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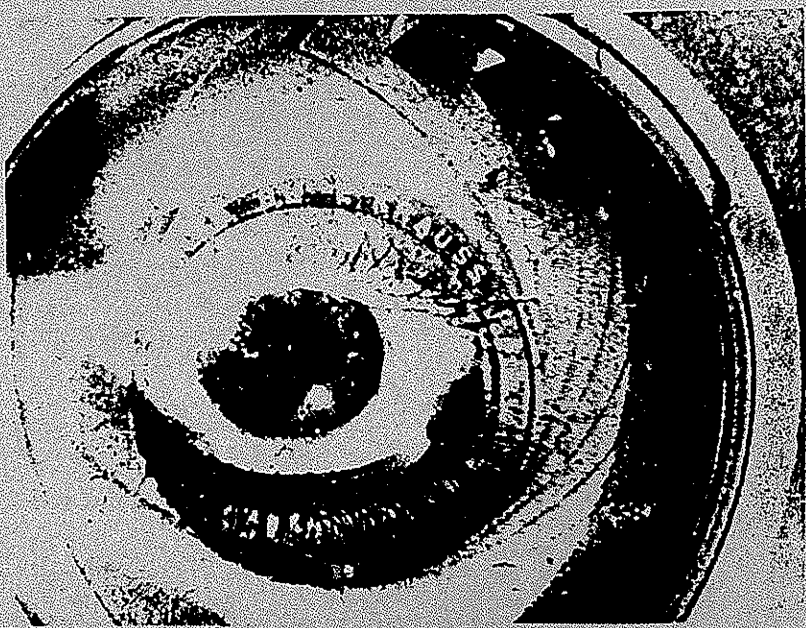

16mm Film Technical Handbook

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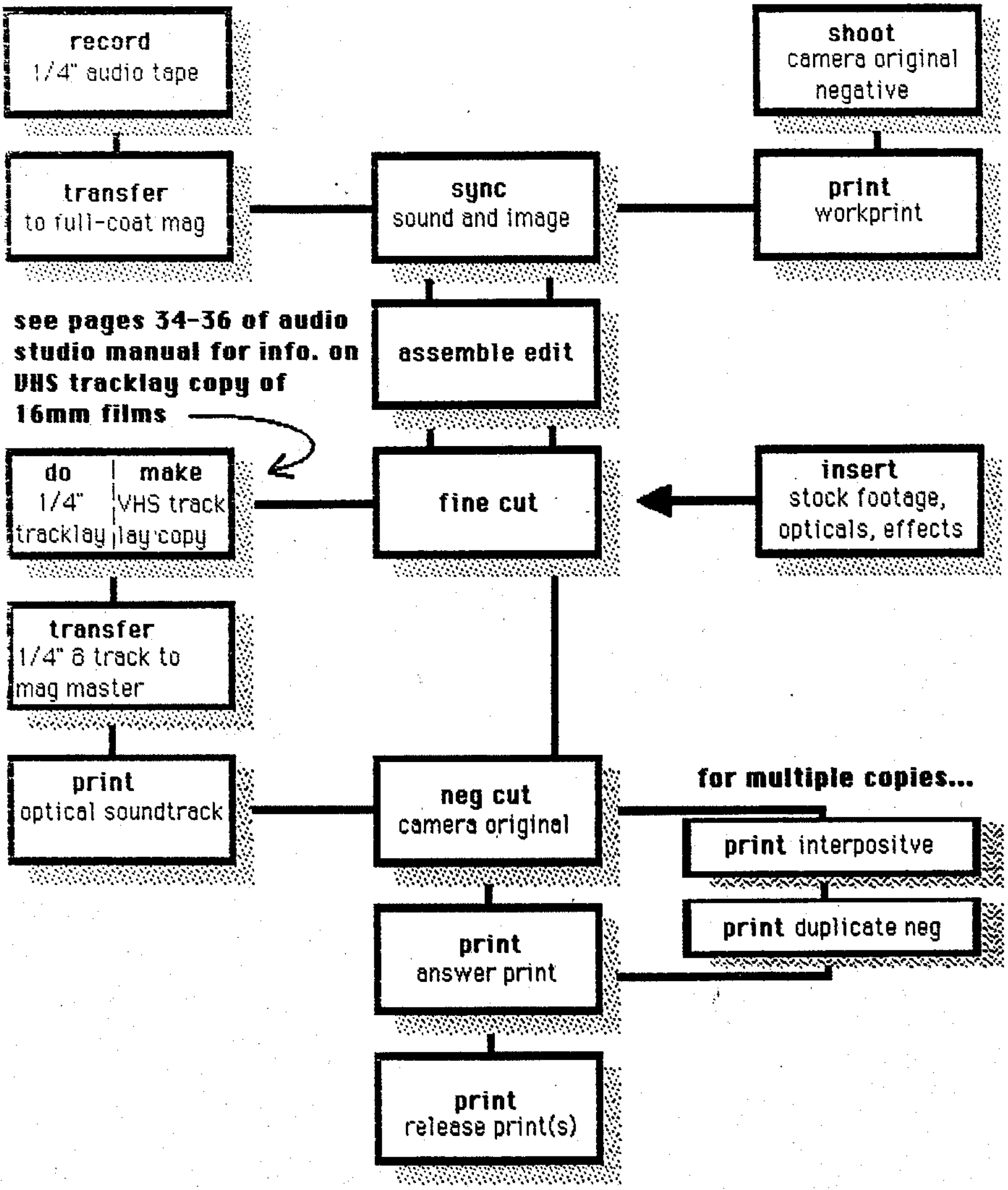
flow chart

