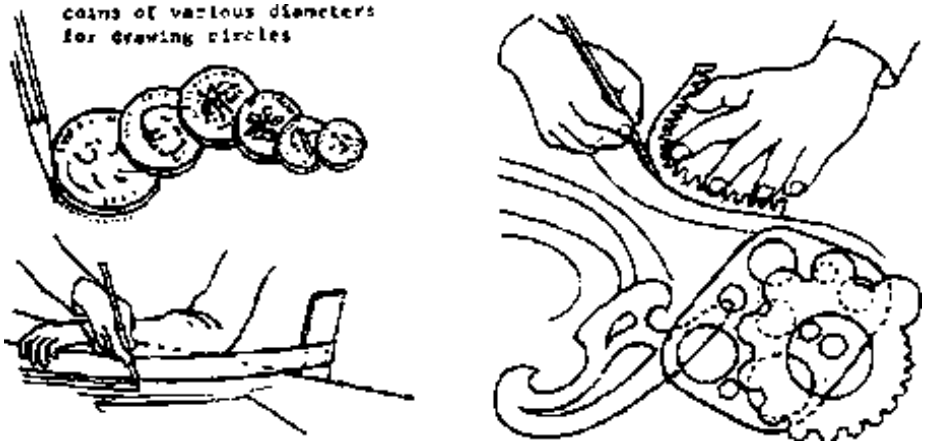

1517
"Renaissance"
1750
"Barock"
1830
"Antiqua"
1910
"Jugendstil"
"Executive/Mercury
1960
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
a b c d e f g h i j k l m n o p q r s t u v w x y z

Points continually to be kept in mind are: avoid accidentally pressing any other letter when making a transfer; keep sheets flat and unfolded and uncreased in a box, wallet or stout envelope away from

excessive heat or humidity when not in use. However, the accidental transfer of a letter to drawing or tracing materials is not usually a serious matter as it can be removed by scraping gently with a razor blade. Incomplete letters can be patched by applying part of another letter or can be made good in indian ink.

Complete words such as PLAN, ELEVATION, EAST, WEST etc. at a size suitable for the majority of production drawings, are available, as are N points, direction arrows, section lines, electrical symbols and other useful architectural characters.

1.4 LINEWORK AND DIMENSIONING



1.4.1 TYPES OF LINES

In architectural drawings five different types of lines are broadly used:

1 continuous lines

2 broken lines
3 broken and
4 dotted lines dotted lines and

5 freehand lines

The thickness of these lines is due to their functions in the drawing as well as to their scale and their is classified into

- **thick lines**
- **medium lines and**
- **thin lines**

The following schedule shows type and thickness of lines as well as their use in architectural drawings.

PROPORTION of thickness:

thick	medium	thin
2	1	0,7

Practice the exercises shown in the following as PENCIL drawings with a thickness of lines from 0,18 mm to 1,4 mm for CONTINUOUS lines as well as for BROKEN and DOTTED lines. Also, the correct and neat drawing of lines meeting or crossing under right or inclined angles should be practiced.

1.4.2 PENCIL DRAWING

- **Use pencils of 2 H to 4 H**

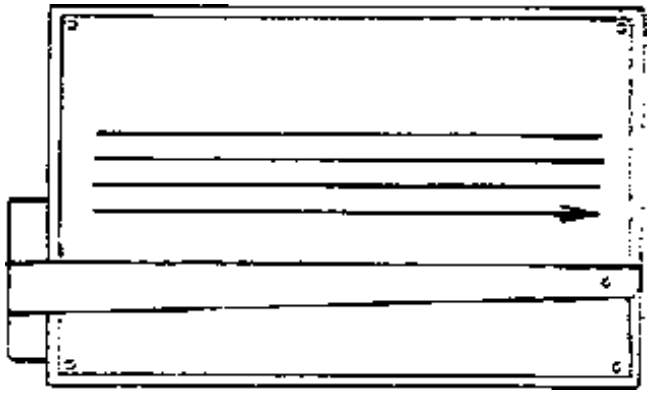
- For thicknesses from 0.18 to 0.5 mm ONE line is sufficient

For thicknesses from 0.7 to 1.4 mm (or thicker) a DOUBLE line with the required distance has to be drawn, which has to be filled in afterwards.

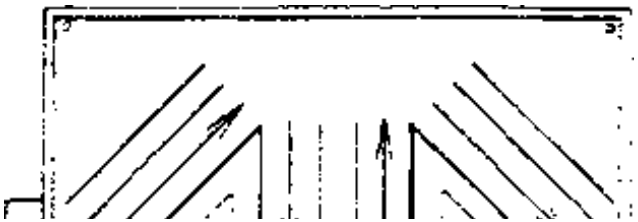
- All corners and crossings of lines have to be drawn very exactly.

- It is important to take care that the thickness of the line is INCLUDED with the area of the drawn figure, so that the drawn EXTERNAL dimension is equal to the REQUIRED measurement.

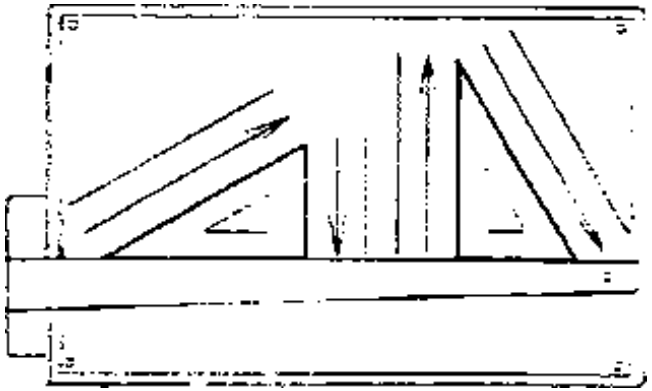
- Draw with the pencil as close as possible along the T- or set-square under an inclination of about 60°



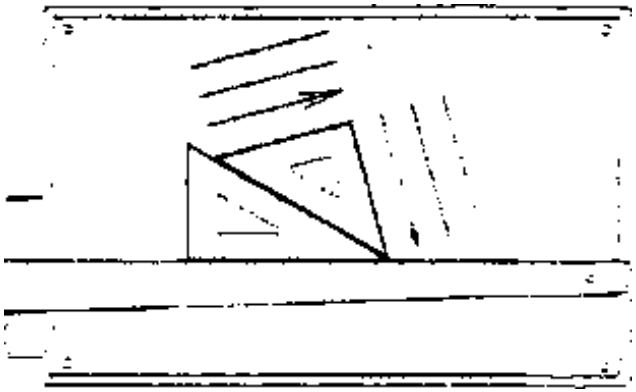
1. HORIZONTAL



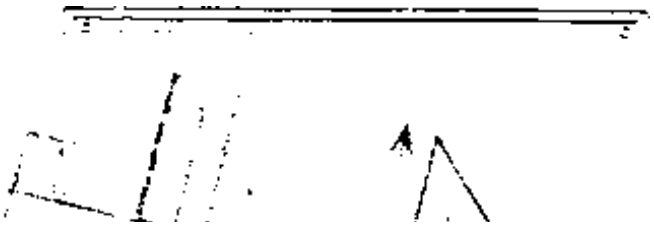
2. VERTICAL AND 45°

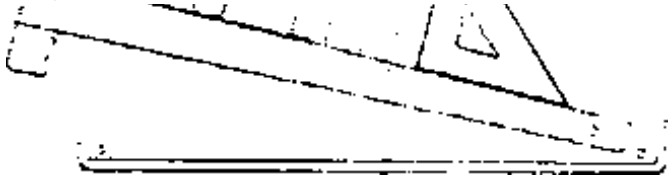


3. VERTICAL, 30° AND 60°



4. 15° AND 75°

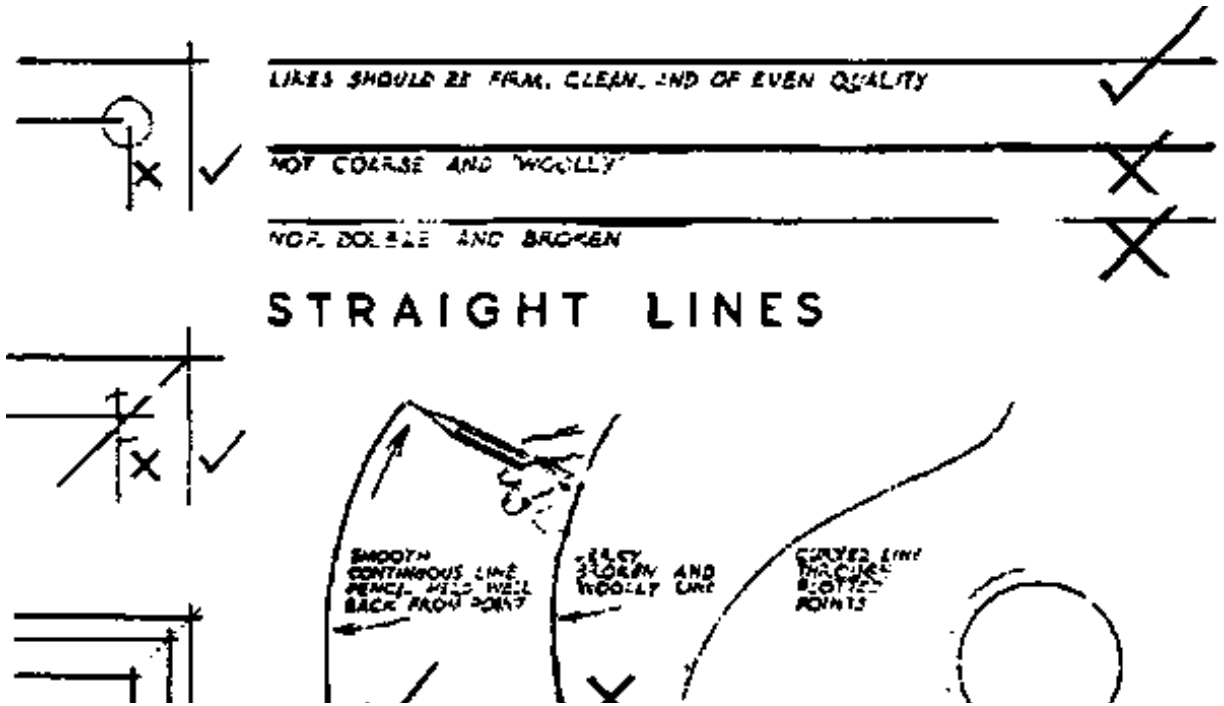




5. PARALLEL TO ANGLE LINE

TYPE OF LINES				USE
A	CONTINUOUS THICK		1.0 mm 07 mm	VISIBLE LINES DETERMINATION OF CUT BUILD, MEMBERS, WALLS ≥ 15 cm, CONCRETE, etc.
B	CONTINUOUS MEDIUM		0.5 mm 0.35 mm	VISIBLE LINES DETERMINATION OF ELEVATIONS OF WALLS AND OTHER BUILD. MEMBERS
C	CONTINUOUS THIN		0.25 mm 0.18 mm	DIMENSION AND HATCHING LINES
D	BROKEN and DOTTED THICK		1.0 mm 0.7 mm	SECTION PLANES
E	BROKEN and DOTTED MEDIUM		0.5 mm 0.35 mm	CENTRE LINES, AXES, etc. (big scale)
F	BROKEN and DOTTED THIN		0.25 mm 0.18 mm	CENTRE LINES AXES, etc. (small scale)

G	BROKEN MEDIUM		0.5 mm 0.35 mm	HIDDEN OR OVERHEAD ELEVATION LINES, PROPOSED ADDITIONS AND ALTERATIONS
H	BROKEN THIN		0.25 mm 0.18 mm	SCREEN OR RASTER LINES
I	DOTTED		0.35 mm 0.25 mm	PARTS TO BE DEMOLISHED, MINOR BUILD. MEMBERS
J			0.35 mm 0.25 mm	ROLLED STEEL JOISTS PIPELINES etc.
K			0.35 mm	BREAKLINE



FREEHAND CURVES

- In order to keep the drawing CLEAN:

. Use clean equipment and good pencils

. keep hands clean and touch the paper with your fingers as little as possible

. avoid unnecessary rubbing

. sharpen pencils away from the drawing board or table

. make any erasures carefully and remove all rubber crumbs

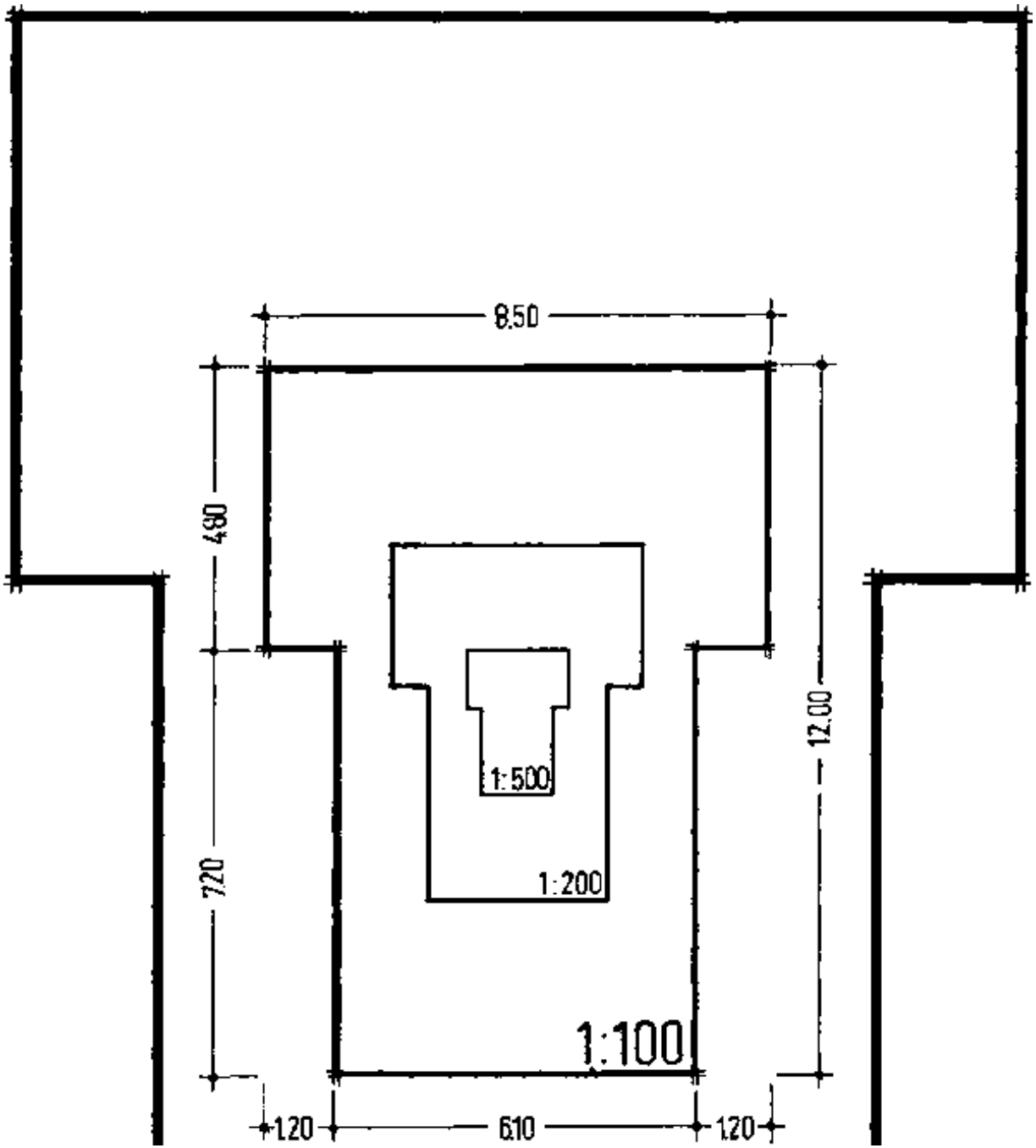
. if much drawing is to be done on several small areas of the sheet, cover the whole of it with tracing paper in which suitable 'flap windows' through which to work can be cut

