Handbook for the technical camera

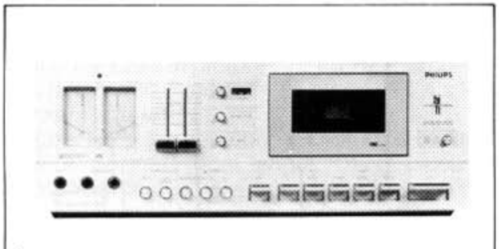
CAMBO

CAMBO

Cambo, an internationally orientated Company in the Netherlands, develops, manufactures and sells modern precision equipment for the professional photographer and the serious amateur. A progressive Company with internationally renowned products, its manufacturing program includes: Large and Medium format cameras, passport and identification cameras, tripods and accessories for photography and science. Production and sales are handled by the Company in Kampen, the Netherlands.

This booklet has been compiled as a guide for the many thousands of users of Cambo technical cameras. It is designed to help photographers make maximum use of the many adjustment possibilities of the large format camera. Keep this booklet handy in your studio or your camera case! Regular reference to it will help you solve many photographic problems.
In close cooperation with the "College of Photographic" at Apeldoorn, the Netherlands, we have tried to make this a compact exposition. The handy, small format facilitates finding and understanding specific camera movements. Although meant to assist the professional or student photographer, advanced amateurs will also find much of interest in this booklet. Cambo hopes that the reader will attain correct use of the technical camera.
For more information concerning possibilities of and accessories for the versatile Cambo SC system, you may contact:

Cambo Fotogr. Industrie B.V.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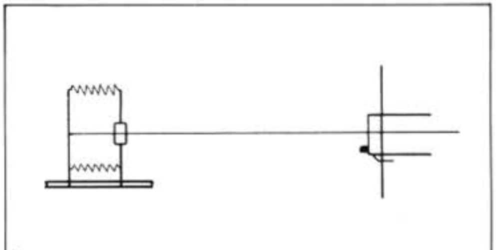
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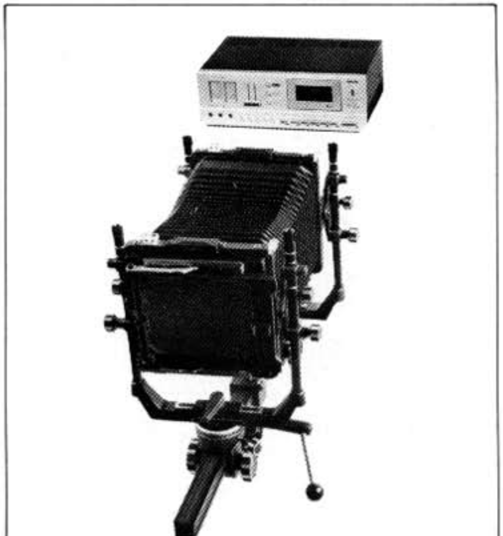
The technical camera

A subject can only be reproduced in a flat perspective if the camera position is straight in front of it. The image is projected on the groundglass in the back of the camera which is replaced by film before exposure. Each subject plane, parallel to the film plane, will be reproduced undistorted. The lens projects a circular image of acceptable sharpness. It is called the circle of good definition of which we use a section say 9 x 12 cm (4" x 5"). Camera movements enable us to move that section inside the circle (see page 13, lenses).
If the film plane is parallel to the subject plane it is possible to include in the photograph part of the side and top of the subject. The examples clarify this.
Picture 1 was taken with the camera in its basic position with all controls zeroed and both lens and film planes parallel. The film plane is also parallel with the front of the recorder. The same subject was taken with a 6 x 6 camera in picture 4. There is no difference in perspective.

Picture 2 and 2A show a side and top view of the camera setting for picture 1. No camera adjustments have been made. (see sketch 3).

However, when taking a photograph of the top of the subject, perhaps because the client wants to draw attention to its dimensions, matters change! Distortion of the front of the subject occurs. It is wider at the top than at the bottom (picture 5).
Picture 6 shows the same subject taken with the Cambo 9 x 12 cm (4" x 5") in such a way that the front of the recorder is parallel with the film plane in the camera. The top of the subject is visible and the front is undistorted.

For picture 6 the camera position was as shown in sketch 7 and picture 8.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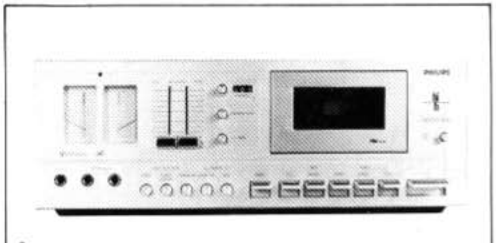
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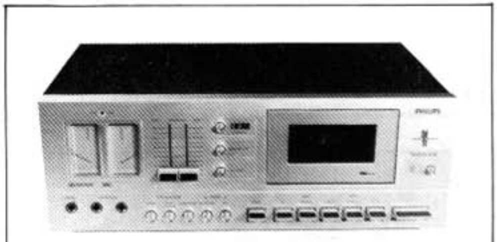
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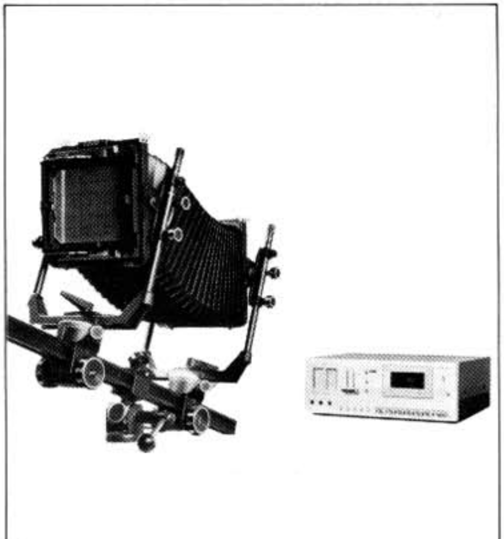
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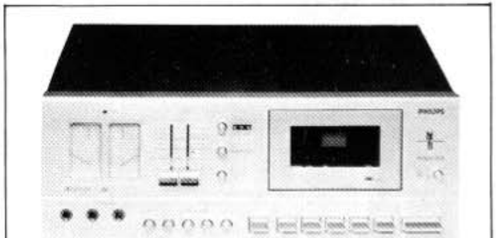
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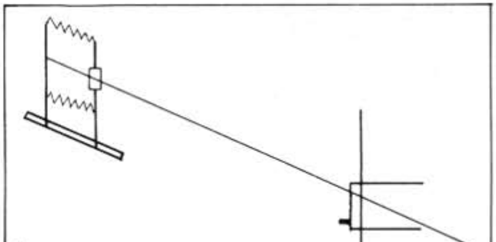
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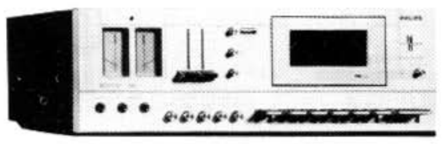

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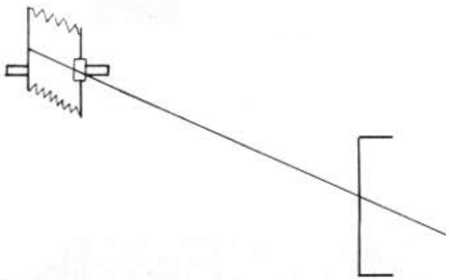