for shooting, cutting and finishing on 16mm colour neg.



16 MM FILM NOTES, PART ONE

BY NICOLETTE FREEMAN 1985.

LIGHTING AND EXPOSURE

A) FILM STOCK

1) Film Speed.

Each film stock has a different A.S.A. rating. This is an indication of the film's sensitivity to light.

- A slow speed film (e.g. ASA 25) needs more light for an exposure than
- a fast speed film (e.g. ASA 400) which can expose with smaller amounts of light.
- The A.S.A. ratings (the speed of the film) of particular film stocks are proportional to the grain size of the emulsion.
  The bigger the grains are the more likely it is that light will hit them, so the faster the stock is.
  Slower speed films are more fine grained.
- A.S.A. ratings increase in the same mathematical manner as F-Stops.
  That is:-
  A.S.A. 50 needs 2 times as much exposure as ASA 100 to give the same result, or 4 times as much exposure as ASA 200.
  (Remember 2 times as much exposure is equivalent to opening up the Iris another stop, e.g. from f5.6 to f4, so that if you get a film stock with double the ASA. It is equivalent to having another stop of light available to you.)

2) Film's Colur Sensitivity

- Each colour stock is balanced for either daylight or tungsten light.
- Each lighting source has a colour temperature which is measured in degrees Kelvin
- Tungsten light is 3600° K.
- Daylight is 5600° K (average). It varies from as much as 7000° K on an overcast day to 4000° K at sunrise and sunset.
- The lower the degrees Kelvin, the warmer (more amber) the light is.
- The higher the degrees Kelvin, the colder (more blue) this light is.

An Example:

Kodak 7291 (ASA 100 for tunsten
ASA 64 for daylight)
is balanced for tungsten (3600°K), therefore when filming outside to bring the colour temperature of daylight back to what the film-stock is balanced for, it is necessary to use an amber filter (No.85) on the camera. (to make the "blue" daylight enter the camera as if it were "amber" tunsten light). When you do this the No 85 filter is blocking out 2/3 rds of a stop of light, hence you must change the ASA rating on your exposure meter to ASA 64 (approx 2/3 of ASA 100).

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When you're filming without an 85 filter you should remember to to return the ASA rating on the meter to 100 ASA.

* These ratings are only for the example of kodak 7291.

Similarly, if you are filming indoors and the light you are using is a mixture of tungsten and daylight, you could put blue gels on the tungsten lights (matching their colour temperature with daylight) and put a No.85 filter on the Camera.

3) Latitude

- Each film stock has its own tolerance of how much variation in light levels (measured in F-stops) it can handle.

For example, if you expose correctly for a certain object, a particular stock may still be able to see that object up to seven F-stops under what you have called correct exposure, or it may still see it when it is three F-stops over correct exposure. (in this case the Latitude of this particular stock would be ten stops.)

There is less latitude:-
a) in slow film than in fast film
b) in reversal than in negative
c) in colour than in black and white.

B) LIGHTING

1) Exposure meters

a) Incident light readings:- taken by reading the amount of light that falls on the subject.

If the lightmeter is held at the subject and pointed towards the camera, light from all directions is being accounted for at once.

If you want to measure each light source separately, you would need to point this meter towards each single light, making sure that no light from any other place is hitting the photocell (white plastic hemisphere) at the same time.

In this way you can control the contrast ratio by measuring the key light level first, and then adjusting the amount of fill light to whatever you want.

b) Reflective light readings:- taken by reading the light that reflects from the subject. This reading takes into account the texture and and material of the surface that is being lit (its reflectance).

The meter is held so that it points at the subject from the same angle as the camera. (For this reading to equal an incident reading, you should read the reflectance off an 18% Grey Card which is equal to average White Flesh Tone).

