wobble pattern is offset, however (Fig. 30b), a fundamental component is developed whose sign tells the direction of the tracking error and whose magnitude tells the amount of the tracking error. The synchronous detector represents these cases by a positive or negative DC output which controls the radial axis of the tipping mirror so as to keep the spot on the track. The wobble amplitude is intended to be small enough to have no degrading effect on signal pickup or on rejection of crosstalk from neighboring tracks.

One more practical imperfection of discs is the nonuniformity of the time base of the recovered signal. This is due to a combination of disc distortions and spin motor errors, and is an equal plague to all video playback methods. Optical playback systems having enough field of view under the objective lens to allow for radial tracking have the same field of view in the tangential direction. This permits the use of a tipping mirror, either similar or identical to that used for radial tracking, to run the spot back and forth along the track to regulate the instantaneous track velocity relative to the spot. Excellent time-base correction is achieved this way.

Conclusion

The partnership of optics and electronics, from the theory of modulation transfer to the actuality of tracking and focus servo loops, has produced a system in which a tiny focused spot of light becomes routinely useful as a massless, inertialess, non-wearing stylus. The technology is advanced, but concentrated effort has made it quite practical.

References

1. P. M. Duffieux, "L'Intégrale de Fourier et ses Applications à L'Optique," Faculté des Sciences, Besançon, 1946.
2. O. H. Schade, "Electro-Optical Characteristics of Television Systems," *RCA Review*, IX, 5 (part I), 245 (part II), 490 (part III), 653 (part IV) 1948.
3. E. L. O'Neill, *Introduction to Statistical Optics*, Addison-Wesley Publishing Co., Inc., Reading, Mass., 1963.
4. J. R. Goodman, *Introduction to Fourier Optics*, McGraw-Hill, New York, 1968.

Standards & Recommended Practices

Approved American National Standards

On 29 March 1976, the American National Standards Institute approved four standards which are primarily editorial revisions of the earlier issue: PH22.88-1976, Specifications for Magnetic Striping of 8-mm Type R (Regular 8) Motion-Picture Film, Perforated 1R-1500; PH22.101-1976, Specifications for Magnetic Striping of 16-mm Motion-Picture Film, Perforated 2R-3000; PH22.127-1976, Specifications for Magnetic Striping of 16-mm Motion-Picture Prints Having Magnetic Photographic Sound Records; and PH22.136-1976, Specifications for Magnetic Striping of 16-mm Motion-Picture Film, Perforated 8-mm Type R (regular 8), 2R-1500.

Inasmuch as compliance with American National Standards is purely voluntary, these standards will become truly effective when broad publicity is given to their existence. ANSI and SMPTE would appreciate any personal influence to promote the use of these standards where such action is appropriate. Copies of the standards may be obtained for a nominal fee from the American National Standards Institute, 1430 Broadway, New York, NY 10018.

Proposes SMPTE Recommended Practices

Two Proposed SMPTE Recommended Practices are published here for a trial period and public review: RP 75, Specifications for Flutter Test Film for 35-mm Three-Track Sound Reproducers, Magnetic Type (Transformation of PH22.98-1963); and RP 76, Specifications for Flutter Test Film for 16-mm Sound Reproducers, Magnetic Type (Transformation of PH22.113 1966).

These are transformations of American National Standards and do not reflect any technical changes.

Approved International Standards

The International Organization for Standardization (ISO) recently approved a new International Standard, the technical content of which is published here for information. ISO 3644-1976, Cinematography — Spindles for 8-mm Type R Motion-Picture Cameras and Projectors — Dimensions, is in complete agreement with USA practices, although there is no comparable American National Standard.

Complete copies of all International Standards are available from the American National Standards Institute, 1430 Broadway, New York, NY 10018. ISO is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO Technical Committees.

The International Standard published here was developed by Technical Committee 36 on Cinematography. The Work of this committee is administered by the Engineering Department of the SMPTE which functions as the Secretariat in ANSI's name. A report of the last meeting of the committee was published in the June 1976 issue of the SMPTE Journal.