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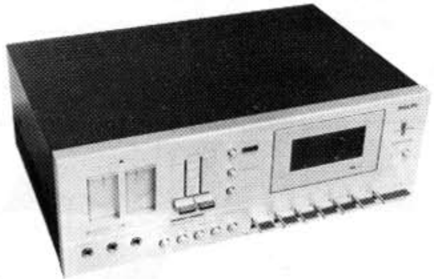

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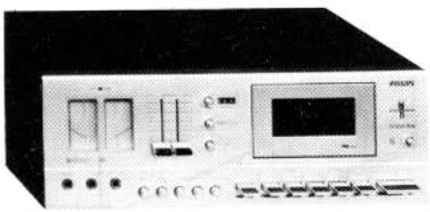

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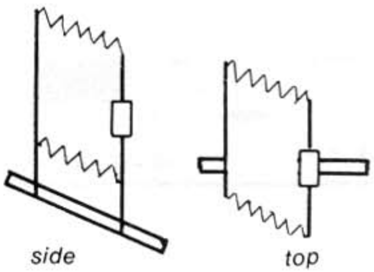
Of course, the same applies to the side of the subject. The front of the recorder and the film plane are again parallel, but camera adjustments also allow the side of the recorder to be seen (picture 9 and sketch 10).
Pictures 11 and 12 depict variations of the photographs with undistorted front, as follows: Once again, the first picture was taken with the camera in its basic position. All vertical lines converge. The second picture was shot using double adjustments (picture 12). The back panel is both raised and shifted sideways in respect of the optical axis (sketch 13).



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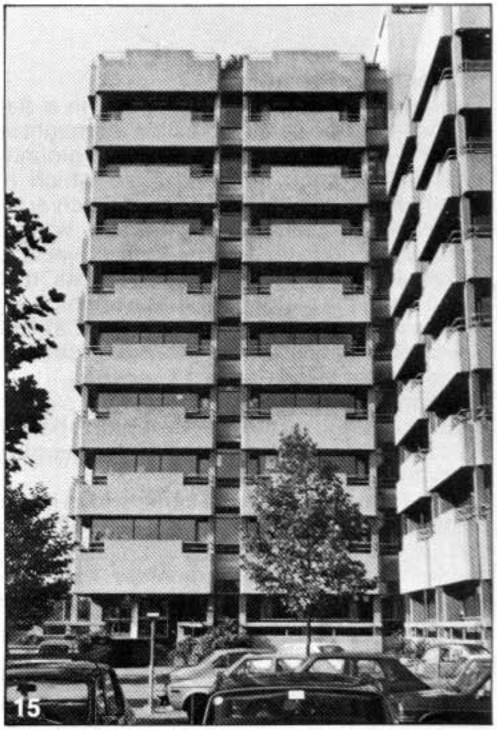

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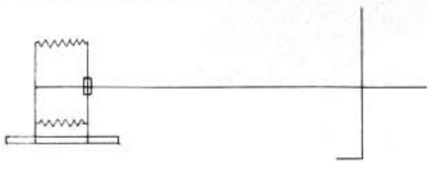

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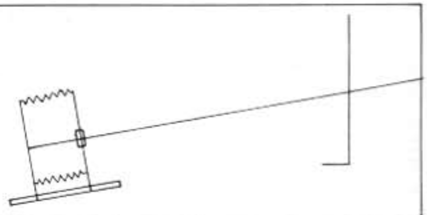
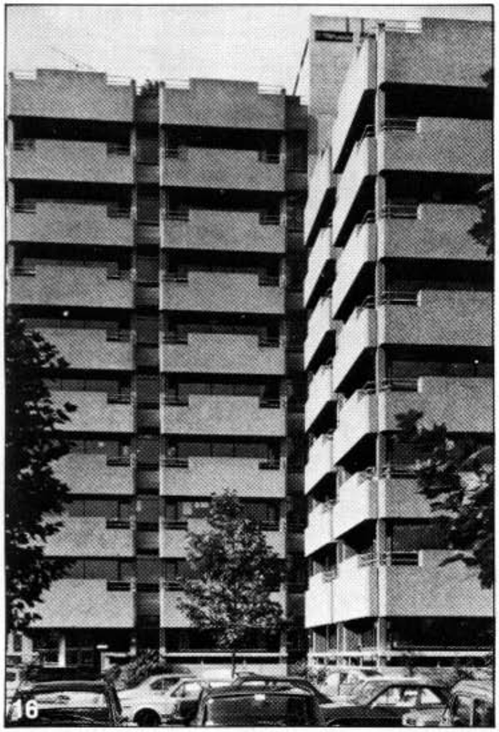
As another example we chose a building. With the technical camera set up in its basic unadjusted position straight in front of the building provides too little information (the height of the building is not shown (picture 14).



15A

Aiming a zeroed camera upwards causes convergence of the vertical lines of the building, as if it is toppling backwards (picture 15). Picture 16 displays the correct image; a building with parallel verticals and the same width, top and

If the camera back is at an angle with the subject, an image with perspective results. That is the case in pictures 18 en 19. Picture 18 was taken with a medium tele lens of 1.4 x the normal focal length.
Picture 19 is the result of a shot taken with a lens of "normal" focal length. These pictures also show that a tele lens foreshortens the image whereas the normal lens elongates it (sketch 20).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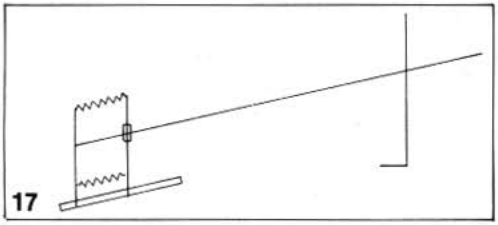
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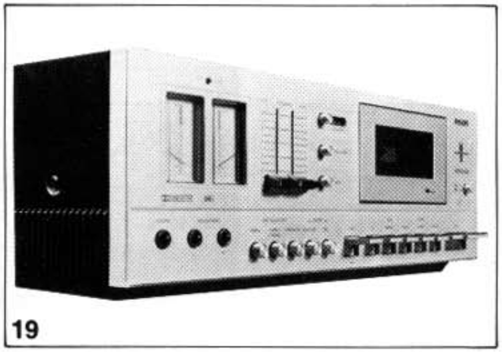
bottom. For shots like these the front panel of the camera is raised (picture 16 en sketch 17).


18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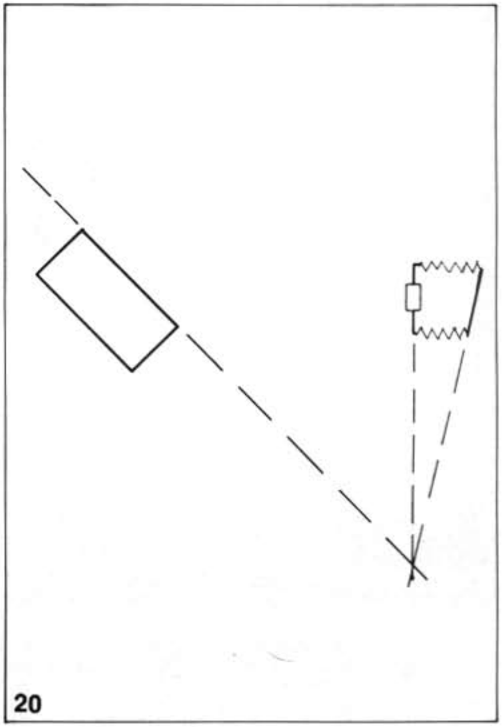
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This effect becomes more apparent when we photograph houses of which size we have some idea. A photograph of a row of town houses taken from a reasonable distance, results in a flat perspective. Shortening the subject to camera distance changes perspective significantly. The town houses appear much wider.