1.4.3 INKING - IN

Follow a certain sequency in the procedure of INKING-IN of a drawing. Ink-in:

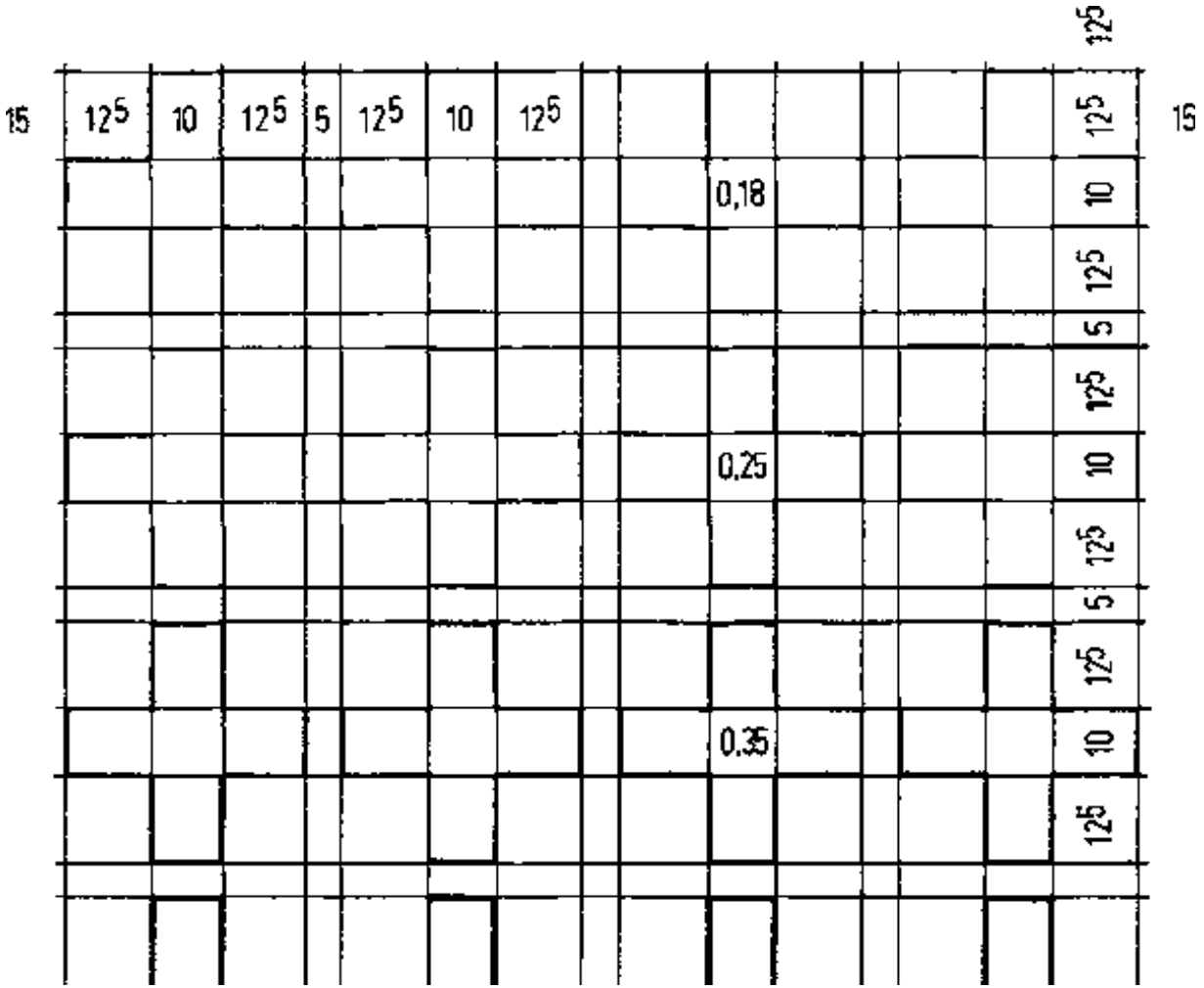
1. **All centre lines**
2. **All circles and arcs**
3. **All horizontal lines**
4. **All vertical and inclined lines**
5. **Hatchings and black-in sectional parts**
6. **All dimension lines, freehand lines, arrows and arrowheads**
7. **Lettering, dimension figures, notes**

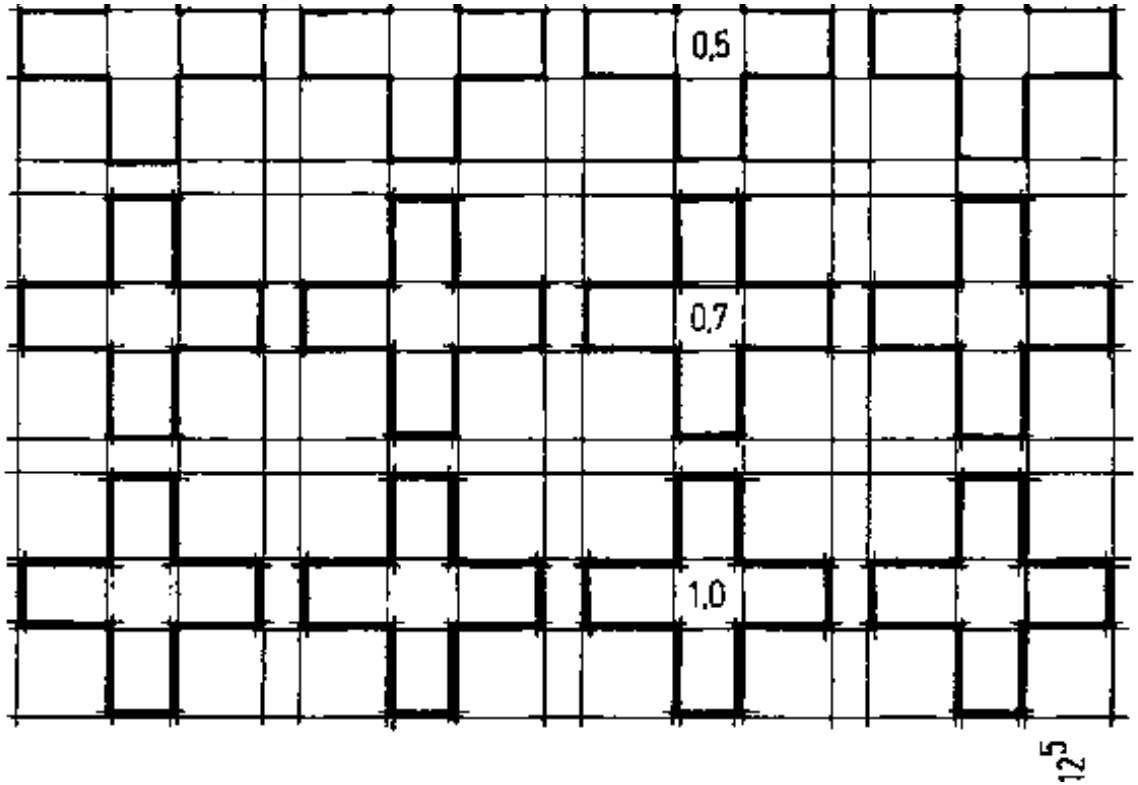
8. Titles etc.

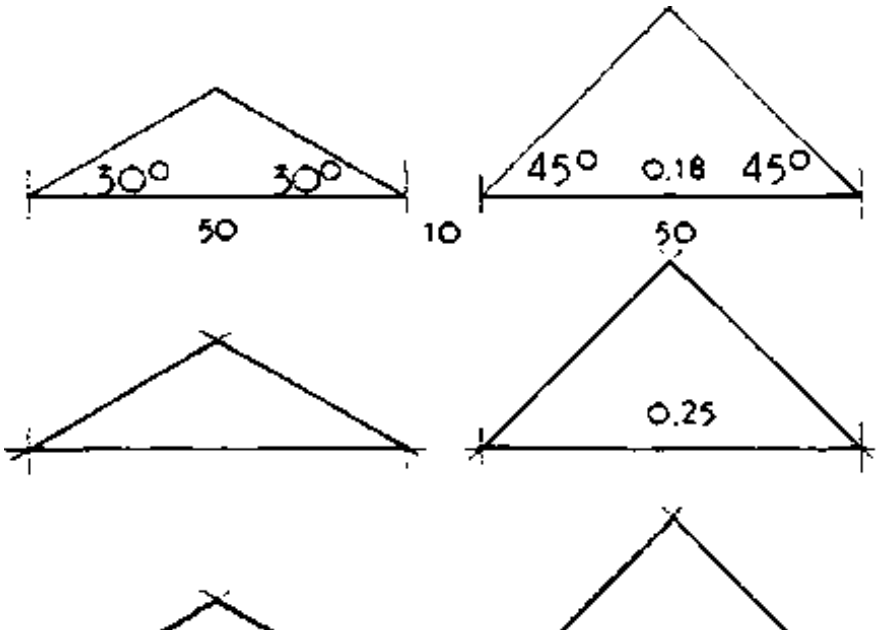


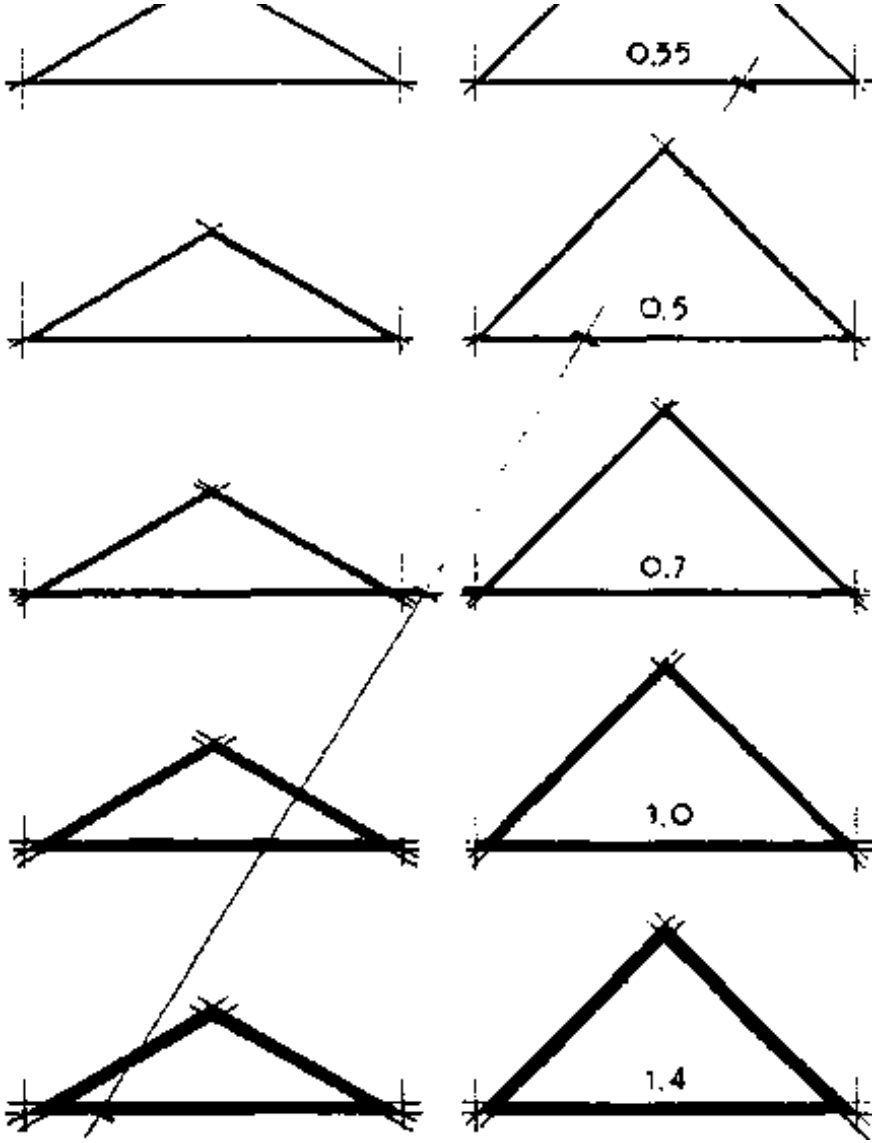
1:50

PLAN OF A BUILDING




0,5
0,7
1,0
125


30°
30°
50
10
45°
0.18
45°
50
0.25



1.4.4 BASIC RULES OF DIMENSIONING

- The METHOD of dimensioning is due to the type of the drawing (Sketch-, design-, working-, detail drawing etc)

- All for clarification of that particular drawing required measurements have to be indicated

- In FLOOR PLANS there are three main types of dimensionings:

1. **Dimensioning of openings, columns and piers,**
2. **Dimensioning of axes of openings**
3. **Dimensioning with coordinates**

- Different alternative DETERMINATIONS of dimension lines are indicated in the figure

1.4.4.1 Types of Dimensions

- OVERALL DIMENSIONS indicate the over all LENGTH, WIDTH and HEIGHT. Each object has three overall dimensions.

- DETAIL DIMENSIONS indicate the size of each part or detail of the object

NOTE: dimension lines and extension lines (they indicate the limits of a dimension and extend this dimension to a convenient place on the drawing) should never cross!

