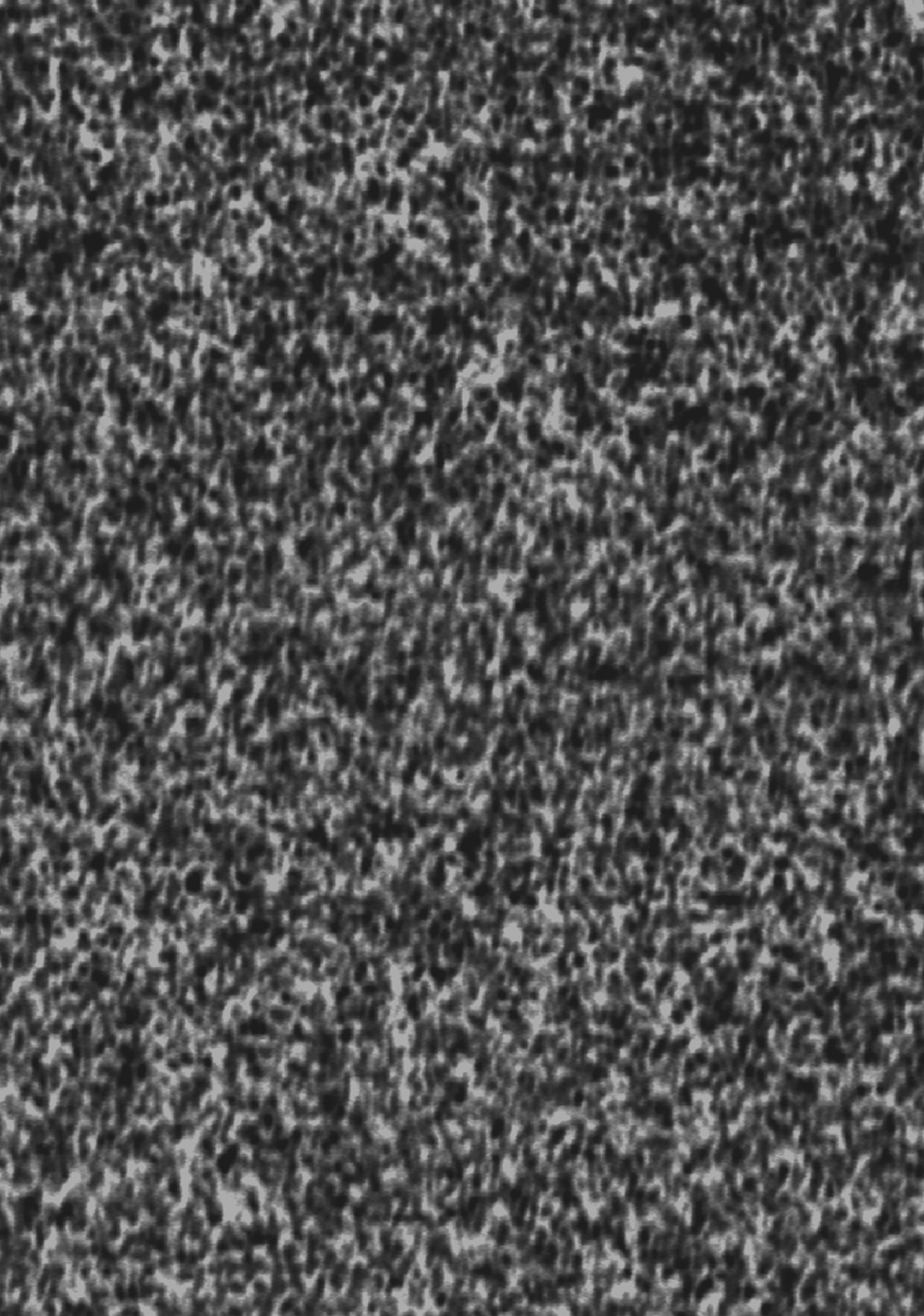


MOBILE DARKROOM UNIT
A project by Matei Bejenaru

Produced by Kettle's Yard, as part of the Associate Artist Programme 2012-2013
Curated by Elizabeth Fisher

Published by Kettle's Yard, University of Cambridge

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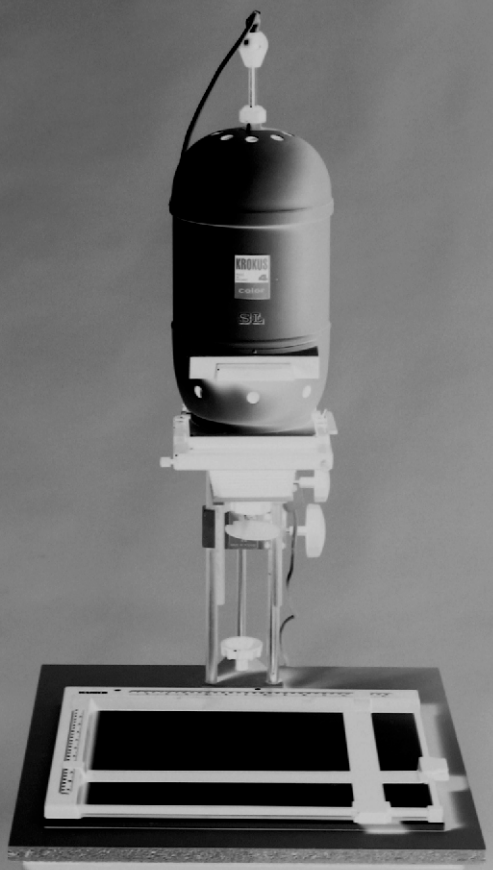
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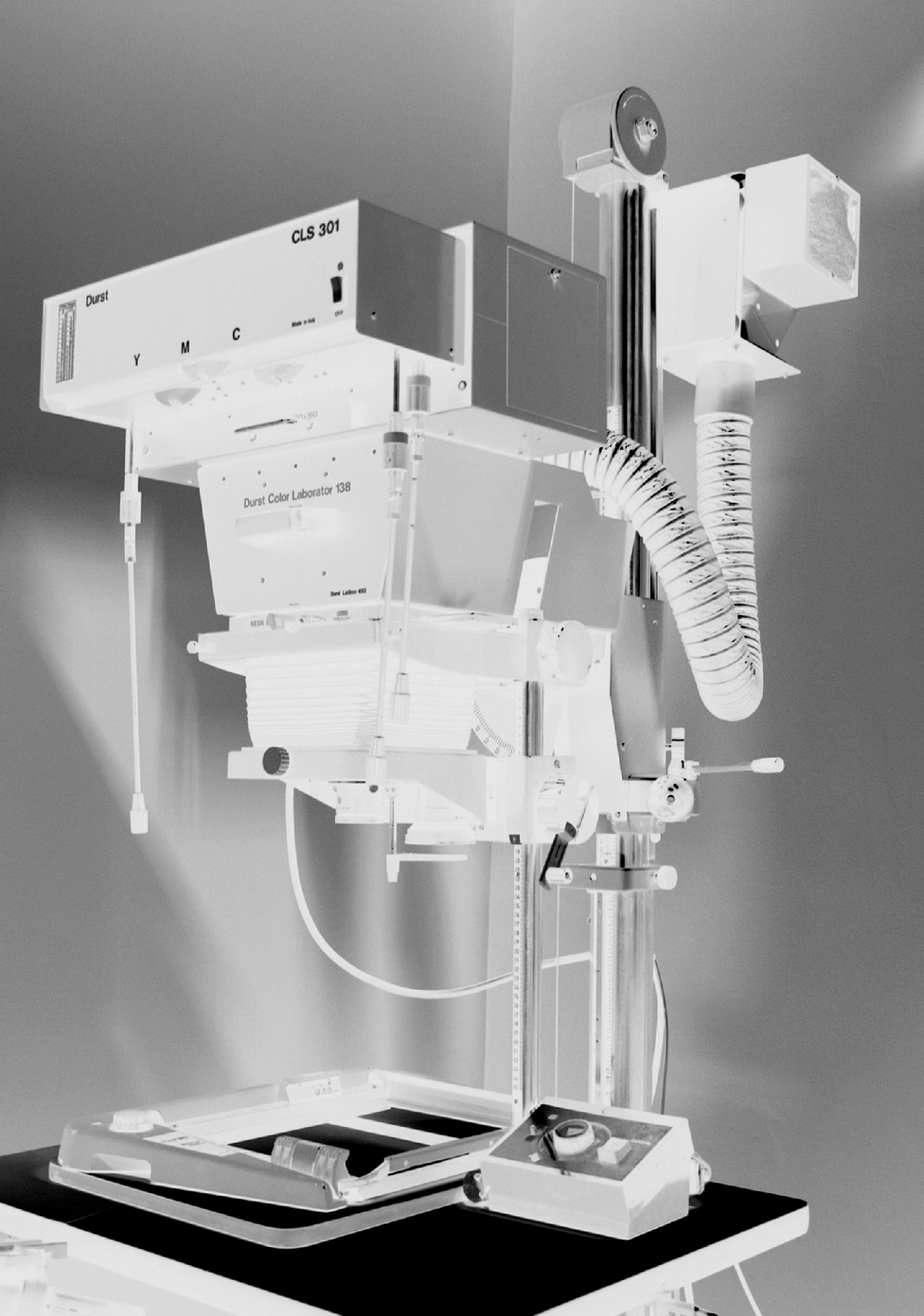
MATEI BEJENARU

MDU

MOBILE DARKROOM UNIT



KETTLE'S YARD, UNIVERSITY OF CAMBRIDGE


CLS 301
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Durst Color Laborator 138

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Mobile Darkroom Unit

Kettle's Yard is the proud recipient of Matei Bejenaru's ingenious new work, the *Mobile Darkroom Unit* (2013). This practical, fully operational kit was developed during Bejenaru's tenure as an Associate Artist at Kettle's Yard. The artist built it using reconditioned photography equipment and materials he had painstakingly collected from all over Europe and used to make photographs and teach photography over the last twenty-odd years. Once constructed, he personally drove the *Mobile Darkroom Unit* (MDU) over 2,600km across Europe from Iași, his home town in Romania, to Cambridge in order to deliver it to Kettle's Yard: an artwork donated to the collection, and a resource given for others to use. Like Jim and Helen Ede who made and gave Kettle's Yard in 1964, blending an ethics of art and life, Bejenaru's response was to also make a gift of art with a social function.

Bejenaru's work always has a strong political and social grounding, or as he puts it, "comes out of a political way of thinking." Living through the privations and hardships of Nicolae Ceaușescu's regime inevitably shaped his artistic identity. In the 1970s and '80s in Romania it was difficult to be a photographer; access to materials was severely limited and the production of images heavily policed by the state. A photograph deemed to 'denigrate the socialist reality' could land the photographer 6 years in prison. Today, Bejenaru's films, photographs and social interventions engage with the socialist 'reality' of the recent past at the same time as confronting the social and economic conditions of late-stage capitalism in the present.

In the early 2000s, Bejenaru undertook a number of projects that used the premise of art to intervene in social space: when he took part in the 2003 Tirana Biennial, he learnt that a large proportion of the city of Tirana's inhabitants did not have access to clean drinking water, so he obtained permission from the local authorities and used his production budget to organise a distribution of free water in the centre of the city by temporarily diverting the city water main (*Cesme,* 2003). He used another production budget for a project in Vienna (*Mehr chancen fur unsere jugend,* 2002*)* to bring fellow artists from Romania to visit the museums, artists and curators in Vienna. More recent projects, including the documentary photography projects *M3: work, memory, movement* (2008-10) and *Prut* (2011-) reveal a critical interest in the interplay of aesthetic languages and political subjects.

Bejenaru's film, *Battling Inertia* (2010), follows the story of a literary circle that was active during the 70s and '80s in communist Romania, and takes its title from the name of the group. The circle was founded by Alexandru Tacu and other workers at the Heavy Equipment Plant in Iași, and met weekly at the factory after work. The artist films Tacu going back to the old plant, still in operation; he revisits the library he created for workers for the first time since he retired. Taking in the aging buildings and rusty machinery in the factory, Bejenaru's camera bears witness to the political and economic history of the country. Little seems to have changed since the 1970s. His film soaks up the rich ochres and metallic shadows, making much of the textures of steel and dust, and shelves stacked full of books, which are easily aestheticized. The factory is a visual feast and the camera's gaze is tender, heavy with nostalgia for the utopian aspirations of industry and technology.

The new MDU also invokes a specific set of aesthetic references that situate it temporally, culturally, economically and geographically; the equipment is fashionably 'dated,' and mostly originates from Eastern Europe. This publication, a 'users' handbook' intended to accompany the MDU, adopts a specific style of presentation and language (written in Romanian and translated into English) in keeping with the conventions of the genre.

Bejenaru built the MDU from the only equipment he had, until recently, had access to: technology on the verge of obsolescence that Western artists have the luxury of regarding with uninhibited nostalgia. Few students in art schools today are taught the skills or knowledge needed to work with photographic film. The materials and equipment themselves are becoming harder to find, as global companies like Kodak and Fuji that became household names on the back of these products have decided that film is now uneconomical to produce. The alchemy of film photography has been usurped by a digital proliferation of images, and the convenience, speed and reproducibility of digital photographs make the digital a truly democratic mass-media.

And yet those who use film wax lyrical about the sensuousness of the medium, the quality of colour and extraordinary depth of field that it can convey, which doesn't translate into digital images. As far as visual culture goes, the virtual dominates. With the MDU Bejenaru has given us the means to make images and to think about images. Not just any images, but ones that are hard-won compared to digital snaps, demanding time and skill to produce. He has made this specialist and increasingly esoteric medium accessible to others; from the students of Comberton Village College, who spent 2 days with the artist learning how to make a photograph, to the visitors and groups who will come across it at Kettle's Yard in future.

In his much-cited book *The Gift: The Erotic Life of Property*, Lewis Hyde points to two types of economies. In a commodity (or exchange) economy, status is accorded to those

who have the most. In a gift economy, status is accorded to those who *give* the most to others. Bejenaru's gesture reverses the logic of technological, economic and ideological flow from West to East, which since 1989 has taken political democracy and the free market economy to countries on the periphery of Europe. His gift of already obsolete technology subverts the terms of exchange, the transactional relationships and commodification of resources upon which capitalist society is premised.

For Bejenaru, the relationship between east and west, centre and periphery is embedded in the relentless progress of technology and its relationship to capitalism. Since 1989, Bucharest, the capital of Romania, has become one of the largest financial and industrial centres in South-Eastern Europe. The irony is that many factories in Romania are equipped with second-hand machinery from Italy, Germany and the UK, kept in operation through technical improvisation. Perhaps because it also has the lowest net average monthly wage in the European Union, Romania is a major producer and exporter of a range of goods from textiles to cars. Thanks to the cheap cost of labour, the goods can be sold at low prices in the West. Unsurprisingly, many Romanians still can't afford to buy the commodities they produce.

Gifts are free. They are given without expectation of reciprocity. Gift economies are said by some to build communities, and with the MDU, Bejenaru offers us the seed of a community, a simple way of building relationships through the sharing of resources. An alternative to the economic relationship proposed.

For a place so rooted in the 20th century, and so invested in the notion of 'fusing art and life', it seems paradoxical that photography, which has utterly transformed our understanding of the relationship between art and life in the 20th century, is virtually absent from the collection at Kettle's Yard. Although in quite different ways, both Jim Ede and Matei Bejenaru understand art as lived experience. For Ede, photography hadn't yet come to stand in for lived experience. Today, however, photographic images have so successfully colonised our visual environment that contemporary life might be lived vicariously through images. In order to interrogate the conditions that shape artistic expression and lived experience, Bejenaru's natural subject is the photographic image. Now, paradoxically, the MDU draws attention to the physical event of making a photograph.

Meanwhile, Bejenaru's gift has its own parallels in the digital age: in the open source movements, social networks and other virtual platforms that offer new ways to share information, create communities and new 'knowledge' economies online and on a global scale. In technology we trust.

Elizabeth Fisher
Curator of Exhibitions and Collections, Kettle's Yard

About MDU manual

This manual was designed as a practical guide for the users of the Mobile Darkroom Unit (MDU) in order to produce gelatin silver prints. The manual has two parts: the first part provides information concerning the photographic equipment included in the MDU and how to use it, while the second part is a synthesis of the basic theoretical and practical knowledge an MDU user should have in order to produce darkroom prints.

The information included in this manual is not new, it can be found in the extremely rich literature produced before the advent of the digital revolution in imaging. I have synthesised what I thought was relevant for someone wishing to know and control the production chain of analogue photographic images, from the exposure of the negative to its processing and printing onto photographic paper.

Most of the equipment in the MDU comes from my first darkroom, set up in the early 1990s, while I was studying art (painting) in Romania; through photography I was experimenting with new artistic practices and with new means of visual expression. I am emotionally attached to the Polish Krokus enlarger and to the other devices, all of them manufactured in the 1980s in the countries of Eastern Europe, and my only motivation for parting with them is the idea to give a gift, in the knowledge that young people in a completely different context will discover the secret joy of working in a darkroom and hopefully pause to reflect on this fact.

MDU is a relational artistic project in which a visual artist from Eastern Europe donates to an institution from the birthplace of the Industrial Revolution a set of apparently obsolete technical equipment used for image production. This is my artistic response to the classic transfer of knowledge and organisation models from the West to the East.

Matei Bejenaru
Iasi, Romania
March 2013







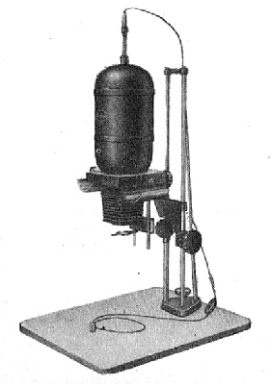


PZO Warsawa Company in the 1950s.
On the right page: An old Krokus enlarger from mid 50s.

1. Mobile Darkroom Unit description

The box containing the kit used for producing gelatin silver prints was manufactured in December 2012, according to a design I made based on two needs: portability (to fit in the boot of a family car) and quick installation (to be assembled in less than one hour in any place that has access to water and can be shielded from light).

