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# INTERNATIONAL STANDARD

**ISO 5530-1**

First edition
1988-12-15

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION
ORGANISATION INTERNATIONALE DE NORMALISATION
МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ

## Wheat flour — Physical characteristics of doughs —

## Part 1: Determination of water absorption and rheological properties using a farinograph



*Farines de blé tendre — Caractéristiques physiques des pâtes —*



*Partie 1: Détermination de l'absorption d'eau et des caractéristiques rhéologiques au moyen du farinographe*

Reference number
ISO 5530-1 : 1988 (E)

# Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.



International Standard ISO 5530-1 was prepared by Technical Committee ISO/TC 34, *Agricultural food products.*



This part of ISO 5530 is based on Standard No. 115 of the International Association for Cereal Science and Technology (ICC).

ISO 5530 consists of the following parts, under the general title *Wheat flour — Physical characteristics of doughs*:

— *Part 1: Determination of water absorption and rheological properties using a farinograph*

— *Part 2: Determination of rheological properties using an extensograph*

— *Part 3: Determination of water absorption and rheological properties using a valorigraph*

— *Part 4: Determination of rheological properties using an alveograph*

Annexes A and B of this part of ISO 5530 are for information only.

# Wheat flour — Physical characteristics of doughs —

# Part 1: Determination of water absorption and rheological properties using a farinograph

## 1 Scope

This part of ISO 5530 specifies a method, using a farinograph[1], for the determination of the water absorption of flours and the mixing behaviour of doughs made from them.



The method is applicable to flour from wheat (*Triticum aestivum* Linnaeus).



## 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 5530. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 5530 are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 712 : 1985, *Cereals and cereal products — Determination of moisture content (Routine reference method).*

ISO 2170 : 1980, *Cereals and pulses — Sampling of milled products.*

## 3 Definitions

For the purposes of this part of ISO 5530, the following definitions apply.

**3.1 consistency**: The resistance, expressed in arbitrary units (farinograph units, FU), of a dough to being mixed in the farinograph at a specified constant speed.

**3.2 water absorption (of flour)**: The volume of water, expressed in millilitres per 100 g of flour at 14 % (*m/m*) moisture content, required to produce a dough with a maximum consistency of 500 FU, under the operating conditions specified in this part of ISO 5530.

## 4 Principle

Measurement and recording, by means of a farinograph, of the consistency of a dough as it is formed from flour and water, as it is developed, and as it is broken down.

NOTE — The maximum consistency of the dough is adjusted to a fixed value by adapting the quantity of water added. The correct water addition, which is called the water absorption, is used to obtain a complete mixing curve, the various features of which are a guide to the strength of the flour.

## 5 Reagent

**Distilled water**, or water of equivalent purity.

## 6 Apparatus

Usual laboratory equipment and, in particular, the following.

**6.1 Farinograph**, with a thermostat consisting of a constant temperature water-bath. (See annex A.)

### 6.1.1 Operating characteristics

— Slow blade rotational frequency: (63 ± 2) $min^{-1}$

The ratio of the rotational frequencies of the mixing blades shall be 1,50 ± 0,01.

1) This part of ISO 5530 has been drawn up on the basis of the Brabender Farinograph.

This information is given for the convenience of users of this part of ISO 5530 and does not constitute an endorsement by ISO of this product.

— Torque per farinograph unit:

a) for a 300 g mixer,
(9,8 ± 0,2) mN·m/FU [(100 ± 2) gf·cm/FU];

b) for a 50 g mixer,
(1,96 ± 0,04) mN·m/FU [(20 ± 0,4) gf·cm/FU].

— Chart speed: (1,00 ± 0,03) cm/min

#### 6.1.2 Burette

a) For a 300 g mixer, graduated from 135 ml to 225 ml in 0,2 ml divisions.

b) For a 50 g mixer, graduated from 22,5 ml to 37,5 ml in 0,1 ml divisions.

The time to flow from 0 ml to 225 ml or from 0 ml to 37,5 ml respectively shall be not more than 20 s.

### 6.2 **Balance,** accurate to 0,1 g.

### 6.3 Soft plastic spatula.

## 7 Sampling

Carry out sampling by the method specified in ISO 2170.



## 8 Procedure

### 8.1 Determination of the moisture content of the flour

Determine the moisture content of the flour using the method specified in ISO 712.

### 8.2 Preparation of sample and apparatus

**8.2.1** If necessary, bring the flour to a temperature of (25 ± 5) °C. Turn on the thermostat and circulate the water, until the required temperature is reached, prior to using the instrument. Before and during use, check the temperatures of the thermostat and of the mixing bowl, the latter in the hole provided for this purpose. The temperature of the mixing bowl shall be (30 ± 0,2) °C.

**8.2.2** Uncouple the mixer from the driving shaft and adjust the position of the counter-weight(s) so as to obtain zero deflection of the pointer with the motor running at the specified rotational frequency (see 6.1.1). Switch off the motor and then couple the mixer.

Lubricate the mixer with a drop of water between its back wall and each of the blades. Check that the deflection of the pointer is within the range (0 ± 5) FU with the mixing blades rotating at the specified rotational frequency in the empty, clean bowl. If the deflection exceeds 5 FU, clean the mixer more thoroughly or eliminate other causes of friction.

Adjust the arm of the pen so as to obtain identical readings from the pointer and the recording pen.

Adjust the damper so that, with the motor running, the time required for the pointer to go from 1000 FU to 100 FU is (1,0 ± 0,2) s.

