



Small Format Anamorphic Reduction Printing New-System 16mm and Super 8 Anamorphic Reduction Prints from 35mm Style B Originals

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A new patented system, called Cineavision[®] in Europe and Animexvision[®] in the U.S., applies lateral masking to the 35mm Style A image area or that of 16mm and super 8mm, or masks the width of a video recording tube. This achieves a uniform anamorphic image area aspect ratio both for image recording and reproduction. Image area losses are thus avoided and no time-consuming readjustments of optical printers are necessary. The aspect ratio chosen is identical in all cases with that of the 35mm anamorphic Style B image area. Normally, image area losses occur when 35mm Style B anamorphic images are reduced to the normal 16mm or super 8mm formats. The Cineavision aspect ratio of 1.18:1, originally standardized for the 35mm Style B anamorphic image area, permits enlargements as well as reductions. A final advantage of a system of uniform aspect ratios for the original as well as the projectable anamorphic image area is that a standardized screen aspect ratio of 2.35:1 becomes possible for all film formats or for an — as yet hypothetical — TV receiver tube of double width.

of the original picture height over its entire width.

If further reductions are now made from such a 16mm anamorphic reduced negative onto super 8mm positive using a reduction ratio of approximately 1.80:1 (as indicated in Note 1 of American National Standard PH22.153-1971) the loss of image area is repeated for the anamorphic super 8mm image. During projection, the total image area loss will be still greater due to the presence of the projector mask.

In a later section we shall explain in detail the actual image area losses of the origi-

The Basic Principle of Anamorphic Cinematography

Professor Henri Chretien, in 1927, presented his invention of the anamorphic Hypergonar to the French Academy of Sciences. He used cylindrical elements to compress the camera image in the horizontal direction and to expand it again in projection. He did not actually invent the anamorphic principle, but his practical application demonstrated the feasibility of an anamorphic adaptor for taking and projecting 35mm motion pictures. Many years later he sold his design to 20th Century-Fox who gave it the name CinemaScope and released the first anamorphic film production, *The Robe*, in 1953. At that time, the aspect ratio of the screen image was 2.55:1 and the camera aperture size was 23.50 × 18.67 mm. Chretien's compression ratio was 2:1 and the expansion ratio for projection was 1:2. These compression and expansion ratios are still valid today. In 1964 the aspect ratio for the 35mm anamorphic projected screen image was standardized as 2.35:1, and in 1966 the camera image area aspect ratio was 1.18074:1. Figure 1 illustrates the application of the anamorphic principle to cinematography.

Anamorphic adaptor lenses have been manufactured in the U.S. by Bausch & Lomb and in Europe by Iseo Optische Werke GmbH after Chretien assigned his invention to 20th Century-Fox. Later on,

other optical manufacturers became involved.

Present Reduction Practices from 35mm Anamorphic Originals

At present, to reduce 35mm images to the 16mm format, the same reduction ratio is applied to both anamorphic and non-anamorphic originals. So far, no reduction ratio has been specified or recommended for reducing 35mm originals to the super 8mm format.

The SMPTE Recommended Practice RP 65-1976 for step optical reduction printing of 35mm negatives to 16mm prints and duplicate negatives recommends a maximum reduction ratio of 2.15:1. Standard reduction printers are customarily set to this reduction ratio. No distinction was made between nonanamorphic and anamorphic 35mm images, even though they have different image area heights (0.63 in = 16 mm for the non-anamorphic Style A, and 0.732 in = 18.59 mm for the anamorphic Style B) according to American National Standard PH22.59-1974. The only logical conclusion is that the recommended reduction ratio was not based on the height but on the width of the 35mm image area. This is the same in both cases, namely 0.864 in = 21.95 mm.

If both types of images are reduced by an identical reduction ratio of 2.15:1, it is clear that the anamorphic image area height difference of +0.102 in (+2.59 mm) representing about 14% of the anamorphic image height will be cut off, because insufficient image height is available on the 16mm format. In other words, the original image composition of an anamorphically photographed picture is disturbed by this type of reduction which cuts off about one-seventh

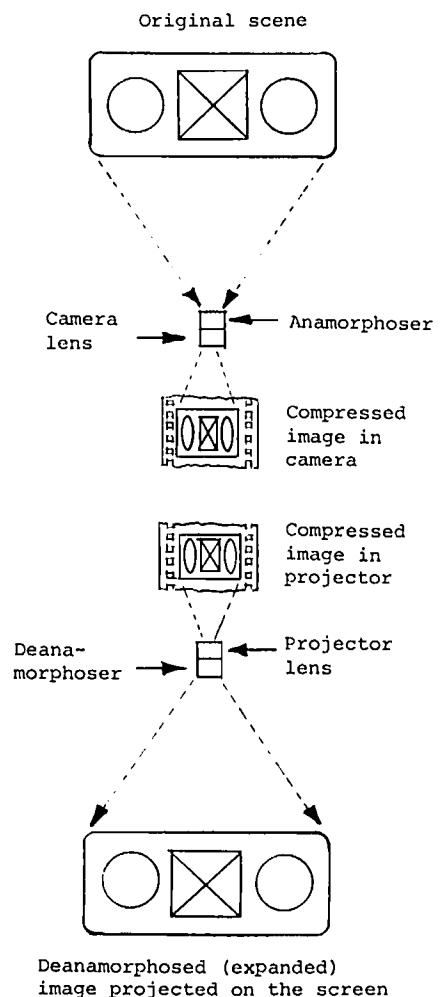


Fig. 1. The anamorphic principle.

A contribution received first on 4 October 1978 and in final form on 10 April 1979 from Wim G. Sips and Anthony M. A. H. van Tetering, Animex Incorporated, Nieuwe Gracht, P. O. Box 6285, Haarlem-Holland. Copyright © 1979 by the Society of Motion Picture and Television Engineers, Inc.

Table I. Standard image areas (mm) and aspect ratios.