Therefore the smallest dimension lines are placed nearest to the view.

Overall dimensions are drawn outside the detail dimensions.

1.4.4.2 Placement of Dimensions

- There are plenty of rules concerning the dimensioning of crawings, and some of them are

contradictory. In case two rules conflict, choose the most logical and practical solution.

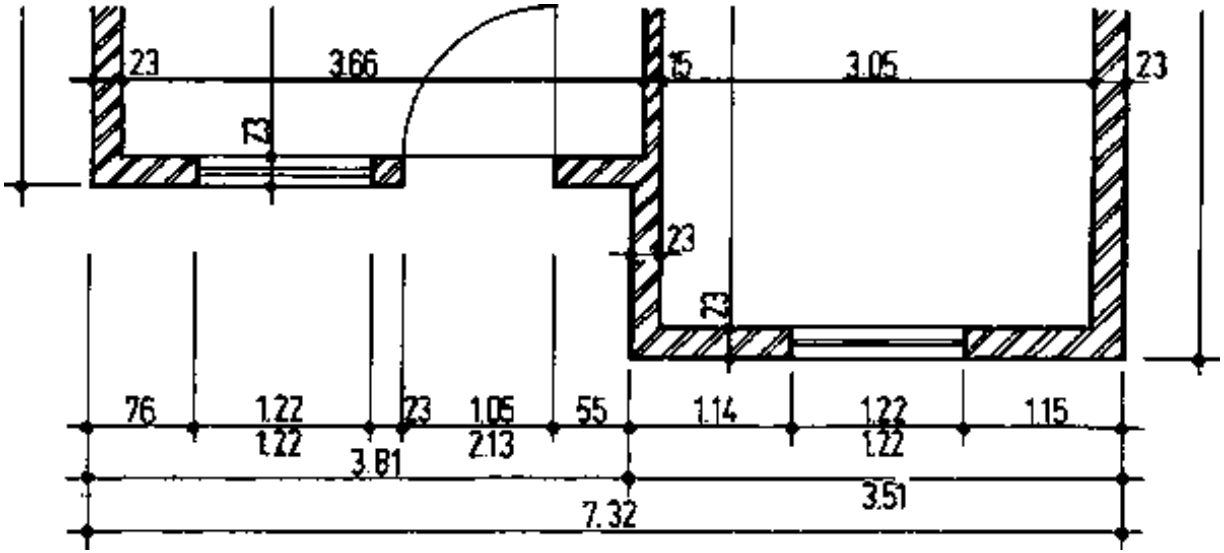
- Dimensions should be placed so that they can be read from the bottom-side or from the righthand-side of the drawing.

- Normally dimensions should be placed OUTSIDE the outer lines of the views, close to the contour. The should be placed INSIDE, if this could avoid long extension lines.

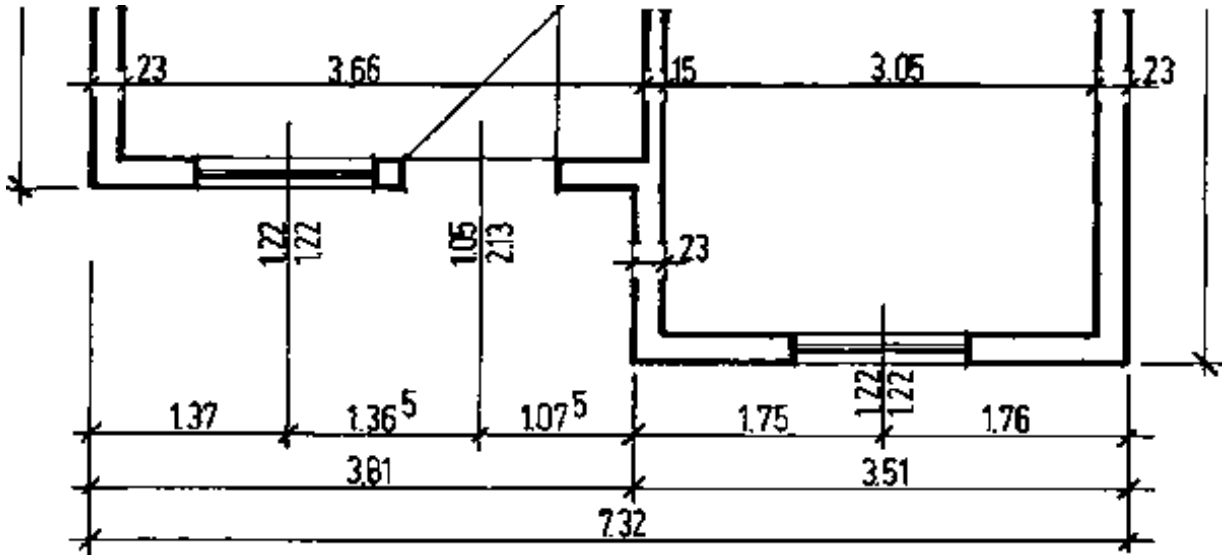
- Place dimensions in the way they are likely to be measured during the construction work.

- Place dimension lines in line

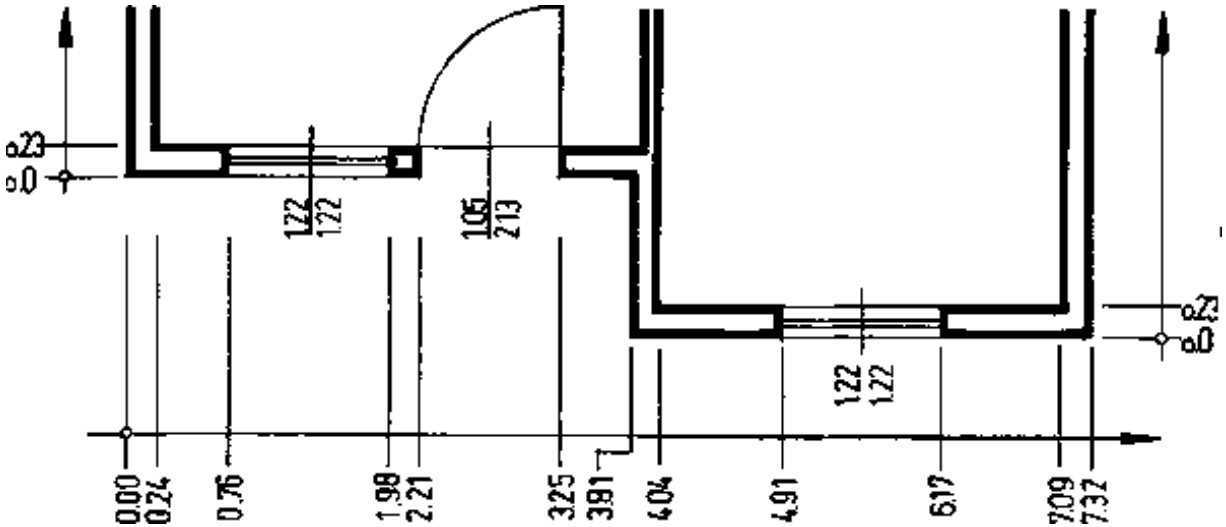
- For dimensioning CIRCLES or PARTS of CIRCLES refer to the figure.



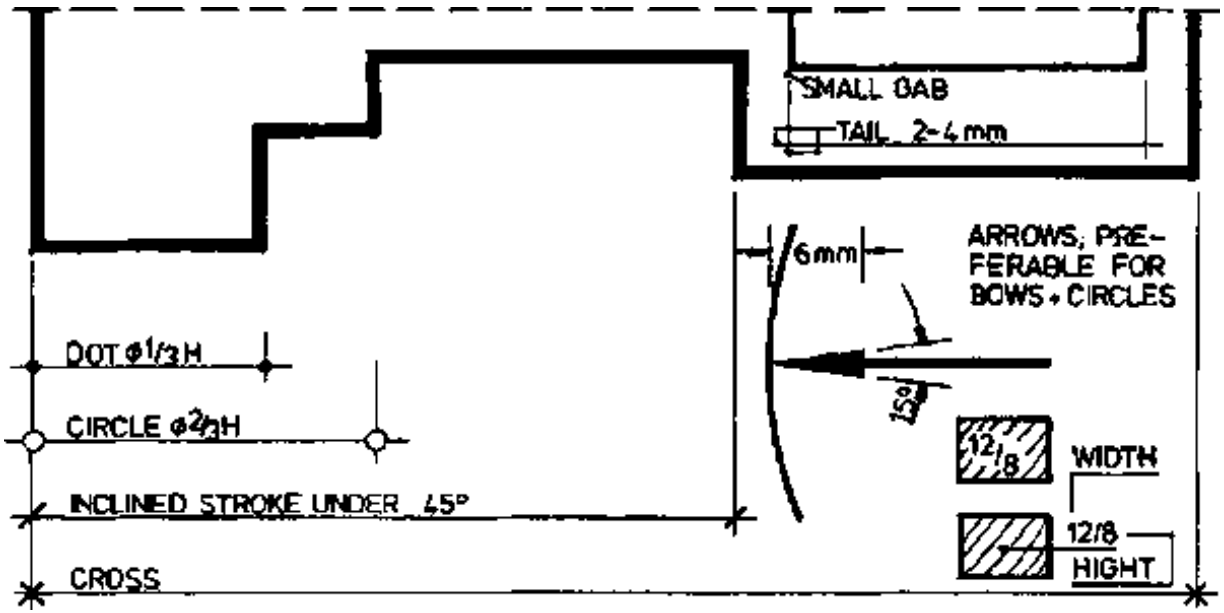
DIMENSIONING OF OPENINGS



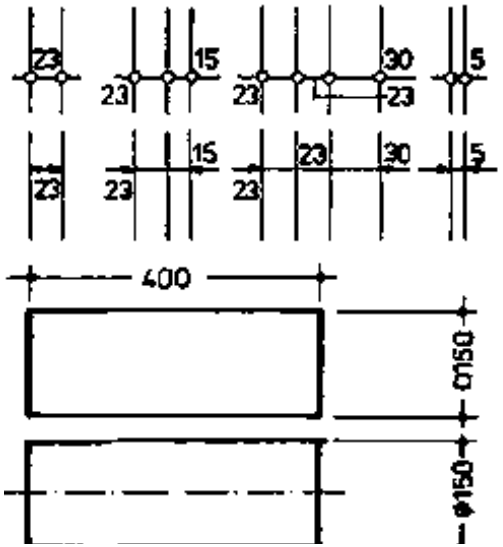
DIMENSIONING OF AXES OF OPENINGS

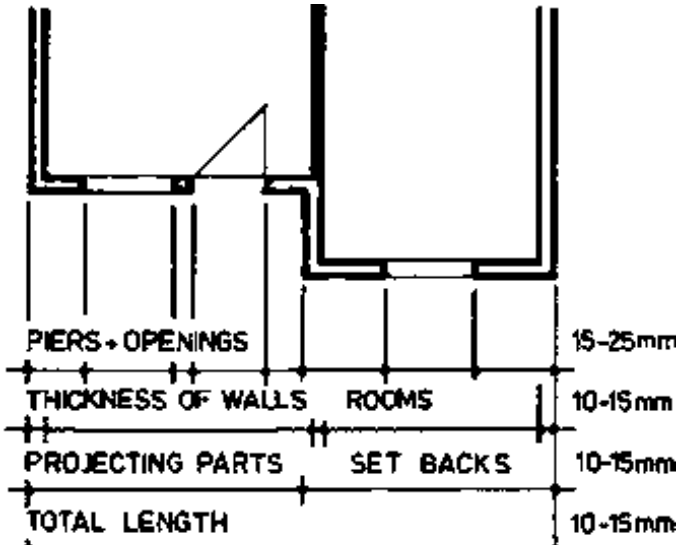


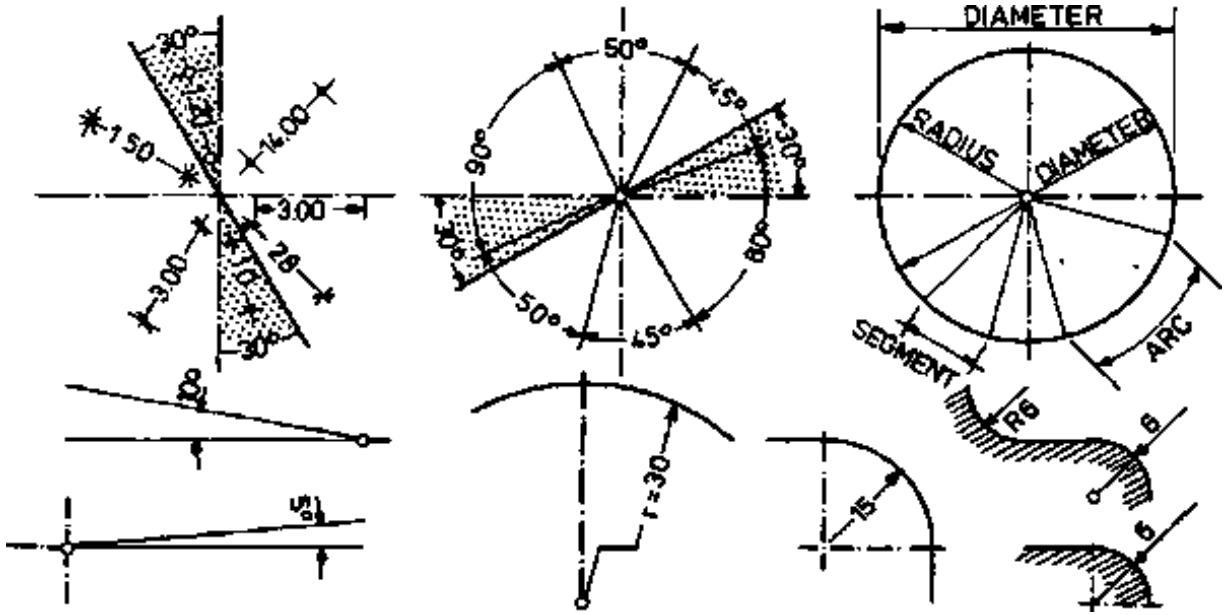
DIMENSIONING WITH COORDINATES



ALTERNATIVE DETERMINATIONS OF DIMENSION OF LINES







1.5 ENLARGEMENT AND REDUCTION OF LINE DRAWINGS

There are various methods of enlarging or reducing a line drawing. Some of the most useful are: The drawing in the figure consists of irregular or complex lines, draw over it a square grid of light lines (or, if the drawing is to be protected, draw the grid on a piece of tracing paper and place over the original), and then for the new drawing make a similar grid but proportionately larger or smaller as required. With this grid as a guide it is comparatively easy to make the copy to the size wanted.