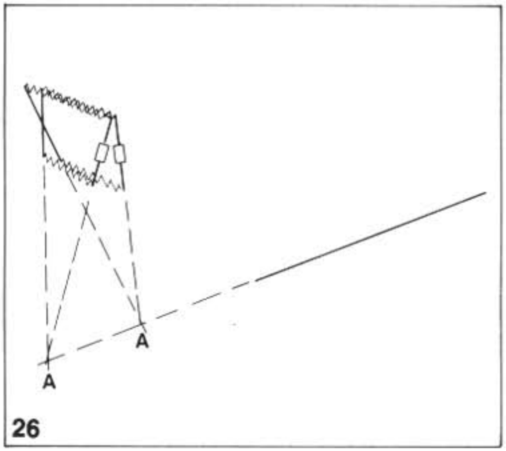

22

In order to fill the format with the subject at a shorter distance, a lens with a wider angle and shorter focal length needs to be employed.
In comparison, the left photograph on the 4" x 5" format was taken with a 240 mm lens, the right one with a 90 mm lens.
Thus: a change in **camera position** changes **perspective.**


23


24

Taking photographs from one camera position with lenses of say 90 mm and 240 mm focal length, we obtain different pictures with the same perspective. Looking at both lantern poles on either side of the building, one could be a cropped photograph of the other.
Thus: A different focal length in the same **camera position** produces the **same perspective**.



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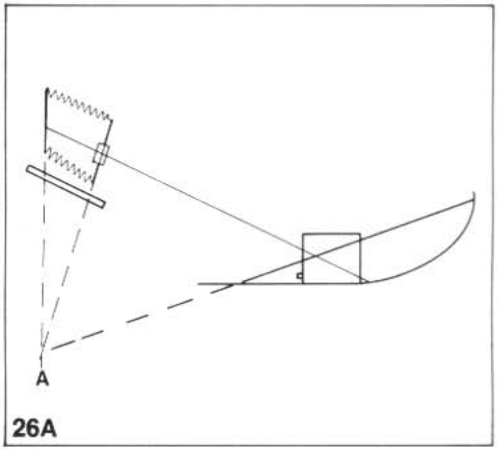

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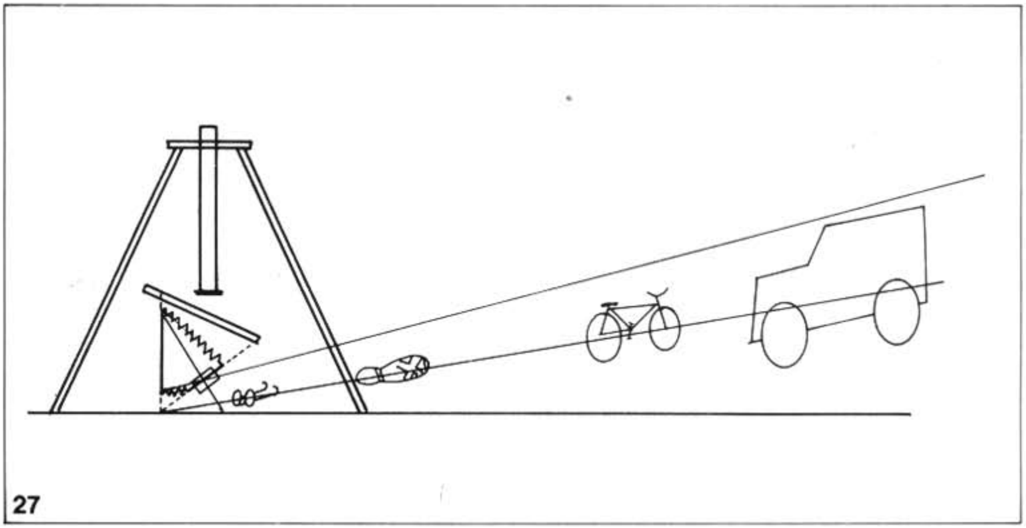
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Having sofar discussed camera adjustments where both front and back standards of the camera remained parallel we must now examine the adjustments used to move the focal plane other than parallel to those standards. According to **Scheimpflug's principle** the focal plane lies on an imaginary line extended through the position of lens, film and subject planes and meeting in a common point A (sketch 26 and 26A). The surprising fact is that it is possible to position the sharpness plane from a few centimetres in front of the camera to infinity (picture 25).
An apparent **gain in depth of field.**

These camera movements are used in many situations. It is often the only way a subject can be reproduced in sharp focus. We often work with a large scale of reproduction and consequently the depth of field is little. Thus critical focusing is essential, taking into account that using a small aperture increases the depth of field over the entire focal plane.

Picture 25 demonstrates the operation of Scheimpflug's principle. Sketch 27 shows the adjustments of the camera relative to the subject.

To obtain a low camera position the camera was attached to the centre column of the tripod upside down.


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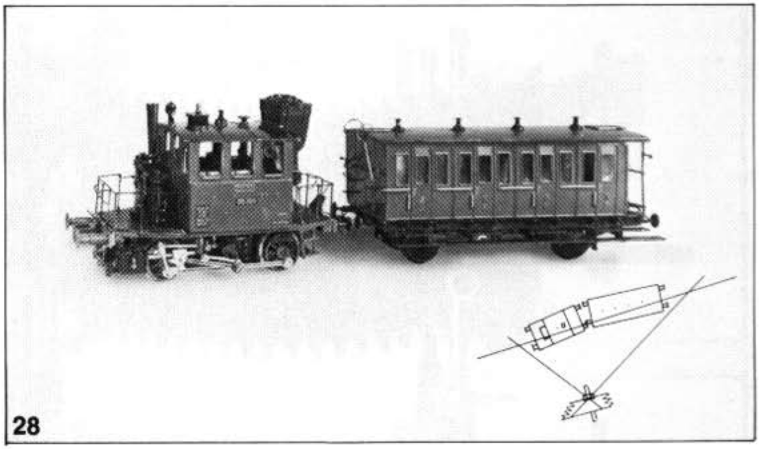
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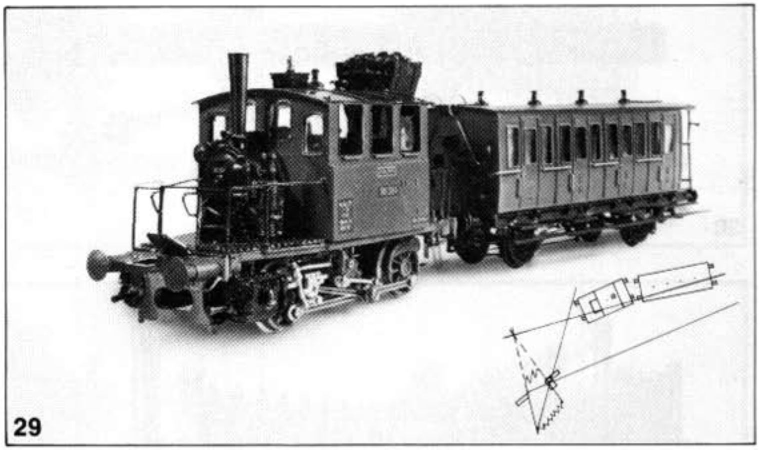
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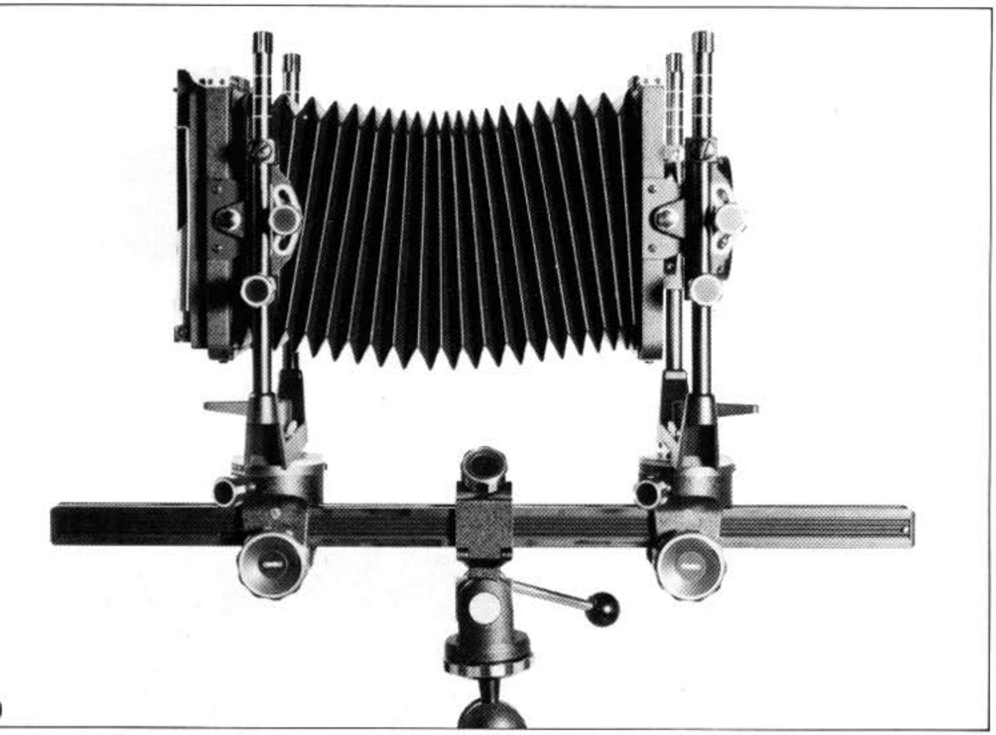
The model train in picture 28 is about 150 mm long. Set up under an angle to the subject, the camera has to be adjusted according to Scheimpflug's principle.
The film plane is nearly parallel to the subject, so there is no perspective. The camera back is shifted slightly sideways to include a front view as well as some of the side. A natural image has resulted.