Format	Image areas		Aspect ratios	
	Camera	Projector	Camera	Projector
35mm Style B anamorphic	21.95 × 18.59	21.29 × 17.78	1.1807 : 1	1.1974 : 1
35mm Style A nonanamorphic	21.95 × 16.00	20.96 × 15.29	1.3719 : 1	1.3708 : 1
16mm	10.26 × 7.49	9.65 × 7.26	1.3698 : 1	1.3296 : 1
Super 8mm	5.79 × 4.14	5.31 × 4.01	1.3986 : 1	1.3243 : 1

Table II. Screen aspect ratios obtained with various anamorphic compression ratios.

Format	Projectable image area (mm)	Anamorphic compression ratio	Screen aspect ratio
35mm Style B	21.29 × 17.78	2 : 1	2.395 : 1
16mm	9.65 × 7.26	2 : 1	2.658 : 1
Super 8mm	5.31 × 4.01	2 : 1	2.648 : 1
16mm	9.65 × 7.26	1.75 : 1	2.326 : 1
Super 8mm	5.31 × 4.01	1.75 : 1	2.317 : 1
16mm	9.65 × 7.26	1.5 : 1	1.994 : 1
Super 8mm	5.31 × 4.01	1.5 : 1	1.986 : 1
16mm	9.65 × 7.26	1.25 : 1	1.662 : 1
Super 8mm	5.31 × 4.01	1.25 : 1	1.655 : 1

nal image occurring during anamorphic-to-anamorphic and anamorphic-to-“flat” reduction printing using customary reduction ratios.

Similar and varying problems are also encountered when recording original anamorphic images with 16mm, super 8mm, or video cameras, because here again there is at present no uniformity of aspect ratios of their various camera apertures. Enlargement (blow-up) printing of small-format anamorphic originals, on the other hand, is impossible at present without suffering considerable image area losses in the enlarged 35mm prints. Bearing in mind that the image width is doubled when the final print is deanamorphosed (expanded) in projection, one can see that the differences in aspect ratio may become unacceptable.

Discrepancies in Camera Image Area Aspect Ratios

The 35mm anamorphic Style B camera image area specified in ANSI PH22.59-1974 has a minimum width 0.864 in (21.95 mm) and a height of 0.732±0.008 in (18.59±0.20 mm), giving an aspect ratio of 1.18074:1 for the anamorphic camera image area. Standardized nonanamorphic aspect ratios for 35mm, 16mm, and super 8mm camera image areas can be found in column 3 of Table I. As can be seen, considerable discrepancies exist among the non-anamorphic formats, as well as with respect to the anamorphic format.

Three problems arise when anamorphic images are recorded with 16mm and super 8mm cameras.

1. Because the standardized aspect ratios of the nonanamorphic camera image areas are different for all film formats, all the anamorphic images thus recorded will also have differing aspect ratios from one another when all these cameras are used with the same anamorphic lateral compression ratio of 2:1.

2. In projection, there will be cumulative additional differences, because no uniformity exists in projectable image area aspect ratios.

3. Anamorphic camera adaptor lenses of different lateral compression ratios may be used with the small format cameras (Table II). These adaptor lenses have been produced by the optical manufacturers in an attempt to obtain small-format images for anamorphic projection with aspect ratios closer to the standard 35mm deanamorphosed wide screen aspect ratio of 2.35:1. Table II shows the many confusing possibilities which resulted.

Not one of the anamorphic 16mm or super 8mm images can be adequately deanamorphosed and projected with the 2.35:1 screen aspect ratio specified for 35mm film and obtained after masking off 3% of the width and 4.312% of the height of the anamorphic camera image area. Yet this has been the attempted practice to date.

(A similar discrepancy would occur if recordings were made with a video camera having an image area aspect ratio of 4:3 = 1.33:1 and using an anamorphic lens with 2:1 lateral compression. To reproduce such an anamorphic video image after electronic deanamorphosing to an aspect ratio of 2.66:1, one would require a monitor or receiver tube of more than double the standard width. Anamorphic images reduced from 35mm film onto videotape would still lose about 14% in height, in the same way as when reducing them to the 16mm or super 8mm formats.)

Image Area Losses in Anamorphic-to-“Flat” Reduction Printing from a 35mm Original

With the recommended reduction ratios of 2.15:1 for 35mm-to-16mm reduction, and 1.80:1 for 16mm-to-super 8mm, no serious problems arise when reducing non-anamorphic 35mm originals. However, when 35mm anamorphic images are re-

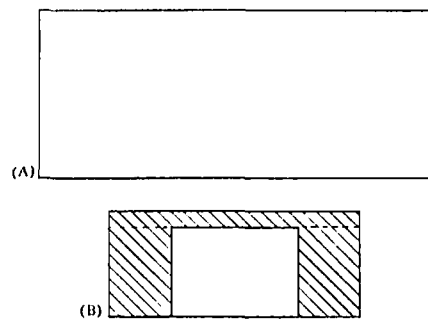


Fig. 2. Image area losses (crosshatched areas) in anamorphic-to-flat reduction printing. (A) is the 2:1 horizontally expanded 35mm Style B anamorphic camera image area; (B) represents the image area losses in the 16mm and super 8mm formats (not drawn to scale) when customary equipment and reduction ratios are used.

duced with these reduction ratios and simultaneously deanamorphosed to obtain a so-called flat reduction print, 57% of the original image area will be lost (Fig. 2), and lateral scanning during the reduction printing process becomes necessary.

