UDC 778.5 : 771.531

Ref. No.: ISO/R 543 - 1966 (E)

ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION

R 543

DEFINITION AND MARKING OF SAFETY FILM FOR MOTION-PICTURE USES

1st EDITION
December 1966

For each individual country the only valid standard is the national standard of that country.

Printed in Switzerland

Also issued in French and Russian. Copies to be obtained through the national standards organizations.

BRIEF HISTORY

The ISO Recommendation R 543, *Definition and Marking of Safety Film for Motion-Picture Uses*, was drawn up by Technical Committee ISO/TC 36, *Cinematography*, the Secretariat of which is held by the United States of America Standards Institute (USASI).

Work on this question by the Technical Committee began in 1948 and led, in 1961, to the adoption of a Draft ISO Recommendation.

In November 1963, this Draft ISO Recommendation (N° 637) replacing Draft ISO Recommendation No. 83 was circulated to all the ISO Member Bodies for enquiry. It was approved, subject to a few modifications of an editorial nature, by the following Member Bodies:

Belgium	France	Romania
Brazil	Germany	Spain
Bulgaria	Greece	Sweden
Canada	Hungary	Switzerland
Chile	Italy	United Kingdom
Colombia	Japan	U.S.A.
Czechoslovakia	Netherlands	U.S.S.R.
Denmark	New Zealand	

No Member Body opposed the approval of the Draft.

The Draft ISO Recommendation was then submitted by correspondence to the ISO Council which decided, in December 1966, to accept it as an ISO RECOMMENDATION.

ISO Recommendation R 543 December 1966

DEFINITION AND MARKING OF SAFETY FILM FOR MOTION-PICTURE USES

1. SCOPE

The specifications contained in this ISO Recommendation apply to both unprocessed and processed film * and to film having magnetic coatings or stripes. Motion-picture films are classified as safety films if they are difficult to ignite, slow burning and low in nitrate nitrogen content.

2. IGNITION TIME

2.1 Definition

Motion-picture films are classified as difficult to ignite when the ignition time is greater than 10 min at the temperature specified below.

2.2 Method of measurement

The ignition time of motion-picture films is measured as follows:

2.2.1 *Preparation of test sample.* A sample 35 mm (1.38 in) long and 8 mm (0.32 in) wide should be cut from the film to be tested. The sample should be free of perforations as far as is practicable. The sample should be conditioned for at least 4 h at a temperature of 20 ± 2 °C and a relative humidity of 50 ± 5 %.

2.2.2 *Procedure.* The test should be made in an electric resistance oven, the interior of which is in the form of a vertical cylinder (preferably with a rounded bottom), having a diameter of 70 mm ($2^3/_4$ in) and a mean height of 70 mm. The top of the oven should be closed by means of a closely overlapping lid having two holes of 7 mm (0.28 in) and of 15 mm (0.59 in) respectively, the centres being at a distance of about 15 mm from each other. A thermocouple should be introduced through the smaller opening, the connecting wires having a porcelain coating fitted tightly into the hole. Alternatively, the temperature in the cylinder may be measured by means of a mercury thermometer protected from rising heat by means of a cork disk lying a little above the lid.

2.2.2.1 *Temperature of tests.* The oven should be brought to, and maintained at, a temperature of 300 ± 3 °C (572 ± 5 °F). When this temperature is reached, the sample attached to a thin U-shaped wire hook should be introduced through the larger opening. The thermocouple (or the thermometer) and the sample should be fixed in such a way that the thermojunction (or the mercury bulb) and the centre of the sample are at an equal depth of about 35 mm (1.38 in).

2.2.2.2 *Preparation for tests.* Between tests, the oven should be thoroughly aired.

2.2.3 *Expression of results.* The time interval from the insertion of the sample to the ignition of the sample is recorded as the ignition time.

---

* Normally, unprocessed and processed films have the same safety characteristics, so that either may be tested for conformance to these specifications. In case of doubt, both unprocessed and processed films should be tested.

3. BURNING TIME

The burning time may be determined by either of the two methods specified.

3.1 First method of measurement

3.1.1 *Principle of method.* Motion-picture films having a thickness equal to or greater than 0.08 mm (0.0032 in) are classified as slow burning when the burning time is not less than 45 s. Motion-picture films having a thickness less than 0.08 mm (0.0032 in) are classified as slow burning when the burning time is not less than 30 s.