In picture 29 we change the film plane in relation to the subject. Its position is almost at right angles to the train. We also take a low camera position. This achieves an exaggerated perspective of the locomotive, an effect often desirable from an advertising point of view. The subject has greater impact and appears longer.
Close up photographs like this with the front buffer only a few centimetres from the lens are about the ultimate that can be attained with three dimensional subjects. If extremes are greater, a reproduction of the original photograph with an adjustable camera or adjustable enlarger must be made. These techniques fall outside the scope of this booklet. We trust that this guide provides you with the necessary inspiration to get the most out of your Cambo.

Camera mounting



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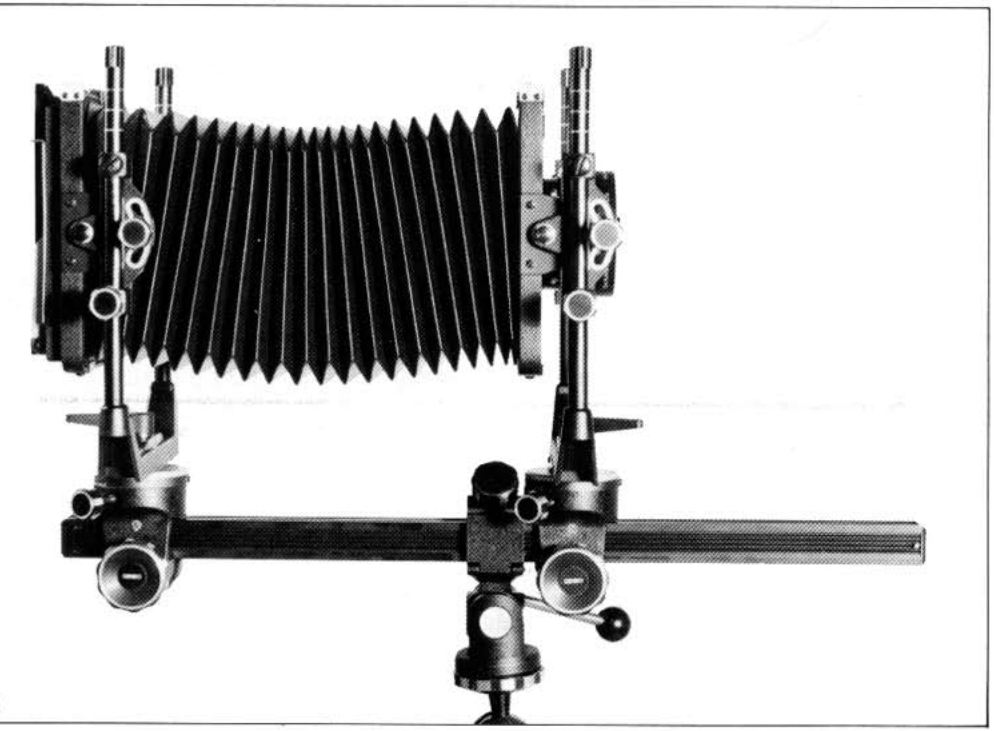
Picture 30
The correct position of a tripod mounted camera. Front and back standards are equal distances from the tripod head. The tripod mounting head is in the centre of the monorail.



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Picture 31
Wrong! The camera is unbalanced. There is a risk of unsharpness due to vibration!

Parallel adjustments

Picture 32 and 33
Photographing downwards with the monorail in a horizontal position. Picture 32 shows the better method. A front frame which is too low reduces ease of operation.

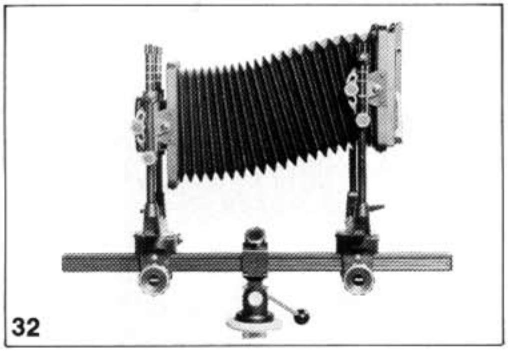
Picture 34 en 35
Photographing upwards with the monorail horizontal. Picture 34 shows a better method than picture 35. There is more freedom of adjustment.

These adjustments are particularly useful when photographing buildings, rectangular objects etc., because these camera movements are simply to execute. The disadvantage is that these adjustments are relatively limited. If greater parallel movement is required operate as in picture 36.

Picture 36. Extreme adjustments to photograph upwards with parallel movements. Downward photography is similarly possible. Photographing sideways can be done in like manner. With the monorail in the horizontal position we shift:

Picture 37. Rear standard to the right, front standard to the left. Both are pictured in their extreme position.