[Figure 2A shows the 35mm Style B anamorphic camera image area expanded horizontally to twice its width for comparison purposes. The 100% image area is then

$$18.59 \times (2 \times 21.95) = 816.10 \text{ mm}^2$$

Figure 2B shows the image area reduced at a ratio of 2.15:1. The resulting 100% image area is now

$$8.65 \times (2 \times 10.21) = 176.63 \text{ mm}^2$$

However, the available 16mm negative image area according to SMPTE RP 65-1976 is only

$$7.44 \times 10.21 = 75.96 \text{ mm}^2$$

That is only 43% of the original image area. The crosshatched areas in Fig. 2B show the 57% of the image area which is lost at the top and on the sides. Figure 2B applies also to the super 8mm format. Reducing the 16mm image further with a reduction ratio of 1.80:1, the 100% image area will now be

$$4.80 \times (2 \times 5.67) = 54.43 \text{ mm}^2$$

The available super 8mm print image area according to ANSI PH22.153-1971 is, however, only

$$4.11 \times 5.71 = 23.47 \text{ mm}^2$$

Again only 43% of the original image will be reproduced.]

Obviously, this method of reduction, in wide commercial use, retains very little of the original image composition and represents a very poor reproduction of the original artistic image composition, even with lateral scanning. In addition, a further 3.1% in height and 5.9% in width are masked off by the projector aperture mask, resulting in the reproduction of only about 39.5% of the original anamorphic image.

Changing the reduction ratio to, say,

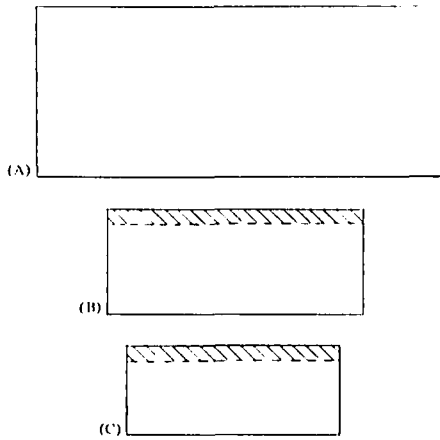


Fig. 3. Image area losses (crosshatched areas) in anamorphic-to-anamorphic reduction printing with currently recommended reduction ratios. (A) expanded 35mm Style B image; (B) and (C) represent image area losses in the 16mm and super 8mm formats (not drawn to scale) respectively.

2.13:1 would be of no help. Width and height of the image projected in the reduction printer would be slightly larger in this way, but the actual image loss on the 16mm side would actually be a fraction greater because less of the original image area would appear in the 16mm camera aperture. The height loss on the print would now be 14.75%, and on the projected image the total image loss would be 61.04%.

Image Area Losses in Anamorphic-to-Anamorphic Reduction Printing from a 35mm Original

Very seldom only are anamorphic-to-anamorphic 16mm reduction prints made from 35mm anamorphic images. Practically none are made in the super 8mm format. Only very recently have such reductions been attempted in England using the conventional reduction ratio.

In anamorphic-to-anamorphic reduction printing (where an anamorphic reduced image is obtained from the larger anamorphic original by means of spherical optics projection) the resultant image loss is less than with anamorphic-to-flat reduction printing, but the image area loss is still considerable (Fig. 3).

[In Fig. 3A we show again the 2:1 horizontally expanded 100% Style B 35mm image area of 816.10 mm². In Fig. 3B we have again the 2.15:1 reduced 16mm image with a 100% area of 176.63 mm². This time however nothing will be lost on the sides because we are dealing with the compressed image here. But at the top, a strip area of

$$(8.65 - 7.44) \times (2 \times 10.21) = 24.71 \text{ mm}^2$$

will be lost, due to the smaller available 16mm image height of only 7.44 mm. This represents a loss of about 14% of the original image area.

Figure 3C applies to the reduced super 8mm format, with a 100% image area of 54.43 mm². Here the available image height

Table III. Theoretical image areas (mm) which would yield uniform aspect ratios for the 35mm Style A, 16mm, and super 8mm formats.

Format	Image areas		Aspect ratios	
	Camera	Projector	Camera	Projector
35mm Style B anamorphic	21.95 × 18.59	21.29 × 17.78	1.1807 : 1	1.1974 : 1
35mm Style A nonanamorphic	21.95 × 16.00	20.96 × 15.29	1.3719 : 1	1.3708 : 1
16mm	10.276 × 7.49	9.952 × 7.26	1.3719 : 1	1.3708 : 1
Super 8mm	5.68 × 4.14	5.497 × 4.01	1.3720 : 1	1.3708 : 1

is only 4.11 mm, and the top strip area loss is found from

$$(4.80 - 4.11) \times (2 \times 5.67) = 7.82 \text{ mm}^2$$

This is again about 14% of the original image area.]

Moreover, the aspect ratios of the reduced anamorphic images are completely out of proportion in comparison with the standardized 35mm Style B anamorphic aspect ratio of 1.18:1. They are 1.3723:1 for the 16mm printer image (SMPTE RP 65-1976), and 1.3729:1 for the super 8mm printer image (ANSI PH22.153-1971). After masking in the projector, the projectable image area yields a 2:1 expanded screen image aspect ratio of 2.6592:1 for 16mm film and 2.6486:1 for the super 8mm format.

Discrepancies of Aspect Ratios of Camera and Projector Image Areas

The various standardized image areas for motion-picture cameras and projectors have no uniformity in aspect ratios. This prevents precise reduction or enlargement printing from one format to another, and the completely different height of the Style B 35mm anamorphic image area creates a further complication. Table I illustrates the various formats and the discrepancies in their aspect ratios.

Theoretically, it would not have been difficult to make the aspect ratios of the 16mm and super 8mm camera image areas identical with the 1.3719:1 aspect ratio of the 35mm Style A camera image area. This could have been done by increasing the width of the 16mm camera image area by 0.016 mm from 10.26 to 10.276 mm nominal, leaving unchanged the nominal image area height of 7.49^{+0.09}_{-0.07} mm. In the super 8mm camera format, the reference image area width could be reduced by 0.11 mm from 5.79 to 5.68 mm, leaving the minimum image area height of 4.14 mm unchanged.