Comments on the proposed practices should be addressed to Alex E. Alden, Manager of Engineering Services, at Society Headquarters prior to 1 January 1977. If no adverse criticism is received on the proposed practices, they will be submitted to the Board of Governors for final approval. — Alex E. Alden, *Manager of Engineering Services.*

ANSI PH22.88-1976
Revision of PH22.88-1963

American National Standard
specifications for magnetic striping of 8-mm type R (regular 8) motion-picture film, perforated 1R-1500

Approved March 29, 1976 Secretariat: Society of Motion Picture and Television Engineers

1. Scope

This standard specifies the location and dimensions of the magnetic striping material applied to 8-mm Type R (regular 8) motion-picture film to be used for both picture and sound.

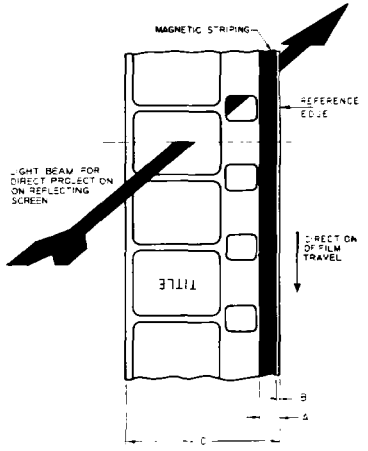
2. Magnetic Striping

2.1 The location and dimensions of the magnetic striping shall be as given in the figure and table.

2.2 The magnetic striping is on the side of the film toward the lamp of a projector arranged for direct front projection on a reflection-type screen.

3. Film Stock

The film stock used shall be cut and perforated in accordance with American National Standard Dimensions for 16-mm Motion-Picture Film Perforated 8-mm Type R (Regular 8), 2R-1500, PH22.17-1974.



Dimensions	Inches		Millimeters	
A	0.031	max	0.79	max
	0.028	min	0.71	min
B	0.005	max	0.13	max
C	0.314	ref	7.98	ref

Appendix

(The Appendix is not a part of this American National Standard, but is included for information purposes only.)

The outer edge of the magnetic striping ideally should be coincident with the edge of the film. Therefore, every effort should be made to reduce Dimension B as much as possible, consistent with the best uniformity of stripe thickness and flatness of stripe profile.

ANSI PH22.101-1976
Revision of PH22.101-1963

American National Standard
specifications for magnetic striping of 16-mm motion-picture film, perforated 2R-3000

Approved March 29, 1976 Secretariat: Society of Motion Picture and Television Engineers

1. Scope

This standard specifies the location and dimensions of the magnetic striping material applied to 16-mm motion-picture film with perforations along both edges to be used for both picture and sound.

2. Magnetic Striping

2.1 The location and dimensions of the magnetic striping shall be as given in the figure and table.

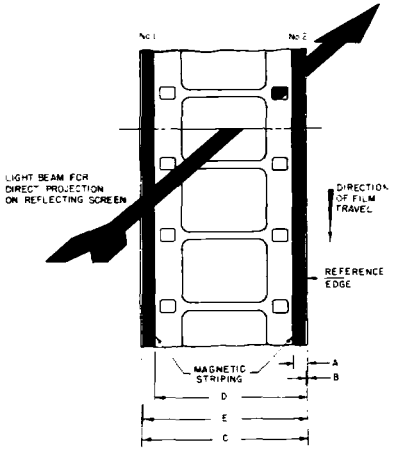
2.2 *The magnetic striping is on the side of the film* toward the lamp of a projector arranged for direct front projection on a reflection-type screen.

2.3 The No. 1 magnetic stripe is intended for the sound record.

3. Film Stock

The film stock used shall be of the low-shrinkage safety type, cut and perforated in accordance with American National Standard Dimensions for *16-mm Motion-Picture Film Perforated 2R*, PH22.110-1974.