Picture 38. Set up as in picture 37, but with the monorail skewed and front and rear standards swung in opposite directions, providing an even greater adjustment.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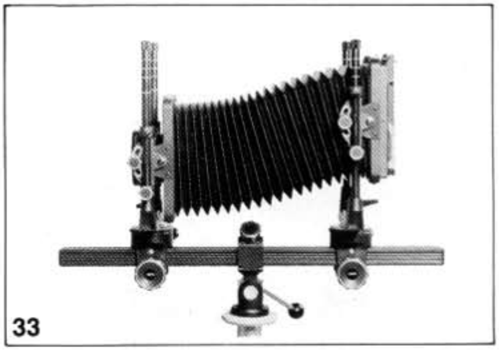
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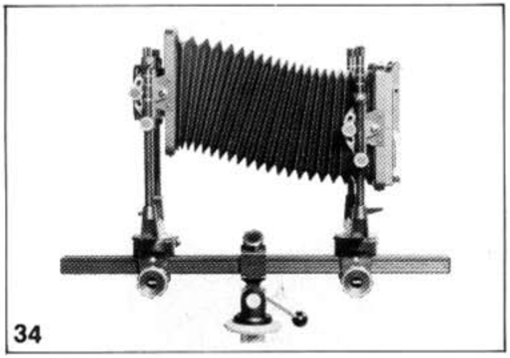
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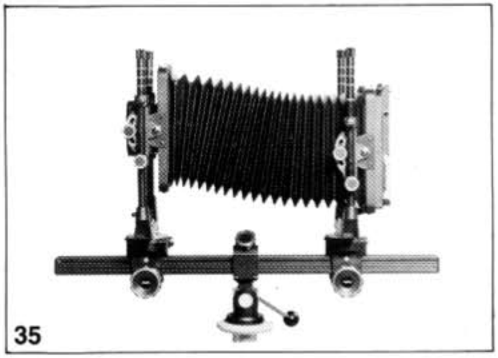
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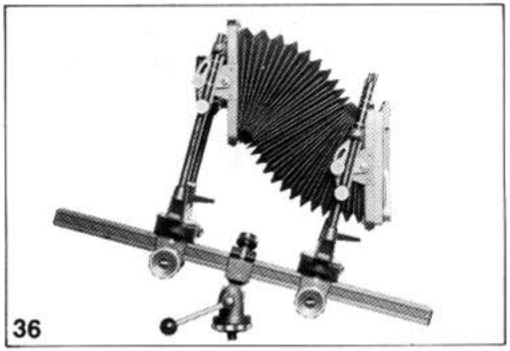
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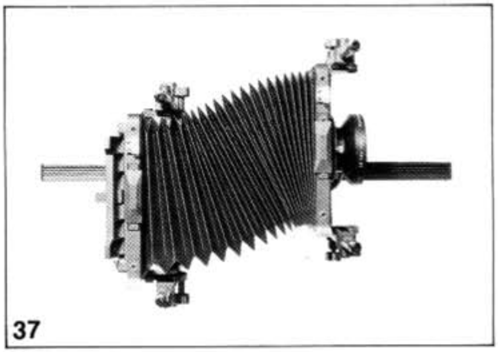
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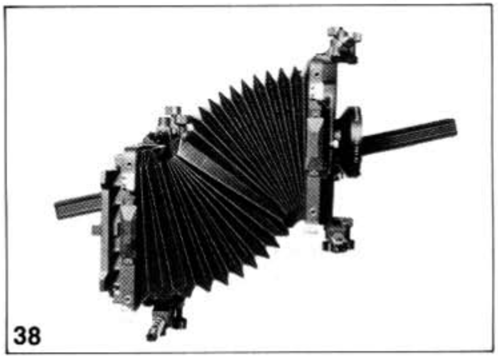
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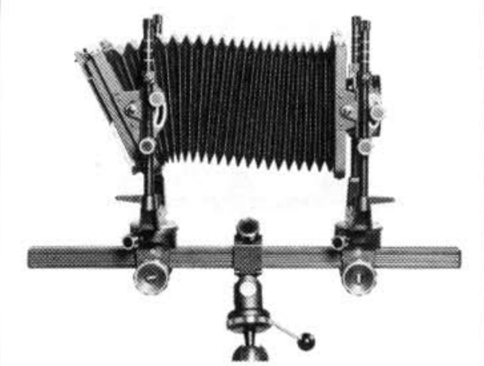
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Adjustments influencing image sharpness
(Scheimpflug)

Picture 39 en 40
To focus on a horizontal plane the lens panel can be tilted forwards and the film plane backwards. The sharpness plane lies on an intersecting line extended along the lens panel, film and subject plane. In the illustrated set up (horizontal monorail) the perspective in picture 40 is strongly influenced (see also sketch 26A on page 6). With the camera slanted downwards (e.g. for product shots) this adjustment will often give the desired effect.

Picture 41 and 42
The same applies as before, but this time with an image line lying above the camera. These adjustments are not often used (shots of ceilings, etc.).

Picture 43 and 44
As in picture 39 en 40; this time in the vertical plane. Shots of a wall taken under an angle. Here, the desired perspective determines whether to swing the front or the back frame or as in most instances both frames (picture 45).

Remember that the adjustments shown are extremes. In practice a combination of a number of adjustments is used.
As a general rule:
- the **rear frame (film plane)** determines **perspective**.
- the **front frame (lens plane)** determines image **sharpness** (i.e. the position of the sharpness of focal plane).

Normally, adjust the rear frame for perspective first, then the front frame for focus.


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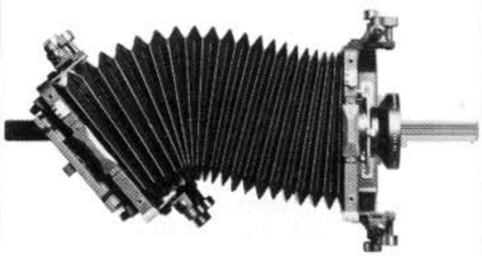
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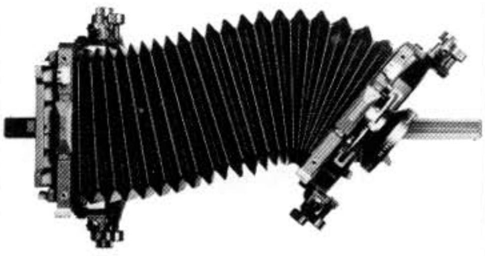
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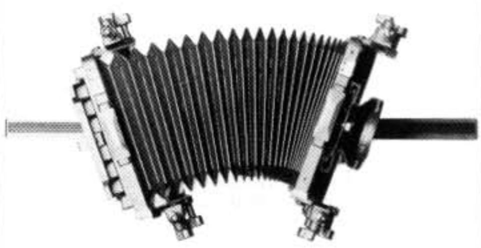
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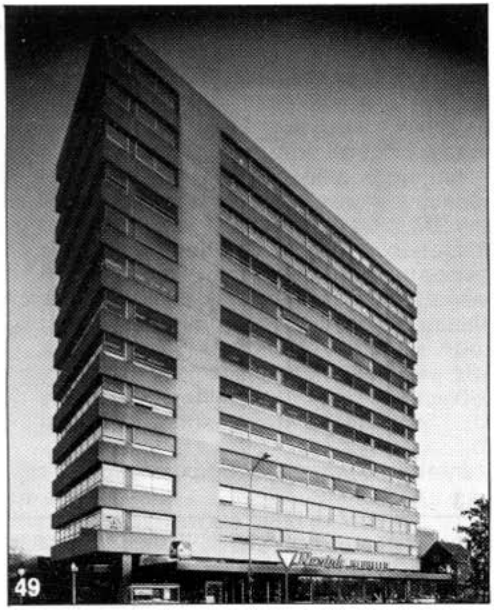
One of the more difficult areas in large format photography is using super wide angle lenses. The picture on page 7 is an example. It was taken with a 65 mm lens on 4" x 5" format. For this type of shot the optical bench is indispensable, as extreme camera adjustments are necessary.

For most "ultra wide angle photography" the optical bench is less suitable. That is to say that even with a wide angle bellows the camera is relatively unwieldy, whilst adjustments are most critical. For this reason, when using super wide angle lenses, it helps to use a special camera, which only provides parallel adjustment and is easy to use hand-held. The three photographs 46, 47 and 48 are typical examples of results obtained with the **wide angle camera**.