Similarly, to arrive at projectable image areas identical to the 35mm nonanamorphic Style A aspect ratio of 1.3708:1, it is possible to increase the reference width of the 16mm projectable image area by 0.302 mm from 9.65 to 9.952 mm, with an unchanged maximum image area height of 7.26 mm. In the super 8mm projector, the reference width of the image area could be increased by 0.187 mm from 5.31 to 5.497 mm, with an unchanged maximum image area height of 4.01 mm. Table III shows the effects these changes would produce for the nonanamorphic formats.

At present, it may be difficult to alter the standard specifications for the width of 16mm and super 8mm camera and projector image areas. Nevertheless, international co-operation on motion-picture film and equipment dimensions is being achieved through the efforts of Working Groups in the ISO/TC36 Committee of the International Standards Organization, with SMPTE acting as Secretariat in the name of the American National Standards Institute. It seems desirable that this international body may find an agreement on the uniform specification of aspect ratios for nonanamorphic motion-picture image areas. Unfortunately, already established ISO specifications or drafts under consideration for 16mm and super 8mm equipment have, so far, not solved this problem. Neither have the problems concerning the reduction printing of 35mm Style B anamorphic images to smaller anamorphic formats been solved.

With present-day equipment and procedures, the problem of nonuniformity of aspect ratios for 16mm and super 8mm camera and projection image areas seems insoluble. Even if the diverse nonanamorphic formats were to have a uniform aspect ratio, as proposed by us, the aspect ratios for anamorphic images on 35mm, 16mm, and super 8mm film, and on videotape, could possibly still not be identical, because of the 16% greater standard image area height of the 35mm Style B anamorphic camera image area with regard to the image area height of the 35mm Style A nonanamorphic image area.

A System for the Achievement of Uniform Aspect Ratios of Anamorphic Image Areas in 35, 16, and Super 8mm

We shall now describe a system that solves the problem of anamorphic-to-anamorphic reduction printing in an extremely simple way and with no need for modifications of the existing 16mm or super 8mm equipment. (For video use, correction of the existing video image recording area would be a simple matter, but of course a playback tube of double width would be required to reproduce almost twice the standard image width.)

The Cineavision system provides two possible solutions for the problems so far discussed. It permits original image recording as well as reduction or enlargement printing without loss of image area, and it assures uniform reproduction of anamorphic 16mm and super 8mm films.

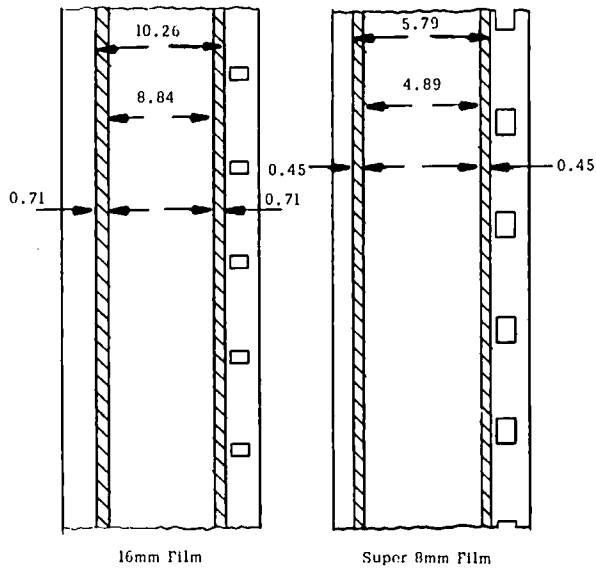


Fig. 4. Lateral masking strips as used in the Cineavision system to restore the Style B anamorphic camera image area aspect ratio of 1.18:1 for reduction printing to the 16mm and super 8mm formats. All measurements in millimeters.

Image Recording Using Standard Equipment and Masked Filmstock

To obtain the 1.1807:1 anamorphic camera image area aspect ratio with 16mm and super 8mm cameras (thus matching the 35mm Style B aspect ratio) the width of the 16mm image area can be diminished from 10.26 to 8.84 mm leaving the height of 7.49 mm unaltered, and the width of the super 8mm image area can similarly be narrowed from 5.79 to 4.89 mm, again leaving the height of 4.14 mm intact (Fig. 4).

Because no height changes are involved, the lateral surplus space can easily be masked off on the filmstock. The required maskings can be carried out by the manufacturer of the filmstock, by a laboratory, or by another competent facility before the anamorphic recording is carried out. On 16mm and super 8mm reversal films, this can be done chemically (etching), mechanically (tape or ink), or by any other suitable method. Normal cameras could then be used for the recording of anamorphic images with the normal 2:1 anamorphic compression ratio and with a corresponding masking in the viewfinder. The widths of the proposed opaque masking strips on 16mm reversal film would be 0.71 mm on each side, and 0.45 mm on super 8mm reversal film. With 16mm negative material, these masking strips must be transparent and may be exposed before or after the anamorphic recording.

Image Recording on Reversal Film with Corrective Camera Masks

The maskings required for the Cineavision system may also be obtained if corresponding corrections are made to the width of the 16mm or super 8mm camera aperture, reducing it to 8.84 and 4.89 mm respectively. (The 4:3 aspect ratio of a video

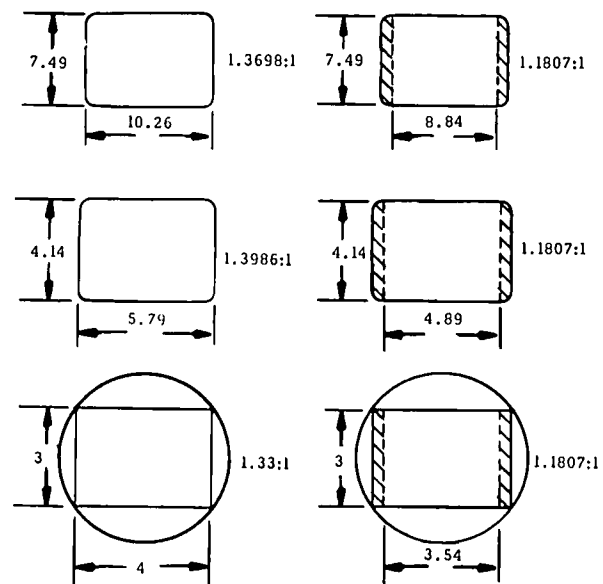


Fig. 5. Standard (left column) and Cineavision (right column) image areas and aspect ratios in the 16mm (top), and super 8mm (center row) formats and on a video camera tube (bottom). Measurements for 16mm and super 8mm formats in millimeters. Drawings not to scale.

recording tube would be changed to 3.54:3 by masking off 5.75% of the normal image width on each side.)