3.1.2 *Preparation of test samples.* Three samples each 40 cm (15.8 in) long and 35 mm (1.38 in) wide should be cut from the film to be tested. If only films narrower than 35 mm are available, samples 40 cm (15.8 in) long and their full width may be tested. * Each sample should be marked at a point 5 cm (2 in) from each end. If not already perforated, the sample should be perforated with holes 3 mm (0.12 in) in diameter along both edges. Perforations should be at intervals of not more than 20 mm (0.8 in). The sample should be conditioned for at least 4 h at a temperature of 20 ± 2 °C and a relative humidity of 50 ± 5 %. **

3.1.3 *Procedure.* The burning time of motion-picture films is measured as follows: a wire having a diameter of not more than 0.5 mm (0.02 in) should be threaded through the perforations on one side so that the sample is supported at points not more than 20 mm (0.8 in) apart. With the wire stretched horizontally and the sample hanging vertically from it, the bottom corner of one end should be ignited.

3.1.4. *Test conditions.* The test should be made in a room free from draughts. At least three tests should be made.

3.1.5 *Expression of results.* The time which elapses from the moment the flame reaches the first mark until it reaches the second mark should be recorded as the burning time. If the sample does not ignite or if the flame does not reach the second mark, the film should be classified as slow burning.

3.2 Alternative method of measurement

3.2.1 *Principle of method.* Motion-picture films are classified as slow burning if each of six samples fulfils one of the following conditions:

(*a*) the sample fails to burn beyond the specified mark;
(*b*) a period of not less than 120 s elapses from the time of ignition of the alcohol to the time at which the flame reaches the specified mark.

3.2.2 *Preparation of test samples.* The test samples should be taken from either end or both ends of the continuous length of film which is to be examined. For the purpose of the burning test, six samples should be taken, each of a length of 533 mm (21 in) for both 35 mm and 16 mm film. The samples should be tested in the condition in which they are cut from the continuous length without removal of protective or magnetic coatings, stripes or emulsion. The samples should be conditioned for at least 4 h at a temperature of 20 ± 2 °C and a relative humidity of 50 ± 5 %. **

NOTE. — It is important to observe that the whole of the samples for both methods of test should be taken from the same continuous length, and that if the roll of film to be examined contains splices, then each individual continuous length should be examined separately. The object of taking six samples for the burning test is to obtain accurate results in the test and not to confirm the homogeneity of the film; the samples may therefore be taken consecutively.

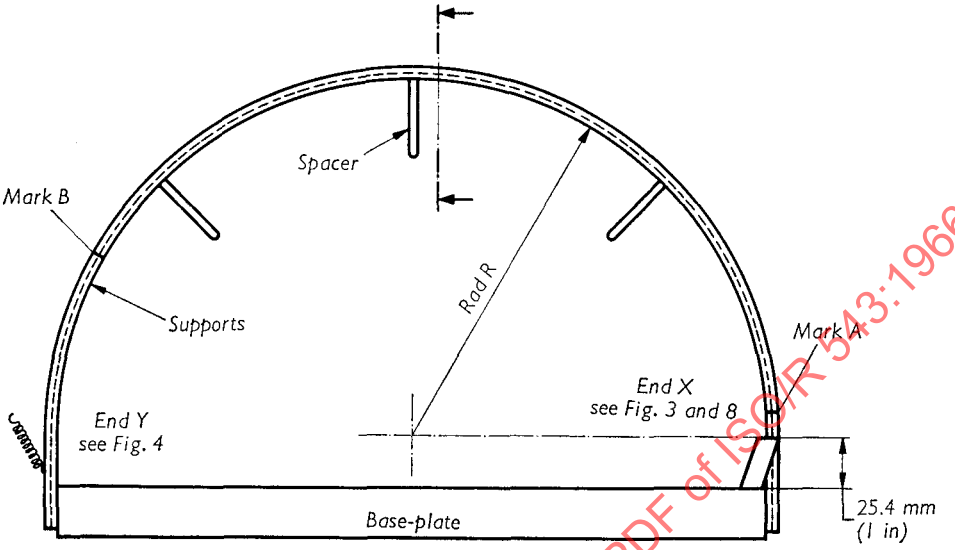
---

* Motion-picture films, when tested by this method, have similar flame propagation characteristics and about the same burning times, regardless of whether the width of the sample tested is 16 mm or 35 mm.