Once you have measured the light level (in footcandles) the 2 variables that need to be checked on the exposure meter to make your calculation are :-

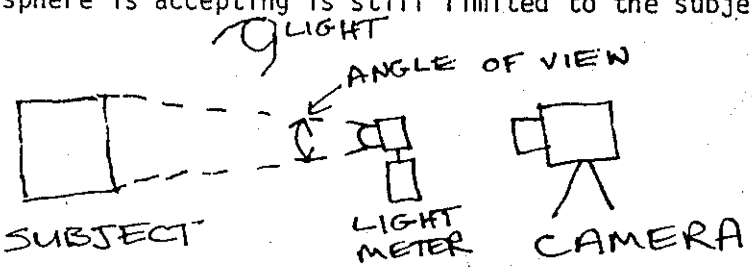
...../3

(i) The ASA Rating
(ii) The Shutter Speed of the Camera

If you have measured the brightest and the darkest parts of the picture, and the difference is more than the Latitude of your particular film stock can handle, then you will have to choose which end of the exposure scale is more important to expose for - for the shadows or for the highlights.

2) A note about distance and the intensity of a light source.

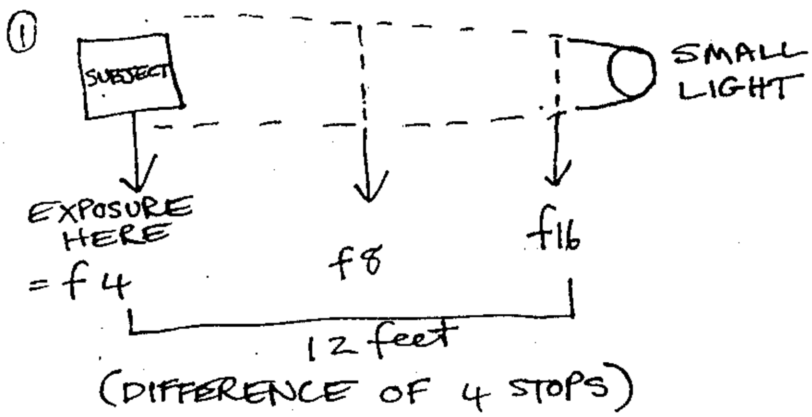
A reflective light reading shouldn't change no matter how far away you are from the subject. (As long as the angle of view that the Hemisphere is accepting is still limited to the subject alone)



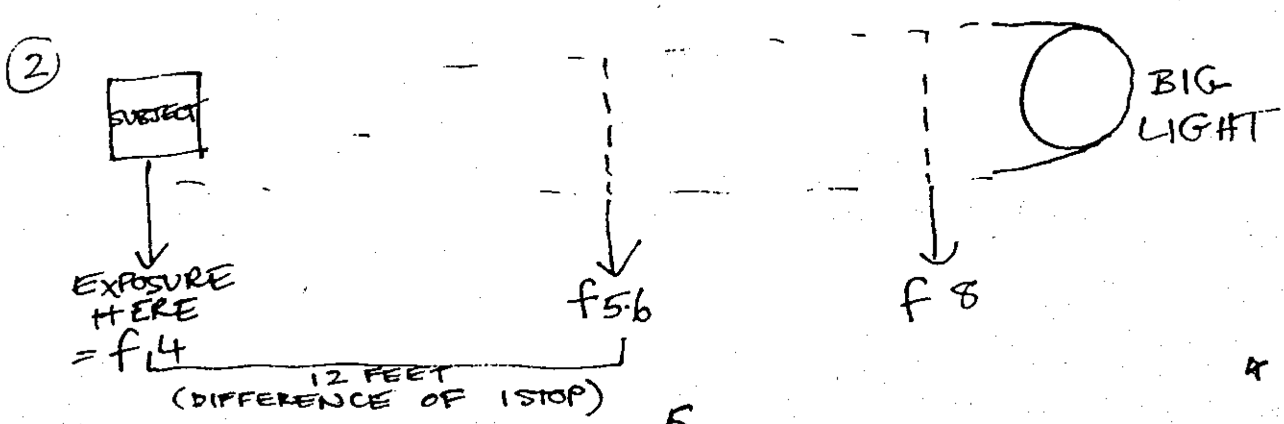
However, incident readings will increase as you move further away from the subject towards the light source. The closer the light is to the subject, the greater this difference in light level will be, over a smaller distance.

If you used a stronger light further away, the light level wouldn't drop off as much in a given area. (the sun is a good example of this)

EXAMPLE:



I.E. When the distance from the light source is halved, the illumination on the subject is 4 x as great.



3) Power

There are 3 variables to take note of:-

(i) In Australia the voltage of the power supply is fixed at 240 volts.

(ii) Each lamp in a light is a certain wattage

(iii) Each circuit in a domestic supply is usuall, 15 AMPS, Although there are usually several circuits available to run lights from.

* One circuit can take a load of 3600⁰ watts. with about 10% overload = 3960 watts.

$$AMPS = \frac{WATTS}{VOLTS}$$

So that if we know that Volts = 240
Amps = 15 (per circuit)
one circuit = 3600 Watts.