If a line and its divisions, e.g. a scale, is to be enlarged or reduced in other than a simple mathematical proportion this is a useful method to employ. Line AB with points C and D along it is to be reduced; with centres A and B and radius equal to AB two arcs are drawn to intersect at O, and lines are drawn from O to A, B, C and D. The new length of the line is now measured along OA from O, and a line A'B' is drawn

parallel to AB to which it corresponds. Where this line cuts CO and DO points C' and D' corresponding to C and D on the original are found.

The proportional enlargement or reduction of rectangles is made by drawing a diagonal so that the alteration of the length of one side automatically gives the required length of the adjacent one. Example: ABCD is the rectangle, BD is a diagonal EFGD is a proportionately reduced rectangle.

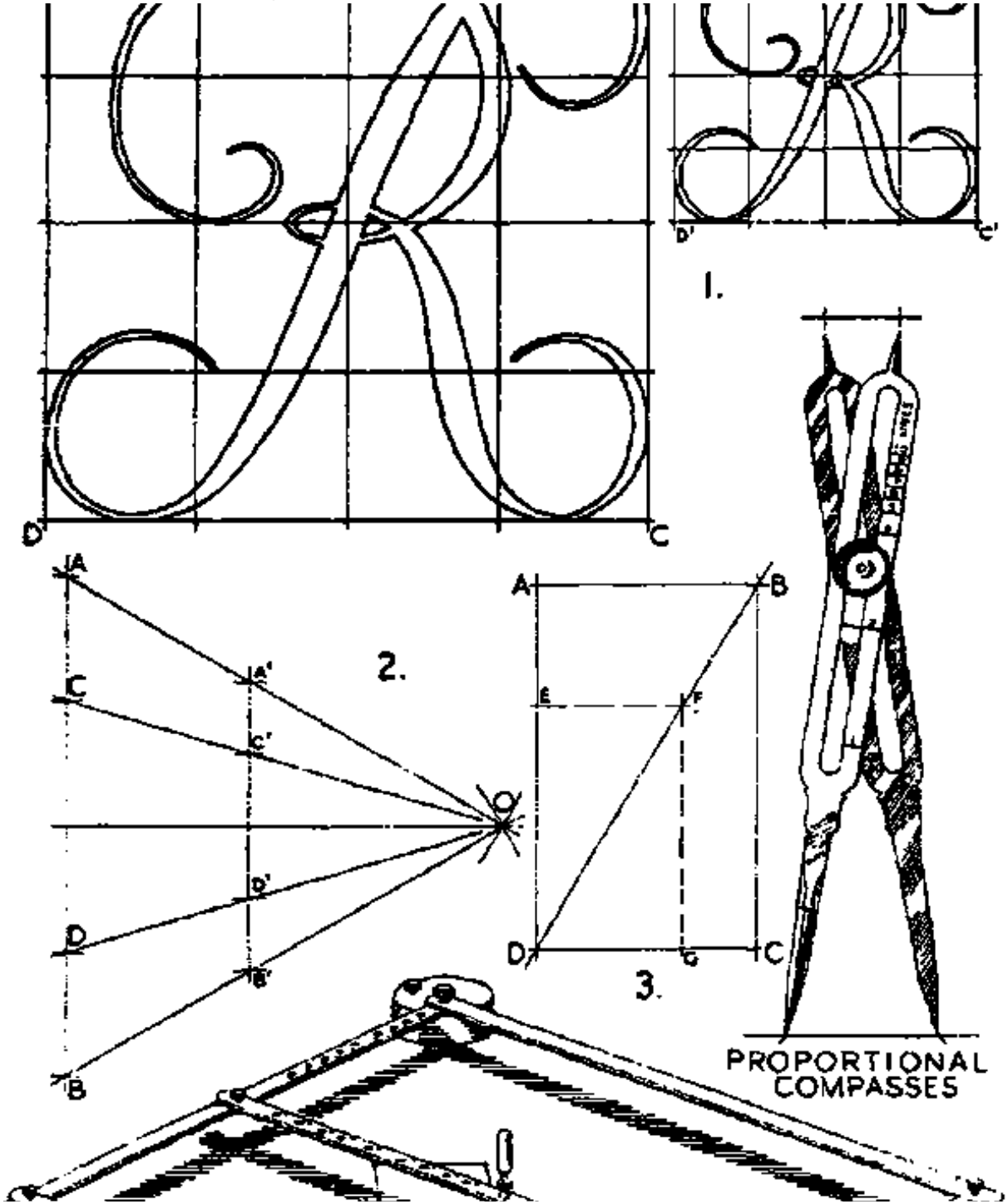
Proportional Compasses. These instruments consist of two slotted pieces of metal with points at each end joined by a centre screw, which can be so set that the distance between the long points is equal to that between the short points or is two, three, four or more times that distance up to ten. They can therefore be used for enlarging or reducing simple drawings in such ratios, although they seem to find little favour with present-day draughtsmen.

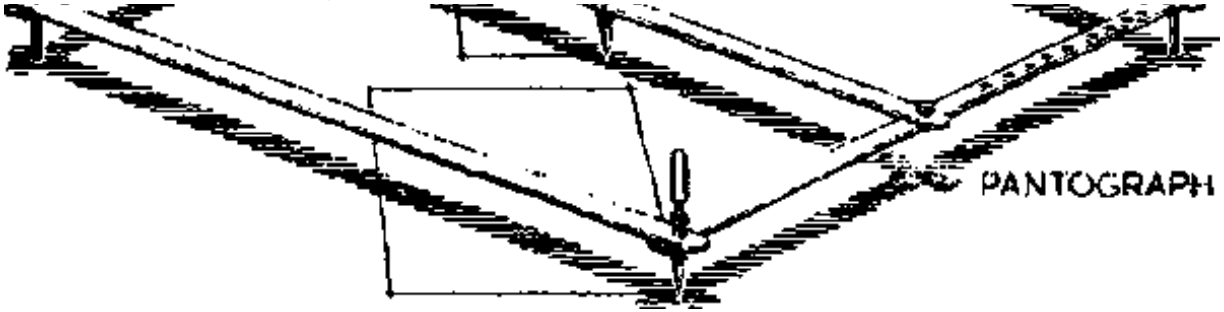
Pantograph: an instrument for enlarging or reducing drawings in various ratios. By following the lines of the original with one marker, the other traces them to a larger or smaller scale, as the case may be, and in the proportionate ratio to which the instrument has been set. The illustration shows a simple type. The Eidograph is a somewhat similar instrument, but having only one point of support, is steadier in action. The cost of these instruments is only justified if dealing with a large number of town plans and surveys.

Two other methods are commonly used and they are known as

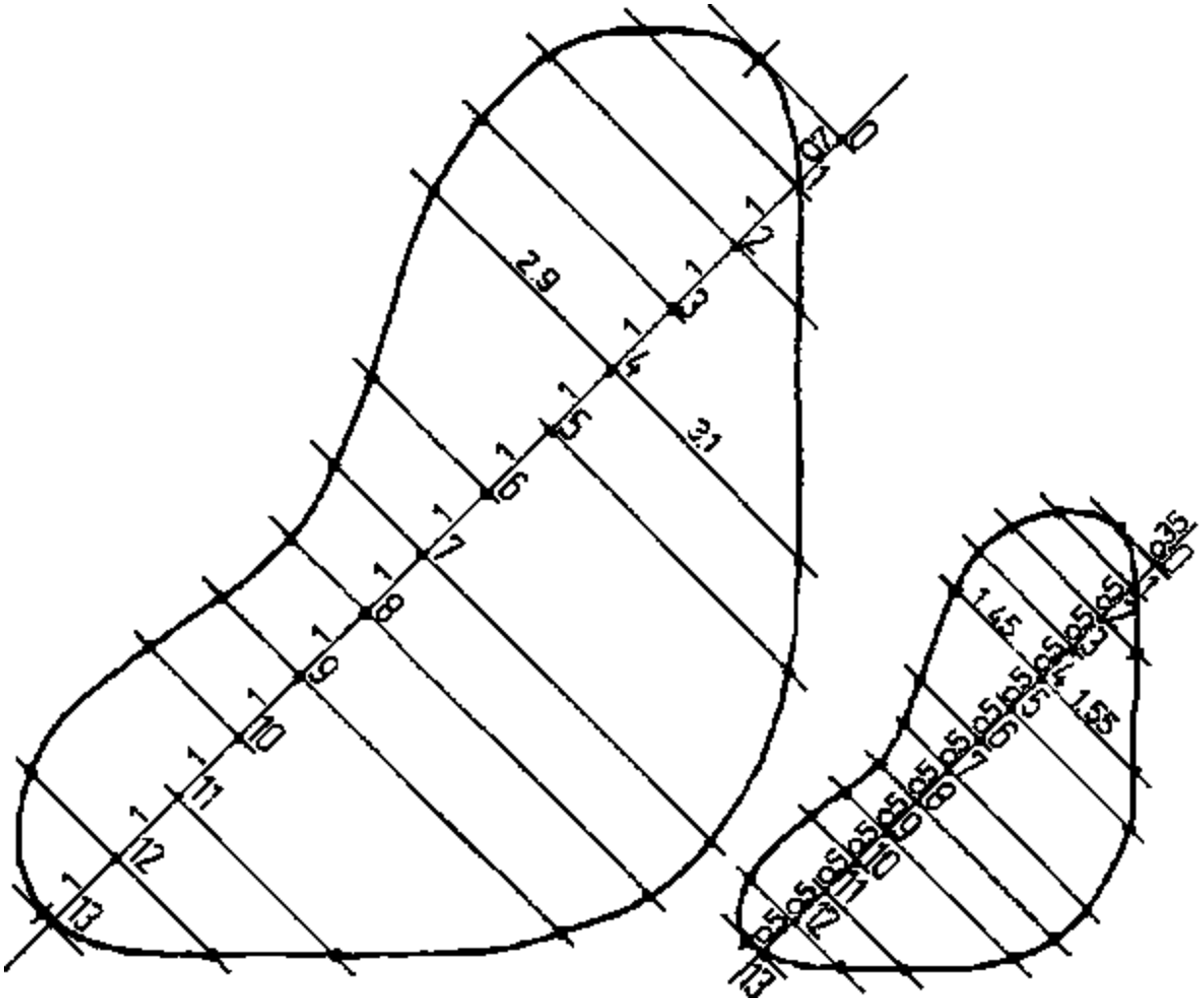
- **OFFSET METHOD and**
- **RADIAL PROJECTION**

For their construction method refer to the drawing.