** Experience has shown that safety film will meet the requirements for burning time when conditioned to any relative humidity in the range of 10 to 70 %. The more stringent range of 50 ± 5 % of this test method is specified in the interest of obtaining strictly comparable results. Likewise, the 4 h conditioning time is not critical and may be reduced to 1 h minimum if the urgency of the test makes this desirable.

3.2.3 *Apparatus for 35 mm film.* Samples of 35 mm film should be tested on an apparatus complying with the following requirements:

The apparatus consists essentially of two semicircular supports, each L-shaped in cross-section, curved to a radius of 178 mm (7 in), spaced apart at a suitable distance for supporting the film within the angles, and structurally completed by a base-plate tying the two ends together (see Fig. 1).



	35 mm	16 mm
R	7 in 178 mm	9 in 229 mm

FIG. 1. — **General arrangement of apparatus for flammability test of safety film**

The two supports should be made of mild steel, about 1.2 mm (0.05 in) thick, and should be spaced so that their inner edges are 25.4 mm (1 in) apart, the spacers being of wire shaped as shown in Figure 2.

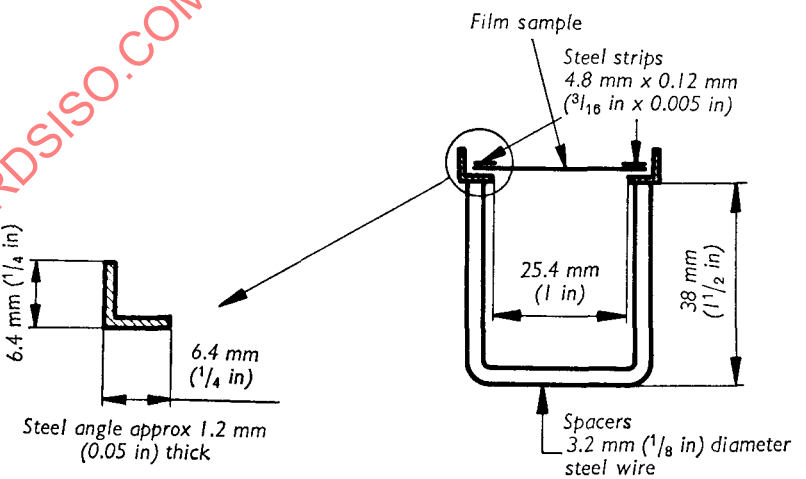


FIG. 2. — **Section through supports showing wire spacers for 35 mm film apparatus**

The film sample should be held in position over the semicircular supports by two strips of spring steel, 4.8 mm wide by 0.12 mm thick ($^3/_{16}$ in by 0.005 in), each of which is riveted at one end to a support (see Fig. 3). The other ends of the two steel strips are connected, at the appropriate distance apart, by a thin steel crossbar (see Fig. 4). At the igniting end there should be, between the supports, a flat platform of heat insulating material

(mica, asbestos, etc.) on which a small alcohol cup may be placed. The upper surface of the platform should be 25 mm (about 1 in) above the base-plate and should be 20 mm (0.8 in) long by 10 mm (0.4 in) wide.

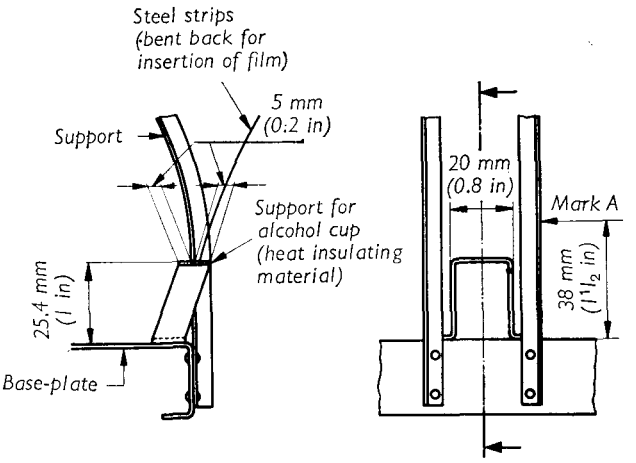


FIG. 3. — **Detail of end X for 35 mm film apparatus**

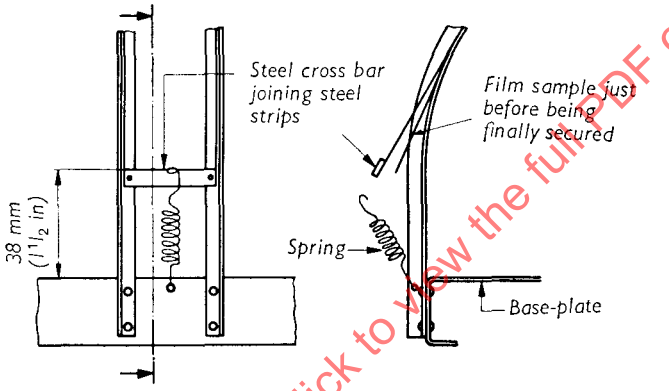


FIG. 4. — **Detail of end Y for 35 mm film apparatus**

The apparatus for 16 mm film is similar in general design.