The kit's main piece is my first photo enlarger, which I bought from a thrift shop in Iași, Romania, in the early 1990s. The brand of the enlarger is Krokus and it was produced in Poland in 1978 by the company PZO Warsawa. The Krokus enlargers were produced in different versions between 1953 and 1990. Like everywhere in the world in the '60s, '70s and '80s, Romanian amateur photographers improvised darkrooms in their apartment bathrooms. This is one reason why the well-known Italian company Durst saw a peak in worldwide sales of enlargers in the late '70s; by the next decade, sales and production declined, once photo minilabs came on the market and increasingly amateur photographers would use them instead of their improvised darkrooms. In Eastern Europe, minilabs imported from the West started to appear after 1990.



The Mobile Darkroom Unit does not contain top-of-the-range equipment, but it does provide the minimum conditions for making decent black-and-white gelatin silver prints. The kit includes, apart from the Krokus enlarger: one Mikar 80mm lens; a Patterson developing tank for films; a set of three trays for processing paper; a Patterson safelight; a set of Ilford multigrade filters that can be placed in front of the objectives or in a drawer in the enlarger's body when using multigrade black-and-white paper; a timer. The wooden box has three compartments with spacers, containing the column and the body, and in another compartment the developing tank, the safelight and the other accessories. The enlarger's wooden baseboard is attached to the lid of the box, under the developing trays. The film carrier is placed in the same compartment as the developing tank.

The wooden box has three compartments with spacers, containing the column and the body, and in another compartment the developing tank, the safelight and the other accessories (fig.1.1.). The enlarger's wooden baseboard is attached to the lid of the box, under the developing trays. The film carrier is placed in the same compartment as the developing tank. The four components of the enlarger – the baseboard, the column, the body and the negative carrier – are assembled as shown in the figures 1.2., 1.3. , 1.4. and 1.5.

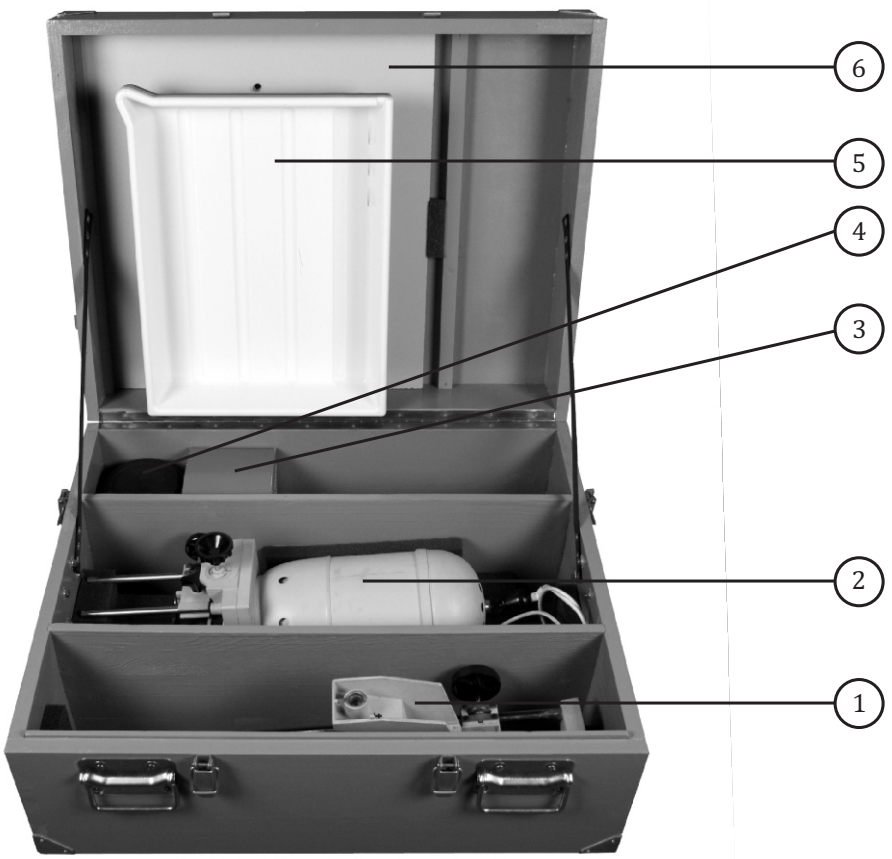
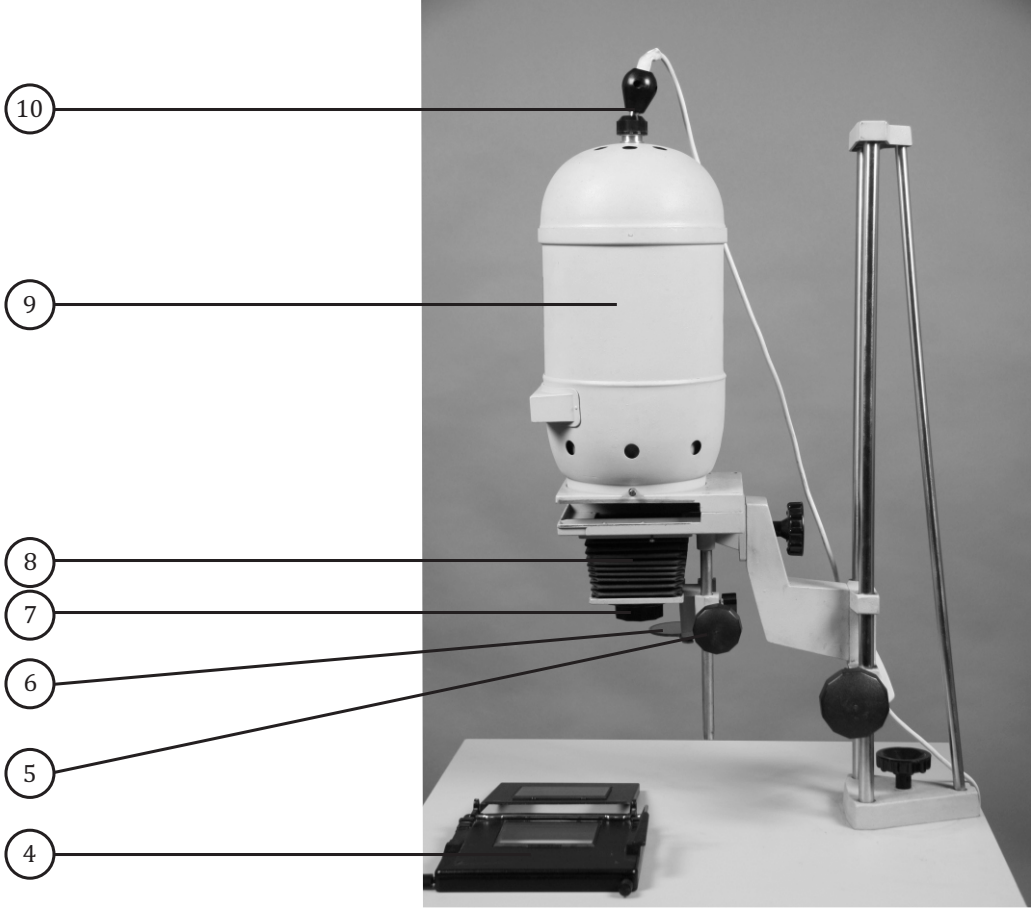


Fig.1.1. On the left-hand page:
1 - Enlarger column; 2 - Enlarger body; 3 - Patterson safelight; 4 - Patterson film developing tank; 5 - Developing trays for photographic paper; 6 - Enlarger 's baseboard

Fig.1.2. On the right-hand page:
1 - Elevation knob for adjusting the position of the enlarger body; 2 - Enlarger 's baseboard;
3 - The enlarger column attached to the baseboard; 4 - Negative carrier; 5 - Focus knob for moving the objective in order to obtain correct focus; 6 - Red filter; 7 - MIKAR lens; 8 - Foscussing bellows;
9 - Enlarger body; 10 - Adjustment knob for optimal position of the enlarger bulb


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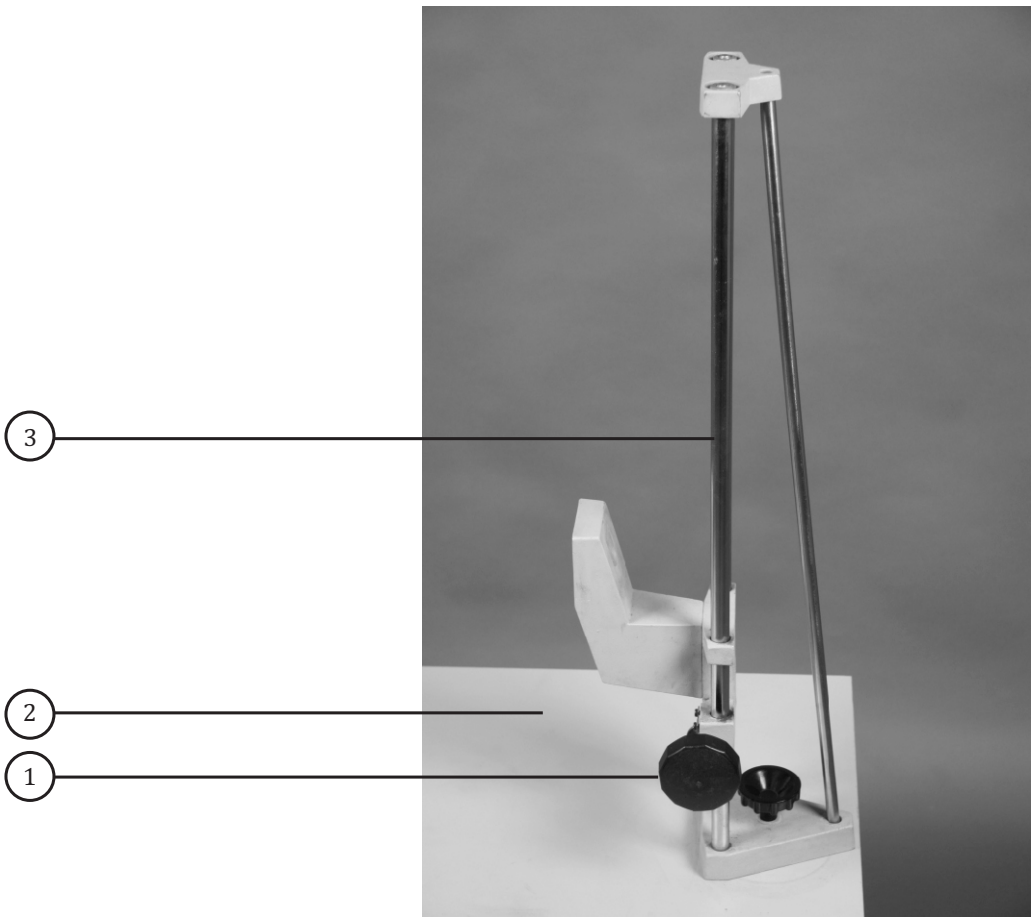

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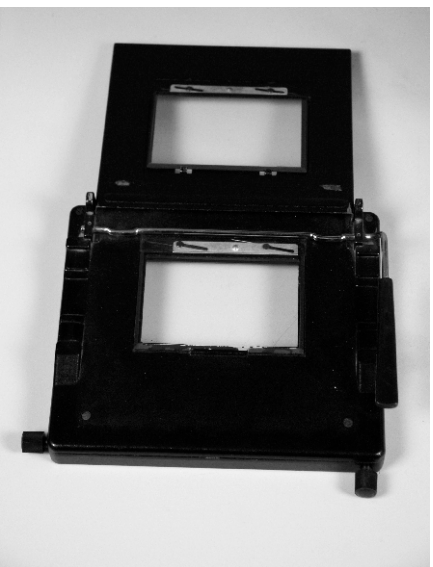


Fig.1.3. The Krokus enlarger with the lamp



Fig.1.4. The Krokus enlarger fully installed

In order to ensure a uniform distribution of light across the projection plane, the user must change – by lifting, lowering or tilting – the position of the rod holding the lightbulb until the desired effect is obtained. This operation must be performed by projecting the light without a negative in the carrier. In the filter drawer, the user can insert filters for multigrade prints. Time-controlled exposure is achieved simply by operating the light switch or, if possible, by using a timer that allows an accurate control of the exposure time.



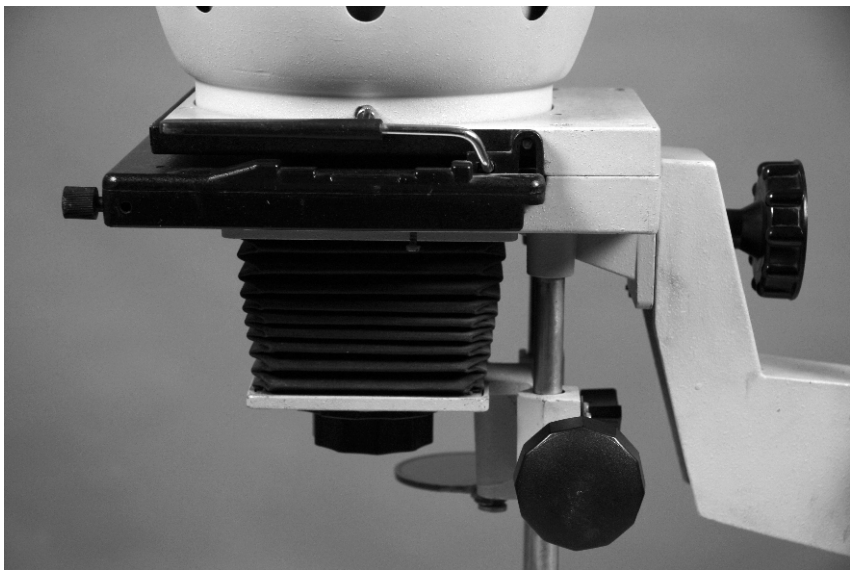


Fig.1.5. The negative carrier
On the left-hand side:
Open negative carrier (it is preferable to position each frame of the negative separately, either by opening the carrier, or by lifting the rod, thus distancing the two glass plates and allowing the film to be moved frame by frame. With this method, however, there is a risk of scratching the negative).
On the right-hand side:
Negative carrier attached to the enlarger body.

The Patterson safe light (fig.1.7.) will be attached to the wall, behind the enlarger, allowing a minimum distance of one metre to the place where the photographic paper will be positioned. In the simplest of configurations, the enlarger will be installed on a table, placing to its right the three photographic developing trays (from left to right: developer tray, stop tray and fix tray) (fig.1.6.). It is preferable that photographic paper is washed in a container with a capacity of at least five litres, changing the water as often as possible. In a professional setting, the paper is washed in a paper washer fed constantly with water from a tap. The photographic paper is handled with tongs while in the trays, using one pair of tongs for each tray.

When you have finished working, rinse the trays and the developing tank well using water, disassemble the enlarger and them put the parts back in the box. If there is any developer and/or fix solution left over, they may be stored in closed plastic bottles. The shelf life of prepared solutions depends on the type of substances they contain and how long they have been used; this information is specified on the package.

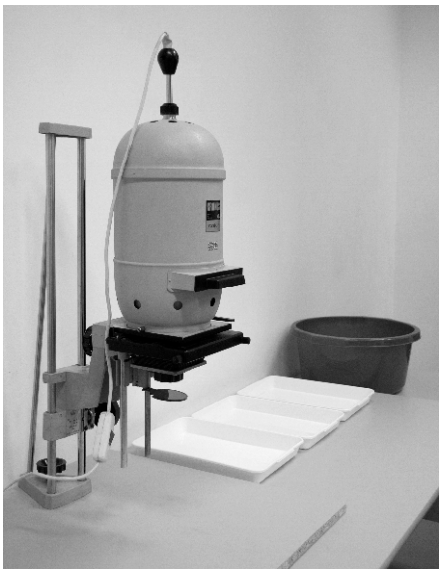


Fig.1.6. The MDU installed in an improvised room
It is important that the space is completely light protected.



Fig.1.7. The Patterson safe light

The following basic safety measures must be applied:
- when you touch the chemicals, such as the developer or fixer solutions, always use gloves.
- when you operate the enlarger, always rinse your hands with water and dry them with a towel before touching electrical devices (switch or timer).
- if the room has no ventilation, after each hour of work in the darkroom protect the paper from light and ventilate the room for a minimum of 10 minutes.
- do not breathe in the air above the trays containing photo chemicals.
- do not eat or drink while working in the improvised darkroom.


Cambridge


Iaşi

2. The Film Camera

In the last decade the range of photographic film still cameras has narrowed dramatically, due to the rapid expansion of digital technology. Currently (at the end of 2012) only a handful of companies continue to manufacture such cameras, for a niche market: Leica, Canon, Nikon, Voigtlander, Zeiss, Hasselblad, Mamiya, Linhof, Toyo, Arca-Swiss, Wista.

However, nowadays the variety of still cameras using photographic film is still quite large, and we can identify a number of components that are present in most of these cameras. A first analysis will reveal the camera body and the lens (which can be rigidly attached to the body or interchangeable). In its turn, the camera body contains several common parts, such as: the camera obscura, the shutter system (excluding the central shutters inside lenses), the viewfinder (less the auxiliary viewfinders such as detachable pentaprisms), the photosensitive material compartment (not including interchangeable film cartridges).