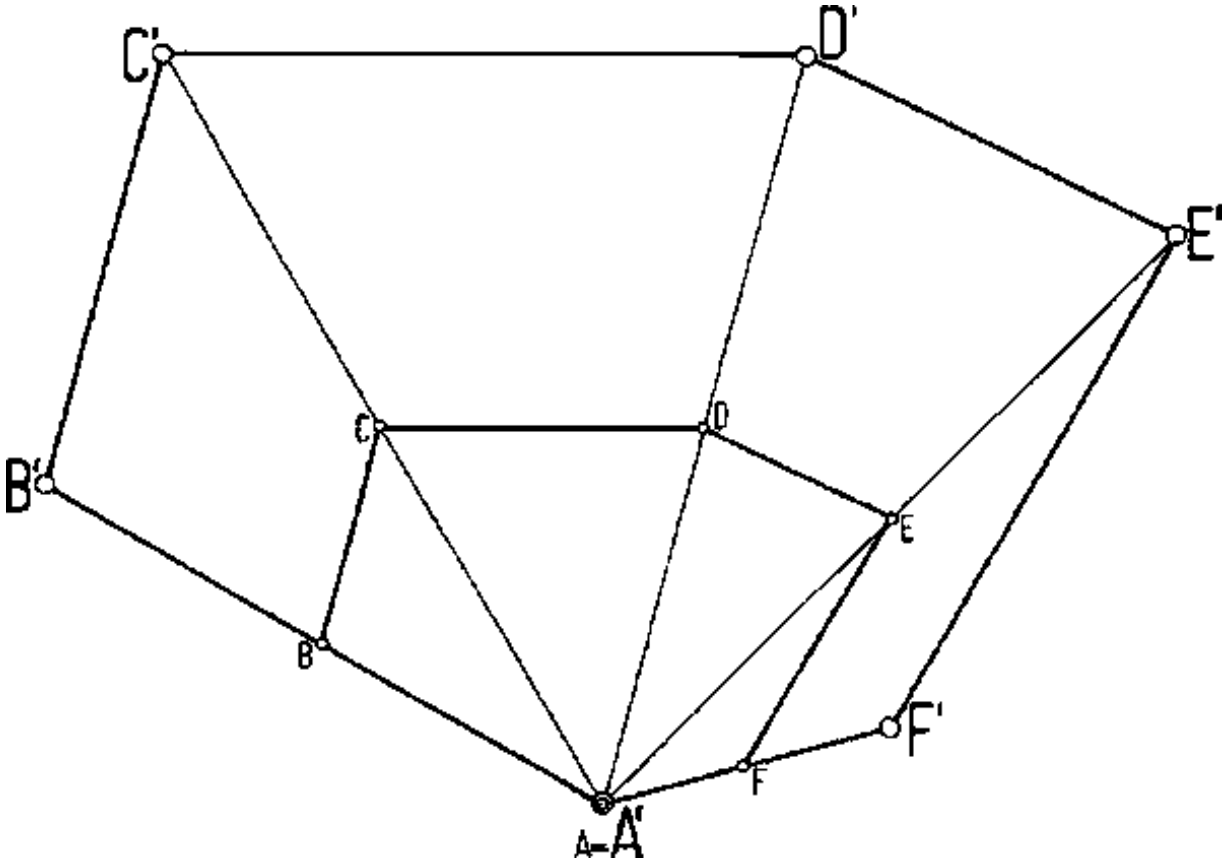

D'
C'
1.
D
C
A
A'
C
C'
O
D'
D
B'
B
2.
A
B
E
F
D
G
C
3.
PROPORTIONAL
COMPASSES



ENLARGEMENT AND REDUCTION

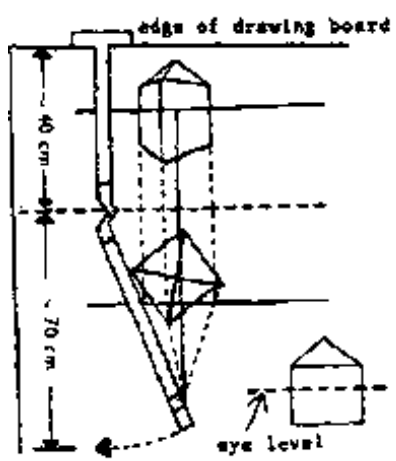


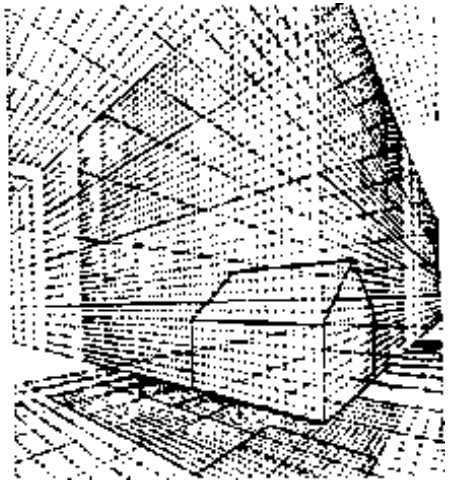
OFFSET-METHODS

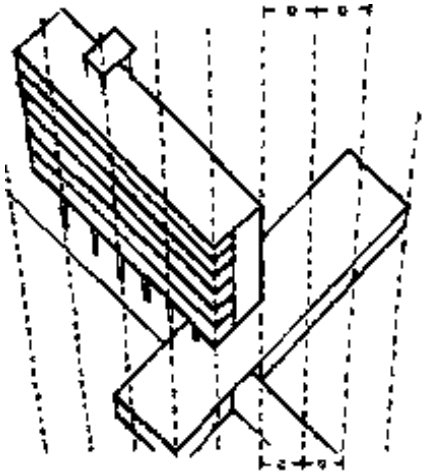


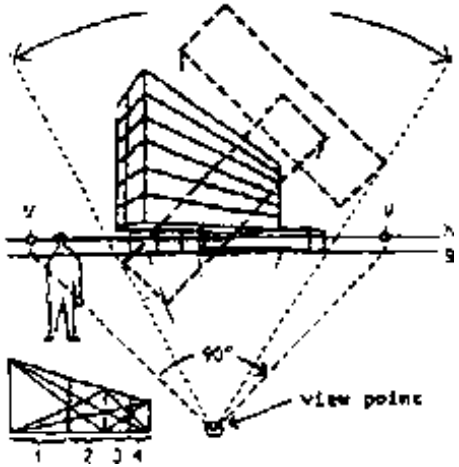
RADIAL PROJECTION

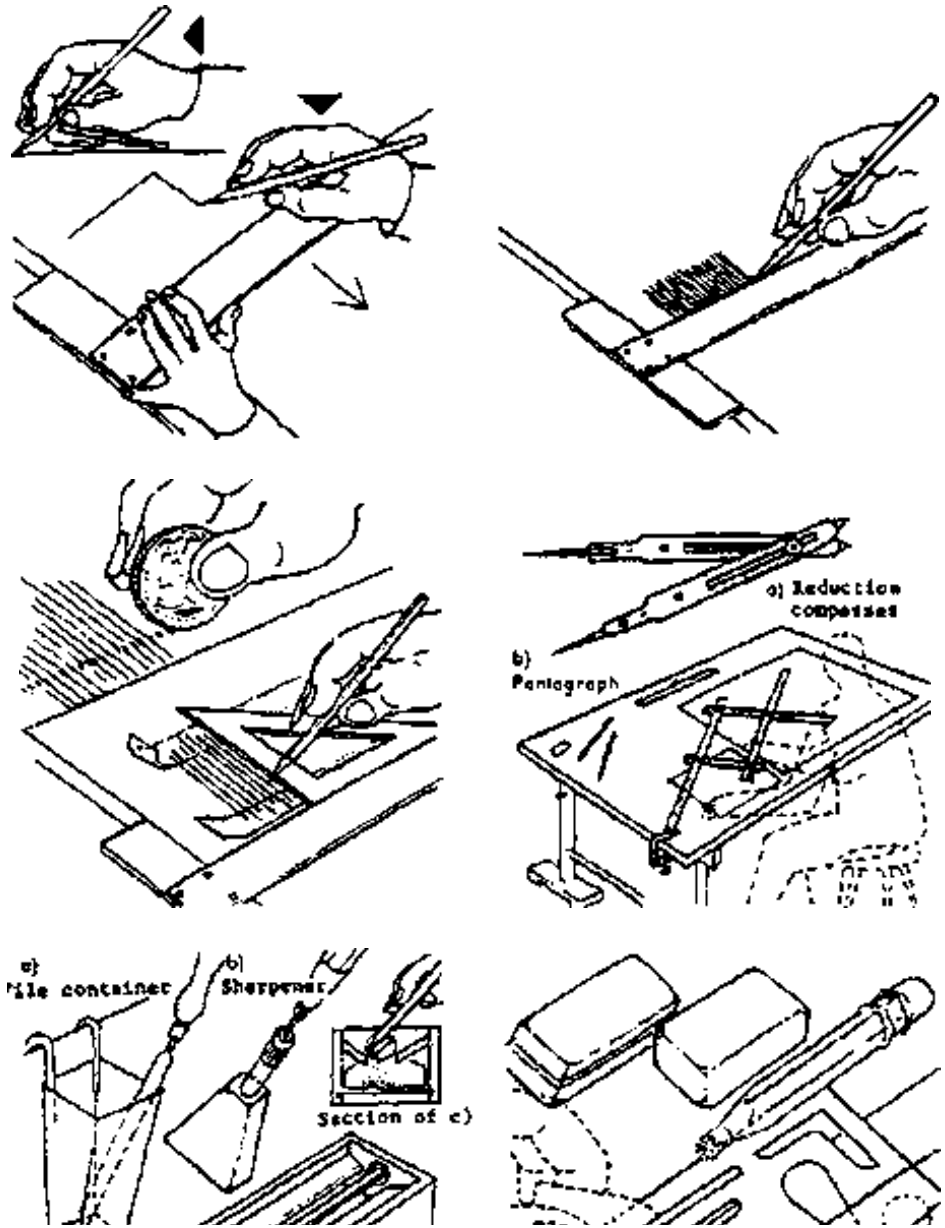
1.6 GEOMETRICAL CONSTRUCTIONS

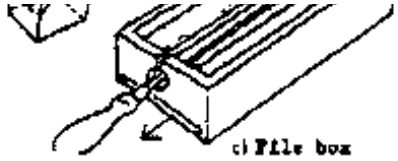

edge of drawing board
40 cm
70 cm
eye level






90°
view point
1 2 3 4


a) Reduction compasses
b)
Pantograph
a)
File container
b)
Sharpener
Section of c)



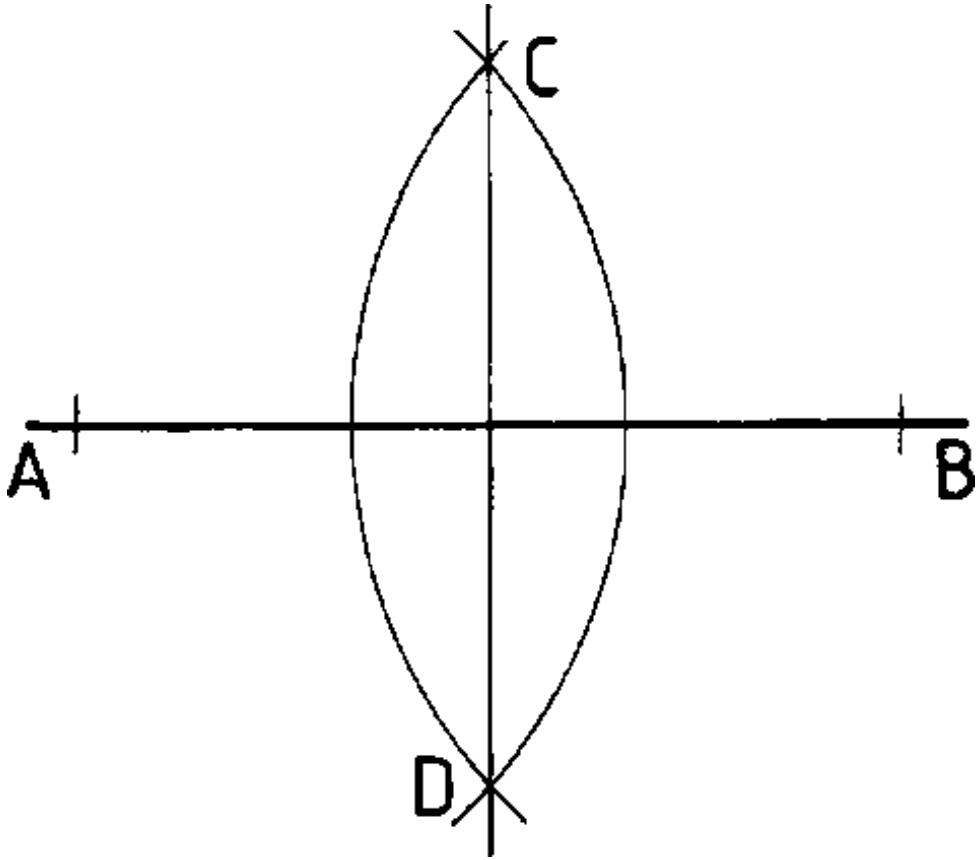
Architectural Drawing a good knowledge about GEOMETRICAL CONSTRUCTIONS is of high importance. In the following constructions are shown with the aim

1. **To demonstrate the principles of BA SIC geometrical constructions**
2. **To practice the use of drawing equipment**

1.6.1 LINES AND ANGLES

1.6.1.1 To bisect a straight line AB

- **Draw AB**
- **With centre A and any suitable radius draw an arc**
- **With centre B and the same radius as before draw an arc to cut the arc with centre A in C and D**
- **Join CD. CD is the required bisecting line.**

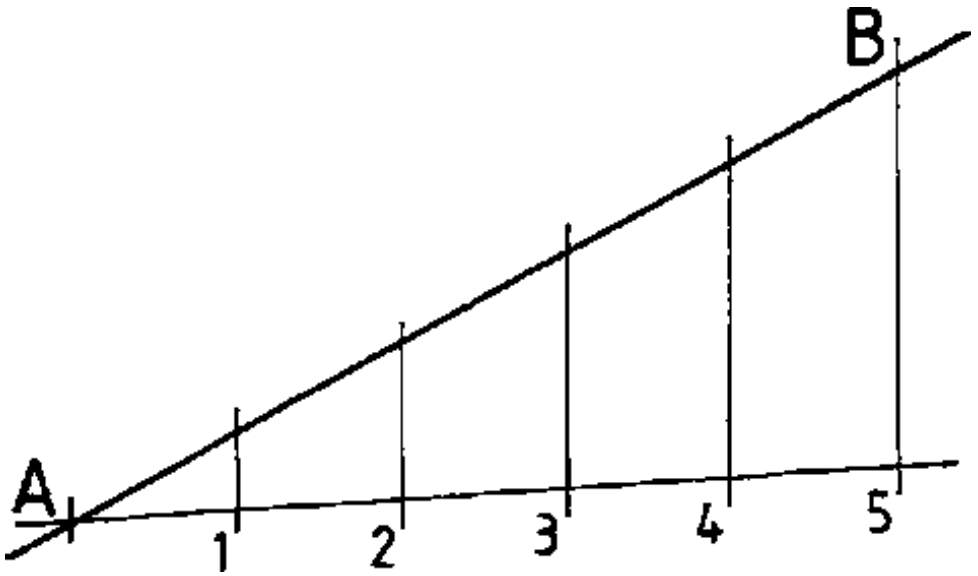


1.6.1.2 To divide a straight line AB into a given number of equal parts

- Draw AB
- At any suitable angle to AB draw a straight line
- Step off along this line the required number of divisions of equal length (here 5 divisions are shown)

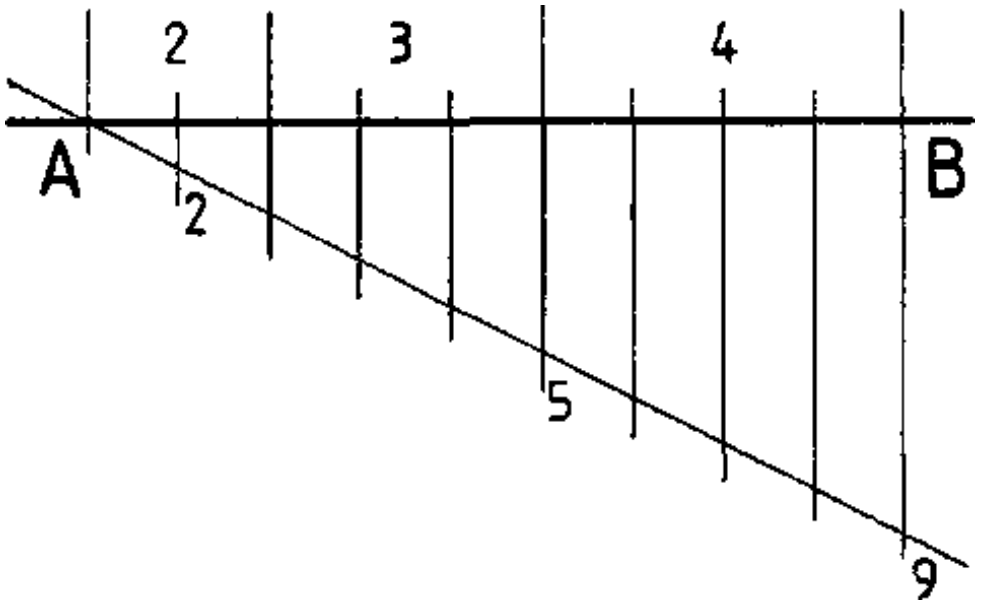
shown)

- Number the divisions from A along the line as shown
- Join the last number (5) to point B
- Draw parallel lines to 5 B from the other numbers as shown. AB is now divided into the required equal parts..