The alcohol cup should be of copper and should have the dimensions shown in Figure 5.

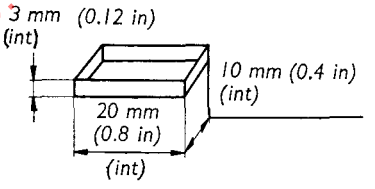


FIG. 5. — **Alcohol cup for 35 mm film apparatus**

One curved support should carry two register lines or marks, as shown in Figure 1, which should be clearly visible when the film sample is in position, and which should be marked *A* and *B* respectively.

The mark *A* should be 38 mm (1.5 in) above the base-plate at the igniting end. The mark *B* should represent the position which would be occupied by the end of a piece of film 457 mm (18 in) long, whose other end coincides with the mark *A*.

3.2.4 *Procedure for 35 mm film.* The 533 mm (21 in) film sample should be placed in the trough formed by the two L-section supports, with its end in line with the mark *A*. The steel strips are drawn over and are held by a small spring which clips on to the crossbar which joins them at their free end (see Fig. 4). Thus the film is securely held by a narrow portion at each side and the centre portion of approximately 25 mm (about 1 in) of the film is in

free air. If the sample to be tested is a coated film, the sample should be placed coating upwards. The copper cup should be placed on the platform centrally below the film; 0.3 ml of alcohol (not less than 95 %) should be placed in it and ignited.

3.2.5 *Apparatus for 16 mm film.* The apparatus is similar in general form to that specified above for the testing of 35 mm film. The circular supports are curved to a radius of 229 mm (9 in). They should be made of mild steel about 0.9 mm (0.036 in) thick, formed to the dimensions shown in Figure 7, and should be spaced so that their inner edges are 12 mm (0.47 in) apart, the spacers being of wire shaped as shown in Figure 7. The film sample should be held in position by steel strips, similar to those for the test of 35 mm film. The upper surface of the platform of heat insulating material should be 25 mm (about 1 in) above the base-plate and should be 10 mm (0.40 in) square. The alcohol cup should be of copper and of the dimensions shown in Figure 6. The mark *A* should be 38 mm (1.5 in) above the base-plate at the igniting end. The mark *B* should represent the position which would be occupied by the end of a piece of film 457 mm (18 in) long, whose other end coincides with the mark *A*.

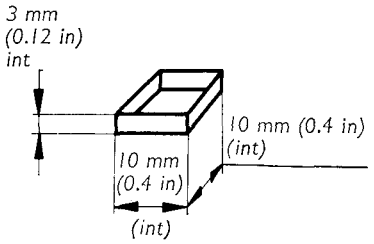


FIG. 6. — **Alcohol cup for 16 mm film apparatus**

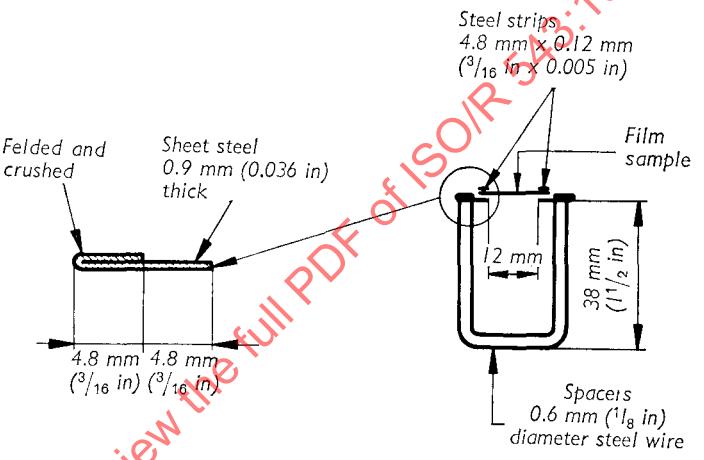


FIG. 7. — **Section through supports, showing wire spacers for 16 mm film apparatus**

3.2.6 *Procedure for 16 mm film.* The method of carrying out the test should be similar to that specified above for 35 mm film. The length of the 16 mm film sample is 533 mm (21 in) and 0.3 ml of alcohol should be placed in the metal cup.