NOTE: The No. 2 stripe is an optional balance stripe and may be a magnetic coating or another material of the same thickness.



Dimensions	Inches		Millimeters	
A	0.031	max	0.79	max
	0.028	min	0.71	min
B	0.005	max	0.13	max
C	0.628	ref	15.95	ref
D	0.600	max	15.24	max
	0.597	min	15.16	min
E	0.623	min	15.82	min

Appendix

(The Appendix is not a part of this American National Standard, but is included for information purposes only.)

The outer edge of the magnetic striping ideally should be coincident with the edge of the film. Therefore, every effort should be made to reduce Dimension B as much as possible, consistent with the best uniformity of stripe thickness and flatness of stripe profile.

ANSI PH22.127-1976
Revision of PH22.127-1962

American National Standard
specifications for magnetic striping of 16-mm motion-picture prints having magnetic-photographic sound records

Approved March 29, 1976 Secretariat: Society of Motion Picture and Television Engineers

1. Scope

This standard specifies the location and dimensions of the magnetic striping material applied to 16-mm motion-picture prints, containing a picture and photographic sound record, for the purpose of employing both a magnetic and the existing photographic sound record.

2. Magnetic Striping

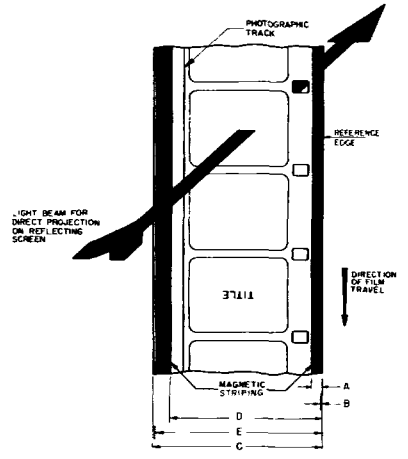
2.1 The location and dimensions of the magnetic striping shall be as given in the figure and table.

2.2 The magnetic striping shall be on the side of the film toward the lamp on a projector arranged for direct front projection on a reflection-type screen.

NOTE 1: This standard is not recommended for unilateral variable-area track.

NOTE 2: The balance stripe is optional and may be a magnetic coating or another material of the same thickness.

NOTE 3: A photographic sound record on this film may be overcoated by as much as 50 percent by the magnetic stripe. However, experience shows that the photographic record can be reproduced acceptably if it has been recorded in accordance with American National Standard Dimensions of Photographic Sound Records on 16-mm Motion-Picture Prints, PH22.41-1975.



Dimensions	Inches		Millimeters	
A	0.031	max	0.79	max
B	0.002	max	0.05	max
C	0.628	ref	15.95	ref
D	0.575	max	14.60	max
	0.570	min	14.48	min
E	0.623	min	15.82	min

Appendix

(The Appendix is not a part of this American National Standard, but is included for information purposes only.)

The outer edge of the magnetic striping ideally should be coincident with the edge of the film. Therefore, every effort should be made to reduce the edge-to-stripe dimension as much as possible, consistent with the best uniformity of stripe thickness and flatness of stripe profile.

ANSI PH22.136-1976
Revision of PH22.136-1963

American National Standard
specifications for magnetic striping of 16-mm motion-picture film perforated 8-mm type R (regular 8), 2R-1500

Approved March 29, 1976 Secretariat: Society of Motion Picture and Television Engineers

1. Scope

This standard specifies the location and dimensions of the magnetic striping material applied to 16-mm motion-picture film with two rows of 8-mm Type R (regular 8) perforations.

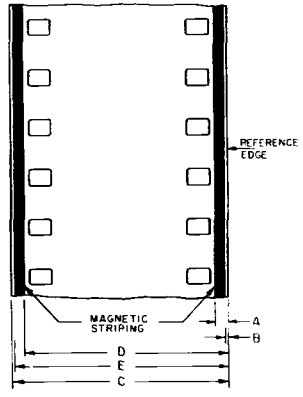
2. Magnetic Striping

2.1 The location and dimensions of the magnetic striping shall be as given in the figure and table.

2.2 The magnetic striping shall be on the side of the film toward the lamp on a projector arranged for direct front projection on a reflection-type screen.