Taking into account all the above, we can divide the constitutive elements of a film camera as follows:

1. Camera obscura (the camera body)
2. Lens
3. Shutter system
4. Viewfinder
5. Photosensitive material compartment
6. Auxiliary devices and accessories

The range of cameras is relatively diverse. The cameras can be classified according to several criteria:

a. The size of the negative image on the film:

- **large and very large format cameras (8x10in, 4x5in)** (fig. 1.2., 1.3.)
- **medium format cameras (6x9cm, 6x7cm, 6x6cm, 6x4.5cm)** (fig. 1.1.)
- **small format cameras (24x36mm or Leica format)** (fig. 1.4., 1.5.)

b. The viewfinding and focus adjusting system:

- **cameras with independent viewfinders**

- **fixed-mirror (SLT – single lens translucent) cameras**
- **single-lens reflex (SLR) cameras**
- **twin-lens reflex (TLR) cameras**
- **parallel viewing cameras**

c. The shutter system:

- **central shutter cameras**
- **cameras with focal-plane shutters**

Fig. 1.1. Pentacon Six TL, a medium format Eastern German camera produced until 1990







Fig. 1.2. Linhof large format cameras
These cameras use 4x5 inch sheet film. Focussing is achieved by sliding the front part of the camera (which contains the lens) or by moving a horizontal plate. For this purpose, this type of camera has expandable bellows. The back part of the camera has a ground glass screen for focus control; the compartment with the sheet film is attached behind this screen.



Fig. 1.3. Globica large format studio camera. It was manufactured until the 1990 in the German Democratic Republic. The lens was produced by Carl Zeiss Jena.



Fig. 1.4. Panoramic Horizont camera, manufactured in the Soviet Union in the '80s
The panoramic image is obtained by swivelling the lens.



Fig. 1.5. Two Leica format SLR cameras
Canon AE-1 was manufactered in Japan in the 1980s and Praktika MTL 5 camera was manufactured in the 1970s and 1980s in the Democratic Republic of Germany.

2.1. The Camera Obscura

A component of the photographic camera, the camera obscura is the advanced version of the device known since the 16th century. It is the interior "bow" located between the lens and the plane where the film is, the plane where the image we want to "memorise" photographically will form. The size of the camera obscura depends on the size of the surface where the image forms. In the early stages of photography, this plane would have between 9x12cm and 20x30cm, without standardisation. Once the photosensitive materials' quality improved and mass photography developed (the last decade of the 19th century), the size of the camera obscura decreased, and the issue of standardising formats was brought into discussion. The formats arrived at can be classified as:

- large (8x10inch, 4x5inch)
- medium (6x9cm, 6x7cm, 6x6cm, 6x4.5cm)
- small (24x36mm)

The cameras using large formats belong to the professional category and are intended for use in extremely strict and precise domains (e.g. large prints in photographic art, scientific photography, advertising, very detailed photographic reproductions). These formats are difficult to transport, and the image is usually produced using a camera installed on a tripod. In most cases, the camera obscura is an expandable bellow, allowing the image to focus by changing dimensions. The photosensitive materials are in the shape of sheet film, with various sensitivities and sizes.

Medium format cameras are smaller in size and easier to transport, and the negative images they capture can be enlarged without loss of quality up to quite large dimensions (100x100cm). Such cameras are used in taking portraits, in journalistic photography and in studio photography. The photosensitive materials used for medium formats are rollfilms, wrapped in paper in order to protect them from exposure to light.
Of the small format cameras, the most used are the Leica type (according to the name of the company marketing it), at 24x36mm. These are currently the most widespread cameras, as they are small and easy to carry. The outstanding quality of the optics, together with the use of increasingly high-performance films, mean that they are used both by professionals (in photojournalism, art and science photography etc.) as well as by amateurs. Narrow photographic films are sold in metal cartridges (which protect them from exposure to light), and have perforations of the edges, to that they can be moved frame by frame inside the camera.

The camera obscura must be perfectly light-proof, so that light can only come in through the lens. In order to avoid parasitic light reflection, the camera obscura is coated in a non-reflective black paint.

Other requirements for the camera obscura include:
- the focal plane must ensure the planarity of the film
- the plane of the photosensitive film must be perpendicular on the lens axis; if the lens can tilt, then it is necessary to have an accurate control of its angle in relation to the film's plane
- to provide good image centring, to be dust-proof, etc.

2.2. The Lens

As it was mentioned before, if we place a converging lens in the orifice of a camera obscura, the quality of the image projected on the opposite wall improves considerably. Nevertheless, given that the quality of the image produced with just one converging lens is still not satisfactory, photographic lenses (also called photographic objectives) are used in photographic cameras; these contain groups of convergent and divergent lenses, arranged in various positions. Thus, the image obtained is of much better quality. The objectives (lenses) are affixed to the camera body, screwed or bayoneted to it, one important requirement being that the optical axis of the lens is perpendicular to the plane of the photographic film.

A converging lens focuses all incident rays parallel with the lens' optical axis into a fixed point, called a focal point, found on the optical axis (fig. 2.1.).

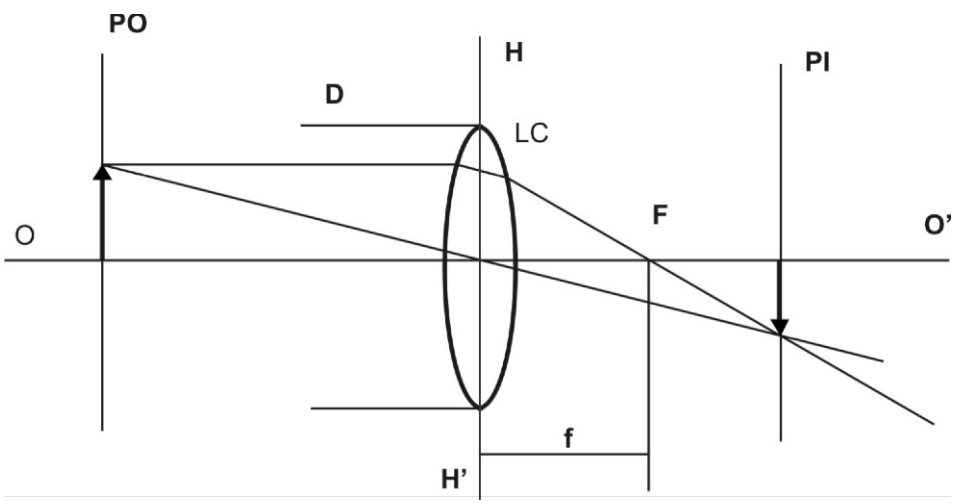


Fig. 2.1. Sketch showing how images are formed through converging lenses
Notations:
LC – converging lens; OO' – the lens' optical axis; HH' – the lens' main plane (for thin lenses);
PO – object's plane; PI – image place; D – lens diameter; F – focal point;
f – focal length (measured in millimetres)

A **converging lens** focuses all incident rays parallel with the lens' optical axis into a fixed point, called a focal point, found on the optical axis. Converging lenses are thicker in the middle and thinner at the edge, forming real images that can be captured on a screen. A **diverging lens** scatters the rays passing through it, the images produced being "virtual" (cannot be captured on a screen). Diverging lenses are thicker around the edges and thinner in the middle.

The characteristic numbers for a photographic objective are **focal length** and **relative aperture**. Focal length (f) is measured in milimetres and it is the interval between the focal point and the lens' main plane. It gives the lens' angle of view (the visual area the lens can include). The smaller the focal length of a lens, the larger its angle of view. The maximum usable aperture of a lens (focal ratio, f-number) is defined as the ratio between the lens' focal length and the effective aperture (or entrance pupil), a dimensionless number. It is noted f: and it is larger than or equal to 1.

f: = f/D

The relative aperture is a measure of the luminosity of the objective. The closer to 1 its value is, the higher the light intensity of the lens – we can thus take pictures in lower light situations or when the subject is moving at high speed.

The photographic lens controls the following functions:

Image focus
The quantity of light transmited to the film
The angle of view
The image's depth of field

From a construction point of view, classic lenses have two rings: a distance ring (for controlling the clarity of the image) and an aperture ring (for controlling the diameter of the beam of light passing through the lens). In variable focal length lenses we also find a ring for adjusting focal length. A lens' aperture and focal length are inscribed on its front.

2.2.1. Image focus

Obtaining clarity in a photographic image (more precisely the clarity of the subject we wish to focus on) involves adjusting the position of the lens in relation to the fixed plane of the photographic film, so that it coincides with the image plane in the figure above. In small format cameras (35mm) and in some medium format ones, this is achieved by turning the distance ring on the lens (fig. 2.2.). On the objective there is a mark, in relation to which both the aperture and the focal distance are adjusted. The clarity of the image is checked through the camera viewfinder.



Fig. 2.2. Rings on a classic photographic lens

2.2.2. The quantity of light transmited to the film

The different lighting conditions of photographed subjects require a rigorous control of the quantity of light in order to obtain the right exposure. As it was mentioned in the introductive chapter, this is achieved by changing the parameters of the shutter, as well as of the diameter of the opening allowing the light to pass through the objective.
The light quantity is adjusted using a device called a diaphragm, which consists of a mobile system of metal blades arranged concentrically inside the objective. The diaphragm opening is controlled with the help of the diaphragm ring, which is also found on the objective (fig. 2.3.).

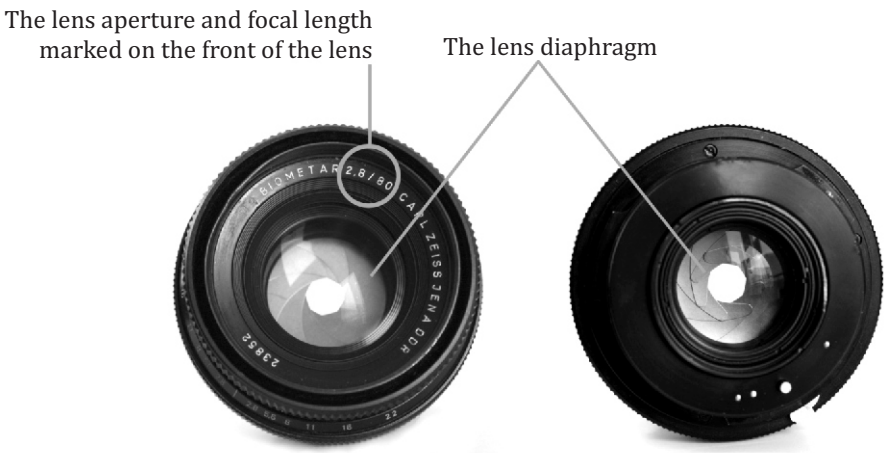


Fig. 2.3. Position of diaphragm inside the lens

The inscription on diaphragm ring shows the relative apertures of the lens. These standard aperture numbers are known as major stops. One example would be:

f: 2
f: 2.8
f: 4
f: 5.6
f: 8
f: 11
f: 16
f: 22

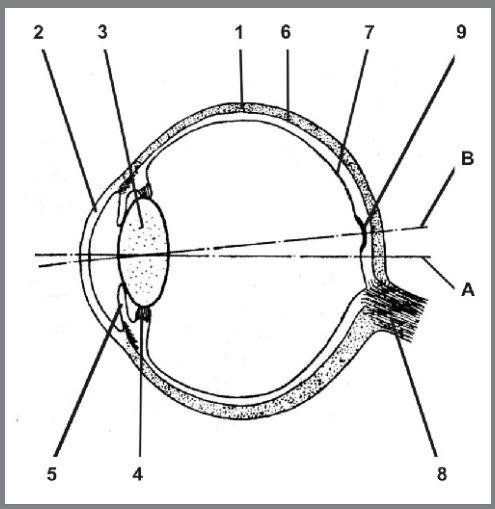


The relative aperture indicates the amount of light that the lens will transmit to the film. The lowest value (f:2) corresponds to the largest opening of the diaphragm, whereas the highest number (f:22) corresponds to the maximum closure of the diaphragm. Each stop transmits twice or half the amount of the adjacent value (for instance moving from f:5.6 to f:8, involves halving the area of the opening letting light through). These quantified and controllable variations of light help us greatly in correlating with exposure time (the second parameter that influences a correct exposure). We shall see that exposure time can also be adjusted, also in factor increments of 2.

The human eye

The eye can be considered a model for the photographic and cinematographic image. Anatomically, the eye globe is almost spherical, being surrounded by a protective membrane called the sclera. At the front of the eye, this membrane forms the transparent cornea, around 2mm in thickness. The eye globe is divided in two compartments by the crystalline lens, which is very similar to a biconvex (converging) lens. Depending on how the muscles surrounding it contract, the lens can change its curvature, and thus its convergence properties, allowing the eye to accommodate, that is to focus on a subject located at a certain distance from it. In front of lens is the iris, a circular muscle with variable opening allowing light to pass through the lens; the size of the opening depends on the brightness of the objects the eye looks at (for instance, if we look at a source of strong light, the iris closes to the minimum, and if we are in a darkened room, the iris opens to the maximum). The diaphragm of a photographic objective operates according to the same principles as the eye's iris. On the inside, the

sclera is lined with a black membrane, called the choroid, which forms the eye's camera obscura. The choroid is in turn lined by the retina, consisting of the photosensitive ramifications of the optic nerve, in the shape of cones (for day vision) and rods (for night vision). The image is formed on the macula, the image being the most clear in the macula's centre, called the fovea.



Cross-section through the eye
1 - sclera; 2 - transparent cornea; 3 - lens; 4 - ciliary muscles; 5 - iris; 6 - coroid; 7 - retina; 8 - optic nerve canal; 9 - fovea; A - geometric axis; B - direct viewing axis.

2.2.3. Angle of view

The angle of view is the magnitude indicating an objective's ability of capturing the field of view. It is measured in degrees and it has a close relation to the focal length. The greater the focal length, the smaller the angle of view (fig. 2.4.). Depending on their angle of view, lenses are classified as **normal lenses**, **wide-angle lenses** and **telephoto** lenses. A special category of lenses includes the ones with variable focal length, also called **zoom lenses**.

Lens type	Angle of view (β)	Focal length (f)	
		Leica format (35mm)	Medium format 6x6cm
Wide-angle	$\beta > 60^0$	f < 43mm	f < 75mm
Normal	$43^\circ < \beta < 60^\circ$	43mm < f < 60mm	75mm < f < 90mm
Tele-lens	$\beta < 43^\circ$	f > 60mm	f > 90mm

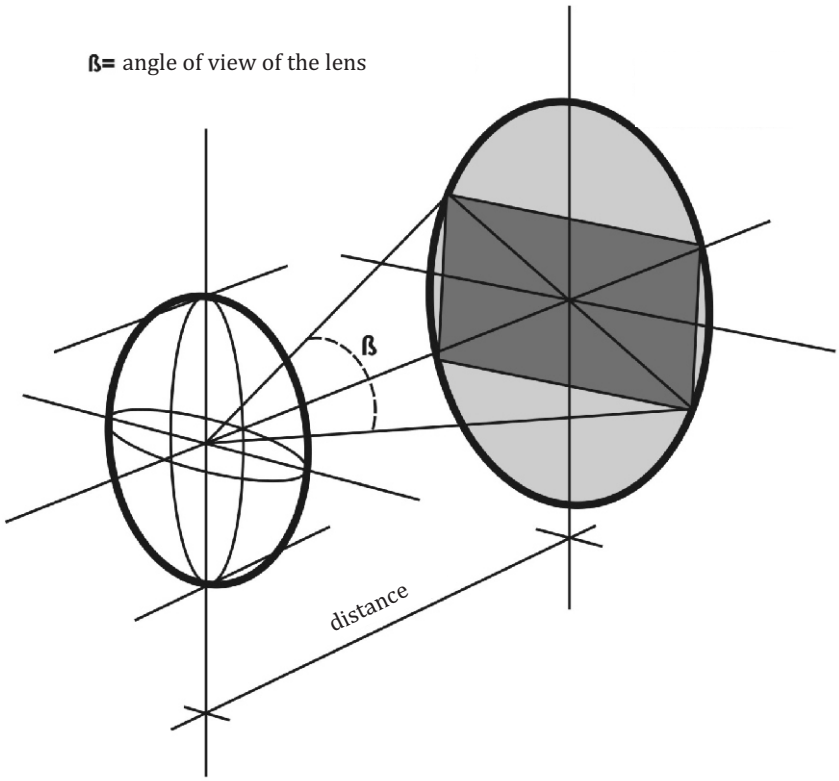


Fig. 2.4. Angle of view of the lens

Analysing the table, we can see that the type of lens varies not only according to focal length, but also according to the camera format. Thus, a lens with a 70mm focal length used with a small format camera (35mm) is a tele-lens, but when used with a medium format camera (6x6cm), it becomes a wide-angle lens.

Normal lenses, with an angle of view between 43^{o} and 60^{o}, "see" in a manner similar to that of the human eye. They are brighter than the wide-angle lenses or the tele-lenses (for the Leica format they reach remarkable values, up to f:1.4) and they are appropriate for photographing in environments with low light.

Wide-angle lenses have wide angles of view, and hence small focal lengths (below 43mm for the Leica format and below 70 mm for the medium format 6x6cm), beginning at 60^{o} and reaching 220^{o}. Very wide angles of view can also be obtained using special cameras, whose lens can swivel in the horizontal plane during exposure. Wide-angle lenses can reproduce perspective in a rectilinear fashion (these are true wide-angle lenses, that do not distort space) or in a spherical fashion (the so-called fish-eye lenses, producing images in which all straight lines are bent). These are used whenever the subject to be photographed requires wide angles in order to be included in the

frame, for instance when we aim to capture an interior of limited dimensions or when we photograph public spaces or large buildings.

Wide-angle lenses have the advantage of a greater depth of field (the image is clear to a greater depth), but they also produce distortions that the photographer must take into account. Thus, the objects in the foreground appear larger, while those in the background appear smaller; therefore, such lenses are not recommended for taking classic portraits (medium close up or close up). Distortion by elongation (when the outlines and shapes are stretched towards the frame edges) and the convergence of parallel lines (when perspective is forced, causing "infinity" to start much closer) are two other examples of distortion caused by wide-angle lenses.