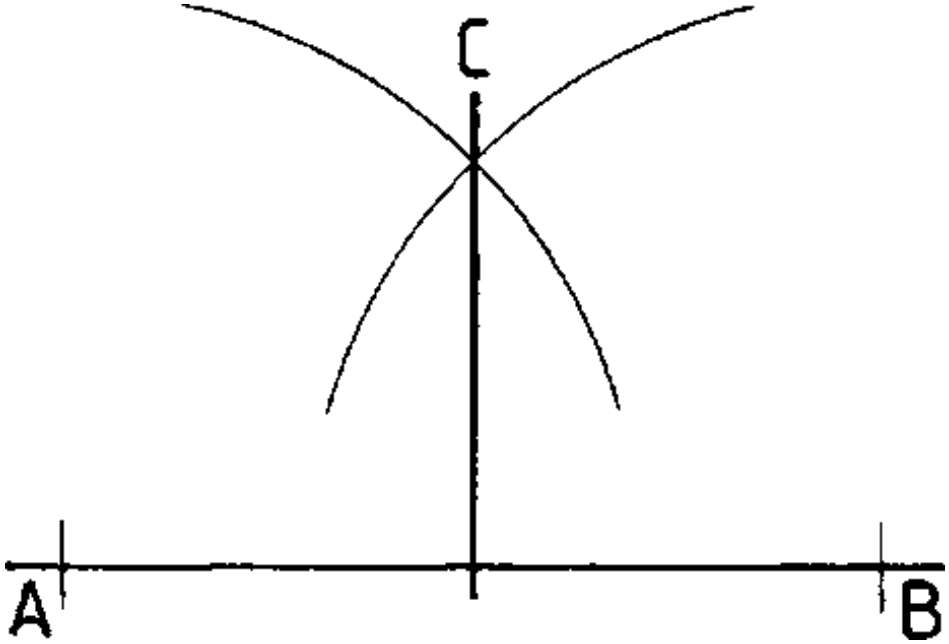
1.6.1.3 To divide a straight line AB into any ratio

- Let the ratio be 2:3:4
- Draw AB
- Draw a straight line at any angle to AB
- Sum up the ratio (i.e. 2+3+4=9) to get the number of equal divisions required
- Step off, along the straight line the number of divisions of equal lengths required (i.e. 9 divisions).
- Join the last division (9) to B and draw parallel lines to 9B through 5 and 2
- Now AB is divided into the ratio 2:3:4.

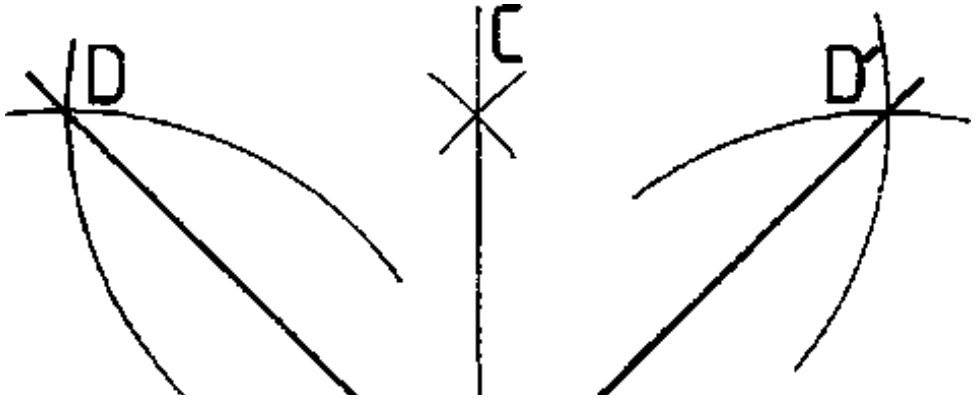


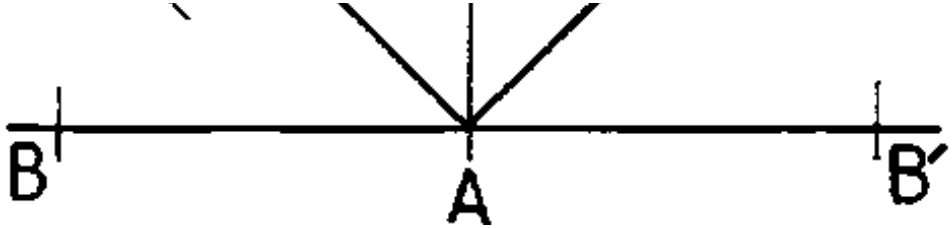
1.6.1.4 To construct an angle of 90°

- Draw a straight line
- With centre A on that line and any suitable radius draw a semi circle to cut the line in B and C
- With centres B and C draw arcs of any the same radius to intersect each other at D
- Join AD. The Angles ABD and ACD are the required angles of 45°.



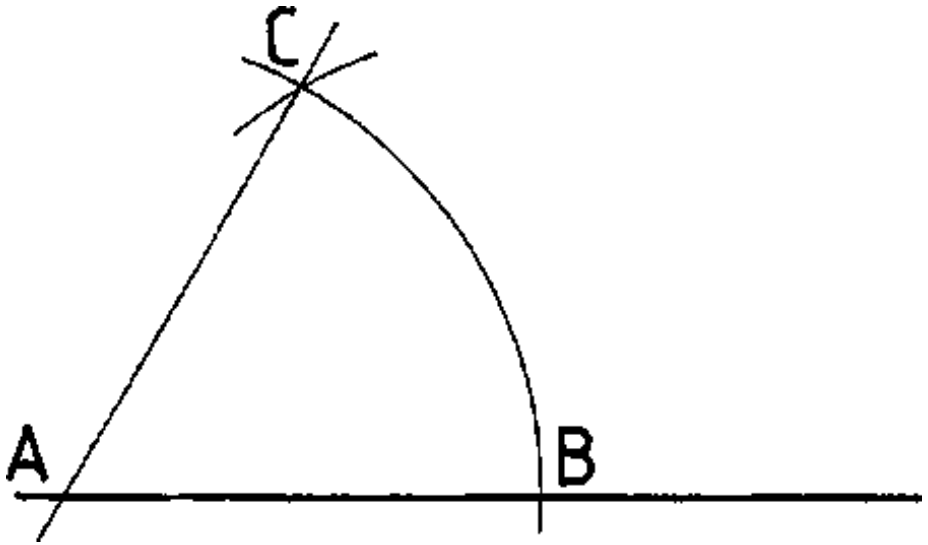
1.6.1.5 To construct an angle of 45°





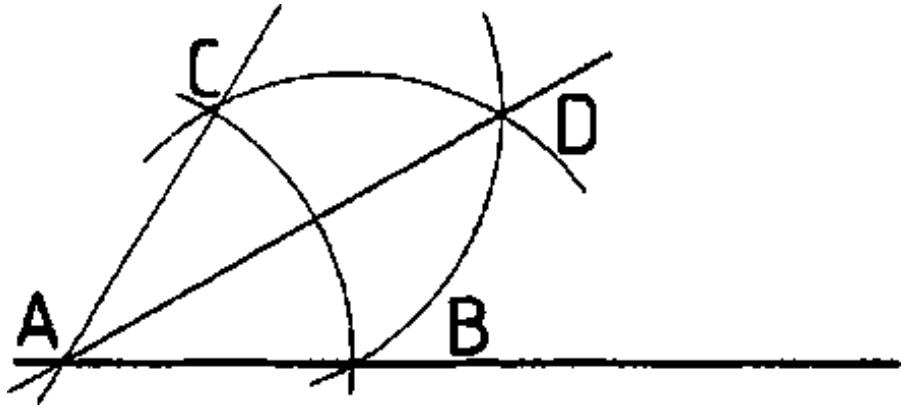
1.6.1.6 To construct an angle of 60°

- Draw a straight line
- With centre A on that line and any suitable radius draw an arc to cut the line at B
- With centre B and the SAME radius draw an arc to cut the former arc at C.
- Join AC. The angle ABC the required angle of 60°.



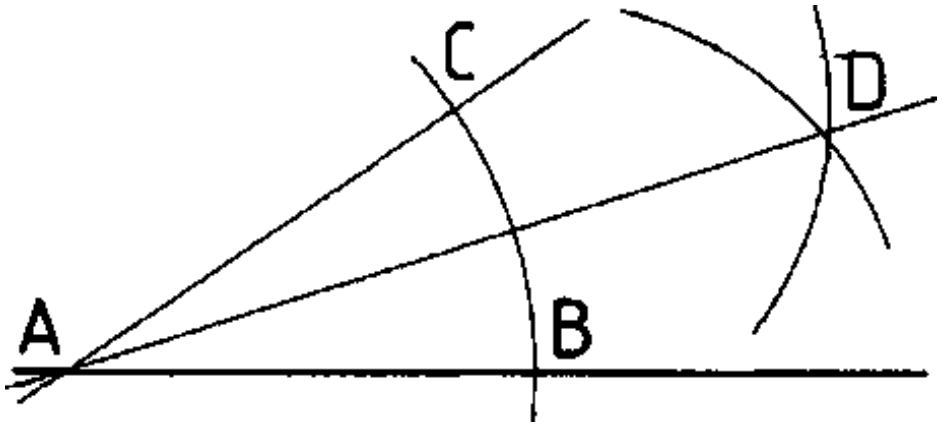
1.6.1.7 To construct an angle of 30°

- This can be reached by bisecting an angle of 60° as described under 6.1.5.



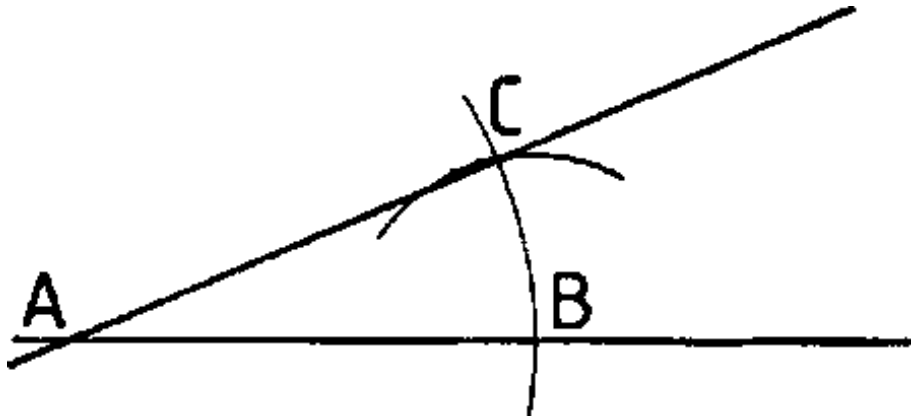
1.6.1.8 To bisect any given angle

- The same method as in 6.1.5 should be employed here.

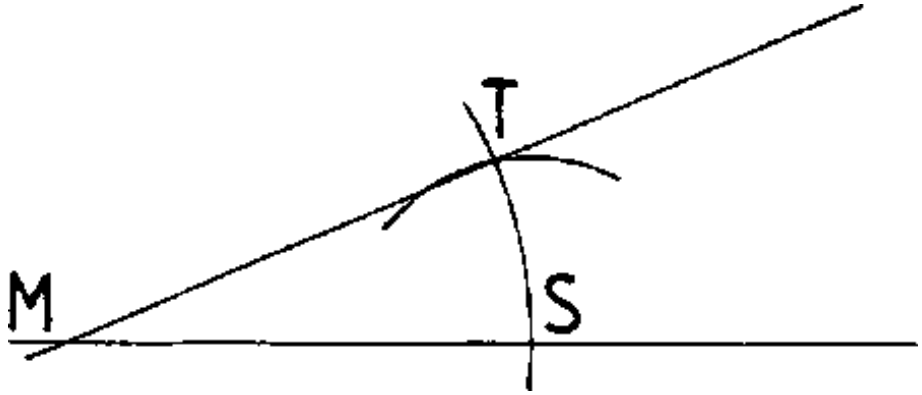


1.6.1.9 To construct an angle SIMILAR to a given angle

- Let the angle shown in (a) be the given angle.
- Draw a straight line through M as: shown in (b)
- With centre A and any suitable radius draw an arc to cut the legs of the given angle in B and C
- With centre M draw the same arc to cut the line through M at S (AB = MS)
- From (a) with centre B take radius BC.
- With centre S and radius BC cut former arc at T
- Join MT and extend the line. The angle MST is similar to ABC.



(a)



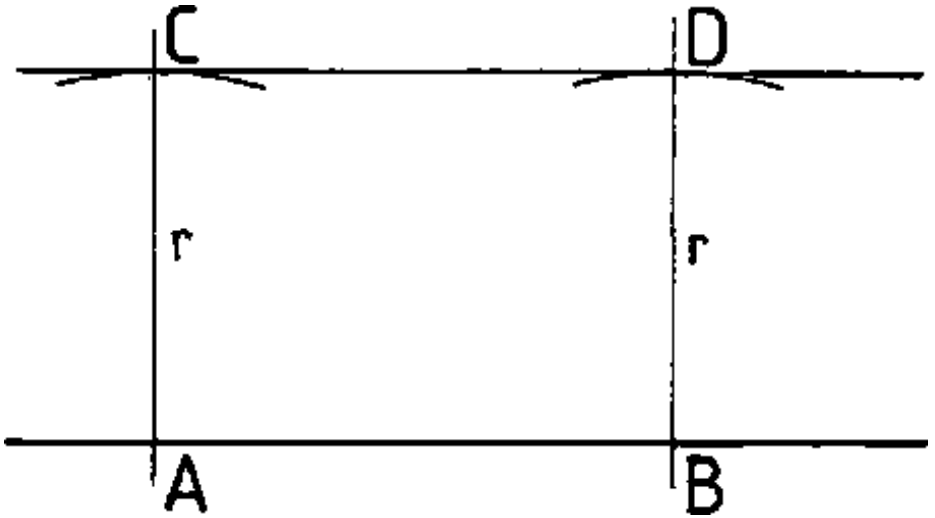
(b)

1.6.1.10 To draw a line PARALLEL to a given line

- Draw the given line

- Using any 2 centres at suitable intervals along the given line and a radius, equal to the required distance between the 2 lines, draw the arcs C and D.

- Draw a straight line tangential to the arc C and D. This is the required line which is parallel to the given line at the distance of the radius.



1.6.2 TRIANGLES

Definition: A TRIANGLE is a PLAIN, bounded by three straight lines.

There are 4 types of triangles:

1. **scale triangle:** **all angles and sides are UNEQUAL**

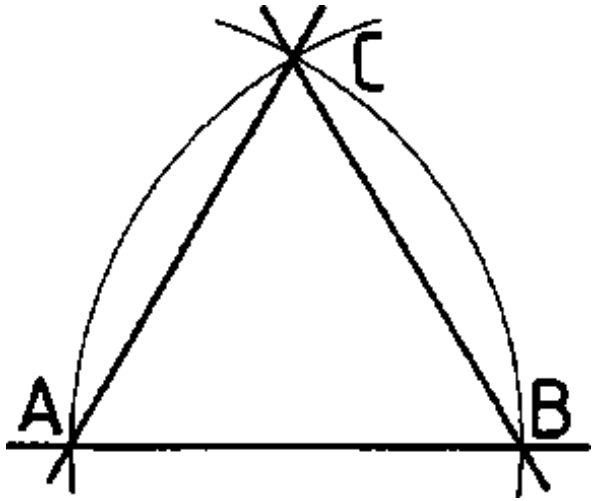
2. **Isosceles triangle:** two sides and angles are EQUAL
3. **Equilateral triangle:** all angles and sides are EQUAL
4. **Right-angled triangle:** contains one right angle.