Therefore, $15 = \frac{3600}{240}$

All you have to do is make sure that there isn't more than 3600 watts (or 3690 watts at the most) running off one circuit at a time.

Blondie	=	2000	Watts
Redhead	=	800	Watts
Mini-Redhead	=	650	Watts
Each bulb in a sixlight	=	650	Watts.

CLASS NOTES – FILM PRODUCTION 2.

LIGHTMETERS

As their name implies, lightmeters measure light. Some types measure the quality of the light – its colour – and we call these colour temperature meters. But most lightmeters measure quantity.

These types of meters are not exposure meters. No meter can tell you how to expose your film; this is an artistic dedision. But obviously the information supplied by the lightmeters is of primary importance in deciding exposure.

"EXPOSURE" METERS AND AUTOMATIC EXPOSURE CAMERAS

Lightmeters are often built-in to cameras. Sometimes as fully automatic systems with the light level in total control of the exposure setting, and sometimes as semi-automatic, or built-in, where the information is given to the cameraman within the viewfinder, and he manually adjusts the aperture.

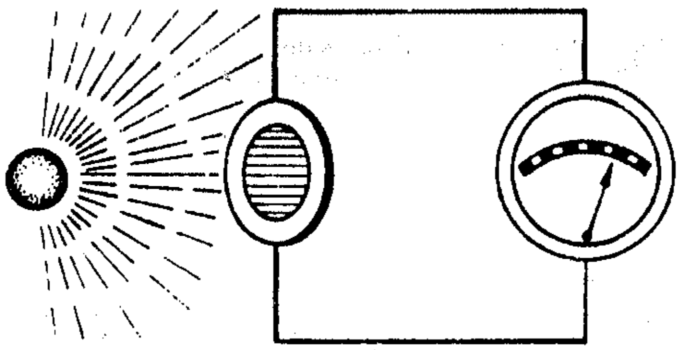
In either case the meters are of a type known as reflected meters. The name indicates that they measure the light reflected from the scene we are photographing.

Very few professional cameras have built-in or automatic systems for very good reasons. These types of meters only function well in average situations and the readings they supply are difficult to interpret. A built-in meter is unable to distinguish between the face of a person, which may be of primary interest in our shot, and the glaring white window behind – which may be of little interest at all. Light-sensitive cells, electric relays and gear chains are unable to make aesthetic judgements.

For this reason, most professionals prefer to use separate lightmeters, where they can make judgements, before manually setting the aperture.

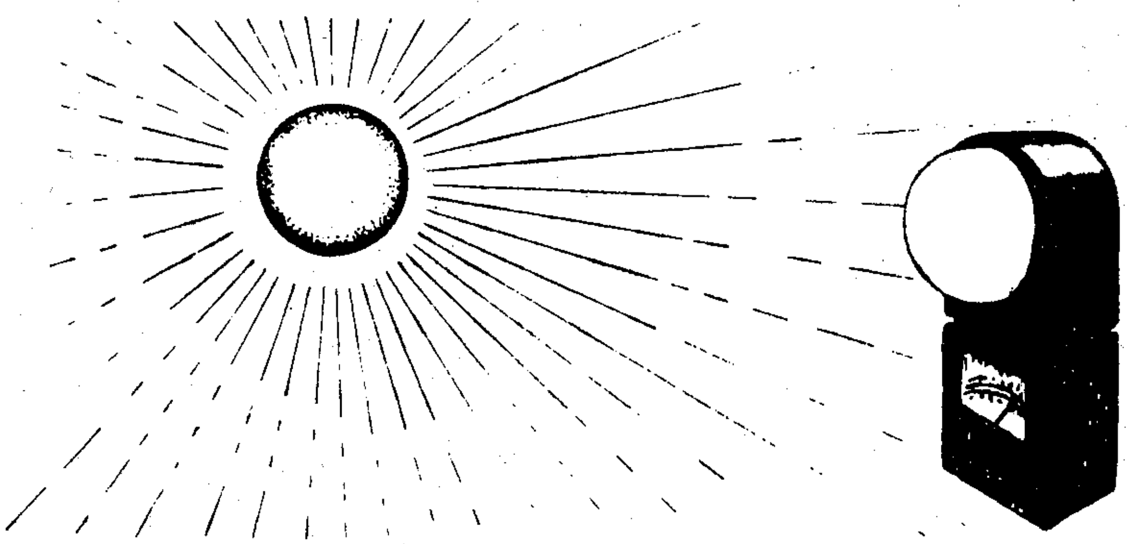
HOW THEY WORK

All lightmeters in common use today work in the same basic way. Light falling on a light-sensitive cell generates a small amount of electricity. This electricity is measured by a simple galvanometer. The deflection of the needle is proportional to the amount of electricity generated, and therefore to the amount of light falling on the cell.