In both the smaller format reversal films, the masked-off strips will appear, after reversal development, as opaque masks of the proposed width on both sides of the anamorphic image. The respective image heights will, of course, be unchanged. Figure 5 shows the standard camera image areas and the revised image areas of the Cineavision system.

Reduction and Enlargement Printing of Anamorphic Images Recorded with the Cineavision System

In this system, enlargement of the anamorphic images from the small formats to a larger one will result in the transfer of the entire image onto the larger format without any loss. The enlargement ratios used are identical with the reduction ratios, namely 1:1.809 from super 8mm to 16mm anamorphic, 1:4.490 from super 8mm to 35mm Style B anamorphic, and 1:2.482 from 16mm to 35mm Style B anamorphic (Fig. 6).

As previously mentioned, 35mm anamorphic-to-flat reduction prints on small-format filmstock result in an image area loss of 60% in final projection, and about 21% in image height is lost with anamorphic-to-anamorphic 16mm or super 8mm reductions. With the Cineavision system, no losses occur in reduction printing of anamorphic images. In this system, reduction ratios are based only on the original image height instead of its width. The larger reduction ratios given above are identical with camera image height ratios of the super 8mm, 16mm, and 35mm Style B image areas.

The required lateral masking strips may be obtained by exposure before, during, or

after reduction of the anamorphic image, and the masking strips must be transparent if a 16mm anamorphic duplicate negative is made. The 16mm positive contact prints, or the super 8mm reduction positives from the 16mm negative will then have opaque masking strips of the required width. (In the case of videotape, the masking strips will be left unrecorded if a video camera tube with the corrected 3.54:3 aspect ratio is employed.)

The system provides various possibilities for obtaining the masks. For example, exposure masks can be used in the gate of the reduction printer in either the 35mm projection head or the 16mm printing head. Alternatively, an additional printing head on the 16mm side of a 35mm-to-16mm reduction printer may be used, having two parallel exposure slots for exposing two strips as the reduced anamorphic 16mm reversal negative is being printed. Technical details will be given in a later section.

Anamorphic Reduction Printing with Nearly Normal Reduction Ratios

Adding an extra step, a possibility for anamorphic reduction printing with near normal reduction ratios exists. The extra step consists in reduction printing of a Style B anamorphic CRI negative to the Style A 35mm format on interpositive material using a reduction ratio of 1.162:1 (Fig. 7). This yields a 35mm master interpositive with a 0.7437×0.63 in (18.89×16 mm) anamorphic image.

In this case the Style A aperture requires lateral opaque masking strips with a width of 0.06015 in (1.53 mm). They may be exposed either simultaneously in a properly matted second Style A 35mm printer head or subsequently exposed by contact printing with a Style A 35mm printer provided with a black matte 0.7437 in (18.89 mm) wide and

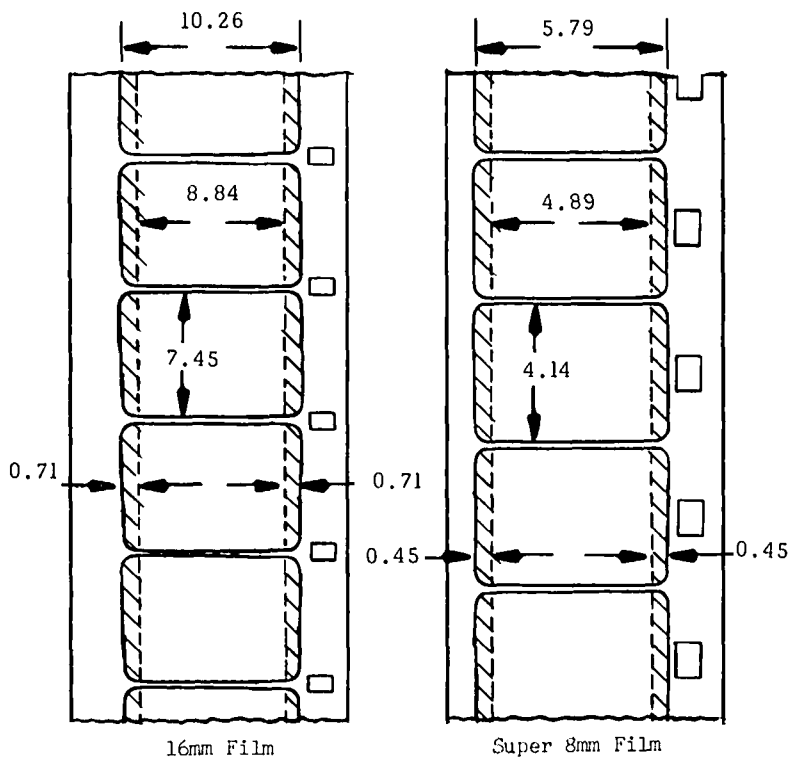


Fig. 6. Reduction ratios and resulting image area dimensions in the Cinevision system: (left) 35mm Style B to 16mm, 2.482:1; (right) 35mm Style B to super 8mm, 2.482:1, and 16mm CRI to super 8mm, 1.809:1. All measurements in millimeters.