Photo 46
A wide angle photograph with the "Cambo-Wide" equipped with a 65 mm Super-Angulon lens. Camera was levelled with the on-camera spirit level.



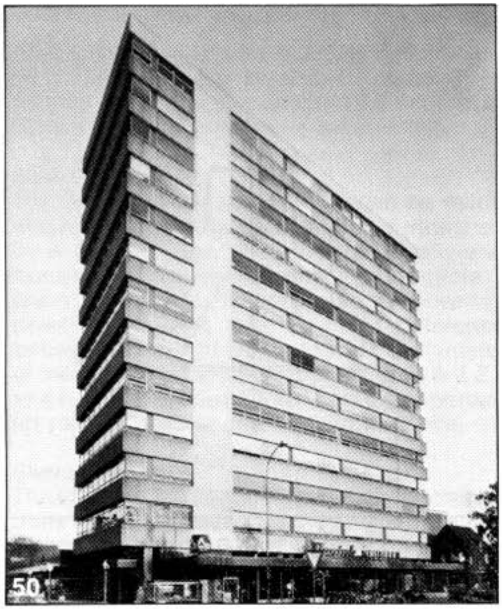
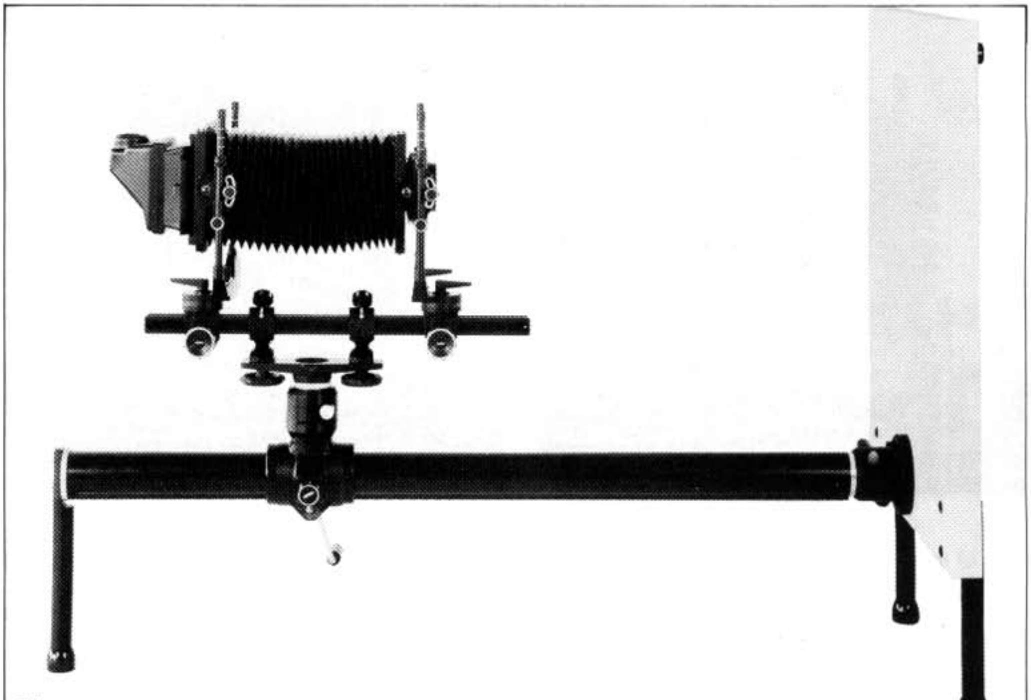


Photo 47
The camera has been slanted slightly upwards. Obviously the perspective of the building is now unacceptable.

Photo 48
This photograph was taken with the camera set up horizontally, with the lens raised by 15 mm. The building is better proportioned all over. In colour photography where the entire 4" x 5" format is generally used, this slight parallel adjustment is very important. Photographing such a building from close by cannot be done even with a super wide angle lens (here f5.6/65 mm Super Angulon lens). Excessive parallel adjustment is needed which the lens will not entirely cover (photo 49). There is light fall off at the edges. This is always a problem with symmetrical lenses with such a wide angle. Modern lenses such as the f5.6 Super Angulon eliminate this effect somewhat, but fall off is still clearly evident in the picture. The solution to the problem is seen in photo 50. The camera is tilted upwards to such a degree that the top of the building is just right. The resulting distortion is eliminated at the enlarging stage (a colour transparency requires duplication). The dark top has been corrected by dodging. This can also be achieved by using a centrally graduated filter on the lens. This type of filter freely transmits light rays coming in at an angle but holds back light at the centre, thus evening out the illumination. In critical colour photography such a filter is necessary when using a super wide angle lens.

Reproductions with the technical camera



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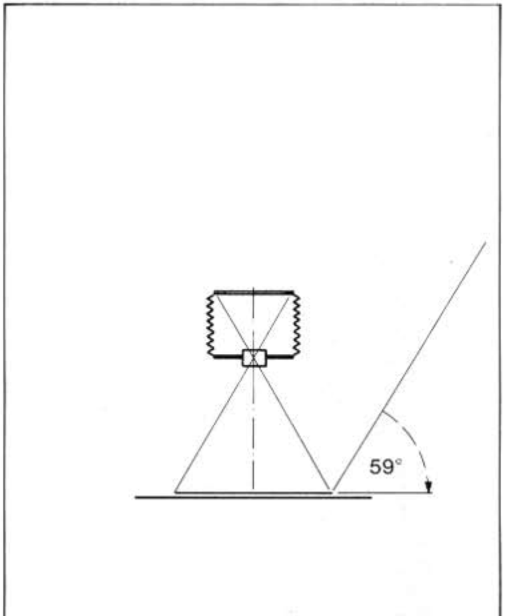
The technical camera is also an ideal copy camera, not only because of its large negative format (allows retouching on the negative), but also because of its adjustments and the possibility of using special lenses. Generally, it is best to use a lens with not too wide an angle of field, i.e. 40° or smaller. Normally, when reducing the image, a 180 mm lens is recommended; for 1:1 and enlargment of the image the 150 mm and 90 mm lenses are more suitable. A high quality double anastigmatic lens such as the Symmar or Sironar is to be preferred. For very critical work use special process lenses. Illumination must be even. For small subjects two photofloods suffice, set up at an angle of 45° on both sides of the subject. The angle of illumination is not critical. To some extent it depends on the circumstances. Adjust the lamps individually and choose an angle of illumination which does not create reflections of the subject on the groundglass. The position of the lamps has to be symmetrical to ensure even lighting. Photographs on light weight paper (glossy or semi-matt) are often difficult to reproduce as they do not lie completely flat. The answer is a sheet of glass to flatten the photograph. Glossy photographs are easier to copy than semi-matt ones. Unwanted reflections on glossy photographs can be easily detected before taking the shot, whereas on semi-matt photos these only become evident at a later stage.

Ensure that no direct light falls on the front of the camera as it will reflect on the subject causing a mottled pattern in the final result. For critical work place in front of the camera a piece of black card board (not too small) with a hole in the centre for the lens.

For straight copies the groundglass and lensboard must be parallel to the copy board. Even a slight deviation causes noticeable distortion. However, distortion in the original can be eliminated with camera adjustments.