Most lightmeters have a calculator, on which the cameraman sets the ASA of the film he is using, and from which he derives the exposure information. In cinematography, some meters use a system of slides which limits the light reaching the cell, (as a substitute for the ASA setting on the calculator). These meters can be read direct from the needle position, and this saves time in professional filmmaking.

There are two types of lightmeters in common use. Reflected lightmeters which are held at the camera position and pointed at the subject; and Incident lightmeters which are held at the subject's position and pointed back at the camera.



INCIDENT LIGHTMETERS

These meters have a characteristic white plastic dome covering the light-cell. The dome can sometimes be replaced by a flat plastic disc which allows the exclusion or inclusion of specific light sources in a studio situation. This disc is mainly used for measuring the ratio between different lights.

The dome on an incident lightmeter is intended as a substitute for the subject. It is round because faces are round – and faces are important in photography. The transluscent dome prevents the meter from 'looking' at the scene itself. It only transmits to the light-cell, the incident light that falls directly on it – not the reflected light which forms the image in the camera. In exposure theory, we say the Incident lightmeters measure a pure factor (I), which is the brightness of the light illuminating the subject.

Incident meters should be held in the position of the subject, with the dome pointing back at the camera. If our subject is 100 metres away, we usually don't have to walk to the subject if the light level near the camera is the same as that falling on the subject.

Before taking a reading, you should try to predict the exposure setting. Always check by using a meter, however, no matter how well you learn to judge. The difference between your prediction, and the meter reading, is always a valuable source of information.

In a studio situation where you are using a number of lights, the Incident meter is invaluable. It is used to check the consistency of the light level across the set, and the relative brightness of different light sources.

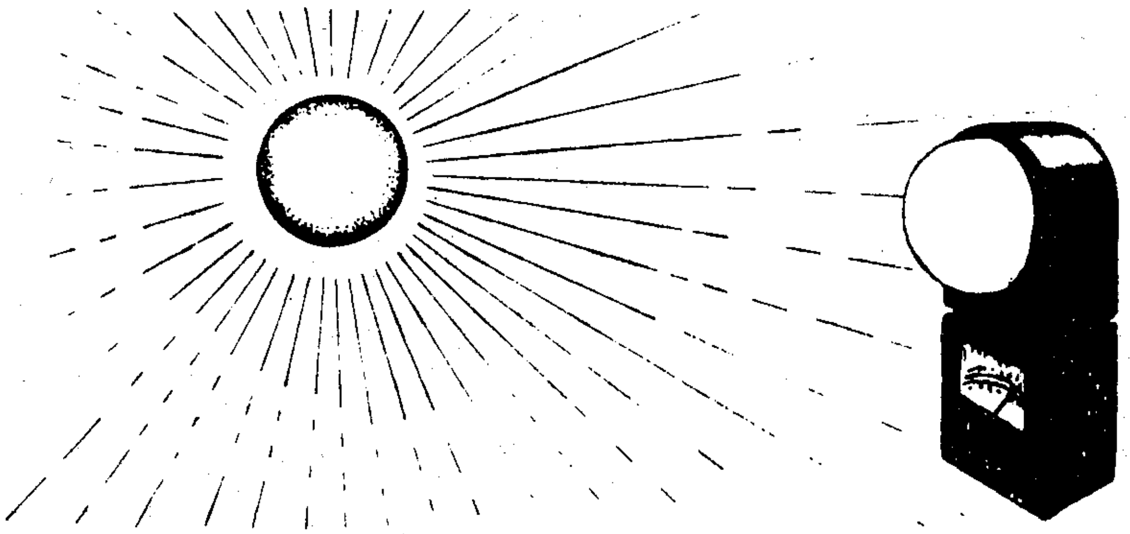
REFLECTED LIGHTMETERS

Reflected lightmeters have their light-sensitive cell overlaid by a beaded-glass surface, or sometimes by a lens system in the case of a special type known as spot-meters. Some reflected meters can be converted to give incident readings by the addition of a white dome over the cell.

Reflected meters measure the light reflected from the various parts of the scene – trees, houses, people etc. They measure the actual light that forms the image – and you would assume therefore that these meters would be more accurate. But this is not the case.

Their reading depends both on the level of general illumination (i.e. the incident light level – I) and the reflectance quality of the subject of the photograph (i.e. its tonal value, or percentage of reflectance – R%). In exposure theory we say that reflected meters measure compound factors of I x R%. The difficulty is in knowing which part of the reading is due to I, and which is due to the R%.

If our illuminating source increases in brightness (say the sun comes out from behind a cloud) then the meter will react to this change. It will provide a change in aperture to compensate for the increased brightness – and it should. However the meter will also react to the change in reflectance value of the scene. If we point it at a snow scene for instance, it will read higher than if we point it at dark jungle foliage. It will provide a reading which will compensate for the white of the snow, and also for the darkness of the foliage. It will try to make both reproduce as mid-grey ... the average tone on the scale between black and white.