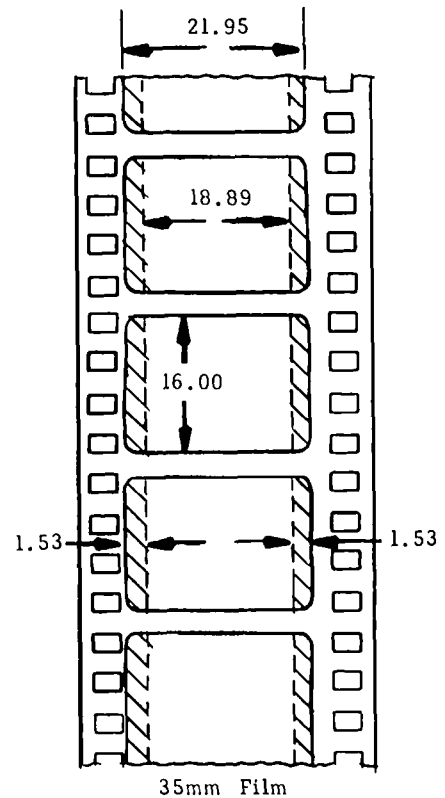


Fig. 7. Resulting image area dimensions when a 35mm Style B anamorphic image is reduced to obtain the same image area height as that of the 35mm Style A image, using a reduction ratio of 1.162:1. All measurements in millimeters.

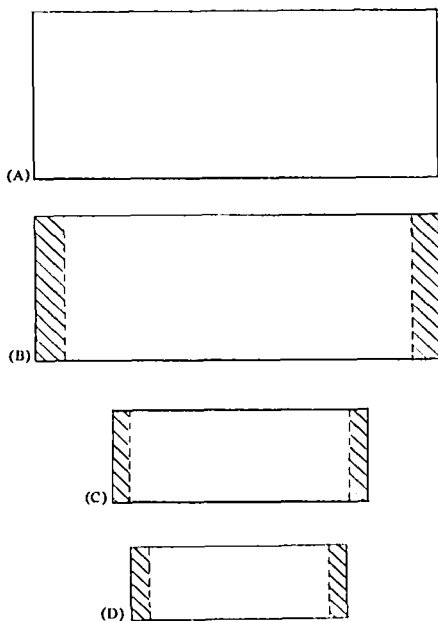


Fig. 8. Anamorphic-to-anamorphic reduction to small formats as achieved by the Cinevision system without any loss of image area. All image areas are shown horizontally expanded 2:1. (A) 35mm Style B anamorphic; (B) 35mm Style B area reduced 1.162:1 to equal height of 35mm Style A area; (C) 16mm area reduced either 2.482:1 from 35mm Style B image, or 2.136:1 from 35mm reduced Style A image; (D) super 8mm image reduced 1.809:1 from reduced 16mm area. The image areas in all formats will give the same screen aspect ratio of 2.35:1. The crosshatched areas represent not image area loss but the masked off unneeded equipment aperture width.

at least 0.63 in (16.00 mm) high having on its sides two transparent parallel vertical slots with dimensions 0.0601×0.63 in (1.53×16.00 mm). Simultaneously exposure really amounts to a two-step exposure with the second printer head of a Style B/Style A 35mm reduction printer positioned downstream of the 35mm Style A printer head.

From the interpositive thus obtained, further reductions on 16mm internegative stock with transparent lateral masking can be obtained which, in turn, may serve either for the printing of 16mm contact positives or super 8mm reduction positives with the required opaque masking. Reversal reduction positives in both formats may also be obtained from the 35mm interpositive. In this case, however, the reduction ratio from 35mm to 16mm is 2.136:1 and for 35mm to super 8mm it is 3.865:1. No change occurs in the 1.809:1 reduction ratio from 16mm to super 8mm.

If Style B anamorphic 35mm images are to be reduced on CRI stock to the Style A 35mm format or to 16mm, the resulting masking must be transparent and obtained by subsequent exposure. Formation of dust specks must be prevented. If 16mm internegatives are reduction printed from opaquely masked anamorphic positive images in 35mm Style A format, the transparent masking strips will appear automatically.

Figure 8 shows 2:1 expanded positive images in the various modes of reduction printing from the original 35mm Style B anamorphic image onto the smaller formats.

[In Fig. 8A we start again by showing the 2:1 horizontally expanded 35mm Style B image area with an aspect ratio of

2.3615:1, and a 100% area of 816.10 mm². Figure 8B shows the result of reducing the 35mm Style B image by a ratio of 1.162:1. The image area is now

$$16.00 \times (2 \times 18.89) = 604.48 \text{ mm}^2$$

The available image area is greater however as given by

$$16.00 \times (2 \times 21.95) = 702.40 \text{ mm}^2$$

No image area is lost. Two unused side strips result, each with an area of

$$16.00 \times (2 \times 1.53) = 48.96 \text{ mm}^2$$

Together they occupy about 14% of the available image area. The aspect ratio of the original image area is preserved.

Similar relations hold true for reductions of the 35mm Style B area to 16mm with a reduction ratio of 2.482:1, or for reduction of the 35mm Style A (compressed reduced) area to 16mm with a reduction ratio of 2.136:1, as shown in Fig. 8C. In both cases the resulting image will be

$$7.49 \times (2 \times 8.85) = 132.6 \text{ mm}^2$$

The available image area is

$$7.49 \times (2 \times 10.26) = 153.69 \text{ mm}^2$$

Again no image is lost, the original aspect ratio is preserved and both the unused side strips make up only about 14% of the available 16mm image area.

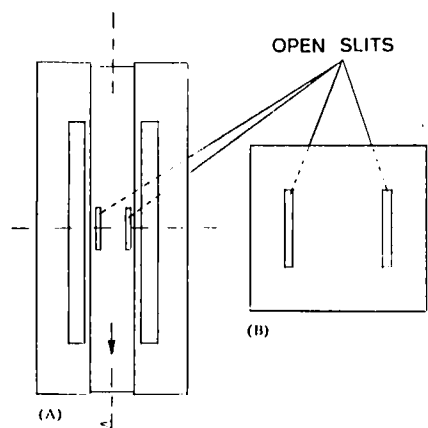


Fig. 9. Special printer aperture mattes to be used for obtaining the Cineavision lateral masks. (A) matte for exposure of transparent masking strips on 16mm CRI negatives in a continuous printer; (B) matte for exposure of opaque masking strips on 35mm intermediate positive stock in a printer with a Style A 35mm aperture.