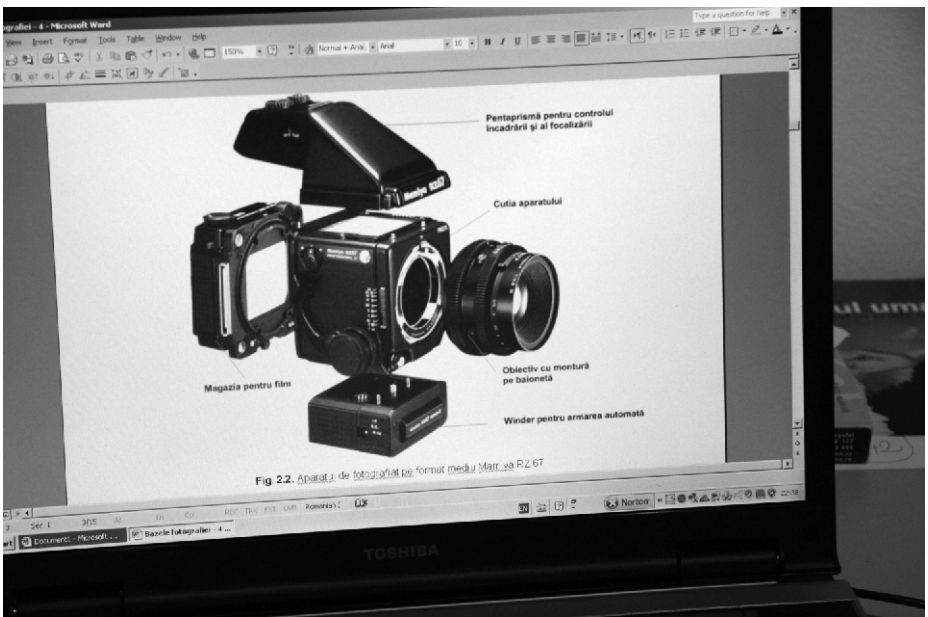
Tele-lenses have narrow angles of view (below 43^{o}), and hence large focal lengths. By using them we can photograph subjects a long way away from the camera (they "bring them closer"). As the focal length increases, the f-number decreases; in order to counteract that, their diameter must be larger (the f-number f: is f divided by D; if the focal length increases, in order to keep the f-number low, the diameter, D, of the lens, must increase). The images obtained using tele-lenses make the subject appear flatter, as the background planes appearing closer than those in the foreground. The greater the focal length of the tele-lens, the higher the risk of obtaining images blurred by movement; for this reason it is best to use a tripod or a short exposure time (for instance, for a focal length of 300mm, the recommended exposure time is less than 1/250 seconds)

Zoom lenses are special lenses with variable focal length, allowing the photographer a greater flexibility in framing the subject, a very useful option in photojournalism (fig.2.5.). The range of focal lengths in zoom lenses is very wide; for the Leica format (24x36mm), for instance, it is 18-35mm (wide-angle zoom), 70-200mm (tele-lens zoom), 28-135mm (zoom with the minimum focal length in the wide-angle range and the maximum one in the tele-lens range). Together with the change in focal distance, the f-number also changes, and thus the objective carries an inscription of the changes in f-number, as well as of the range limits for focal length (for instance: 35-70mm / f:2.8-4). In the case of zoom lenses, once the focus is adjusted, it is preserved for any focal length selected subsequently. In order to obtain accurate focus, it is important to adjust it for the greatest focal length, and then select the desired focal length.

Opposite page:
Fig. 2.5. Series of three images taken with a zoom lens of 28-135mm
The top image was taken with a focal length of 28mm (wide-angle), the middle one with 50mm (normal) and the bottom one with 135mm (tele-lens).






Pentaprismă pentru controlul încadrării și al focalizării
Cutia aparatului
Obiectiv cu montură pe baionetă
Magazia pentru film
Winder pentru armarea automată
Fig. 2.2. Aparatul de fotografiat pe format mediu Mamiya RZ 67

The focal length and focus adjustment can be done using a separate ring on the objective (twisting it adjusts focus and sliding it adjusts focal distance) or by twisting two separate rings, one for focus (the focus ring) and one for focal length (the focal length ring). If a zoom lens is unaffordable, we can use fewer resources in order to use converters or additional lenses. These are optical devices which, when attached to the front or to the back of objectives, can change focal length. Both converters and additional lenses have a magnification factor inscribed on them. The key disadvantages they have are distortion and loss of clarity and brightness.

2.2.4. Depth of field

When photographing details or small-size subjects, it is necessary to use objectives with a short minimum focus distance (10-30cm as a rule), this type of objective being most useful in macrophotography. For the same purpose we can also use extension rings or expandable bellows, installed between the camera body and the lens. When focus has been adjusted, the image is most clear in the chosen focal plane. The **depth of field** is the area before and behind the focal plane where the objects have acceptable clarity.

Depth of field increases as the diaphragm closes, decreases as the subject moves closer to the camera, and as the lenses focal length increases. Analysing the above, we can see that in the case of tele-lenses the depth of field is small (in general the backdrop being more blurry than the foreground); depth of field is also reduced when subjects come closer to the camera (in the special case of macrophotography it is preferable to photograph subjects that are as flat as possible, in order to have clarity in as much of the frame as possible) (fig. 2.6.).



Fig. 2.6. Depth of field
In the image from the left, the focus plane is on the foreground book, closer to the lens and the depth of field is reduced. In the image from the right, the focus plane is on the middle book and the depth of field increases.

Optical formulas of lenses

The successful optical formulas, the ones yielding the best results, were invented over 100 years ago and have been in use ever since. Some of the best known objectives are: the Planar objective, first manufactured in 1896 by the Zeiss company according to Dr. Rudolph's blueprints; the Tessar lens, first made in 1902 by the same company; the Taylor lens, designed in 1893, consisting of three simple lenses.

Objective resolution and contrast

The resolution of a lens is a magnitude measuring its capacity of reproducing details and it is expressed in lines per millimetre. Contrast measures the objective's capacity to distinguish between two shades of grey with very close values. In order to capture very fine details, an objective must have both a high resolution and a high contrast.

Distribution of light in the image field

The image quality decreases in an lens from the centre towards the edges. The decrease in quality concerns both contrast and resolution, as well as the distribution of light within the frame. The causes leading to loss of light towards the edges can be found in the optical formula of the objective, as well as in the vignetting phenomenon (darkening of the frame edges).

Optical aberrations of lenses

The flaws in an image produced by a lens are called optical aberrations. They can be corrected either during the construction of the objective or during the photographing process.

The main types of optical aberrations are:

- **spherical aberrations** (converging lenses have at least one spherical surface, causing marginal light beams to be concentrated in different points, and thus the image loses clarity).
- **chromatic aberrations** (in their passage through the marginal parts of the lens, the various wavelength radiations that compose light are not reflected to the same extent).
- **image distortion** (the distorted image of straight lines at the edge of a converging lens, caused by the spherical shape of the lens' surface).
- **astigmatism** (the light beams hitting the objective obliquely are not concentrated only in the focal point, but instead in a farther point, and this results in loss of image clarity).
- **coma** (the occurrence of inconsistently lit spots on the film when the subject being photographed includes isolated point sources).

2.3. The Shutter

The camera shutter ensures the controlled penetration of light through the opening towards the photographic film. Shutters can be controlled mechanically or electronically. Mechanical shutters are set with a lever, which doubles as a film advance lever, its motion advancing the film frame by frame, and are released by pressing a button (the release button) (fig. 2.7.).

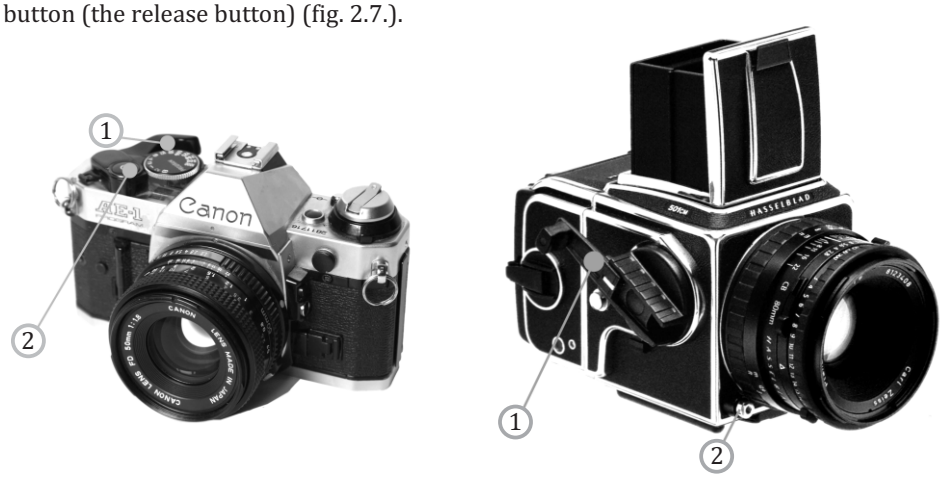


Fig. 2.7. Advance lever and release button on the Canon AE1 and on the Hasselblad 501
The Canon AE1 SLR camera uses the narrow format and has a focal-plane shutter, while the Hasselblad 501 uses the medium, 6x6cm format, and has the shutter located centrally in the lens (leaf shutter).
1 - lever arm; 2 - release buton

Depending on where they sit inside the camera, shutters may be central or focal. Central shutters (leaf shutters) are located inside the lens, very close to its optical centre. They are used chiefly in medium and large format cameras. The main advantages of these types of shutters are that they do not introduce distortions in the images of moving objects, and that they can be synchronised with the electronic flash at all shutter speeds (fig. 2.8.). One of the disadvantages would be a stronger lighting in the centre of the image.

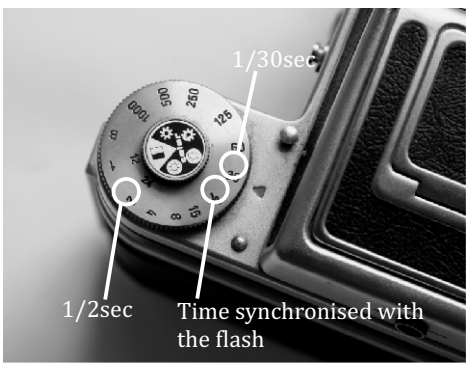


Fig. 2.8. Shutter speed dial on a Pentacon Six TL camera

Focal-plane shutters are mounted near the film plane. They consist of a system of metal blades or cloth curtains (fig. 2.9.). In the latter case, the shutter has two curtains. The first curtain, the opening one, travels across the focal plane and it uncovers the film to begin the exposure. The second curtain, the closing one, follows after a controlled interval of time to terminate the exposure. In the case of short exposure times, the closing curtain begins closing before the opening one has uncovered the film. In this situation, the exposure is made through the slit formed by the two curtains, and the very fast shutter times are possible.[2]

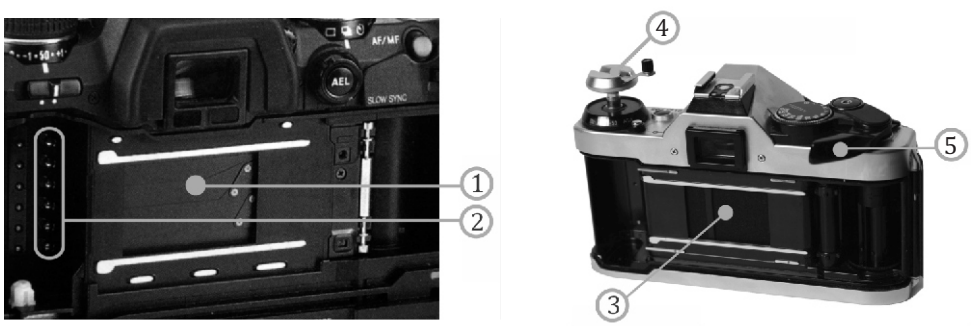


Fig. 2.9. Focal-plane shutter curtains
At the left we have the metal curtains of the Minolta Dynax 7 camera shutter, at the right we see cloth curtains, as used by the Canon AE1 Program camera.
1 - Metal blade; 2 - DX code contacts; 3 - Cloth courtains; 4 - Film winder; 5 - Lever arm

2.4. The Viewfinder

This is the system that allows the photographer to frame the subject and to check focus. There are several types of viewfinders, each with its own advantages and disadvantages:

- direct viewing through the lens and a ground glass plate

It has the advantage that the ground glass plate shows a picture instead of several objects in space. The main disadvantages are the reduced luminosity of the picture, requiring the use of the traditional "dark cloth" and the picture is reversed. This system is used in large-format cameras (fig. 2.10.).

- single lens reflex (SLR)

The image given by the lens is reflected by the mirror and is viewed through the ground glass plate. The image is reversed and is viewed from top down, a difficult situation when photographing subjects in motion. In order to solve this inconvenience, cameras use pentaprisms. In SLR cameras, the 45^{o} angle mirror is flipped at the precise moment the film is exposed (fig. 2.11.).

- twin-lens reflex (TLR)

This type of viewing provides good control on framing and focus, unless the subject is very close to the camera, because the exposure lens is different from the viewfinder lens (fig. 2.12.).

2 - Ansel Adams, *The Camera*, Little, Brown and Company, 1980, p.84

- rangefinder system

The viewing system is completely separate from the picture-making lens system. The advantage is that the visor is bright; however, we cannot control focus. In more advanced cameras, this viewing system has a rangefinder for accurate focussing (fig. 2.13.).

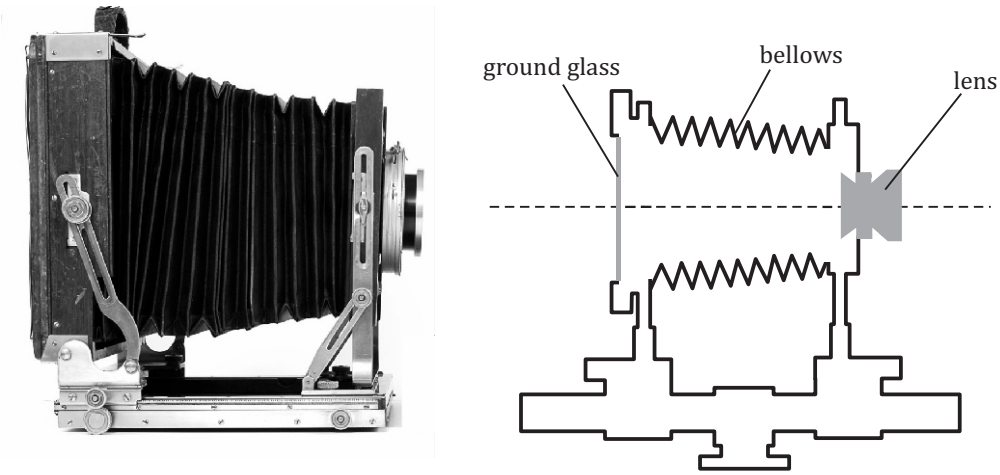


Fig. 2.10. Direct viewing through a ground glass (usually on large format cameras)

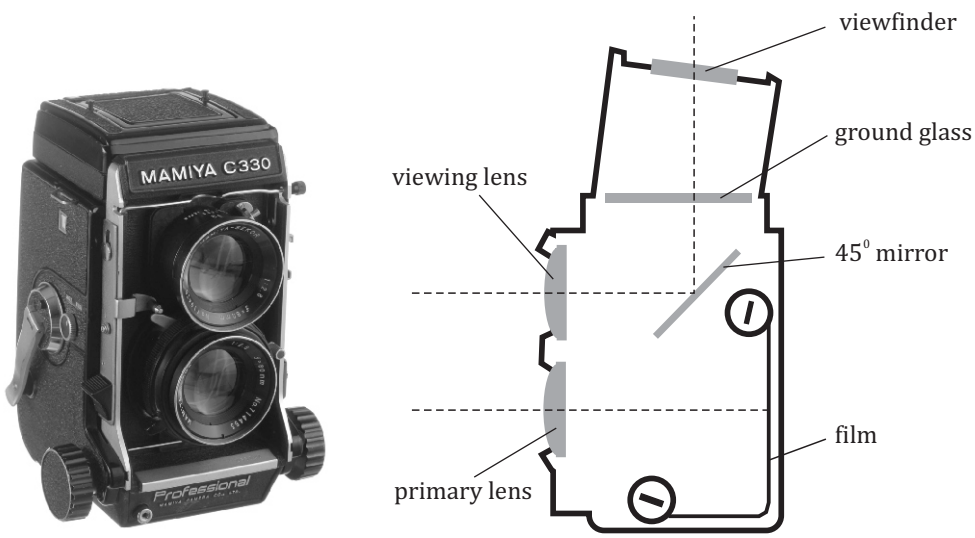


Fig. 2.11. Viewing through a parallel lens (TLR)
Cameras using the TLR viewing system between the '40s and the '70s: Rolleiflex, Mamiya C330, Flexaret, Seagull

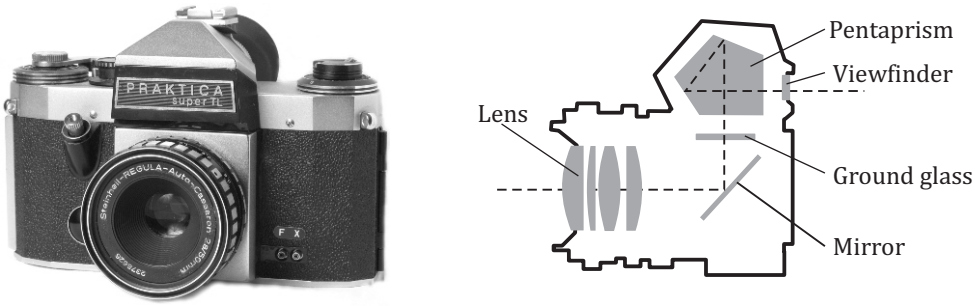


Fig. 2.12. Single lens reflex viewing system (SLR)

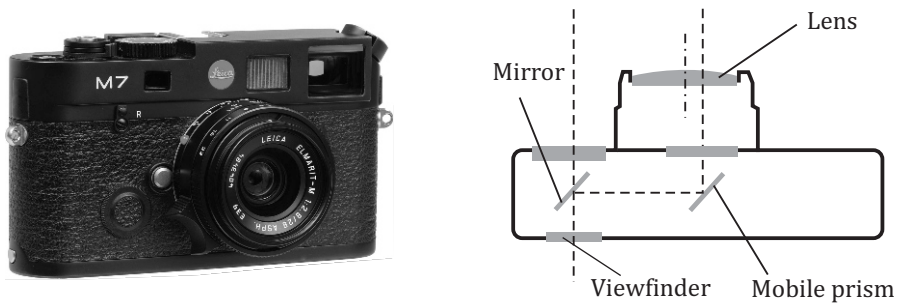


Fig. 2.13. Rangefinder system

In order to have an accurate control of the clarity of images, especially in the case of poorly-lit subjects, the viewfinder screen has been improved continuously, by covering it with Fresnel rings, with microprisms or with fibre optic laid in a honeycomb structure on the entire surface (fig. 2.14.).