3. Film Stock

The film stock used shall be of the low-shrinkage safety type, cut and perforated in accordance with American National Standard Dimensions for 16-mm Motion-Picture Film Perforated 8-mm Type R (Regular 8), 2R-1500, PH22.17-1974.



Dimensions	Inches		Millimeters	
A	0.031	max	0.79	max
	0.028	min	0.71	min
B	0.005	max	0.13	max
C	0.628	ref	15.95	ref
D	0.600	max	15.24	max
	0.597	*min*	15.16	*min*
E	0.623	min	15.82	min

Appendix

(The Appendix is not a part of this American National Standard, but is included for information purposes only.)

The outer edge of the magnetic striping ideally should be coincident with the edge of the film. Therefore, every effort should be made to reduce Dimension B as much as possible, consistent with the best uniformity of stripe thickness and flatness of stripe profile.

PROPOSED

SMPTE RECOMMENDED PRACTICE — RP 75

Specifications for Flutter Test Film for 35-mm Three-Track Sound Reproducers, Magnetic Type

1. *Scope*

This practice specifies a test film for determining the presence of flutter in 35-mm motion-picture magnetic sound reproducers operating at 90 ft (27.4 m) per minute and designed for three 200-mil (5.08 mm) sound records.

2. *Test Film Signal*

2.1 Frequency. The sound record on each of the three tracks shall be an original recording which will reproduce at a frequency of 3150 ± 25 Hz when the linear speed of the film is 96 perforations per second or approximately 90 ft per minute (18 in or 45.7 cm per second).

2.2 Distortion. The total harmonic distortion of the recorded signals shall not exceed 1 percent.

2.3 Sound Record. The location and dimensions of the recorded sound records shall be in accordance with American National Standard Position, Dimensions and Reproducing Speed of Three 200-Mil Magnetic Sound Records on 35-mm and One Record on 17½-mm Motion-Picture Film, PH-22.86-1975. The sound record may also be recorded so that it extends from one edge of the film to the other.

2.4 Recorded Level. The recorded signal shall have a recorded level of 6.0 ± 1.5 dB below the reference level of a frequency of 1000 Hz having an rms shortcircuit flux per unit track width of 200 nanowebers per meter (0 dB). The signal level shall not fluctuate more than ± 0.5 dB within the test film length.

2.5 Flutter. The weighted peak flutter of the sound record shall not exceed ± 0.04 percent when measured in accordance with American National Standard Method for Measurement of Weighted Peak Flutter of Sound Recording and Reproducing Equipment, S4.3-1972.

2.6 Azimuth. The azimuth of the sound record shall be 90° ± 5′ to the reference edge of the film.

2.7 Signal Phase. The recorded signal in each of the three records shall be in an in-phase relationship to the other two. A recording made as described in the Appendix is considered to be in phase.

3. *Film Stock*

3.1 The film stock shall be full-coat, splice-free and of the low-shrinkage, safety type in compliance with American National Standard Specifications for Motion-Picture Safety Film, PH22.31-1967 (R1973).

3.2 The difference in compliance between triacetate and polyester bases will establish different head wear patterns. A change from one base to the other may cause a temporary loss of high-frequency response until a new wear pattern is established. Therefore, it is recommended that users employ test films having the same film base as used in production recording for any given recorder/reproducer.

3.2.1 Test films made on triacetate base shall be cut and perforated in accordance with long-pitch dimensions specified in American National Standard Dimensions for 35-mm Motion-Picture Film Perforated KS, PH22.139-1974.

3.2.2 Test films made on polyester base shall be perforated in accordance with short-pitch dimensions specified in ANSI PH22.139-1974.

3.3 The film stock shall be conditioned for 10 days at 20°C ± 3° (68°F ± 5.4°) at a relative humidity of 50 ± 10 percent prior to recording.