Figure 8D, finally, shows that with a 1.809:1 reduction of the 16mm image to super 8mm, an image with an area of

$$4.14 \times (2 \times 4.89) = 40.49 \text{ mm}^2$$

is obtained. The available super 8mm area is

$$4.14 \times (2 \times 5.79) = 47.96 \text{ mm}^2$$

Again, no image area is lost, and the unused side strips make up about 15½%, while preserving the original aspect ratio.]

Technical Details and Modes of Application

As mentioned, the reduction of 35mm Style B anamorphic images to 16mm with a reduction factor of 2.15 results in a loss of image height. The reduction of such films to super 8mm using a reduction factor of about 3.8 gives also a loss in height.

Most laboratories, however, work with these reduction factors for obtaining 16mm or super 8mm anamorphic reduction prints from 35mm Style B anamorphic originals, disregarding the resulting losses. In a way, this is understandable because single-purpose reduction printers commonly are set for a fixed distance between film gates, giving a fixed reduction ratio. Reduction printers with an adjustable reduction ratio are not suitable because of the time involved in making corrections. With one adjustable model the author became familiar with, the loss in time was so great that it was justified only for a very large print order.

The loss in height not only results in aesthetic imperfections, but also gives rise to a technical problem. When reducing subtitled pictures, it is necessary to have complete information at the bottom of the picture. Hence, the image can be cropped only at the top. Quite apart from the foregoing, close-ups (and sometimes main titles) often have vital parts of the image missing when reduced in the conventional way.

The use of different reduction factors for

anamorphic films makes sense in many respects. Single-purpose reduction printers do not offer such a possibility in an economic way. This would require the use of a multi-purpose optical printer in one of the production steps. There are several ways of achieving the desired result.

Mode 1. An anamorphic 16mm CRI negative is produced from the original 35mm anamorphic negative (Style B image area) using a reduction factor of 2.482. ($18.59:7.49 = 2.482$, which is the ratio of the height of the Style B image area to the height of the 16mm image area.) The dimensions of the resulting 16mm image area are now 8.84×7.49 mm. Because this image area is 1.42 mm narrower than the normal 16mm image area, the difference is divided into two vertical strips (one on each side) of 0.71 mm width. They are unexposed and would appear opaque in the CRI negative. However, to prevent flare in final projection, these strips must be opaque in the print and therefore transparent in the CRI negative. To achieve this the CRI must receive an additional extra exposure in the appropriate places. For this purpose a 16mm continuous printer having a special aperture mask in the gate (Fig. 9A) can be used. Also a separate simple rotary printing head (similar to those used for edge number printing) could be mounted directly on the reduction printer.

From the resulting 16mm CRI negative, the final 16mm contact prints or super 8mm reduction prints are obtained directly.

Mode 2. An anamorphic 35mm intermediate contact positive is made from the original 35mm Style B anamorphic negative by means of a standard printer. This positive is reduced to a 16mm intermediate negative on an optical printer, again with a reduction factor of 2.482. Using a Style B gate on the 35mm side of the optical printer and a 16mm camera gate of 8.84×7.49 mm dimensions, the result will be a 16mm intermediate negative image with two transparent side strips, thus avoiding the need for an extra exposure step. From this intermediate negative the final 16mm or super 8mm prints can be obtained.

Mode 3. The original anamorphic 35mm Style B negative is optically reduced to a 35mm intermediate positive in such a way that an image height of 16.00 mm is obtained. This requires a reduction ratio of $18.59:16.00 = 1.162:1$. The resulting image area will now be 18.89×16 mm, with its width 3.06 mm less than the standard width. Again, this difference is divided into two equal side strips, each 1.53 mm wide, which will have to be exposed subsequently to obtain opaque areas in the positive and corresponding transparent strips in the 16mm intermediate negative. This can be achieved using a 35mm rotary printer provided with the proper matte (Fig. 9B).

This rather unusual method gives results of good quality. Its advantages are that correctly proportioned 16mm dupes can be provided with equipment using the standard 2.15:1 reduction ratios for 35mm-to-16mm

reductions and that protection is available in case the dupe is damaged. Here, again, a 16mm internegative is obtained for the production of 16mm or super 8mm anamorphic final prints without loss in picture height or width.

Projection Quality of Super 8mm Anamorphic Reduction Prints

In 1977 Isco of Göttingen, Germany, developed an anamorphic super 8mm projector lens especially for use with super 8mm films reduced or recorded with the Cineavision system. This lens was named Animex-Iscorama S8/2X, after Animex Inc. (the company holding the patent rights on the Cineavision system) and Iscorama (the registered trademark for Isco's anamorphic lenses). The Animex-Iscorama combines in a single unit the spherical projection prime lens with the cylindrical elements for expanding the image on the screen. It embodies a 20-mm projection lens with an aperture of $f/1.3$, and has a lateral expansion ratio of 1:2. It takes the place of the normal projection lens and is extremely compact — only a little larger than the normal projection lenses. An anamorphic attachment can also be used in front of a normal projection lens sustained by a suitable mounting bracket, if the use of the standard lens of the projector is deemed desirable.

The very fine grain of present-day 16mm and super 8mm color release stocks and the resulting very high resolving power makes a lateral projection enlargement of 400 to 600 diameters completely acceptable, even if the image has been slightly reduced in width by the added lateral masking strips. An average lateral enlargement of about 500 diameters with anamorphic super 8mm projection equipment will usually be more than sufficient for general amateur use. With a 20-mm projection lens, the projected super 8mm image will be about 7½ by 3ft (2.13 by 0.91 m) at a projection distance of 14½ ft (4.41 m) and with 1:2 expansion. Only half of the width of the two lateral masking strips will be projected through the projector gate. In the final projection, both will be covered by the vertical screen masking borders.