Focussing can be done manually, by rotating the focussing ring until the picture becomes sharp in the viewfinder, or automatically, by using the autofocus (AF) system, widely found in cameras nowadays. In this situation, the photographer can select the point (spot AF function) or the group of points (average AF function) that the camera will focus on, all that remains to be done is to half-press the release button. Automatic focus is extremely useful in journalism and in any other type of photography that involves subjects in motion. The inconvenient part is that the camera cannot focus if the subjects are very poorly lit or if the frame does not contain shapes with edges. The new generations of autofocus systems have partially solved these inconveniences, also improving the speed of focus. The viewfinders of newer cameras contain, apart from the microprisms used for focus control, other types of information, from exposure parameters to the points where the AF system focusses.

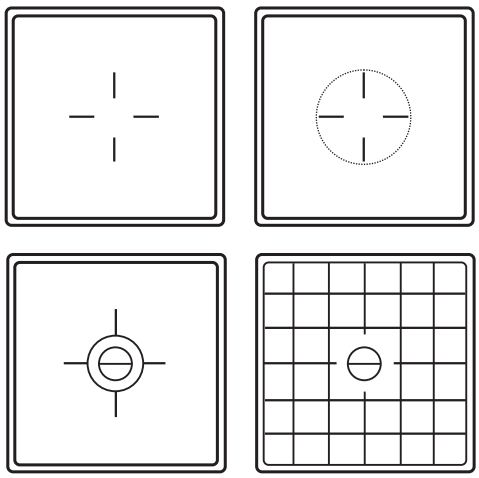


Fig. 2.14. Viewfinder screens for the 6x6cm format

2.5. The Film Compartment

It is located at the back of the camera, so that the film can travel easily from its cartridge to the compartment where the exposed film is spooled. In small-format Leica cameras (24x36mm), the film is transported by a device with two sprockets, whose teeth engage the standardised perforations on the edge of the film. Some types of medium-format cameras have the option of using interchangeable film backs. In large-format cameras, sheet film is inserted in film holders (fig2.15.).



Fig.2.15. A Hasselblad medim format 120 film back and some 8x10 Fidelity Elite film holders for large format cameras

2.6. Auxiliary Devices and Accessories

A professional camera is an ensemble of components, each with its own precise functionality. Handling the camera is a complex, if not difficult, operation and requires practice and a certain amount of specialised technical knowledge. Among the auxiliary devices and accessories we find: lens filters, additional lenses and convertors, flashbulbs, devices used in macrophotography. Here we can also include lens shades, tripods, shutter release cables, carrier bags, etc…

Filters are used in order to protect the frontal lens and to obtain tone or chromatic modifications on the photographic film. Most filters are made from special glass or gel sheets, and they are installed in front of the lens by screwing them directly on the lens by using special rigs. Each filter absorbs differently the light passing through it, and this must be taken into account when adjusting shutter speed. **UV filters** eliminate ultraviolet radiation, but do not cause significant changes to the picture; this is the reason why many photographers always keep it on the camera, thus protecting the lens. ***Sky Light*** filters are slightly pink and have the role of reducing the access of excessive blue light coming from a clear sky. Many *Sky Light* filters also block out UV radiation. **ND filters** or density filters are made of optical glass tinted with various shades of grey; their role is to retain part of the light, while absorbing all wavelengths equally. **Polarising filters** are used both in black-and-white and in colour photography; their role is to block polarised light. Polarised light is generated by shiny surfaces such as glass. **Coloured filters** are used in black-and-white photography in order to enhance contrast or for "enhancing the value" of certain colours (fig. 2.16.). The influence of coloured filters in black-and-white photography can be illustrated by using the table below:

Filter colour	Brightened colours	Darkened colours	Scope of use
Yellow	Yellow, Orange	Blue	Outdoor portraits, landscapes, skyscapes
Green	Green	Red, Blue, Violet	Dramatic outdoor portraits, lighting foliage
Orange, Red	Yellow, Orange, Red	Blue, Green	Increases contrast more than the yellow and green filters



Fig. 2.16. Using the orange-red filter in black-and-white photography
The image on the left is taken without a filter; the one on the right has a much more intense sky, due to the use of the orange-red filter.



3. Film exposure

The most important step in obtaining a good-quality photograph is to obtain a well-exposed and well-developed negative copy. In order to expose photographic film correctly we must adjust the quantity of light reaching the film. A properly exposed negative has a good density both in the brightly-lit areas as well as in the shadows, where details can be identified. The brightly-lit areas of the photographed subject correspond to dark areas on the negative, and the shadow areas of subject correspond to bright areas on the film. If too much light reaches the film (and we thus have an overexposure), there will be no details distinguishable in the bright areas; if the quantity of light is insufficient (underexposure), no details will be distinguishable in the shade. In certain situations, when the photographed subject has strong contrasts between light and shadow, it will be more difficult to meet the requirements above and we would need to choose films with a broader range of greys (dynamic range). As the great American photographer **Ansel Adams** (1902-1984) wrote, "if there is such a thing as a perfect negative, it is one exposed and developed in specific relation to the visualized values of the functional or expressive print"[1].

Depending on its sensitivity to light (also called "speed"), measured in ISO (ASA) or DIN degrees, photographic film requires a certain quantity of light in order to be exposed appropriately; the quantity of light is calculated using the formula:
E = I x t
E – quantity of light
I – light intensity (regulated by the aperture of the diaphragm)
T – exposure time (regulated by the shutter speed)

To conclude, the parameters that need to be adjusted on the camera in order to have a correct exposure are exposure time (shitter speed) and diaphragm opening (aperture). The values selected for these parameters will be determined by the film's light sensitivity. Depending on the lighting conditions around the subject, be they natural or artificial, a correct exposure (appropriate values of exposure time and aperture depending on the film's speed) can be achieved by using exposure tables or by using light meters (fig. 3.1). The latter yield more accurate results, being used in most cases when the photograph is taken manually.

1 - Ansel Adams, *The Negative*, Little Brown and Company, Boston, New York, London, 1981, p. 29



Fig. 3.1. Gossen Miranda Cadius and Sekonic L-556R light meters
The Gossen light meter (a 1970s model) operates as follows:

- film sensitivity is selected with the correspondence ring
- the sensor is pointed towards the subject, the reflected light or the light emitted by the source
- the correspondence between the position of the needle on the scale and the exposure time/aperture pair is read in order to obtain a correct exposure.

For the Sekonic L-556R light meter, the principle is similar, except that all the settings are displayed on the LCD screen, together with the data required for a correct exposure.

The light meter

A light meter is a device consisting of an opto-electric sensor, am amplifier and a display system. The sensor has the role of sending an electrical signal depending on the quantity of light falling on it. The sensors are photodiodes, photoelements or photoresistors. Photodiodes and photoresistors require an external source of power – a battery. The display system may be a classic one, with a needle, or an LCD screen.

Most cameras currently manufactured, be they digital or film cameras, have a light meter incorporated in them, measuring the light passing through the lens (TTL), and the indications concerning exposure are displayed on the side of the viewfinder. Depending on the type of camera, the operation mode can be manual (M - meaning that the photographers must set the exposure time / diaphragm opening pairs themselves), semiautomatic (the photographer sets one of the priorities, according to the diaphragm opening in Av – aperture value – mode or to the exposure time in Tv – time value – mode, and the other value of the pair is set automatically), and automatic (both values are set automatically by the camera, the operation being P - program).

Once the film speed is selected on the light meter, the device is pointed towards the photographed subject in order to measure the reflected light; the display will show the exposure time - aperture values that need to be set on the camera in order to obtain a correct exposure. As it was shown in the previous chapter in the description of a camera, both the relative aperture and the exposure time parameters have incremental values doubling or halving them. Transition from one value to the next, either for relative aperture or for exposure time, represents an exposure step. In order to obtain the same exposure, according to the formula E=I x t, the quantity of light being the result of the multiplication of light intensity (regulated by the diaphragm opening) by exposure time (regulated by the shutter speed), whenever we double the exposure time we need to halve the diaphragm opening.

Measuring light with a light meter is a demanding operation, requiring skill from the photographer, knowledge of the light meter's operation and of the way the subject is lit. The steps of the light measuring process are the following:

1. Selecting the film's light sensitivity on the light meter or on the camera (when the camera has an in-built light meter).
2. Measuring the light by pointing the light meter's sensor towards the subject or towards the light source.
3. Reading the exposure time / aperture value pairs, and choosing the pair that is most appropriate for the desired type of photography.
4. Setting the aperture value and the exposure time on the camera.

3.1. Selecting the exposure time / aperture value pair

After setting the film speed and measuring the light, the light meter's display will provide us with the pairs of exposure times and aperture values that would result in the same correct exposure of the film. For instance, we may obtain the following equivalent pairs: 2 (aperture value) / 250 (exposure time 1/250 seconds); 2.8/125; 4/60; 5.6/30. 8/15; 11/8; 16/4; 22/2. The choice is related to the subject’s particularity. For greater depth of field we have to choose big aperture values, like 16 or 22. If the subject is moving, we'll choose a short exposure time in order to "freeze" the movement, for instance 1/250sec, which corresponds to diaphragm opening 2. If we want to isolate an element from a general context, such as a person from a group, we can choose as a priority the maximum diaphragm opening, which will give us a low field depth.

There are two ways of measuring light:
- measuring the **incident light** coming directly from the source; in this case the light meter's sensor is pointed towards the light source, after we place a calibrated diffusing screen in front of it.
- measuring the **reflected light** by the subject being photographed; in this case the light meter's sensor is pointed towards the subject (fig. 3.2).

Whether it is autonomous or incorporated in the camera, the light meter will measure an average of the light reflected by the subject. More recent light meters allow an adjustment of the angle of measured light, from the spot meter mode, with an angle of less than 5 degrees, to the evaluative meter mode, where the light meter calculates light exposure as an average of several points. For very precise measurements we can use spot meters.

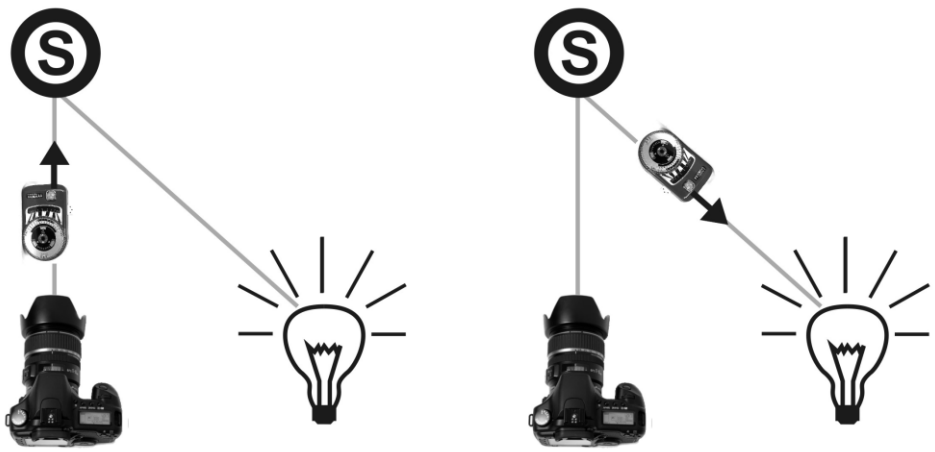


Fig. 3.2. Measuring light using the light meter
On the left we have the indirect measurement of the light reflected by the subject "S", and on the right we have the direct measurement of the source (represented here by a lightbulb).

Another way of measuring indirect light is by using an 18% grey card, as this is an acceptable average of the greys that can be found in an image with strong contrasts (for instance, photographing an ink drawing on a white page). The 18% grey card is placed in the plane of the subject and the reflected light is measured (fig. 3.3).



Fig. 3.3. Exposure using the 18% grey card
In the left-hand picture, the exposure was calculated according to the light reflected by the white background, the result being a two-degree overexposure. In the middle image, the light reflected by the 18% grey card was taken into account for the exposure, the result being an acceptable exposure for the subject. In the right-hand image, the exposure was carried out taking into consideration the light reflected by the subject, the result being a two-degree underexposure.

3.2. Exposure corrections

In a situation where we cannot use the light meter in the spot mode and we do not have an 18% grey card, it is recommended to correct for the results displayed by the light meter. Here are several such situations:

1. Predominantly dark subjects (dark backgrounds, characters wearing dark colours) with several light-tone elements (for instance the face or hands). It is recommended to lower exposure by one or two steps.
2. Predominantly light-tone subjects (people in the snow, birds on the backdrop of a clear sky, pencil drawings on paper, printed text). Exposure can be brought up by one or two steps.
3. Behind the subject there are light sources that are visible in the frame (the subject is backlit). In the evaluative mode, the indication of the light meter will be strongly influenced by the light sources, and thus the subject will be underexposed (dark). It is preferable to use the spot mode or to measure the light reflected by the subject from close up. The result will involve an overexposure of one to three steps compared to the evaluative measurement (fig. 3.4).



Fig. 3.4. Exposure for a subject that is backlit
In the image on the left, the light meter took a general reading of the light, resulting in the underexposure of the subject and in the capture of details from the background. In the image on the right, only the light reflected by the subject was measured, the result being a correct exposure and the disappearance of background details.

4. Photographic Film and Paper

Photographic materials are based on the sensitivity to light of silver halides. Of these, the most commonly used in photography are silver bromide, chloride and iodide. Under the action of light, atomic-level changes take place in the silver halide crystals, producing thus a latent image, which is not stable when exposed to light and cannot be viewed with the naked eye. This image becomes visible and stable under light after the film undergoes a chemical process called development. As a result of this process, the silver halide crystals that have been exposed to light are reduced to granules of colloidal metallic silver, black in colour and stable when exposed to light. The parts of the film that have been exposed to more light will contain more granules of colloidal metallic silver, and thus that particular portion will be darker. This way, the brighter areas captured by the lens will appear on the film as darker areas. On the contrary, the darker parts of the image will be represented on the film by more transparent, brighter regions. Due to this inversion of tones, the image on the film is called a "negative", and the development process is called "negative processing". The subsequent process of printing the image onto photographic paper is called "positive processing". The main components of a photographic film's structure are:

- a transparent or opaque supporting sheet
- one or several coats of photosensitive emulsion
- reflexive and anti-reflex coats
- protective coating

4.1. Photosensitive emulsions

The transparent support must be strong, malleable, non-deformable and fireproof. It is made of cellulose acetate or polyesters. The photographic emulsion consists of gelatin or a similar product containing silver halide crystals in suspension. These microcrystals, of very small dimensions (0.02-0.04mm) are sensitive only to blue and ultraviolet radiation; in order to make them sensitive to all the radiations in the visible spectrum, special sensitivity-enhancing compounds are introduced.

Colour film contain three layers of photographic emulsion, sensitive to blue, green and red radiation. These layers react differently to their complementary colours, and the negative image obtained contains the complementaries of the colours in the image captured by the lens.

The main characteristics of photosensitive film are: sensitivity to light, tonal range, contrast, grain size (fig. 4.1) and, in the case of colour film, the ability to reproduce colour. Photographic film sensitivity (or "speed") represents its ability of being impressed by the smallest quantity of light. The more sensitive a film, the less light it requires in order to be exposed correctly. The sensitivity of a film is influenced by the composition of the silver halide crystals, by grain size and by sensitivity-enhancing agents. The larger the grain size, the more sensitive the film. Sensitivity is measured in two universally-accepted systems: the arithmetic ISO (International Standard Organization) system, which is equivalent to the ASA (American Standard Association) system, and the German logarithmic DIN (Deutsche Industrie Normen) system. Below we have a table illustrating the correspondences between the two measurement scales:

Low sensitivity films (slow-speed films)	Medium sensitivity films (medium-speed films)	High sensitivity films (high-speed films)
25-50 ISO (ASA)	**100-200 ISO (ASA)**	**400-3200 ISO (ASA)**

Low-speed films (25-50 ASA) have high contrast and reproduce fine details due to their fine grain, but the tone range is narrower and they require a larger quantity of light in order to obtain a correct exposure. The images have a graphic quality, with strong contrasts. Medium-speed films (100-200 ASA) have acceptable parameters in terms of contrast, grain size and tone range, whereas high-speed films (400-3200 ASA) have larger grain sizes (despite the fact that in the last two decades very sensitive T-grain crystal emulsions have been manufactured) and a wide tone range (lower contrast). Due to the high number of grey shades or to coloured tints, the images taken using high-speed films have pictorial quality.

4.2. Details concerning the exposure of films

Current black-and-white films are panchromatic (sensitive to the entire visible chromatic spectrum), whereas colour films are calibrated for two types of light: daylight (the normal light of day, with a colour temperature of 5500K) and tungsten light (artificial halogen light, with a colour temperature of 3200K).

Current photographic films have gained much in the range of exposure, coping with considerable over- and underexposure, compared to films manufactured a few decades ago. Low speed films have an exposure range that is smaller than that of high-speed films.