3.2.7. *Expression of results.* The time which elapses from the time of ignition until the flame reaches Mark *B* should be recorded as the burning time. If, for each of six samples, the sample does not ignite or if the flame does not reach Mark *B* within 120 seconds, the film should be classified as slow burning.

4. NITRATE NITROGEN CONTENT

4.1 Definition

Motion-picture films which have a nitrate nitrogen content of not more than a certain percentage by mass, depending on the method used, are classified as having a low nitrogen content. This percentage is 0.40 % when the De Varda method is used, whereby the error in nitrogen content owing to the presence of the gelatin layer is taken into account. The percentage is 0.36 % when the Schulze-Tiemann method is used.

4.2 First method of measurement – De Varda method

The nitrogen content of motion-picture films is measured as follows:

4.2.1 *Preparation of test sample.* The test sample should be conditioned for at least 4 h at a temperature of 20 ± 2 °C and a relative humidity of 50 ± 5 %.

4.2.2 *Procedure.* Cut 5 g of the film into small pieces (25 mm (about 1 in) by 6 mm (0.24 in)) and place them in an 800 ml Kjeldahl flask. Add 90 ml of 30 % sodium hydroxide and 10 ml of ethyl alcohol.* Connect the flask with a rubber stopper to a vertical cooler. Heat on a steam bath or over an open flame at 30 to 40 °C and add 25 ml of 30 % hydrogen peroxide slowly, with agitation. Boil slowly until the hydrogen peroxide is reacted. If necessary, add another 25 ml portion of hydrogen peroxide and continue the boiling until it is reacted. Boil for 15 min until the reaction is completed.

Then adjust the contents of the flask to approximately 200 ml using distilled water. (If desired, the test may be conveniently held over for the night at this point). The solution is then evaporated over a small flame to about 75 ml in order to remove any traces of ammonia, after which it is cooled to room temperature.

The solution is diluted to 350 ml with distilled water.** Add 2.5 g of De Varda's alloy and quickly connect the flask to the Kjeldahl apparatus. This addition should be done through a funnelled tube, so that no alloy clings to the flask neck. The mixture should be left for 1 h and then distilled with great care. Collect approximately 150 ml of distillate in a 500 ml receiving flask containing about 50 ml of approximately 4 % boric acid solution. The contents of the flask are then titrated with tenth-normal sulphuric acid, using methyl red as indicator.

4.2.3 *Expression of results.* A blank determination is made on the reagents, using the same quantities as are used in the actual determination. The percentage of nitrate nitrogen is calculated as follows:

$$\frac{(A - B) \times 0.1 \times 0.014 \times 100}{5} = (A - B) \times 0.028$$

where A = amount of tenth-normal acid used for sample, in millilitres,
B = amount of tenth-normal acid used for blank determination, in millilitres.

4.3 Alternative method of measurement – Schulze-Tiemann method

4.3.1 *Preparation of test sample.* The sample should be taken from either end or both ends of the continuous length of film which is to be examined. For the purposes of this test for nitrate nitrogen content, three samples, each of a length 152 mm (6 in) for 35 mm film and 305 mm (12 in) for 16 mm film should be taken. The samples should be conditioned for at least 4 h at a temperature of 20 ± 2 °C and a relative humidity of 50 ± 5 %.

4.3.2 *Procedure.* Cut the film into strips approximately 6.35 mm (1/4 in) wide by 25 mm (about 1 in) long. Weigh about 10 g of the film into the flask *A* (of capacity of about 250 ml) and add about 50 ml of water to cover the film, ensuring that no film is stuck to the sides of the flask. Replace the rubber bung fitted with delivery tube and filling tube (see Fig. 8, page 9). Turn on the water supply to the tube jacket of the eudiometer; raise the levelling arm *B*, open taps *C* and *D* and pour 24 % sodium hydroxide solution into cup *E* until the eudiometer tube is full, taking care that there are no air bubbles enclosed. Close taps *C* and *D*. Close spring clip *F* on the delivery tube of the apparatus and fully open clip *G*. Light a burner under the flask and bring the water to a boil. Allow to boil for half a minute. Continue boiling and, without removing the burner, close clip *G* and open clip *F* at the same time. Pour 45 ml of aqueous saturated ferrous chloride solution into the boiling tube *H*. When steam issues from the end of the delivery tube *J*, place this under the sodium hydroxide in cup *K*. Close clip *F* and open clip *G* simultaneously. The steam from the flask now passes through the ferrous chloride solution, boiling it. Continue boiling until most of the water in the flask has been boiled away and no more air bubbles pass up through the ferrous chloride solution.