Because of the 2:1 anamorphic expansion in width of the super 8mm masked images, a high quality of the final prints is required. Reductions made from 35mm release prints or from second generation duplicating negatives derived from CRI's will not give the required top quality.

Conclusions

When anamorphic films are reduced to 16mm or super 8mm formats on conventional single-purpose reduction printers with fixed reduction ratios of 2.15:1 or 3.865:1 respectively, an appreciable loss of vertical picture information results. This loss can be avoided by several methods, all requiring the use of a multi-purpose optical printer. We have described three possible ways to restrict the use of this expensive

piece of equipment to one of the intermediate stages. All other steps can be performed on conventional reduction printers. Practical tests have shown that a good print quality may be expected when using Mode 3, described above.

Original anamorphic image recordings made with the Cineavision system with a 16mm, super 8mm, or video camera will all have the same aspect ratio, identical with the image area aspect ratio standardized for 35mm Style B anamorphic recordings. The uniformity of the aspect ratios of anamorphic images in all these cases makes it possible to obtain reduction or enlargement prints without image area losses. The means for obtaining these results are extremely simple and can be achieved with little additional cost in existing equipment.

It is important to note that in all the given examples of dimensional image area variations, neither the incidence angle of the light beam on the camera, printing, and projection gates, nor the type of lens aperture used was considered. In practice, the tolerances of the image area dimensions depend on such factors as the *f*/stop and focal length of the camera lenses used, the distance between the emulsion and the physical gate aperture, and distance variations between

Table IV. Reference Standards and Recommended Practices.

Subject matter	Reference
35mm camera image areas, anamorphic and nonanamorphic	ANSI PH22.59-1974
16mm camera image area	ANSI PH22.7-1976
Super 8mm camera image area	ANSI PH22.157-1971, R1977
35mm projectable image areas, anamorphic and nonanamorphic	ANSI PH22.195-1977
16mm projectable image area	ANSI PH22.8-1969, R1975
Super 8mm projectable image area	ANSI PH22.154-1976
Image area, step optical reduction and enlargement printing 35mm-to-16mm and 16mm-to-35mm	SMPTE RP 65-1976, reduction SMPTE RP 66-1976, enlargement
Image area, reduction printing 16mm-to-super 8mm	ANSI PH22.153-1971, Note 1
Optical printing ratios for enlargement and reduction of motion-picture images	ISO 4238-1976

the projector mask and the film during final projection.

All the dimensions given refer exclusively to the image area dimensions that should be obtained on the film in agreement with the respective standards (Table IV), or the corresponding screen image aspect ratios. They are not directly applicable to the mechanical camera, printer, or projector gate dimensions.

On request, the authors will gladly furnish detailed information about their actual experiences with camera, printer, and projector aperture tolerances found in practice. Also available is information about recom-

mended splicing methods so that certain types of splices will not become visible in projection.

Readers should note that the Cineavision system is covered by patent applications in the U.S. and other industrially developed countries.

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Anamorphic Super-8 Wide-Screen Prints with Stereophonic Sound

By JOHANNES WEBERS

Initially, a short overview of the use of stereophonic sound in wide-screen pictures is given. The basics of obtaining a stereophonic soundtrack and its use in conjunction with a wide-screen film are briefly discussed. The basic sequence of printing steps for obtaining a print with magnetic sound are outlined. Next, the manufacturing steps for obtaining deanamorphosed reduction prints from anamorphic originals are discussed in detail. The image scanning process, necessary in this type of reduction printing, is analyzed, and an automatic scanning system for the optical reduction printer is described. A control tape for the automatic optical printer scanning is obtained by first scanning a workprint of the original anamorphic film by means of a video camera tube. Methods are described for producing an anamorphic super-8 print from an anamorphic original. Finally, methods are discussed for applying high quality stereophonic soundtracks to anamorphic super-8 prints.

The human eye covers a vertical angle of about 20° and its horizontal angle is about 40°. Over the years there have been many attempts by the motion-picture industry to develop wide-screen processes which simulate the field of view of the eye.

The effect of the panoramic picture can be greatly enhanced by adding stereophonic sound. Here, the capability of the ear to localize sound sources in space by their relative differences in time, intensity, and phase comes into play. In wide-screen projection, the content of the picture and the simulta-

neous acoustic source displacements are thus thoroughly intertwined. This gives the viewer an almost perfect illusion, in contrast to normal projection where only a single speaker is used.

The original CinemaScope film uses four channels — three channels for the left, center, and right speakers and an extra channel. The Todd-AO system employs six-channel recording and in projection uses speakers in left, half left, center, half right, and right positions. A special sound space effects channel is used.

The initial sound input for the release printing of magnetic striped stereophonic films is a master tape. It is the end result of the final post production sound mixing operation. This is one of the most important post

production procedures. Of all the diverse phases of film production, where only one or two sound tapes can be played synchronously with the picture, the final mix is the opportunity at which the director and his artistic collaborators can judge for the first time the image and the sound of a film as a whole. It opens multiple possibilities for further creative work.

In stereophonic sound recording, all sounds, except the music, are normally single-channel recordings. The reason for this practice is that, within a motion-picture studio hall, true stereophonic sound recording simultaneously with the shooting of the picture would be extremely difficult. In Todd-AO, for example, five microphones would be needed, creating a difficult problem of multiple microphone shadows. Furthermore, most studio scenes show only single sound sources, and thus true stereophonic sound recording would be economically unjustified.

Hence, in most cases, single sound sources are recorded in single-channel fashion. They are then distributed across the screen in a premixing step by means of a pan pot. With its help, the audio signal is routed between three or four front channels, so that their relative intensity corresponds with the apparent screen location of the visual sound

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