In the case where we take photographs using very short (below 1/1000sec) or very long (over 1sec) exposure times we need to increase exposure progressively in order to compensate for any breach of reciprocity. Thus, for exposure times of 1-2sec we need to add ½ an exposure step, for 4-8sec we need to add one exposure step and for 16sec we need to add 2-3 exposure steps. We need to proceed similarly for short exposure times: for 1/1000sec we'll add ½ an exposure step, for 1/2000sec we'll add one exposure step, and for 1/4000sec we'll add 1½ exposure step.

There are several types of photographic film, such as:

- negative black-and-white film (fig. 4.2.)
- negative colour film
- black-and-white or colour reversal film (transparencies) (fig. 4.3.)



Fig. 4.2. Ilford black-and-white film
British manufacturer Ilford specialises in black-and-white photographic films and chemicals. The films in the picture are: Ilford HP5-ISO400 (medium format film), Ilford Delta-ISO100 (wide medium format film), Ilford XP2 Super-ISO400 (medim format chromogenic film, developed in the colour C41 process), Ilford Delta-ISO400 (medium format film), Ilford PANF Plus-ISO50 (professional high-definition small format film).



Fig. 4.3. Fuji and Kodak colour negative and reversal films
From left to right: Fuji Provia-ISO100 (wide professional daylight reversal film), Kodak T400CN (black-and-white chromogenic film developed in the colour C41 process), Fuji Sensia-ISO100 (narrow colour reversal film developed in the E6 process), Fuji Superia-ISO200 (colour negative film developed in the C41 process).

Similar to the classification of photographic formats mentioned earlier, photographic films are also classified according to format. Narrow-format films (24x36mm) are sold in metallic or plastic cartridges that protect them from light. The cartridge carries the manufacturer's name (some of the best known manufacturers being Kodak, Fuji, Agfa, Ilford – for black-and-white film), the type of film, sensitivity/speed and the type of developing process to be used (for instance, the most widely-used automatic film development process is C41, whereas E6 is the most popular choice for developing colour transparencies). The cartridge also carries a code consisting of metal contacts (a DX barcode), which helps cameras with in-built light meters such as the ones manufactured in the past decade to read film speed automatically. Medium format films for medium format are delivered in paper wrapping, and therefore their handling is a little more complicated. They are 6cm wide, the width of the photo frames (6x4.5cm, 6x6cm, 6x7cm, 6x9cm) being given by the camera. Formats larger than 9cm (9x12cm, 13x18cm, 18x24cm) use sheet film, which needs to be loaded in the camera's film compartment in order to be exposed (fig. 4.4.).

4.3. Photographic paper

Unlike film, photographic paper has lower sensitivities, of around 10-25 ISO, and this allows them to be handled in the photographic laboratory under a"safe" light. In the case of paper, photographic emulsions are coated on a fiber base or resin coated surface. The colour of the paper can be white or chamois. Depending on the clients' demands, photographic paper is manufactured in several varieties of contrast: low (producing soft tones and a fine range of greys), normal and high (harsh tones, less grey shades, the images are more graphic). There are varieties of paper with variable

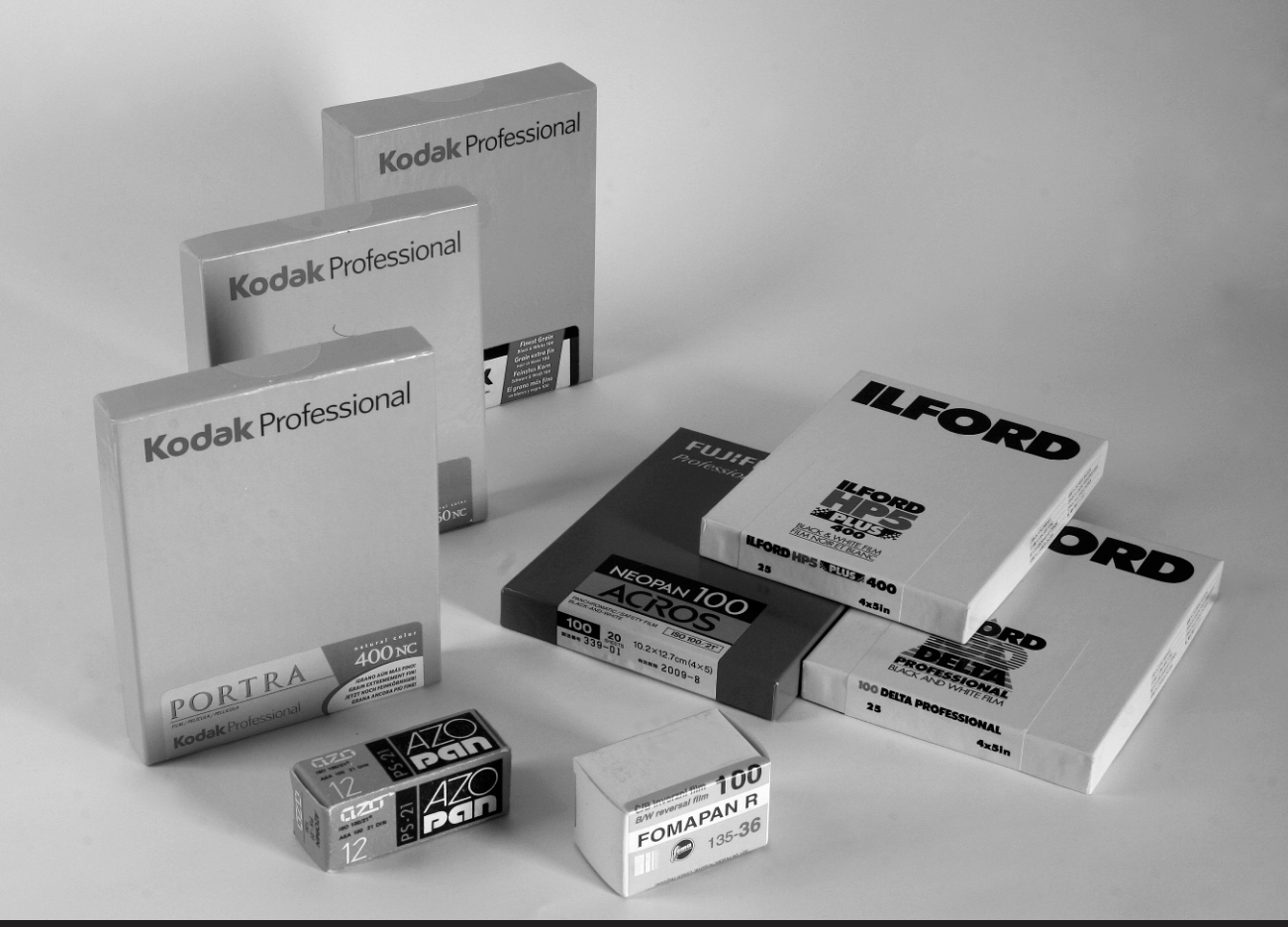


Fig. 4.4. Large format films and Eastern European films
From left to right: 4x5inch Kodak Portra 400NC and 160NC colour negative films, 4x5inch Kodak Tmax 100 black-and-white film, AZOPAN PS-21 black-and-white negative medium format film (produced by Azomures Romania until 2004), FOMAPAN R100 black-and-white reversal film produced by FOMA in Czech Republic, 4x5inch Fuji NEOPAN Across 100, 4x5inch Ilford HP5 400 and Delta100.

contrast, controlled with the help of a set of filters that can be installed on the enlarger. Paper is also produced in various textures: matte, semi-matte, glossy, pearl. By using paper of various grades and textures it is possible to improve or correct the images captured on negatives, as well as to create artistic effects. For instance, if we have an underexposed negative with low contrast, we can choose a high-contrast paper that will partially or completely attenuate the incorrect exposure.

4.4. Storing photosensitive materials

Photographic film and paper have expiry dates, which are marked on their packaging. They must be stored away from light, moisture and especially from heat. Photosensitive emulsions preserve their qualities at low temperatures. For this reason, professional paper and film are kept in special refrigerators.

5. Negative Processing

After the photographic film has been exposed to light, a number of atomic-level changes take place in the intimate structure of the silver halide crystals in the emulsion, thus forming the **latent image**. For this image to be visualised, it needs to be enhanced through a chemical process. This chemical process is called **development**, and the result will be the negative image, which is stable under light; this will then be used for the positive process of printing onto photographic paper.

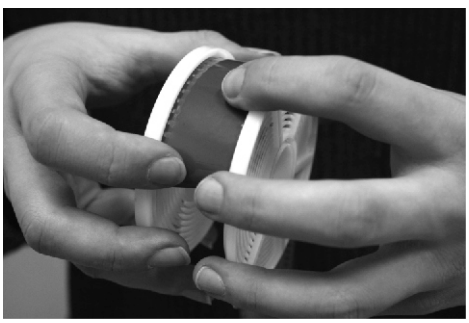
Black-and-white negatives are developed in two main stages: **developing** and **fixing**. Developing is a photochemical process through which the latent image is enhanced to the point where it becomes visible. The result will be an image consisting of black granules of metallic silver. The basis of the process is a chemical reaction in which the silver halide is reduced to metallic silver, which is not sensitive to light. The reducing agent is called a **developer**. At the end of this process we have various concentrations of metallic silver in the emulsion on the film, stable under light and forming the enhanced latent image, as well as the rest of the silver halide that has not been exposed. These residual salts are still sensitive to light and if we were to submit the developed film to light, it would be completely exposed, that is it would fog (all the silver salts in the emulsion would turn into metallic salts and the result would be a black image).
In order to remove the silver halide crystals that have not been developed, the film must be placed in another solution, called a **fixer**, which contains solvents that will dissolve these crystals. This reaction is called fixing, and it consists in the dissolution of the silver halide from the film, the result being a negative image that is not sensitive to light.

5.1. Developing black-and-white negatives

Negatives are developed in a special container called a **developing tank**. This protects the film from light and have an opening through which solutions can be poured in and out. The film is spooled in the dark on a special reel, which holds it in such a way that it occupies a small volume inside the tank while no part of the film touches another. After this operation, the reel with the film is immersed in the developing tank (fig. 5.1.).



Fig. 5.1. A developing tank with a reel for the film and spooling the film on the reel
The operation takes place in the dark. The film is inserted in an opening, and then it is spooled by rotating the ends of the reel.





The major steps in developing black-and-white films are:

1. Inserting the film in the tank
2. Preparing the developer (dilution, checking its temperature and bringing it to the proper value using a *bain-marie*)
3. Placing the film in contact with the developer
4. Development proper
5. Discarding the developer
6. Stopping the development using a stop bath
7. Placing the film in contact with the fixer
8. Fixing
9. Discarding the fixer
10. Washing
11. Rinsing
12. Drying

Steps 1 to 8 take place in the dark. The factors that influence the fixing and developing process are: the duration of reactions, the degree of agitation and the temperature. The length of the process used in order to develop black-and-white negatives depends on the type of developer chosen. It must be increased as the sensitivity of the film increases, in order to obtain a standard development. The degree of agitation is 10 seconds each minute. The concentration of solutions is specified in the developing agent's instructions, and the temperature can vary between 20 and 24^{0}C. When time, agitation degree, concentration or temperature increase, the intensity of the developing and the fixing processes also increase; the result being an overdevelopment. In general, the length of the development process for a black-and-white negative can vary between four and sixteen minutes.

The **stop bath** is a solution of 2% acetic acid with the role of arresting the development reaction and of dissolving the drops of developing substance left behind on the film, which could lower the fixer's capacity of action.

Fixing the negative can take between two and five minutes.

Washing is an important operation. It lasts for approximately 30 minutes at a temperature of 20-24^{0}C and is carried out in running water (which needs to be soft, that is, to have a low content of lime), thus removing the soluble compounds resulting from the combination of sodium thiosulphate with the silver halide crystals; in time these leftover compounds would damage the negative. After washing, the film is treated for one minute with a solution consisting of a softening agent and tanning substances, the aim being to allow all the water to drain from the film and to harden the gelatin, increasing its resistance to scratching.

Drying is done in dust-free places and as far as possible from heat sources. After the film has dried out, it will be cut into strips of four to six frames, which can be inserted into special pouches. Each type of developer and fixer is marked with its concentration, length of time of the process and processing temperature. Developers and fixers are sold as concentrated solutions or as sachets of substances that need to be diluted with water.

A well-developed negative is the basis for obtaining good quality photographs on paper. There are situations where controlled deviations from developing parameters can result in the correction of wrong film exposures or in more expressive contrasts or tone ranges (fig. 5.2. a, b, c). If a film has been exposed inadequately (the most affected being the dark areas), it must be overdeveloped. Overdeveloping can also help in increasing the contrast of films with images of subjects with low contrasts (fig. 5.3.).

Chemicals used in developing black-and-white negatives

The most widely used developing chemicals are: methol, hydroquinone, glicyne, phenidone and starch. The fixing agents used are sodium or ammonium thiosulphate. Depending on the desired type of process, there are a multitude of formulas for developers and fixers. Many of these are produced by the large photographic materials manufacturers and are dedicated to certain types of film. There are developers that aim to be universal, such as those manufactured by Tetenal. Here are two easy-to-follow recipes for preparing broad-use developers:

The Kodak D76 developer

Distilled water.....700ml
Methol..... 2g
Anhydrous sodium sulphite..... 100g
Hydroquinone..... 5g
Borax..... 2g
Distilled water up to 1000ml
Developing time is 7 minutes at 20^{0}C and the solution prepared can be used for 4 to 6 films. The substances must be dissolved in water successively, at 22-26^{0}C.

The Ilford ID 68 developer

Distilled water.....750ml
Anhydrous sodium sulphite..... 85g
Hydroquinone..... 5g
Borax..... 7g
Potassium bromide..... 1g
Phenidone..... 0.13g
Distilled water up to 1000ml
Developing times range from 4 minutes 30 seconds and 6 minutes 30 seconds at 20^{0}C. This developer produces contrast easily, the grey tones are neat and homogenous and the grain size is fine.

Universal fixer

Distilled water.....750ml
Crystal sodium thiosulphate.....200-250g
Potassium metabisulphite.....20-25g
Distilled water up to 1000ml
The substances are dissolved at 35-40^{0}C. The films are fixed for 3-4 minutes at 20^{0}C, and the solution can be used for 9 or 10 films.

In contact with air, developers oxidise rapidly. For this reason, diluted solutions must be stored in dark glass containers, filled to the brim and hermetically sealed. A developer solution stores for a maximum of four weeks. Fixers are less delicate: they can be used for two months, on condition that they are stored at temperatures below 24^{0}C.



Fig. 5.2.a. Properly exposed negative and the resulting positive image.
There is a balance between highlights and shadows.



Fig. 5.2.b. Underexposed negative and the resulting positive image
On the negative we have large transparent (whitish) areas with no details, rendered in the positive as very dark areas.



Fig. 5.2.c. Overexposed negative and its image in the positive
The negative is very dark in the subject's bright areas, and the positive has a narrow range of tones, with no details in the bright areas.

The contrast of negatives can be controlled through the manipulation of film exposure and also on development. Contrast is a measure of the difference between the bright area, the highlights, and the dark, shadow areas. The shadow areas on the negative are controlled through exposure; the highlights are also affected by the same process, but they can also be controlled by changing the development time.

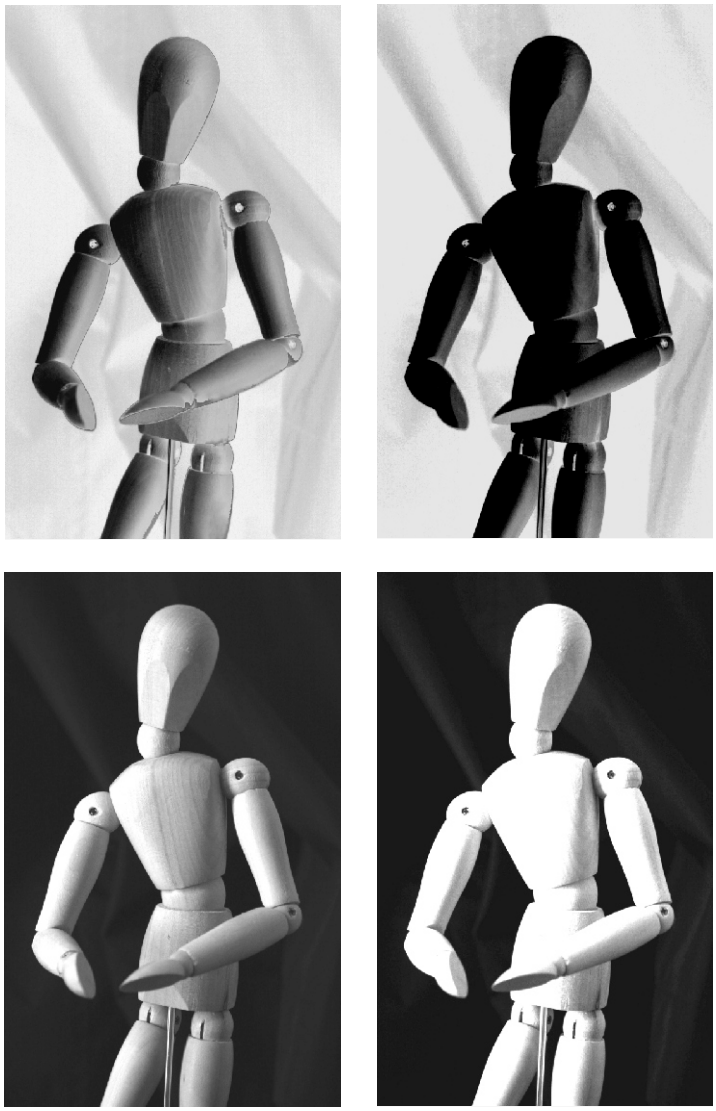


Fig. 5.3. Increasing the negative's contrast through overdevelopment
In the top row we have the negatives: the one of the left was submitted to a normal development lasting 9 minutes. The one of the right was obtained by doubling the development time. In the bottom row we have the resulting positive images. The shadow areas are relatively little affected by overdevelopment, whereas the bright areas (highlights) become increasingly dense and no longer have details (in the negative they are black, in the positive, white).