3.4 The film shall be recorded and packaged within the temperature and humidity limits specified in Sec. 3.3. The recorded film shall be packaged in a metal can and sealed either with a low-moisture permeability plastic tape or a fabric tape having a moisture barrier.

4. *Identification*

Each test film shall be identified by a suitable identification marking.

5. *Calibration*

5.1 Flux. The shortcircuit flux on the test film shall be determined by means of the calibrated short-gap ferromagnetic core reproducer technique. This technique is described in American National Standard Method of Measuring Recorded Flux of Magnetic Sound Records at Medium Wavelengths, S4.6-1973.

5.2 Level. The signal level measurements specified in Sec. 2.4 shall be measured with a standard volume indicator conforming to American National Standard Volume Measurements of Electrical Speech and Program Waves, C16.5-1954 (R1961).

NOTE: A test film made in accordance with this practice is available from the Society of Motion Picture and Television Engineers.

Appendix

(The Appendix is not a part of this SMPTE Recommended Practice, but is included for information purposes only.)

In-phase relationship of the sound records, as printed by a multiple-head recorder, can be assured if the individual coils of the recording head are similar and are assembled in the same manner.

The relationship is accomplished by connecting the winding in series so that the end of each coil is connected to the beginning of the next coil maintaining a consistent direction of winding.

The relationship is also accomplished in a parallel-type connection if the corresponding beginning leads are connected together and the corresponding ending leads are connected together and the direction of winding of each coil is kept consistent with other coils.

PROPOSED

SMPTE RECOMMENDED PRACTICE — RP 76

Specifications for Flutter Test Film for 16-mm Sound Reproducers, Magnetic Type

1. *Scope*

This practice specifies a test film for determining the presence of flutter in 16-mm motion-picture magnetic sound reproducers operating at 36 ft (11 m) per minute.

2. *Test Film Signal*

2.1 Frequency. The sound record on the film shall be an original recording which will reproduce at a frequency of 3150 ± 25 Hz when the linear speed of the film is 24 perforations per second or approximately 36 ft per minute (7.2 in or 18.3 cm per second).

2.2 Distortion. The total harmonic distortion of the recorded signal shall not exceed 1 percent.

2.3 Sound Record. The location and dimentions of the recorded sound record shall be in accordance with American National Standard Position, Dimensions and Reproducing Speed of 200-Mil Magnetic Sound Records on 16-mm Motion-Picture Film, PH22.97-1975. The sound record may also be recorded so that it extends from one edge of the film to the other.

2.4 Recorded Level. The recorded signal shall have a recorded level of 6.0 ± 1.5 dB below the reference level of a frequency of 1000 Hz having an rms shortcircuit flux per unit track width of 200 nanowebers per meter (0 dB). The signal level shall not fluctuate more than ± 0.5 dB within the test film length.

2.5 Flutter. The weighted peak flutter of the sound record shall not exceed ± 0.07 percent when measured in accordance with American National Standard Method for Measurement of Weighted Peak Flutter of Sound Recording and Reproducing Equipment, S4.3-1972.

2.6 Azimuth. The azimuth of the sound record shall be 90° ± 5′ to the reference edge of the film.

3. *Film Stock*

3.1 The film stock shall be full-coat, splice-free and of the low-shrinkage, safety type in compliance with American National Standard Specifications for Motion-Picture Safety Film, PH22.31-1967 (R1973).

3.2 The difference in compliance between triacetate and polyester bases will establish different head wear patterns. A change from one base to the other may cause a temporary loss of high-frequency response until a new wear pattern is established. Therefore, it is recommended that users employ test films having the same film base as used in production recording for any given recorded/reproducer.

3.2.1 Test films made on triacetate base shall be cut and perforated in accordance with long-pitch dimensions specified in American National Standard Dimensions for 16-mm Motion-Picture Film Perforated 1R, PH22.109-1974.

3.2.2 Test films made on polyester base shall be perforated in accordance with short-pitch dimensions specified in ANSI PH22.109-1974.