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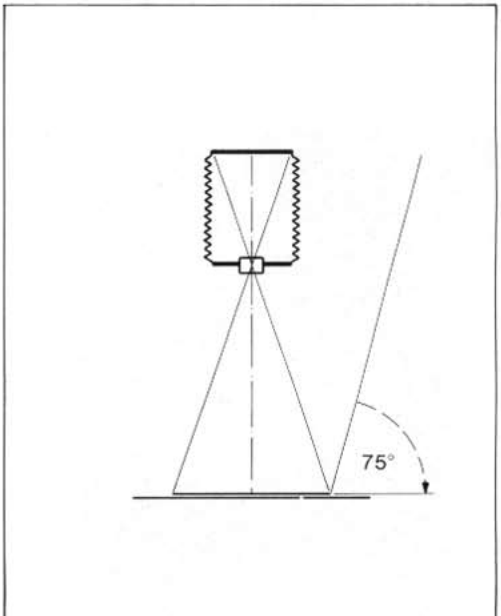
Reproduction shot with a short focal length lens. The angle of illumination is indicated by the dotted line (i.e. the edge of the reflector).



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Reproduction shot with a longer lens. It is evident that the angle of illumination is considerably greater.

Lenses

The limit of adjustment also depends on the negative format.
Data for the most popular negative formats are:

"Ideal format" (6 x 7 cm)	nett 5.6 x 7.2 cm	diagonal 9,1 cm
6.5 x 9 cm	nett 5.8 x 8.1 cm	diagonal 10 cm
9 x 12 cm	nett 8.3 x 11.4 cm	diagonal 14.1 cm
4" x 5" (10.2 x 12.7 cm)	nett 9.6 x 12. cm	diagonal 15.4 cm
13 x 18 cm	nett 12.2 x 17.1 cm	diagonal 21.0 cm
18 x 24 cm	nett 17.1 x 23.1 cm	diagonal 28.7 cm
8" x 10" (20.3 x 25.4 cm)	nett 19.4 x 24.5 cm	diagonal 31.3 cm

Adjustment capabilities of the technical camera and its application for so many different assignments complicate the choice of lens. Much more so than in 35 mm and 6 x 6 photography. Some lenses are designed to allow maximum camera adjustment, e.g. for architectural photography. Others are fast lenses more suited to portraiture, whilst a third group gives maximum colour rendition for reproduction.

Chiefly, there are four groups of lenses:

a. **Triplets** (Xenar etc.). Maximum aperture **usually f4.5. Angle of field 50°**. Application: landscape and portrait.
b. **Symmetrical lenses** (Super Angulon, Symmar, Sironar). Maximum aperture f5.6. Angle of field 70°-100°, depending on the type. Application: Most suitable for technical work, architecture, product photography, etc. Symmar-S and Sironar lenses are the work horses of technical photography.
c. **Tele lenses** have the advantage that bellows extension is very short relative to focal distance (e.g. Tele Arton, focal distance 270 mm, extension 170 mm at ∞). Angle of field about 30°. Maximum aperture f5.6. Application: Ideal for landscape and portrait.
d. **Process lenses**. These are slow, symmetrical lenses with an angle of field of 50° and with a great degree of colour correction (which can also deviate from normal correction: e.g. optimum for U.V.). Process lenses are ideal for reproductions and are usually identified with the prefix Repro... or Apo... (Repro-Claron, Apo-Ronar). They are also suitable for normal photography, provided slow shutter speeds are acceptable.

The type of photography determines the lens to be used.
For a given format we need to look at:

1. **Focal distance**: The choice of lens is influenced by format and perspective (apart from adjustments).
2. **The size of the circle of good definition** of the lens. This mainly determines the degree of adjustment possible.

Factory specifications often include the angle of field of the lens (e.g. Symmar-S 70° at f22). The angle of field as such means very little. A 100 mm Symmar-S lens covers the 6 x 9 cm format; a 180 mm Symmar-S with the same angle of field covers the 13 x 18 cm format, but can be used for smaller formats too. In the latter case there is opportunity for adjustments.

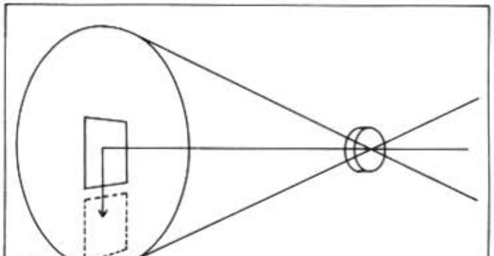
The lens produces sharpness within a circular area. As long as the film plane stays within that circle a sharp image will result. The size of the circle of good definition determines the limit of the adjustments that can be made. In their brochures lens manufacturers usually indicate the diameter of the circle of good definition of a lens at maximum aperture and at f22.

(Especially in symmetrical lenses the difference is significant: e.g. the Super Angulon f5.6/75 mm: at f5.6 the diameter is 15.6 cm and at f22 it is 19.8 cm, with focus set at infinity).

Sketch 54 and 55
The limit to which adjustments can be made within the circle of good definition is indicated by a. and b. respectively, both vertically and horizontally. (Film format relative to the circle of good definition). To work out the covering power of a lens, take half the difference between the format diagonal and the diameter of the circle of good definition. Then a. is 1.2 x and b. 1.4 x this value. These data are important for parallel adjustments (e.g. architecture).

Sketch 56
The effect on the image of camera adjustments does not only depend on the size of the circle of good definition, but also on the focal distance. For example, a 90 mm Super Angulon lens has a circle of good definition of 23.5 cm at f22. A 180 mm Symmar-S lens has a circle of 25.2 cm. The diagonal of the 4" x 5" format is 15.4 cm (see table) $\frac{23.5 - 15.4}{2} = 4.05$ cm. If we use a vertical 4" x 5" groundglass, then the maximum vertical adjustment is 1.2 x 4.05 = 4.86 cm. Maximum vertical adjustment for the 180 mm Symmar-S is $\frac{25.2 - 15.4}{2} \times 1.2 = 5.88$ cm. In practice tenths of millimetres are ignored. Here they are only given as part of the computation.

However, at maximum adjustment one "looks" at the subject under a steeper angle with the Super Angulon than with the Symmar lens. The



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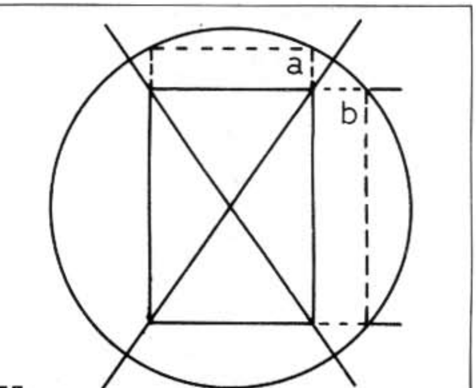

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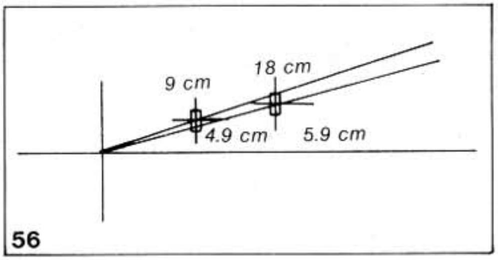

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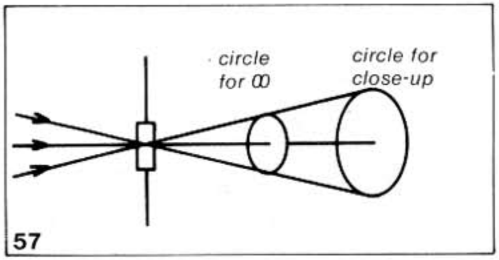

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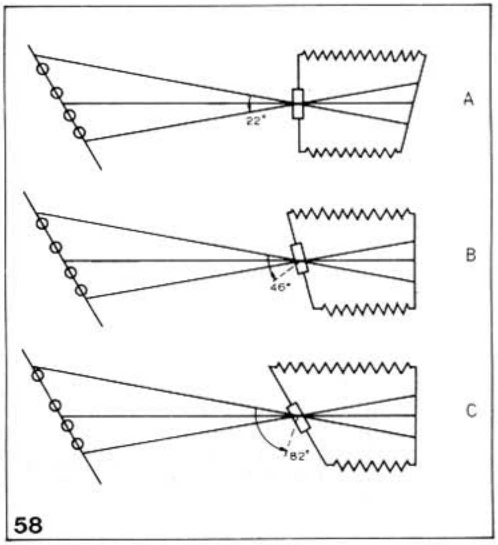

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effect of camera adjustments with the Super Angulon is greater despite the smaller movement.