Ansel Adams used to say that in order to obtain a good negative, one must "expose (overexpose) for shadows and develop (overdevelop) for highlights". The shadows are the areas where the film has been exposed less, due to the fact that the dark parts of the photographed subject reflect less light in comparison with the bright areas. Due to the fact that they receive very little light, the shadow areas form much quicker on the negative than the highlights. For instance, if the processing time is 10 minutes, after the first five minutes of processing, the shadow areas will be formed completely, whereas in the next five minutes just the highlights become stronger.

This fact is used in the compensating development, which results in a negative with a greater range of tones (in both the bright and the dark areas), thus compensating extreme darkening values. The compensating development is a two-step process; the first stage is a normal development lasting 70-80% of the time; the second stage lasts 20-30% of the time; during the latter, the developer is drained from the tank, and water at the development temperature (20-22^{0}C) is put in. The development will continue only in the underexposed areas (in the highlights). The compensating development is useful only when photographing subjects with strong contrasts. It is not recommended to use films that are close to their expiry date, due to the increased risk of fogging.

Conclusions:

- **by increasing the processing time, the density of highlights increases.**
- **by increasing the processing time, the negative's contrast increases (decreasing the time results in a decrease in contrast).**
- **in order to lower a negative's contrast, we must overexpose the film and then underdevelop it.**
- **in order to increase a negative's contrast, we must underexpose the film and then overdevelop it.**
- **the film grain size increases as the processing temperature increases, or whenever there is a difference in temperature between the developing and the washing solutions.**

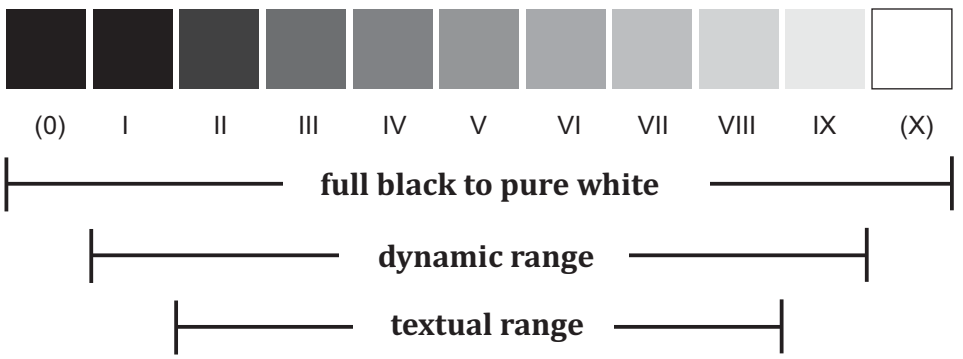
5.2. The Zone System

Ansel Adams developed a technique for exposing negatives and developing them in such a way as to have a more accurate control of the final image obtained on photographic paper; the technique is called the **Zone System**. According to Adams, whenever we wish to obtain a professional-grade photograph, we form in our mind a vision of the subject we plan to photograph. He calls this process **visualisation**, stating that our mental image of the subject (i.e. the image in our mind's eye) is not a copy of reality but instead an interpretation of it by photographic means. In the case of amateur

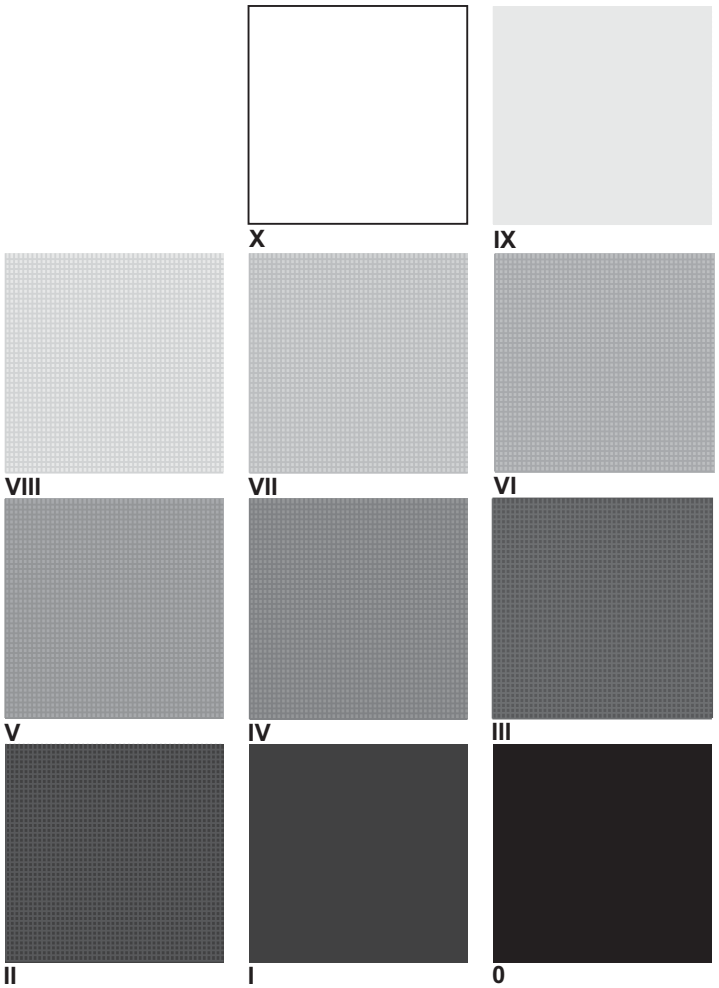
photographers, the light reflected by the photographed subject is measured directly by the camera, using the in-built light meter. For a more accurate control of exposure, one may use a spot meter, which measures the light reflected by a point of the photographed subject.

In the process of obtaining gelatin silver prints, when measuring the light reflected by a middle grey surface (light reflectance 18%) we shall obtain on the negative a middle grey area, which on the photographic paper will be translated into the same middle grey. When measuring the light reflected by a white surface, we shall obtain on the negative the same middle grey that will then be copied onto the paper. In other words, in order to expose correctly a subject that has several shades of grey reflected, we shall have to expose it for a middle grey value, so that we can have information both in the highlighted areas and in the shadows. Black-and-white photographic film has an exposure latitude of 7-8 steps; that is it preserves the information of the darkest and the brightest greys up to a difference of 7-8 steps between them.

Ansel Adams' Zone System, perfected in the 1940s, consists in defining in advance a system of ten value zones corresponding to the values on the black-and-white negative film. Thus, Zone 0 is pure black, and Zone X is pure white. The difference in darkness between two consecutive zones equals one step of negative exposure.



Between Zone I and Zone IX we have the dynamic range, and between Zone II and Zone VIII we have the textural range, this means we have information both in Zone II and in Zone VIII.



When using a spot meter to measure a photographic subject, we must find out where to measure the value of middle grey, corresponding to Zone V, in order to have a correct negative exposure. For this purpose we measure the subject's darkest shadow, as well as the brightest spot. Depending on the particularities of the subject, we may place the shadow in Zone II or III, and then work out what would be the exposure for Zone V of the middle grey. For example, if we place the shadow in Zone II and measure the exposure, for Zone V we shall have to expose three steps less.

When we have subjects with strong contrasts, that is with differences between highlights and shadows of more than seven steps, we shall have to overexpose the negative by one or two steps, and then reduce developing time by 25-40%. Using this combined method we obtain in fact a reduction of contrast on the negative, having information both in the highlighted areas and in the shadows. In other words, we expose for shadows (overexpose) and underdevelop the film.

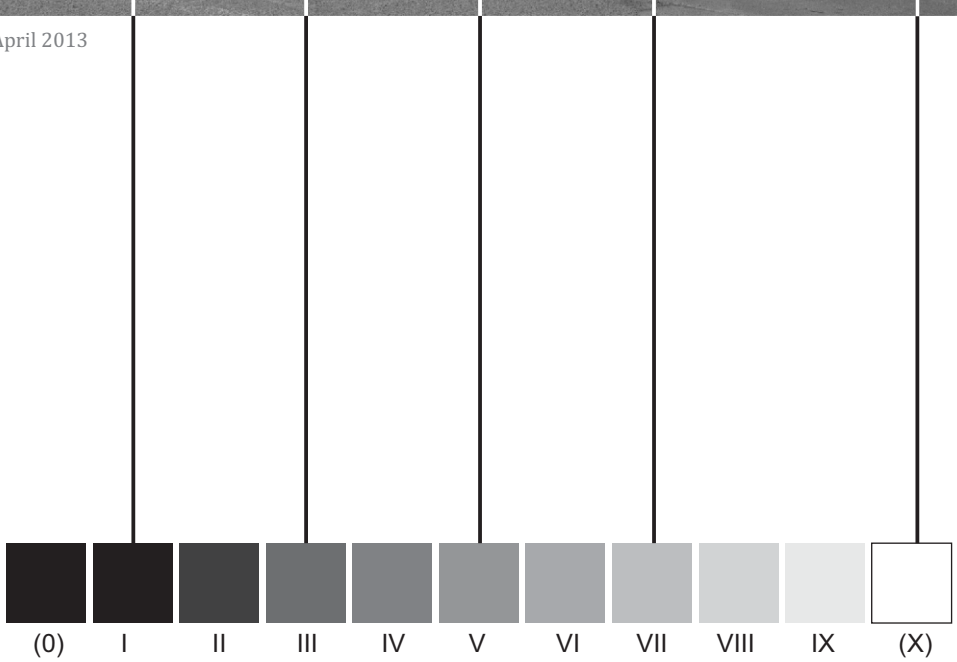


(0) I II III IV V VI VII VIII IX (X)

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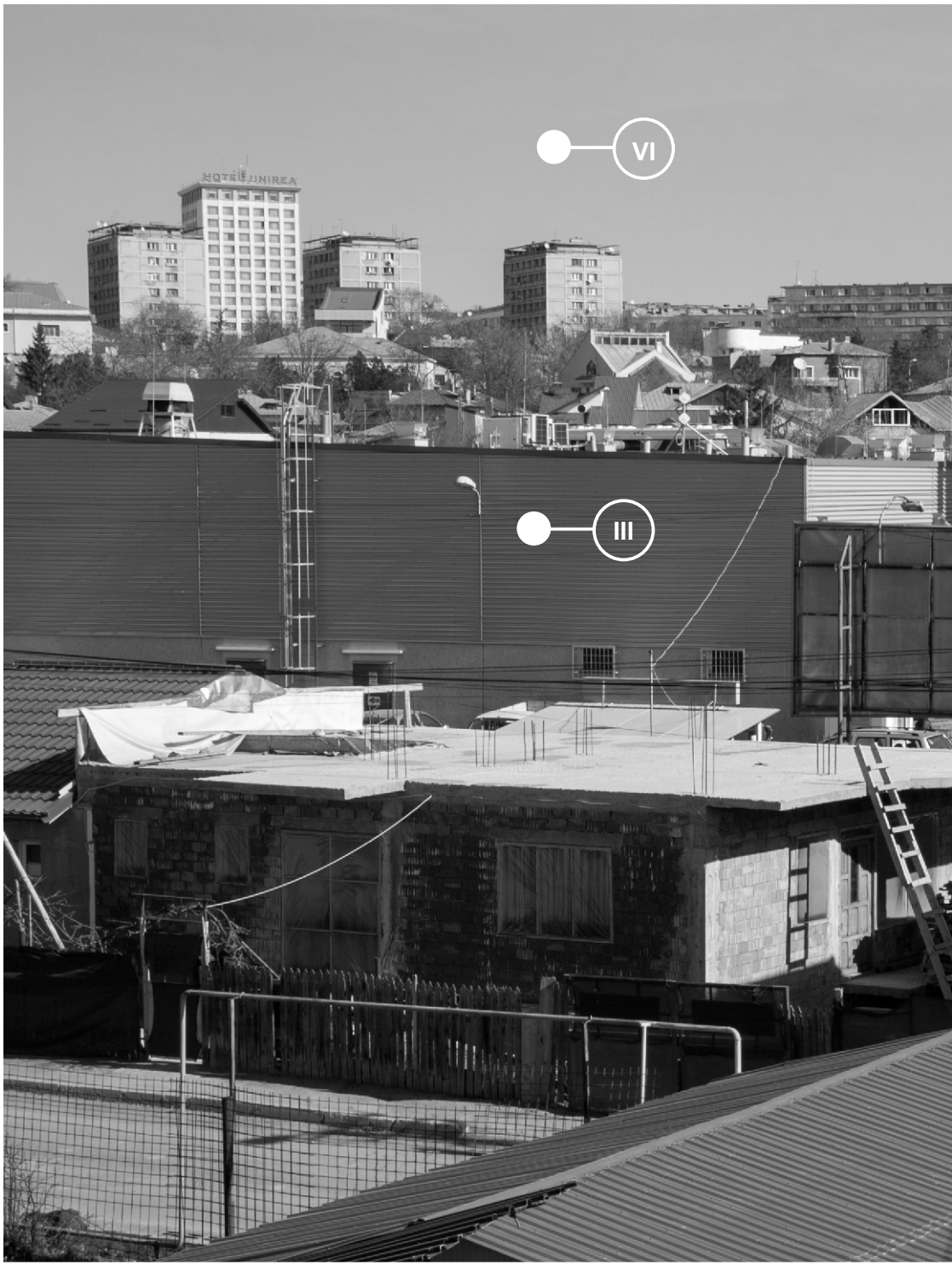
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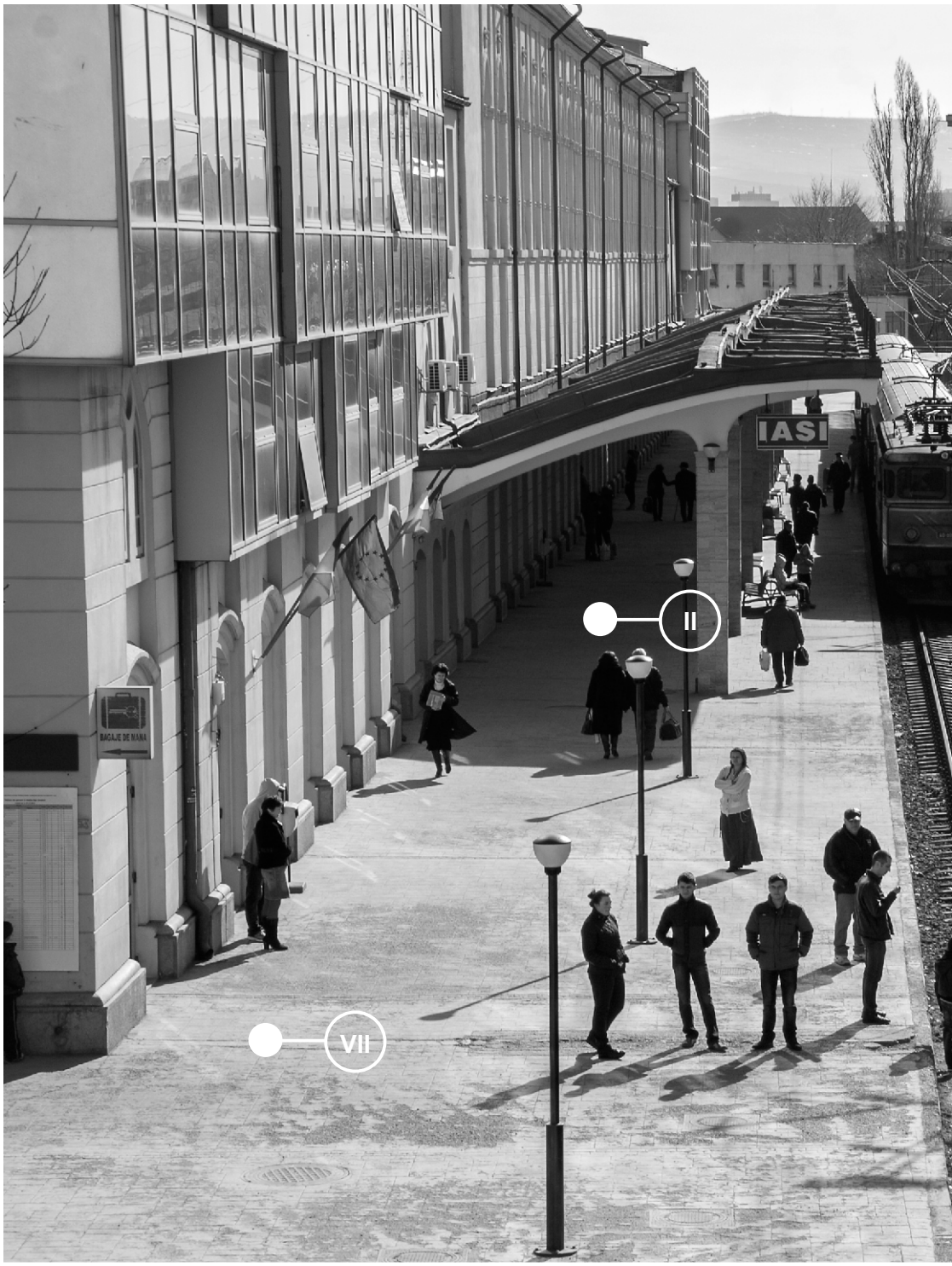