3.3 The film stock shall be conditioned for 10 days at 20°C ± 3° (68°F ± 5.4°) at a relative humidity of 50 ± 10 percent prior to recording.

3.4 The film shall be recorded and packaged within the temperature and humidity limits specified in Sec. 3.3. The recorded film shall be packaged in a metal can and sealed either with a low-moisture permeability plastic tape or a fabric tape having a moisture barrier.

4. *Identification*

Each test film shall be identified by a suitable identification marking.

5. *Calibration*

5.1 Flux. The shortcircuit flux on the test film shall be determined by means of the calibrated short-gap ferromagnetic core reproducer technique. This technique is described in American National Standard Method of Measuring Recorded Flux of Magnetic Sound Records at Medium Wavelengths, S4.6-1973.

5.2 Level. The signal level measurements specified in Sec. 2.4 shall be measured with a standard volume indicator conforming to American National Standard Volume Measurements of Electrical Speech and Program Waves, C16.5-1954 (R1961).

NOTE: A test film made in accordance with this practice is available from the Society of Motion Picture and Television Engineers.

Cinematography — Spindles for 8 mm Type R motion-picture cameras and projectors — Dimensions

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies the dimensions and characteristics of 8 mm Type R camera and projector spindles.

2 REFERENCE

ISO 1020, *Cinematography — Spools, daylight loading type for double-8 mm motion-picture cameras — Dimensions.*

3 DIMENSIONS

The dimensions shall be as shown in the figures and given in the tables.

NOTES

1 Angle γ represents the minimum effective angle between sides of two neighbouring lugs, but is not intended to limit the shape of the lug sides.

2 Dimension *D* represents profile limits for the tops of lugs, but is not intended to limit their shape to an arc. However, the radial height of the lug beyond the main shaft, diameter *C*, must not exceed the mating cut-out in the spool flange. The height of any spindle lug is therefore limited to 1,25 mm (0.050 in), in accordance with the spool flange cut-out shown in ISO 1020.

3 Dimension *C* represents the diameter of the spindle shaft, excluding key, drive lugs, and locking means. The maximum applies to all portions of the shaft but the minimum applies only to zones dimensioned by *Q*, *R*, *S* and *T* (see note 4 and A.3).

4 The zones dimensioned by *Q*, *R*, *S* and *T*, illustrated by cross-hatching on the figure, represent the spindle shaft areas on which the spool flanges rest or rotate.

5 The shape and action of the device for locking spools on spindles is optional but it should be located outside the area where spools are located on the spindle. Overall thickness of spools in the vicinity of the spindle hole is given as dimension

J and $J_1 = 18{,}5\ ^{0}_{-0.4}$ mm ($0.73\ ^{0}_{-0.02}$ in) in ISO 1020.

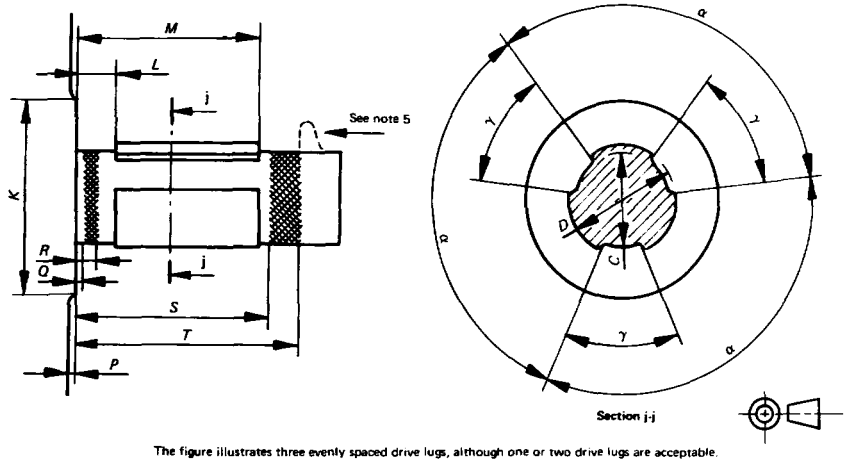
6 Some cameras are designed so that both the take-up and supply spools are driven during film exposure. For those cameras, the dimension *L* of the supply spindle should be 0,25 mm (0.01 in) maximum.