In the main, the circle of good definition becomes greater the shorter the camera to subject distance. The image distance (b) increases, whilst the image angle remains constant. (With very asymmetrical lenses – e.g. tele lenses – this does not always apply).

Sketch 57
To compute the diameter of the circle of good definition for a close up photograph, divide the subject distance by the focal distance and multiply by the given diameter.
D close up = $\frac{b}{f}$ x D
D = diameter
b = subject distance
f = focal distance

The closer the camera is to the subject, the further is the sharp image on the groundglass from the lens. Diaphragm values are calculated at infinity. Light intensity of the image drops off the further it is from the lens. Therefore, when using a hand-held lightmeter exposure times need correction. This applies if the subject is closer than about 8 x the focal distance. The correction factor is calculated by squaring the quotient of the subject distance and the focal distance $(\frac{b}{f})^2$. Especially in reproduction work it is handy to use the scale of reproduction formula $(M = \frac{B}{V})$, the correction factor then becomes $(M + 1)^2$. Measure on the focusing screen the dimensions of say 10 cm of the subject. If, for instance, it is 5 cm, then $M = \frac{5}{10} = ½$; the correction factor is $(1 + ½)^2 = (1 ½)^2 = 2.25$ is 1 stop (0.25 can be ignored).

Image distance is best measured from the centre of the lens to the centre of the groundglass. Measure that distance by holding a ruler next to the camera. In computing the adjustment capabilities of the camera relative to the lens, start with parallel adjustments.

With other camera movements the angle of field of the lens can also play an important role. The dispersion of the depth of field in the subject is described by Scheimpflug's principle: The focal plane lies on intersecting lines extended through the film plane, the lens plane and the subject plane. (With a zeroed camera that line lies in infinity, all planes are parallel).

Sketch 58
Starting with identical circumstances in set-up A and B, the depth of field in A is corrected with the rear frame, in B with the front panel.
The lens covers an angle of field of minimum 22° in A and 46° in B, almost twice as much! The disadvantage of set-up A is that perspective is very steep. Should perspective stay flat, parallel adjustment C is needed. The required angle of field is 82° in this example. All three set-ups are in the same camera position.

For many technical applications it makes sense to buy a lens having both a large angle of field and a large circle of good definition. If it happens to be convenient, in technical photography a wide angle lens may be used as a tele lens.

To illustrate:
A f5.6/90 mm Super Angulon lens, according to its angle of field (105°), is a super wide angle lens. The circle of good definition at f22 is 23.5 cm. Using it with the 13 x 18 cm format it will produce a super wide angle image.

For the 4" x 5" format it is a normal wide angle lens with adjustment reserve. On the 6 x 7 cm format it acts as a normal lens (focal distance equal to the format diagonal), but with extreme adjustment reserve.

Compendium
In technical photography it is necessary to use a lens shade or compendium to prevent flare. That is not so simple, especially when camera adjustments are used. A normal lens shade can cause vignetting. Particularly with wide angle lenses a "normal" lens shade is largely ineffective.
A compendium is a better proposition. It is a bellows lens shade attached to the front frame of the camera and can be so adjusted that only image producing light rays enter the lens. At the same time, colour correcting gelatin filters may be inserted into the compendium. If no compendium is available, use a grey card or a focusing cloth to cut off light falling directly into the lens. To simply check whether in a certain set-up the lens shade or compendium vignets, look at the lens through the cut off corners of the groundglass. If the inside of the lens shade can be seen through the lens, it vignets and should not be used. If your groundglass does not have cut off corners it should be removed to perform this test.

Focusing
It is best to focus on a well-lit subject. The use of a magnifier is recommended.

Critical focus is not easy to achieve due to the grain structure in the groundglass. Moreover, when focusing, the entire image should be viewed. To some extent depth of field can be judged on the groundglass when stopping down the lens.

If the photograph is taken with the aperture where the image is just sharp, a loss of sharpness will occur when **enlarging** the negative or transparency. The subsequent degree of enlargement has to be taken into account when taking the photograph. A 2 x linear enlargement requires stopping down an extra two stops in addition to the aperture where the image appears sharp. A smaller diaphragm than f32 should not be used as beyond it the brilliance of the image will suffer (more so with lenses of short focal distance than long ones). In principle, if the photograph is **not** to be enlarged the shot can be taken with the stop that produces visual sharpness on the groundglass. As a general rule, shots that are to be enlarged should be stopped down by 2 or 3 apertures. Thus, if visually the image is not sharp at f11 the adjustment or position of the camera must be changed.

Following is a handy method of finding optimum sharpness and of checking whether the adjustment is right. Move the rear standard backwards until the entire image is unsharp on the groundglass; then move the rear standard forwards until the front of the subject is **just** in focus. Now place a finger on the monorail against the rear standard. Move the rear panel forwards until that part of the subject furthest from the camera is just in focus. The distance between finger and rear standard is the **"zone of focus"**. Optimum focus lies exactly in its centre. The size of the zone of focus is also an indication of the feasibility of the shot. The general rule for critical work is:
If enlargement is **not** required: about 1 cm at f22.
If enlargement **is** required: about ½ cm at f22. (1.4 and 0.7 cm at f32 respectively). With difficult shots, at least all visually important details of the image must fall within the zone of focus. It must also be realised that transparencies are often greatly enlarged for graphic reproduction. Very critical focusing is then also important.

Cambo PP 40
passportraitcamera **59**

Cambo WIDE
wide-angle camera 9x12/4x5 **60**

Cambo TWR 54
twin reflex camera 9x12/5x4 **61**

Cambo RTM
repro copy stand

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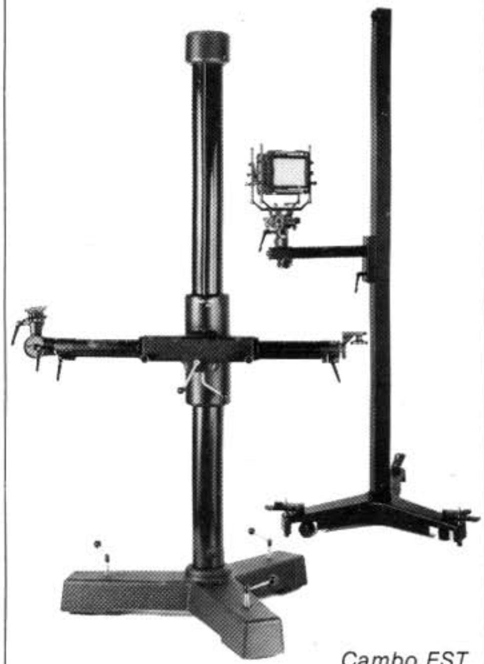
Cambo UST
studiostand



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Apart from the technical cameras described in this booklet, Cambo manufactures an extensive range of products for the professional photographer. Some are illustrated here.