---

* A denatured ethyl alcohol may be used which does not contain nitrogen compounds.

** The volume at this point should be controlled within ± 10 ml, because of the influence of alkali dilution upon the rate of reaction of De Varda's alloy.

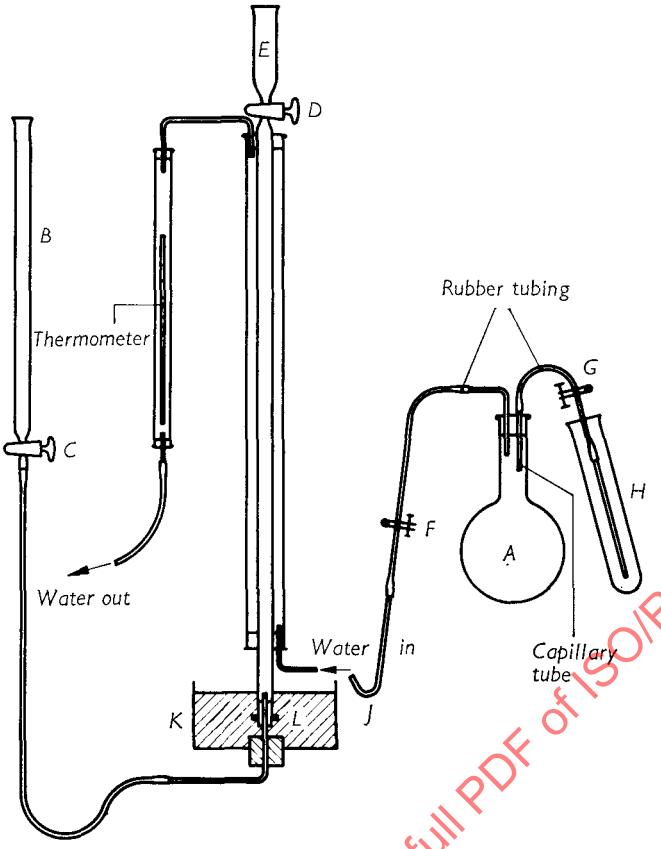


FIG. 8. — **Schulze-Tiemann method for determination of nitrate nitrogen content**

Remove the burner and close clip *G*. Gently lift the eudiometer tube jacket off the rubber stopper *L* and slip the lower end of the eudiometer over the end of the delivery tube *J*, clamping the tube jacket in this position. Pour about 5 ml of the 24 % sodium hydroxide solution into the cup *E* at the upper end of the eudiometer.

A vacuum will have formed in the reaction flask *A*. Slowly open clip *G* and allow the ferrous chloride solution to run slowly into the flask. Close clip *G* just before the last of the ferrous chloride has run out. Pour 45 ml of concentrated hydrochloric acid into the boiling tube and, by opening clip *G*, allow the whole of this, except the last 1 ml or so, to be drawn into the flask. Close clip *G*. Pour 5 ml of ferrous chloride solution into the boiling tube. Replace the burner under the reaction flask and gradually bring the contents of the flask to a boil, keeping one hand on clip *G* and the other on clip *F*. Open clip *G* slightly, so that ferrous chloride just drips into the flask.

As decomposition of the nitrogen compound proceeds, pressure will gradually develop in the flask and a point will be reached at which the gas evolved will begin to drive the ferrous chloride back into the boiling tube (for greater accuracy, use a capillary tube), i.e. when the flask has attained atmospheric pressure. As soon as the drop of ferrous chloride on the end of the tube begins to recede, close clip *G* and open clip *F* simultaneously. Slide clip *F* off the rubber tube and allow it to rest on the lower part of the delivery tube against cup *K*.

Boil the contents of the flask until no more gas collects in the eudiometer, agitating the flask fairly vigorously in the later stages of the reaction. When this agitation no longer produces gas bubbles, remove the burner and close the delivery tube with clip *F*.