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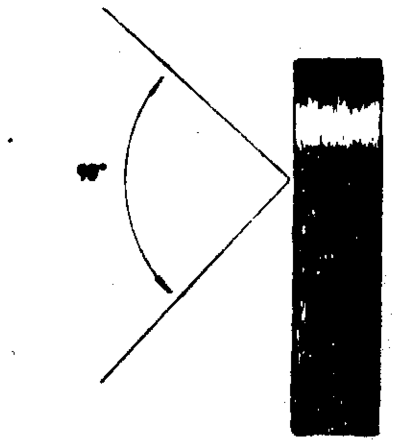
We do not want mid-grey snow or mid-grey 'dark' foliage. We want them white and black respectively.

Fortunately reflected meters give accurate readings for 'average' scenes, where the areas of dark and light tones are balanced. Most general photography approximates these average conditions when the subject is front-lit. (i.e. when the source light falls on the side of the subject towards the camera.)

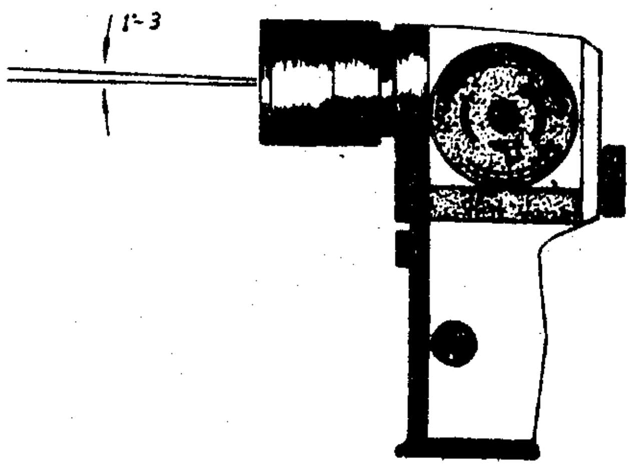
Where scenes are backlit, the tones that the camera is reproducing are not 'average'. Usually with back-lit photography we have large areas of black shadow, and small rim-lit areas around the hair, faces etc. Reflected meters in this situation often give entirely false readings.

Reflected lightmeters are held at the position of the camera and pointed at the subject. The reading is therefore partly determined by how much of the scene they'see'. Do they react to the total light coming from a wide panoramic view of the scene, or do they only select out a small portion of the picture? This angle of view is called the angle of acceptance, and in normal reflected lightmeters it is about 90%. A special type of reflected lightmeter known as a spot-meter is made with a much narrower angle of acceptance – usually between one and three degrees.

ANGLE OF ACCEPTANCE



Normal Reflected Lightmeters



Spot-meters

With experience you will be able to interpret the readings provided by normal reflected lightmeters. Here are some hints:

a) Where there is a balance between the areas of light and dark tones in a scene, the meter will provide an 'average' reading, and in most cases this will be accurate enough for exposure.

b) Tend to point your meter slightly lower than the centre-point of the scene when you are outdoors. The angle of acceptance of most meters is too great in the vertical plane and includes too much of the sky.

c) If in doubt, take your meter in closer to the principle subject and diminish the effect of background sky, clouds etc., if these are of secondary importance only.

d) By reading the back of your hand under the same illumination conditions as the subject, you will get an approximation of an incident meter reading, and this will allow you to compensate for light or dark subject. Be careful here. Don't allow the meter to cast a shadow on your hand and effect the results.

Remember that lightmeters give readings that compensate for brightness or darkness. If you read a near-black object with a reflected lightmeter it will provide you with an exposure setting that will overexpose your film. If the object is white or off-white, the reading you will get will tend to under-expose the film.

Reflected lightmeters always tend to provide an exposure which will make the scene average. White objects will be converted to mid-grey, as will black objects if the meter reading is used without compensation.

say that reflected meters:

"believe that the whole world is mid-grey, and they therefore provide a reading which will conver any scene to mid-grey".

You should never use a reflected meter reading without first considering the range and effect of areas and tones in the scene. You should then adjust the reading accordingly.

SPOT METERS

Spot meters are simply reflected lightmeters with a very narrow angle of acceptance. They only 'see' a small part of any scene. The angle of acceptance with most spot-meters is about one or two degrees.

Spot-meters can be used to calculate exposure – especially in difficult circumstances – but this is not their main function. They primarily serve to help the cameraman predict the result of an exposure setting already chosen.

The spot-meter is used for basic exposure setting in difficult circumstances. For instance, if you are filming from the back of a theatre, and you can't get on to, or near, the stage.

If you use your normal reflected lightmeter, it would include too much of the dark areas of the theatre in its angle of acceptance, and the reading would almost be meaningless. An incident lightmeter would probably give no reading at all in the dark.