1.6.2.1 To construct an EQUILATERAL triangle

Given is one of the sides AB

Draw AB

With centres A and B and the radius AB draw arcs to intersect at C Join AC and BC, the triangle ABC is equilateral.



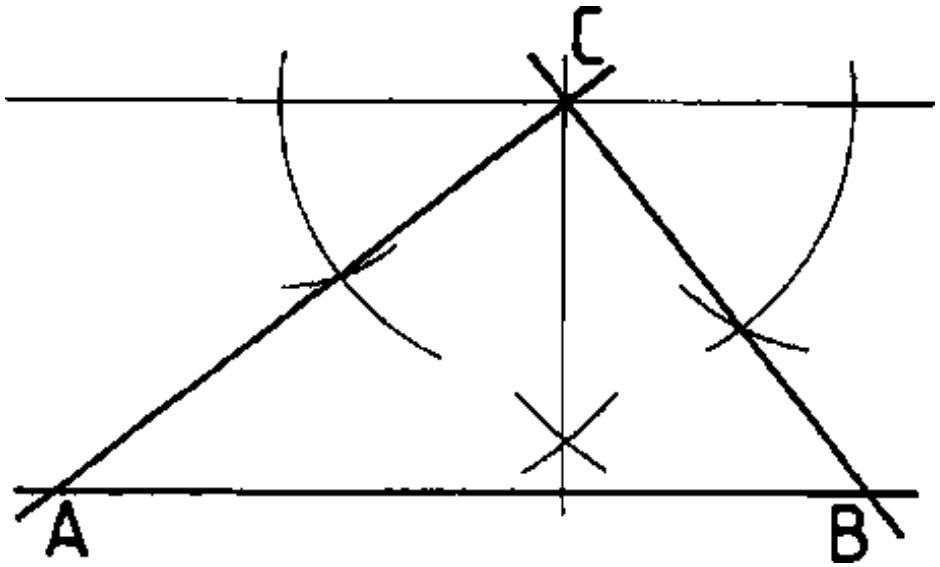
1.6.2.2 To construct a triangle with given BASE ANGLES and ALTITUDE

- Draw a straight line

- Construct a straight line PARALLEL to the drawn line so that the distance between the two lines is equal to the altitude (ref. to 6.1.10)

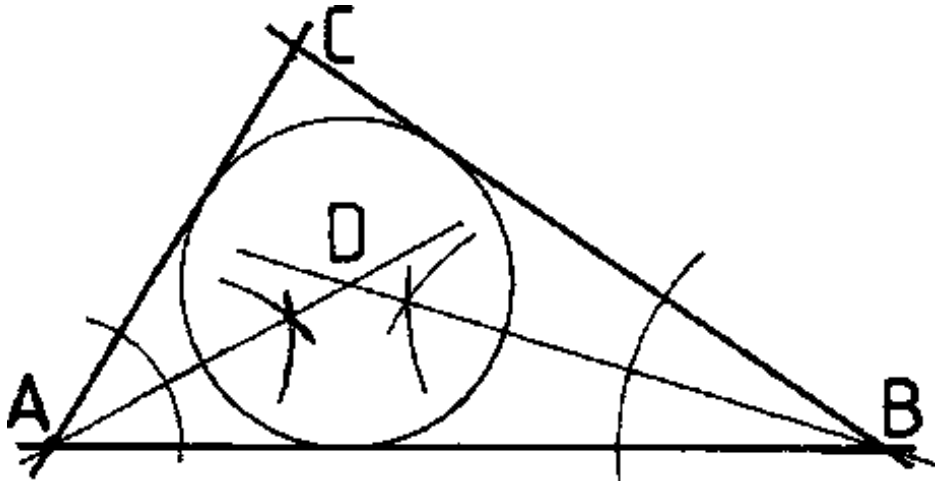
- From any point C on the parallel line draw the given angles as shown so that they cut the straight line in A and B

- Join AC and BC. The triangle ABC is the required triangle.



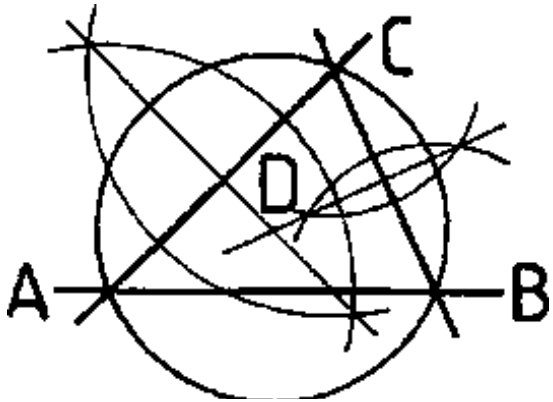
1.6.2.3 To inscribe a circle in a given triangle ABC

- Bisect any two of the angles, as shown, so that the bisectors intersect at D.
- The centre of the inscribing circle is point D.



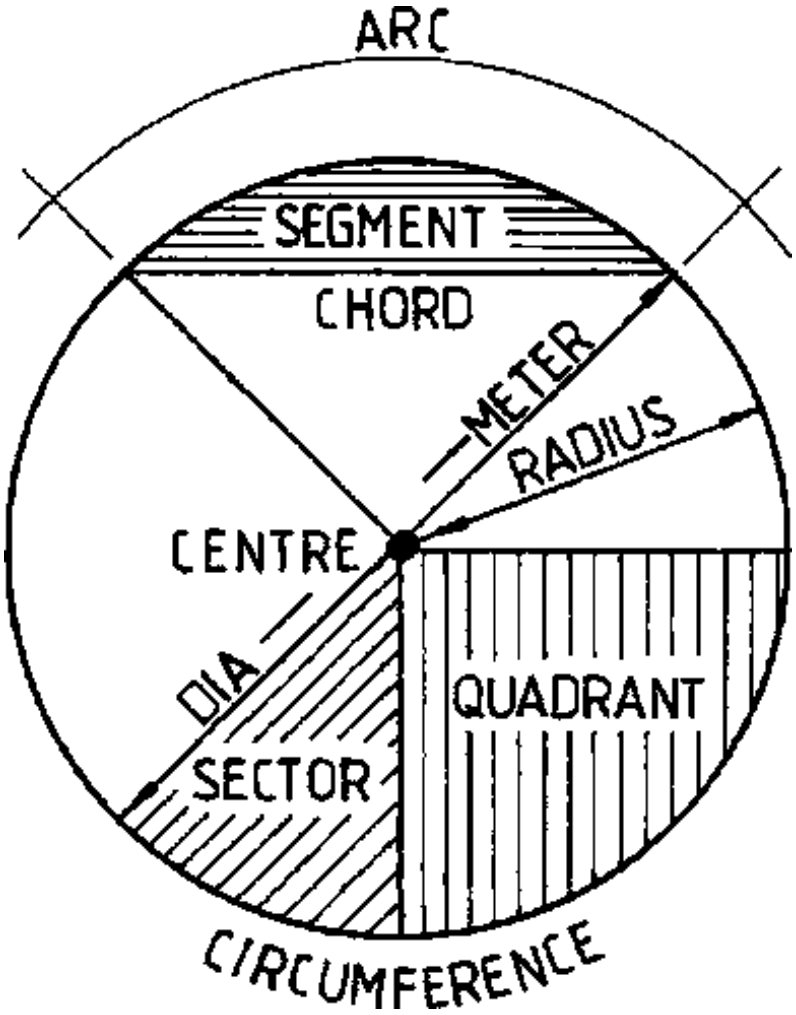
1.6.2.4 To circiumscribe a triangle ABC

- **Bisect any two of the sides of the triangle, as shown, so that the bisectors intersect at D.**
- **The centre of the circumscribing circle is point D.**



1.6.3 CIRCLES

A circle is a plane figure hounded by a curved line called the CIRCUMFERENCE; which is always at equal distance from a fixed point called the CENTRE of the circle. This distance from the centre O to the circumference is known as the RADIUS. Other terms are: -



DIAMETER: A straight line passing through the centre and bounded by the circumference

ARC Is a name given to a part of a circumference

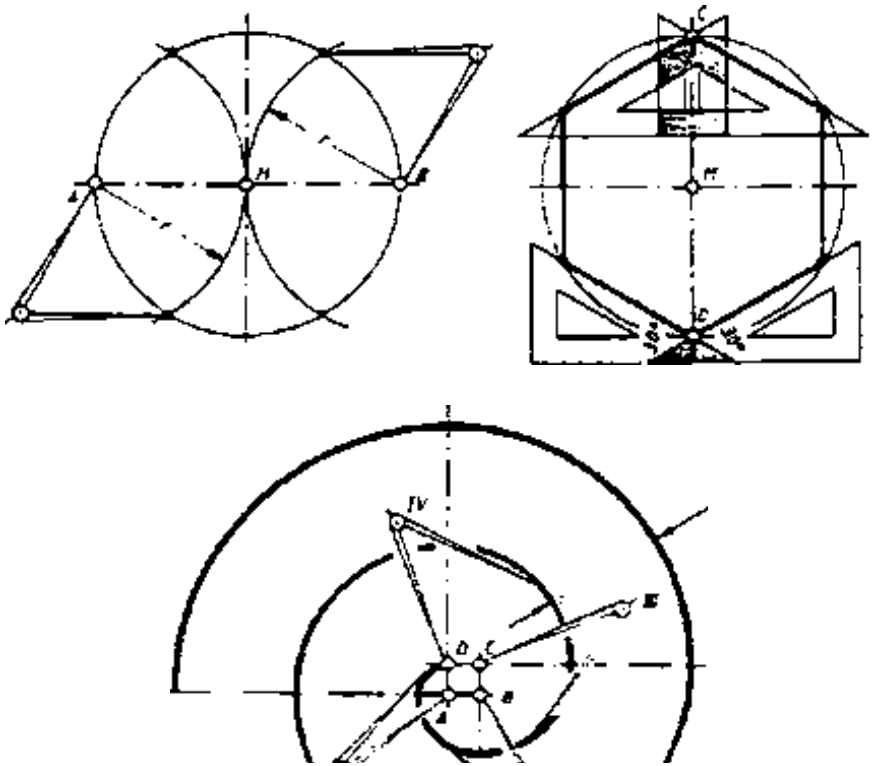
CHORD A straight line joining two points on the circumference

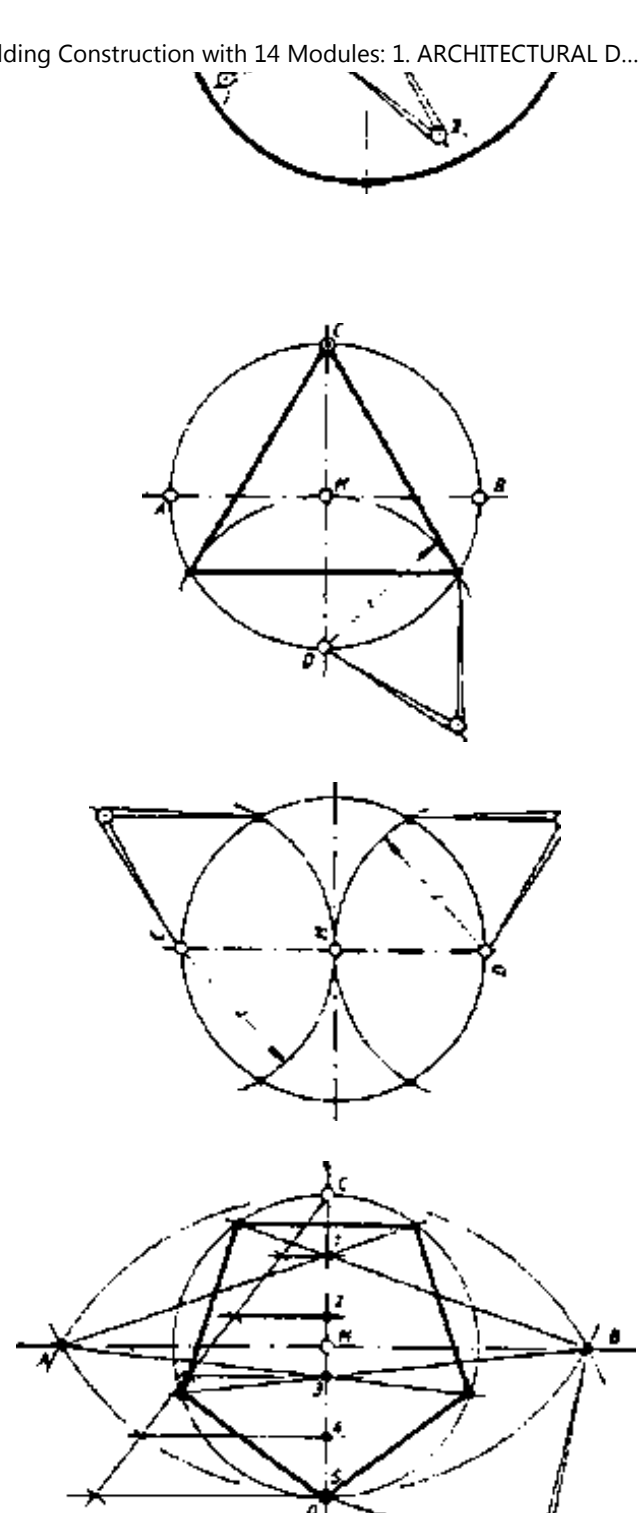
SEGMENT An area bounded by a chord and the arc it cuts

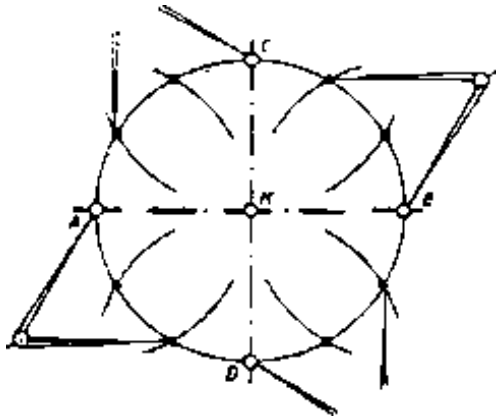
SECTOR An area bounded by two radii and the arc between them

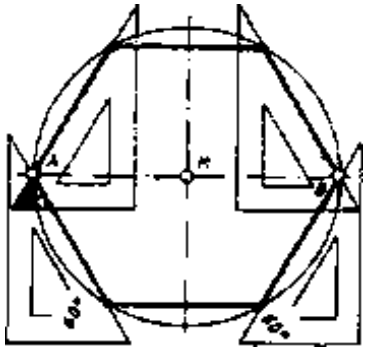
QUADRANT An area bounded by two radii at right angles and the arc between them. It is a quarter of a circle.