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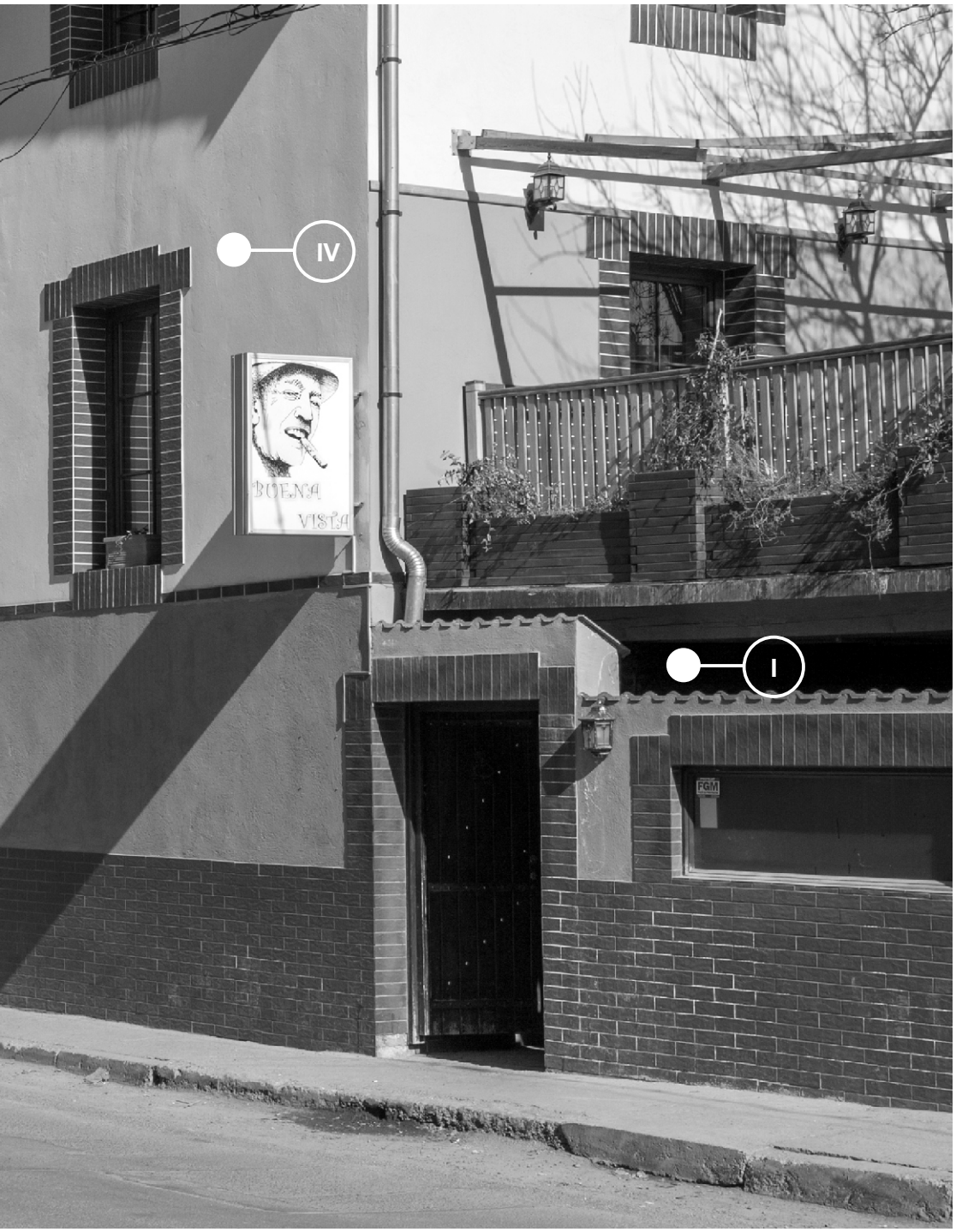

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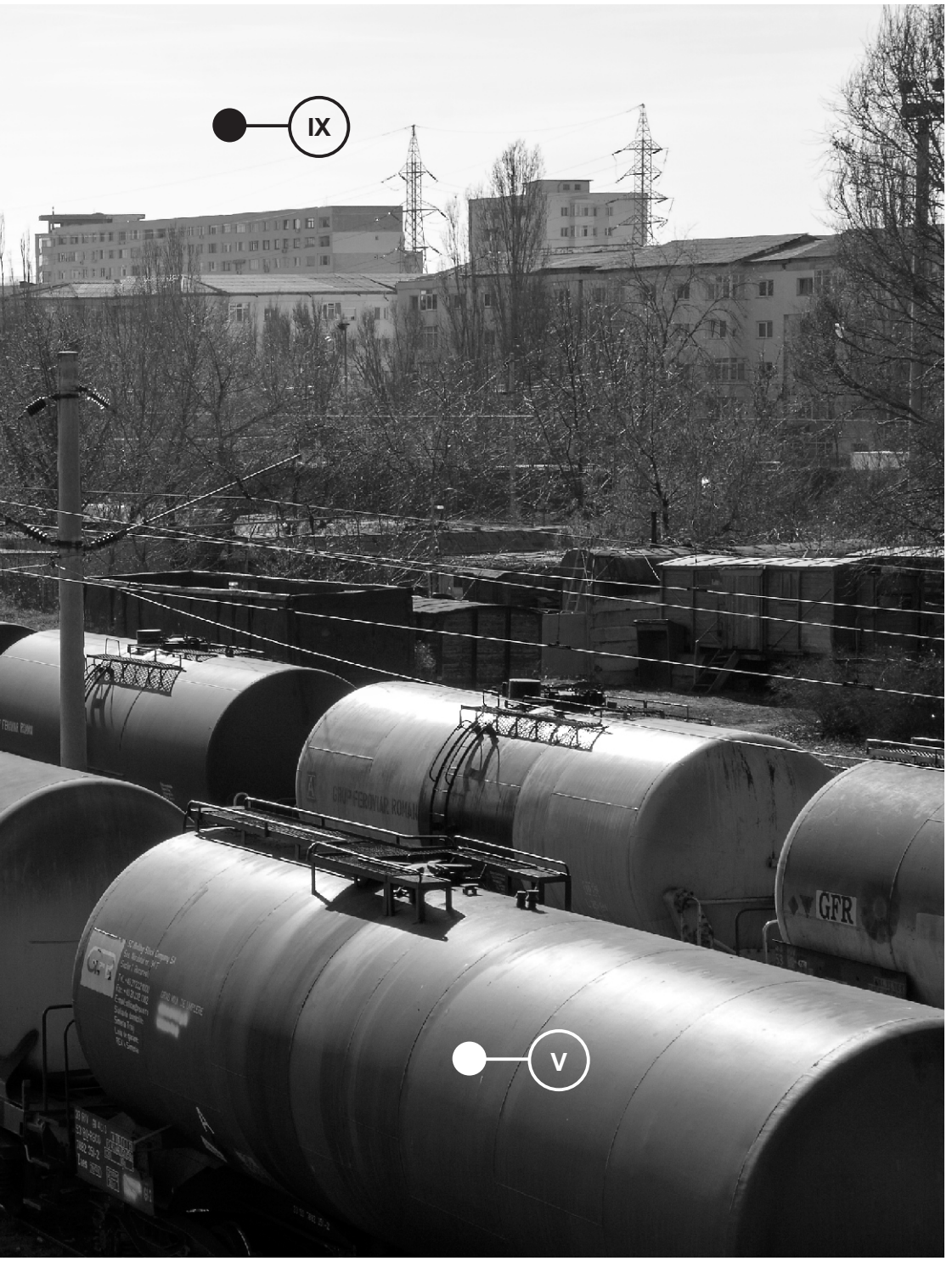
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Iași, March 2013

6. Printing on photographic paper

The processing of negatives and then printing on paper take place in the **darkroom**, which can be set up in a room with access to running water and with the possibility of being made light-proof. The basic equipment required for a darkroom consist of an **enlarger,** a **table,** three **processing trays, tongs, graduated cylinders, dark glass bottles for solutions,** a **safe-light lamp,** a **photographic thermometer.** Apart from these utensils, we may have auxiliary devices such as: easels, timers, grain focusers, lab light meters, colour analysers, dryers. The enlarger has the role of projecting the image of the negative on the surface of the photographic paper. Based on the same principles as those used when exposing negatives, the photographic paper is exposed to light for a certain time interval, then it is developed, stopped, fixed, washed and dried, thus obtaining the final product of the photography process.

The enlarger consists of a body, which has inside it a lamp, a condenser, a filter drawer, a negative carrier, bellows, and ends in a lens (fig. 6.1.). Enlargers can be fitted with dichroic-colour heads for printing colour photographs. The enlarger's body can slide vertically on a metal column, rigidly attached to a horizontal baseboard, where the image is projected. The role of the condenser is to focus the light flow into the lens (objective), illuminating equally the entire surface of the negative. In the negative carrier, the film is fixed between two glass plates, which need to be always dust-free, in order to have clear, speck-free images. The bellows have the role of allowing the operator to focus the image through the lens in relation to the size of the image being projected.

Due to the low sensitivity of photographic paper, in the laboratory we may use a coloured, amber or red light of low intensity, called a safelight. This light does not fog the photosensitive material. The enlarger also has, under the lens, a mobile coloured filter used while framing the paper so that it corresponds with the projected image. Let us go through the successive stages of exposing and developing black-and-white photographic paper.

After preparing the developing solutions, the stop bath and the fixer according to the manufacturer's instructions, and after pouring them in the processing trays, we insert the film into the enlarger's negative carrier. We focus the image depending on the desired size of the projection on the horizontal baseboard where the paper will be exposed. In order to obtain a correct exposure and to save paper, it is recommended to

cut one sheet into small strips and to use them for exposure tests (fig. 6.2.). If the negative is saturated with dark areas (overexposed), we need to increase the exposure time; conversely, if the negative has many transparent areas, we need to shorten the exposure time. Choosing the optimal exposure time is based on the results of the tests; the standard recommended time is approximately 10 seconds. The correctly exposed paper is placed in the developer tray, and within 60 to 90 seconds the saturated image will form. Here is where the exposure can be controlled: if the image forms abruptly and darkens rapidly, it means we have overexposed the paper and therefore we'll need to reduce exposure time by 10%, 20%, 30%, etc. or to close the aperture of the enlarger lens with one or two steps. On the contrary, if after more than a minute the image does not reach tone saturation, we need to increase exposure time.

After development, the paper is immersed in a stop bath (a solution of 2-3% acetic acid) for one minute, and afterwards it is fixed for approximately 5 minutes (each fixer has the fixing time marked on its label). After fixing, the photograph is washed well (15-20 minutes for resin coated papers and 1 hour for fiber base papers) and dried on a flat surface.

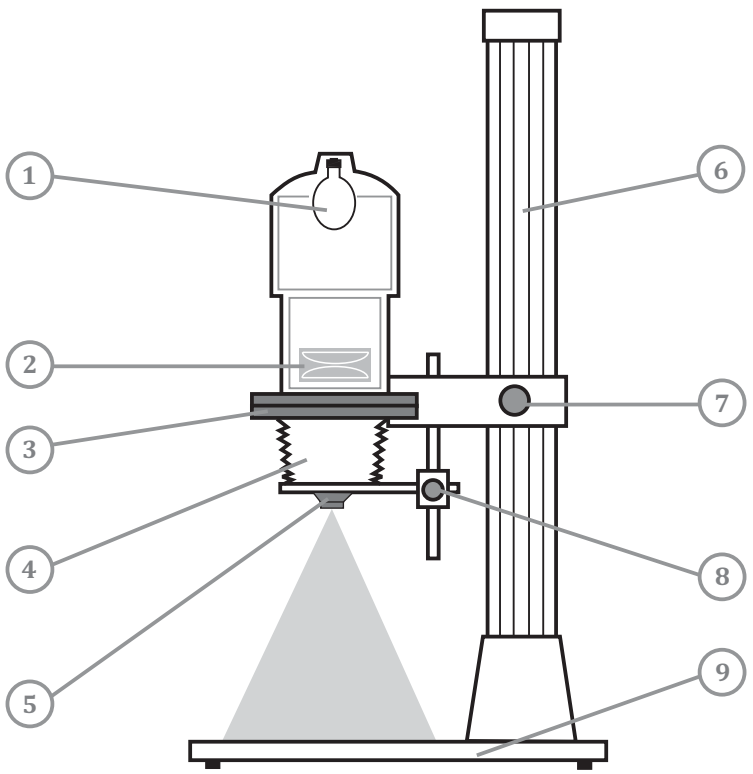


Fig. 6.1. The classical black-and-white photographic enlarger
1 - lamp; 2 - condenser; 3 - film carrier; 4 - bellows; 5 - enlarger lens; 6 - column; 7- height adjusting lever (adjusts image size); 8 - focus knob; 9 - base board

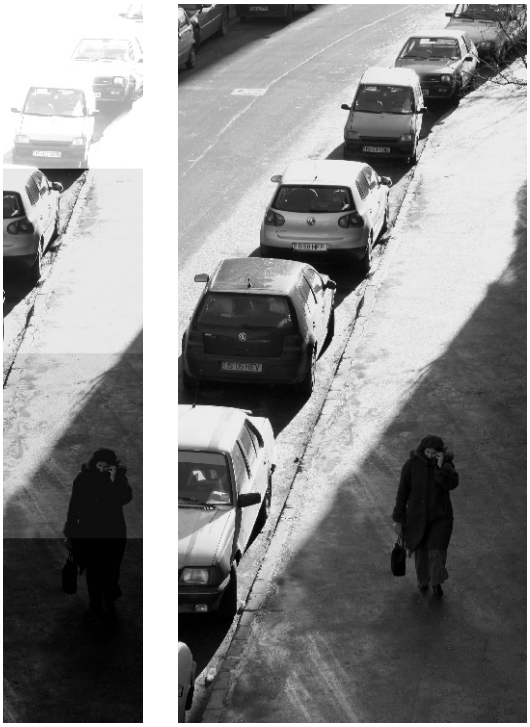


Fig. 6.2. Paper exposure samples
The image was printed according to the second sample from the top.

Details concerning black-and-white and colour prints

Variable-contrast photographic paper can produce different types of images, depending on the filters inserted in the enlarger (fig. 6.3.). The quality of the enlarger's lens, as well as the quality of the light filtered by the condenser, become crucial in obtaining professional photographs. In order to examine and archive photographic films, professional photographers produce contact sheets, which are a direct copy of all the segments of the photographic film. The film strips are placed directly in between the photographic paper and a glass plate in order to ensure the flatness of the film. There are many darkroom techniques that result in the production of artistically expressive images: **tone separation** (obtaining a graphic-like image with two or three tones) and ***faux relief*** (images with just one tone value, only the outlines being distinguishable). Making colour copies is a work-intensive process, now seldom carried out manually. For the colour positive process the enlarger must be equipped with a colour head.



Fig. 6.3. Exposure on photographic paper with variable contrast
(the middle section has an acceptable contrast)

6.1. Using multigrade filters. "Dodging" and "burning"

Once we have a well exposed and well developed negative, we can go on to print the photographs on paper in the darkroom. This is a creative process, involving the interpretation of the negative image by manipulating exposure using the enlarger. We can choose between two main methods:

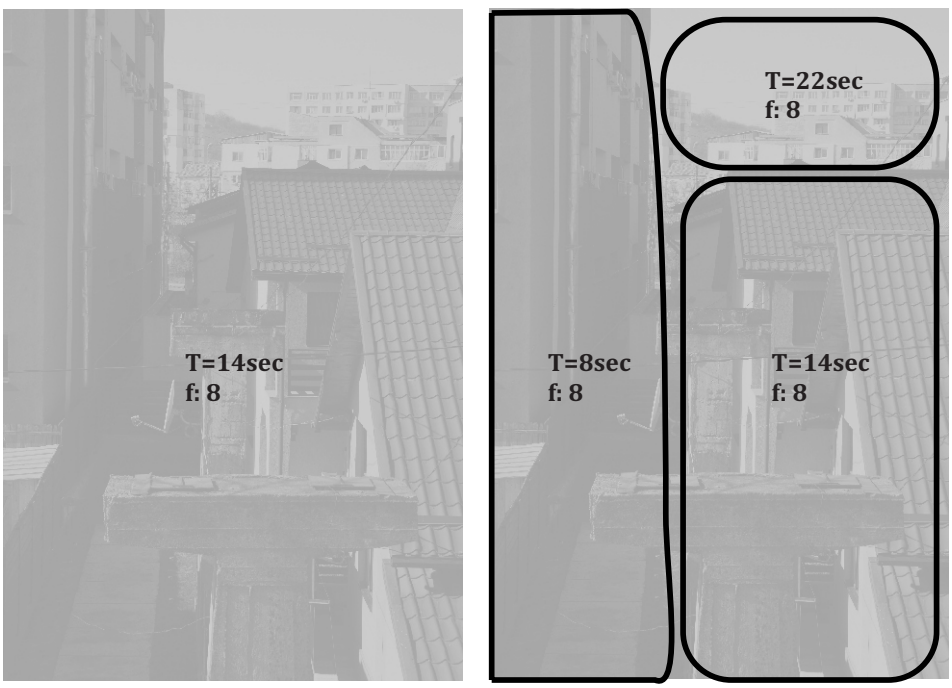
- **manipulate the contrast of the picture by using multigrade filters**
- **expose different areas of the negative in different manners, using "dodging" and "burning" methods.**

By using multigrade filters attached under the enlarger's objective or in the filter drawer, we can obtain images with varying contrasts. The multigrade filters made by Ilford have five steps (from 0 to 5, quantified at half-step), step 0 having minimum contrast, and step 5 maximum contrast. For low contrasts, yellow filters are used, while for strong contrasts the filters used are magenta. Using simple implements for "dodging" and "burning", the range for creative manipulation of images in the darkroom is greatly increased. Thus, after several tests, some areas of the image will be exposed more intensely (burn), and others less intensely (dodge) (fig. 6.4.). Professional photographers devise their own dodging and burning models, so that they are able to reproduce the same creative scheme when making prints.



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Fig. 6.4. Dodging and burning
Left image: print without "dodging" and "burning"
Right image: print manipulated with "dodging" and "burning"
Down-right image: the print "dodging" and "burning" diagram



6.2. Displaying photographs

Gelatin silver prints must be washed well (for at least 1 hour) if we want to preserve them for a long period of time. In order to remove fixer (hypo) traces, hypo clearing agents are used. Preservation is also helped by using selenium toning. As a rule, it is not advisable to mount prints on supports using adhesives; it is best to display them pressed between a back board and a passe-partout frame. If we do mount them, the best results are obtained by dry mounting; the conservation board and the adhesive must be Ph neutral, so as not to attack the photographic paper over time.

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