The narrow angle of the spot-meter will allow you to read perhaps the face of an actor on the stage, and under the circumstances this will be the most accurate reading you will be able to get.

Spot-meters are used mainly to predict results, and to assist in making minor adjustments to an exposure setting already established. The cameraman can read the level of light reflectance from a number of key parts of the scene, and through his experience and knowledge, he will know whether these parts will be distinguishable in the final film.

He will be able to tell whether the Angus cow under the shade of the tree will show up on his film as a distinct animal, or a meaningless blob. If the cow is important in the scene, then he will know from the readings how much change to his basic exposure he will have to make.

COLOUR TEMPERATURE METERS

Most meters measure the brightness (or quantity) of light, but colour temperature meters measure the quality (or colour) of light-sources. They are therefore a form of Incident lightmeter – because they measure the quality of the general illumination.

The human eye is amazingly adaptive to changes in the colour of light that still appears to be white. Outside, sunlight appears to be white. Indoors at night our normal tungsten room lights appear to be white. But they contain different amounts of red and blue.

If we measure these two light sources in terms of the amount of red and blue they contain, we find that daylight is very blue by comparison to the tungsten light.

It is for this reason that colour film is made in both Daylight and Tungsten balanced forms. The colour sensitivity of the film is manipulated in an attempt to duplicate the adaption that the eye makes for the change in the colour temperature of these sources.

If we use a Tungsten balanced film outdoors in sunlight, then we need to compensate for incorrect colour temperature by the use of a deep orange filter known as a Wratten 85. Indoors, if we use a Daylight balanced film, we will need a deep blue Wratten 80 filter.

In most documentary film production these are the only two common filming situations, and usually the cameraman has no need for an accurate measurement of the colour of his light sources. He knows from experience which filter to use.

in feature cinematography, a great deal more accuracy is needed to preserve the picture quality. The Director of Photography will often need to measure the exact colour of the sources and choose from a wide range of filter variations. In these circumstances he will use a colour temperature meter.

There are two types of colour meters in common use. The simpler and cheaper type is the two-colour meter, which simply measures the balance between the amount of red and the amount of blue in the 'whiteness' of his light source.

Perhaps he is shooting outdoors during the bushfire season. A thin layer of smoke over the sun could produce a golden cast over the actors. The colour meter would read this increase in the red spectrum and provide him with a measurement of this colour shift to enable him to choose a correcting filter.

Two-colour meters have an intrinsic problems when measuring colour changes which are mid-way between red and blue along the spectrum. They can not read changes taking place in green and they are unable to give a satisfactory reading for fluorescent light — a common problem in photography.

For these reasons the three-colour meters were devised. They are designed to match the three colour layers in colour film, and they are therefore much more accurate.

CHECKING YOUR LIGHTMETERS

We are now talking about 'exposure' meters again.

1. You should always check that your lightmeter is correctly adjusted at the zero point. If there is no light reaching the light-sensitive cell, then the needle should be on zero. Most meters have a small screw adjustment which can be turned with a jewellers screw-driver to set the needle to the zero point.

2. Incident lightmeters should only give the same reading as reflected lightmeters when the reflected meter is pointing at an 'average' scene. For the purposes of calibration and adjustment, the average scene is replaced by a Kodak mid-grey 18% Reflectance test card available from many camera stores.

3. The back of this card is white, and this can be used to check the acceptance angle of your reflected meter. Place the white card against a black background, and light it with a strong light. Hold your meter close to the card, and very slowly draw it away. At a certain point the needle will start to drop, and this indicates that the meter is now starting to be influenced by the black background. From this you can judge the angle of acceptance.

To summarise:

1. Lightmeters give information other than for just basic exposure selection.

2. Incident lightmeters provide information that is more easily interpreted by an experienced cameraman.

3. Reflected lightmeters are reasonably accurate in 'average' circumstances but difficult to interpret in non-average.

4. All types of meters require interpretation. None of them give an exposure setting without some form of judgement from the cameraman.

5. Lightmeters are relatively delicate and they require care and adjustment. You also need to 'know' your lightmeter/s, so it is best to buy, rather than to borrow or hire.

Feb. '84

16 MM FILM NOTES, PART 2

BY NICOLETTE FREEMAN 1985.

THE CAMERA

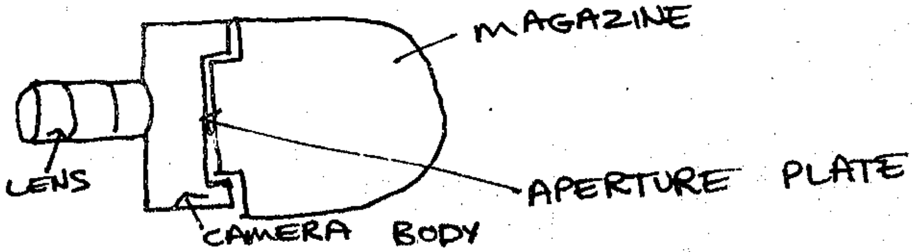
All a camera is, is a light-proof box with a hole in it. That a lens fits into, behind which the film runs as it passes by the hole and gets exposed to light.