1.6.3.1 Basic CIRCLE-Constructions



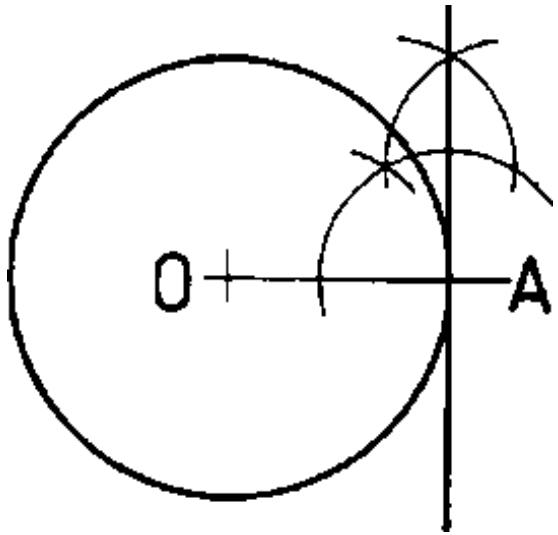






1.6.3.2 To draw a tangent to a point A on the circumference of a circle centre O

- Join OA
- Erect a perpendicular at point A as shown. The perpendicular is the re- required tangent.



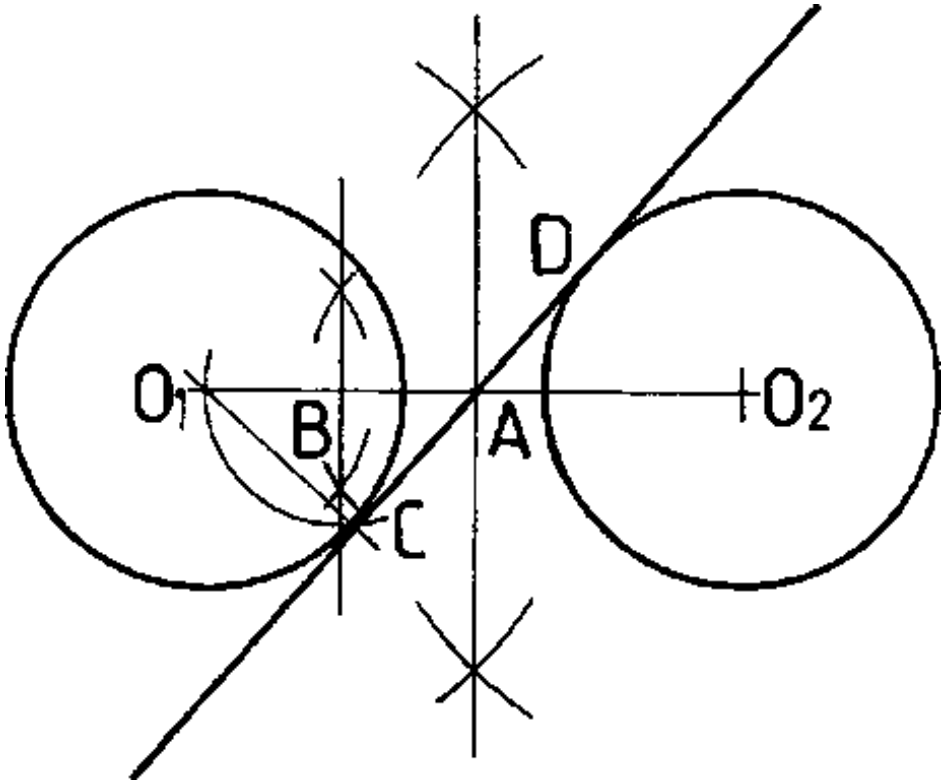
1.6.3.3 To draw an internal tangent to two circles of equal diameter

- Join the centres of both circles by line O_1O_2
- Bisect the line O_1O_2 to get the point A.

Then bisect O_1A to get the point B.

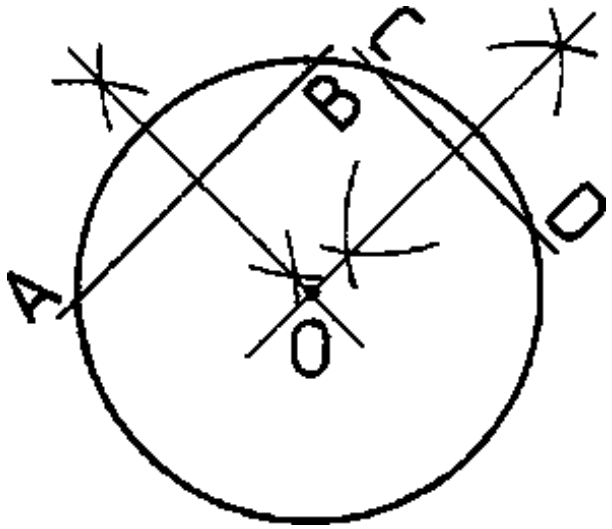
- With radius BO_1 and centre B describe a semi-circle to cut the circumference of one of the given circles at C

- Join CA and extend it to tough the other circle at D. Line CAD is the required tangent. O_1C and O_2D are normals.



1.6.3.4 To find the centre of a given circle arc

- **Draw any two chords AB and CD**
- **Draw perpendicular bisectors of AB and CD**
- **Produce the bisectors to meet at O. O is the required centre of circle.**



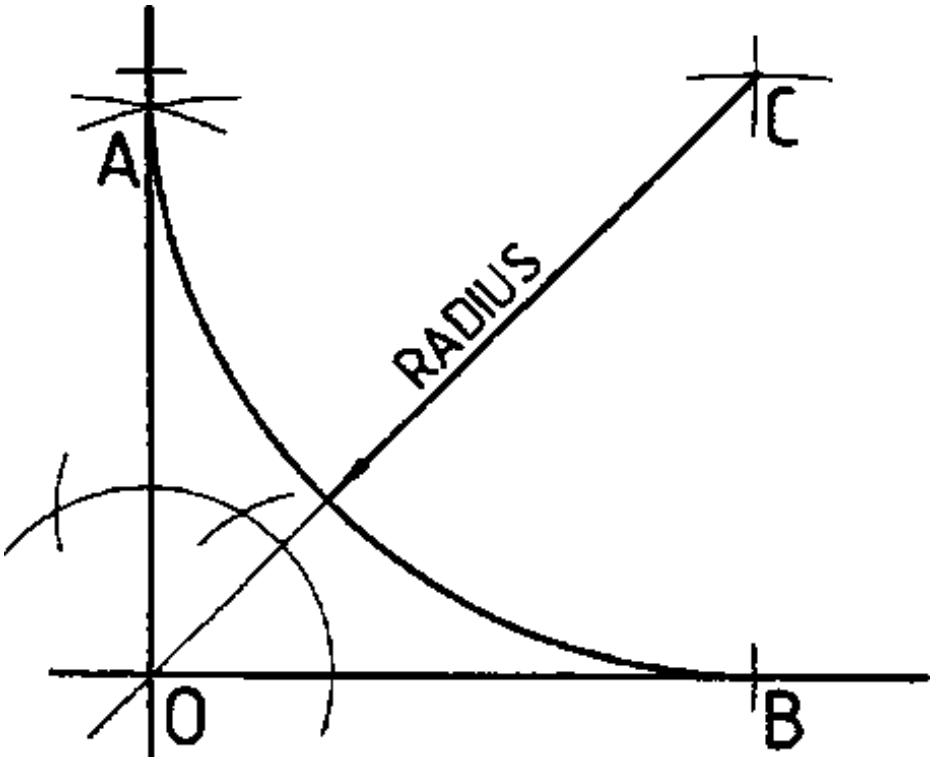
1.6.3.5 To join two straight lines at RIGHT ANGLES to each other by an arc of given radius

- Draw the given straight lines at a right angle to meet at O

- With the centre O and the radius equal to the required radius of the arc, draw arcs to intersect the straight lines at A and B

- With the centres A and B and the same radius draw arcs to intersect at C

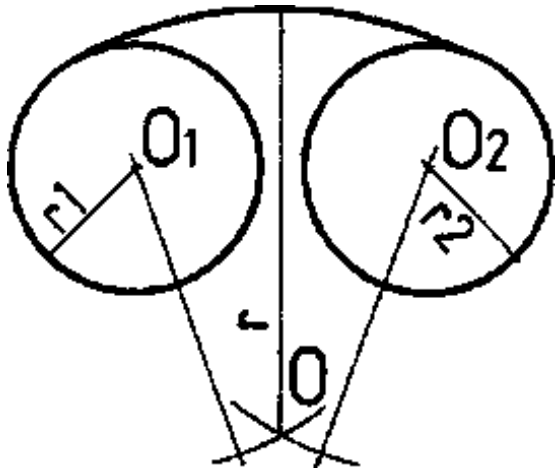
- With the centres C and given radius, draw the required arc.



1.6.3.6 To draw a curve of given radius joining two circles

(The circles have to be inside the radius R)

- **With centre O and radius T_1 draw an arc,**
- **With centre O_2 radius T_2 draw an arc to intersect the first arc in O. O is the required centre.**



1.6.3.7 To join two straight lines by two arcs of equal radius

- Draw the two straight lines XA and YB at their correct positions.

- Join AB and bisect it at C

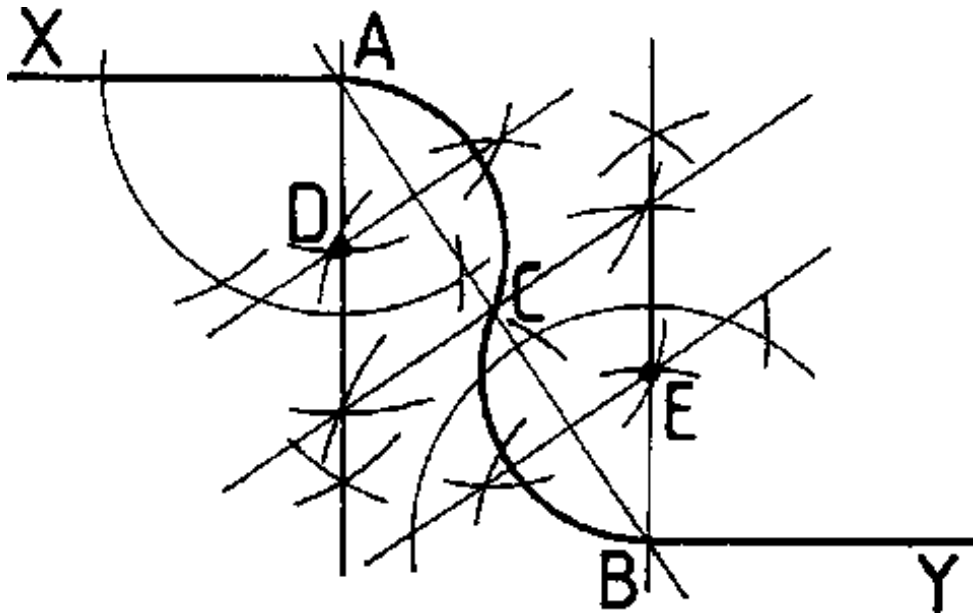
- Bisect AC and CB and extend the two bisectors to meet perpendiculars from A and B at points D and E respectively.

- With centre D and radius AD draw an arc from A to C

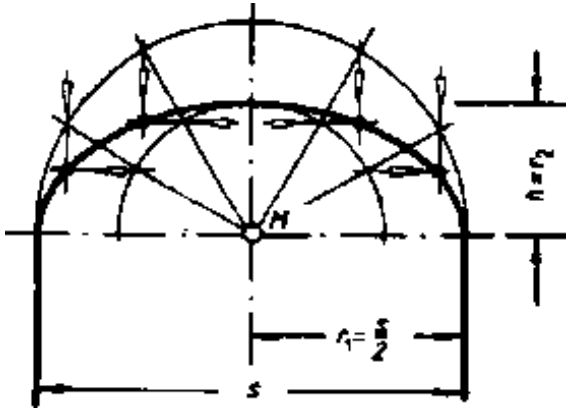
- With centre E and radius EB draw an arc from B to C.

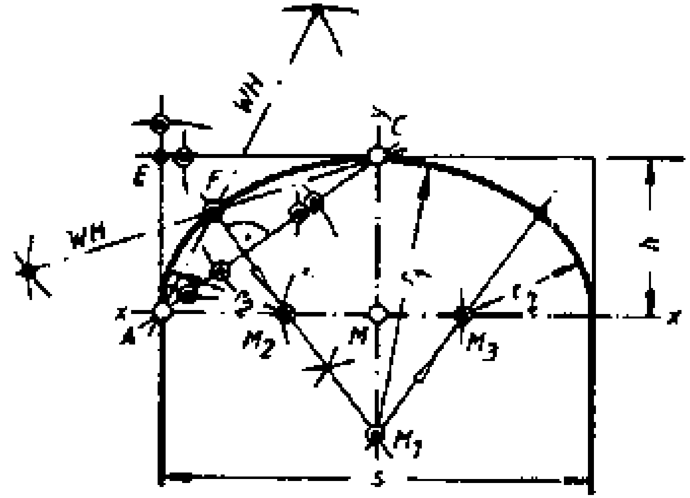
- These are the required curves and give a smooth continuous curve ACB

- These are the required curves and give a smooth continuous curve ACB.



1.6.4 BASIC ARCH CONSTRUCTIONS

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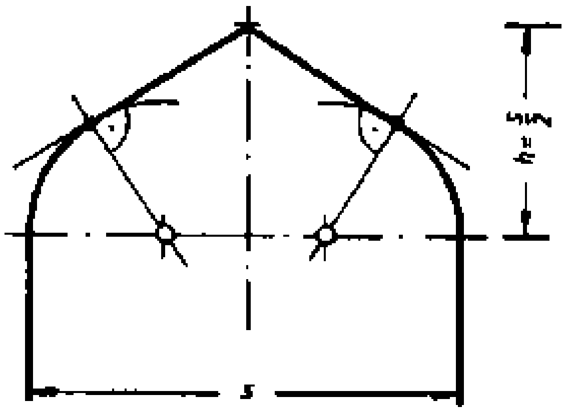
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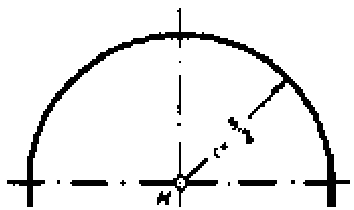
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