7 The dimension *D* maximum does not apply to 8 mm Type R camera take-up spindles manufactured with spring-loaded drive lugs which bear against the circumference as well as the sides of the corresponding slots in the spool spindle hole.

8 Dimension *A* maximum does not apply to projector spindles manufactured with spring-loaded reel-locking keys.

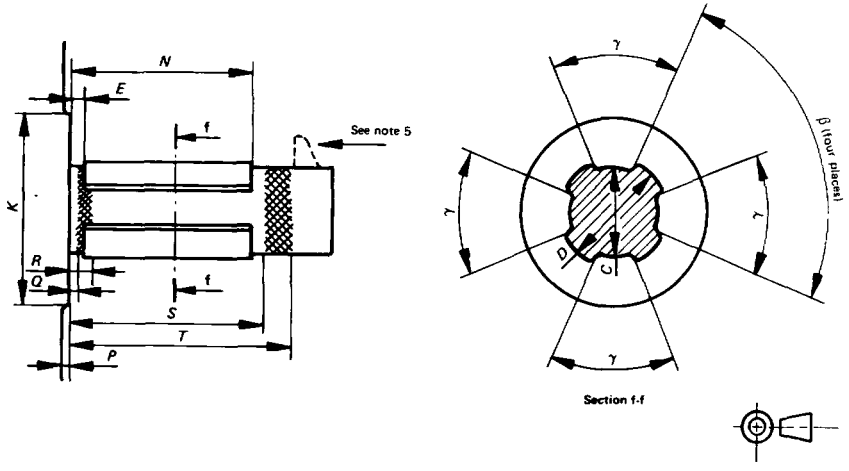
9 The shape and action of the device for locking reels on spindles is optional, but it should be located outside the area where reels are located on the spindle. Overall thickness of reels in the vicinity of the spindle hole is given as dimension

J and $J_1 = 12{,}5\ ^{0}_{-1.5}$ mm ($0.49\ ^{0}_{-0.06}$ in).



The figure illustrates three evenly spaced drive lugs, although one or two drive lugs are acceptable.

FIGURE 1 – **Camera supply spindle**



The figure illustrates four evenly spaced drive lugs, although two lugs, preferably opposite each other, are acceptable (see A.2).

FIGURE 2 – **Camera take-up spindle**

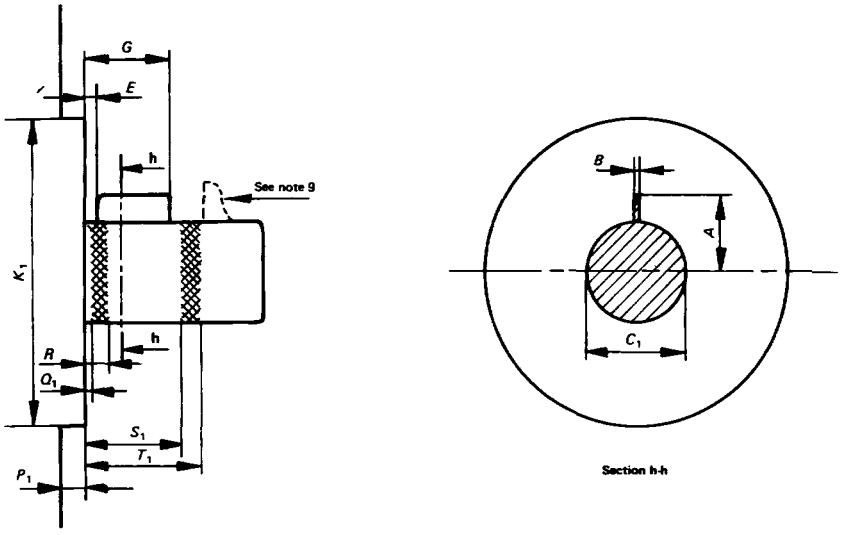
TABLE 1 – **Dimensions of 8 mm Type R camera supply and take-up spindles**