Nearly all cine-cameras have the same basic components:-

1) Camera Body with Apertures (holes) for

(A) Lenses
(B) Film feed in & out
(C) A lid (door) for access to inside of camera

(* in some cameras, the plate of the Magazine where the film comes o , sits up flush against the aperture plate and all the film- transport happens inside the magazine in these cameras there is therefore no door) e.g.



2) A movement that combines :-

a) The pull down claw that keeps the Frames of film travelling past the gate.

b) Film registration pin that holds each frame in place as it gets exposed.

3) Lenses With:-

a) Particular lens mounts that are compatible with the camera body.

b) Internal movements for focus and aperture

4) A viewfinder system, either:-

a) Parallax (that doesn't see the view through the lens)

b) Reflex viewfinder (that sees what the film will see, via a reflex shutter system).

5) Aperture Plate and Gate (size dependent on film format)

6) Rear pressure plate, that holds the film firmly against the aperture plate as the film runs down past the gate).

... ./2

7) Sprockets and Guide Rollers, to keep the film feeding through properly and in a fixed loop size.

8) Motor and Speed Controls. Often some cameras have inter-changeable motors depending on what speed the film will be running at. The motor is powered by either spring, battery, or mains power supply.

9) Ground Glass - That enables you to focus the viewfinder to the correct setting compatible for your own eyes and the lens focusing system.

10) Footage Counter

11) Magazine take-up drive. That pulls the exposed film and winds it onto a core or spool.

12) On-off switch. Either on camera body or also sometimes on hand grip.

13) Battery

14) Lens Hood or Matte Box

15) Filter Holder

16) Tachometer indicating frames per second.

17) Trip switches, in the film path, they are tripped if the loop becomes dangeroursly small and tight, and then they turn off the motor before a disasterhappens.

18) Shutter (sometimes adjustable) turns in sync with the pull down mechanism of the film in the aperture plate, so that the shutter is closed while the film moves and is open for when the film is sitting steadily in the gate waiting for exposure.

19) Focus Measuring Mark. That indicates the position of the focal plane from which point all measurements of distance should be taken.

The focal plane corresponds to the position of the film in the aperture plate, so that if there isn't one of these marks you would have to judge where the aperture plate was inside the camera.

20) Footage Counter. Either woris:-

a) Like a Tachometer, you have to zero it at the beginning of the roll.

b) On the side of the magazine (controlled by a guide lever that moves as the size of the roll moves from the feed spindle to the take-up spindle.)

THE CAMERA MOVEMENTS

The final result of each exposure of a single frame is a combination of:

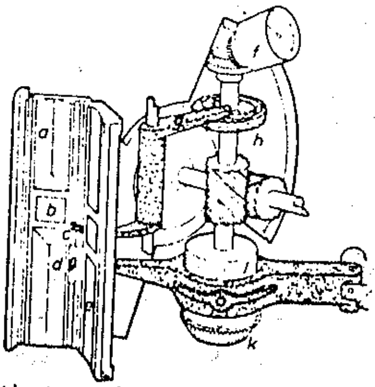
a) Camera movement (frames per second)
b) Exposure (amount of light through lens)
c) Focus (effects depth of field).

A) The Camera Movements. is a combination of:-

1) The Pull Down Claw that enters the sprocket holes of the film and transports the film downwards past the gate, after each exposure is made.

2) The Registration Pin that goes into the sprocket hole beside the gate and which holds the film in place during the time of exposure

3) The Shutter Movement that is geared to the pull down mechanism.



Arriflex 16BL mo[illegible]ment
a. Aperture plate; **b.** Aperture; **c.** Registration pin; **d.** Pull-down claw; **e.** Rear pressure plate; **f.** Tachometer; **g.** Registration pin cam; **h.** Mirror shutter; **i.** Shutter drive shafts; **j.** Film transport claw; **k.** Bevel gear to transfer drive from motor.

B) The Exposure

1) The Shutter. The amount of time that each frame is exposed to light is dependent on:
a) The film speed (frames per second)
b) The shutter angle.

The faster the film speed or the smaller the shutter angle (the size of the shutter opening) the less exposure there will be.

The exposure time (in fractions of a second) is figured out as the Reciprocal of the Multiplication of -

frames per second x (360^o ÷ Shutter angle)
(in degrees)

e.g. At 24 F.P.S., the exposure time is
24 x (360^o ÷ 180^o)
=48
=1/48th second
(or roughly 1/50th)

(Most cameras have shutter openings of 170^o - 180^o, but using 180^o as a likely average is usually sufficient, and quick!!)