Dimension	Minimum		Maximum	
	mm	in	mm	in
*C** (see note 3)	7,11**	0.280**	7,24***	0.285***
*D** (see note 7)	9,0	0.35	9,5	0.37
E (see A.1)	–	–	0,25	0.010
*K** (see A.3)	12,0	0.47	15,0	0.59
L	2,5	0.10	(see note 6)	
M (see A.1)	–	–	15,0	0.59
N	2,5	0.10	15,0	0.59
P If camera accommodates only 7,5 m (25 ft) spool	0,50	0.020	–	–
P If camera accommodates 15 m (50 ft) or 30 m (100 ft) spool	0,65	0.026	–	–
Q (see note 4, A.1 and A.3)	–	–	0,15	0.006
R (see note 4, A.1 and A.3)	2,0	0.08	–	–
S (see note 4, A.1 and A.3)	–	–	16,00	0.630
T (see note 4, A.1 and A.3)	19,0	0.75	–	–
α	120° basic			
β	90° basic			
γ (see A.1)	46°			

* Dimensions *C*, *D* and *K* are diameters.

** Applies only to zones defined by dimensions *Q*, *R*, *S* and *T*.

*** Some existing spools may have a minimum spindle hole at or near a diameter of 7,21 mm (0.284 in), but it is expected that the quantity at this value is not large, and for future spool construction, ISO 1020 specifies 7,30 mm (0.287 in) minimum.



Section h-h

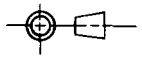


FIGURE 3 – Projector spindle

TABLE 2 – Dimensions of projector spindles

Dimension	Minimum		Maximum	
	mm	in	mm	in
A (see note 8)	5,59	0.220	7,0	0.28
B (see A.1)	–	–	1,3	0.05
C_1* (see note 3)	7,9**	0.31**	8,00	0.315
E (see A.1)	–	–	0,25	0.010
G	2,5	0.10	8,0	0.31
K_1*	16,0	0.63	24,5	0.96
P_1 (see A.1)	2,4	0.09	–	–
Q_1 (see note 4, A.1 and A.3)	–	–	0,13	0.005
R (see note 4, A.1 and A.3)	2,0	0.08	–	–
S_1 (see note 4, A.1 and A.3)	–	–	8,89	0.350
T_1 (see note 4, A.1 and A.3)	12,95	0.510	–	–

* Dimensions C_1 and K_1 are diameters.

** Applies only to zones defined by dimensions Q_1, R, S_1 and T_1.

ANNEX

A.1 Where only maximum or minimum values for a dimension are given, it is because the particular dimension is used to specify a function and to achieve interchangeability, and not to dictate design. While dimensions given only as a maximum can obviously go to zero, and dimensions given only as a minimum can obviously become very large, it is understood that designers will utilize established engineering practice in the dimensioning of the equipment covered by this International Standard.

A.2 Some cameras have been designed with the take-up spindle having only a single drive lug to engage one of the three or four spool slots. To ensure that the four-sided spool flange is placed into the take-up spindle first, the spindle was designed with four short orientation lugs located below the drive lug.

A.3 Some spool supports on old spindle designs have been as small as $K = 10{,}00$ mm (0.39 in) or as large as 15,5 mm (0.61 in). The first provides too little support and the latter corresponds exactly with the minimum diameter of the 7,5 m (25 ft) spool flange "clear area" assigned in ISO 1020. It is recommended that all future spindle construction observe the K dimensions shown in table 1 except that a 24,5 mm (0.97 in) K maximum would be permissible for cameras designed to accept only spools larger than the 7,5 m (25 ft) capacity size.