**8.2.3** Fill the burette, including the tip, with water at a temperature of (30 ± 5) °C.

### 8.3 Test portion

Weigh, to the nearest 0,1 g, the equivalent of 300 g (for a 300 g mixer) or 50 g (for a 50 g mixer) of flour having a moisture content of 14 % ($m/m$). Let this mass, in grams, be $m$; see table 1 for $m$ as a function of moisture content.

Place the flour in the mixer. Cover the mixer, and keep it covered until the end of mixing (8.4.1), except for the shortest possible time, when water has to be added, and the dough scraped down (see A.2.2).

### 8.4 Determination

**8.4.1** Mix at the specified rotational frequency (see 6.1.1) for 1 min or slightly longer. Start adding water from the burette into the right-hand front corner of the mixer, when a whole-minute line on the recorder paper passes by the pen.

NOTE — In order to reduce the waiting time, the recorder paper may be moved forward during mixing of the flour. Do not move it backwards.

Add a volume of water close to that expected to produce a maximum consistency (9.1) of 500 FU. When the dough forms, scrape down the sides of the bowl with the spatula (6.3), adding any adhering particles to the dough, without stopping the mixer. If the consistency is too high, add a little more water to obtain a maximum consistency (9.1) of approximately 500 FU. Stop mixing and clean the mixer.

**8.4.2** Make further mixings as necessary, until two mixings are available

— in which the water addition has been completed within 25 s;

— the maximum consistencies (9.1) of which are between 480 FU and 520 FU; and

— the recording of which has been continued for at least 12 min after the end of the development time (9.2), if the degree of softening is to be reported.

Stop mixing and clean the mixer.

## 9 Expression of results

### 9.1 Water absorption

From each of the mixings with maximum consistencies between 480 FU and 520 FU, derive the corrected volume $V_c$,

**Table 1 — Mass of flour, in grams, equivalent to 300 g and 500 g at a moisture content of 14 % (*m*/*m*)**

| Moisture content % (*m*/*m*) | Mass *m* of flour equivalent to 300 g | Mass *m* of flour equivalent to 50 g | Moisture content % (*m*/*m*) | Mass *m* of flour equivalent to 300 g | Mass *m* of flour equivalent to 50 g |
|---|---|---|---|---|---|
| 9,0 | 283,5 | 47,3 | 13,6 | 298,6 | 49,8 |
| 9,1 | 283,8 | 47,3 | 13,7 | 299,0 | 49,8 |
| 9,2 | 284,1 | 47,4 | 13,8 | 299,3 | 49,9 |
| 9,3 | 284,5 | 47,4 | 13,9 | 299,7 | 49,9 |
| 9,4 | 284,8 | 47,5 | 14,0 | 300,0 | 50,0 |
| 9,5 | 285,1 | 47,5 | 14,1 | 300,3 | 50,1 |
| 9,6 | 285,4 | 47,6 | 14,2 | 300,7 | 50,1 |
| 9,7 | 285,7 | 47,6 | 14,3 | 301,1 | 50,2 |
| 9,8 | 286,0 | 47,7 | 14,4 | 301,4 | 50,2 |
| 9,9 | 286,3 | 47,7 | 14,5 | 301,8 | 50,3 |
| 10,0 | 286,7 | 47,8 | 14,6 | 302,1 | 50,4 |
| 10,1 | 287,0 | 47,8 | 14,7 | 302,5 | 50,4 |
| 10,2 | 287,3 | 47,9 | 14,8 | 302,8 | 50,5 |
| 10,3 | 287,6 | 47,9 | 14,9 | 303,2 | 50,5 |
| 10,4 | 287,9 | 48,0 | 15,0 | 303,5 | 50,6 |
| 10,5 | 288,3 | 48,0 | 15,1 | 303,9 | 50,6 |
| 10,6 | 288,6 | 48,1 | 15,2 | 304,2 | 50,7 |
| 10,7 | 288,9 | 48,2 | 15,3 | 304,6 | 50,8 |
| 10,8 | 289,2 | 48,2 | 15,4 | 305,0 | 50,8 |
| 10,9 | 289,6 | 48,3 | 15,5 | 305,3 | 50,9 |
| 11,0 | 289,9 | 48,3 | 15,6 | 305,7 | 50,9 |
| 11,1 | 290,2 | 48,4 | 15,7 | 306,0 | 51,0 |
| 11,2 | 290,5 | 48,4 | 15,8 | 306,4 | 51,1 |
| 11,3 | 290,9 | 48,5 | 15,9 | 306,8 | 51,1 |
| 11,4 | 291,2 | 48,5 | 16,0 | 307,1 | 51,2 |
| 11,5 | 291,5 | 48,6 | 16,1 | 307,5 | 51,3 |
| 11,6 | 291,9 | 48,6 | 16,2 | 307,9 | 51,3 |
| 11,7 | 292,2 | 48,7 | 16,3 | 308,2 | 51,4 |
| 11,8 | 292,5 | 48,8 | 16,4 | 308,6 | 51,4 |
| 11,9 | 292,8 | 48,8 | 16,5 | 309,0 | 51,5 |
| 12,0 | 293,2 | 48,9 | 16,6 | 309,4 | 51,6 |
| 12,1 | 293,5 | 48,9 | 16,7 | 309,7 | 51,6 |
| 12,2 | 293,8 | 49,0 | 16,8 | 310,1 | 51,7 |
| 12,3 | 294,2 | 49,0 | 16,9 | 310,5 | 51,7 |
| 12,4 | 294,5 | 49,1 | 17,0 | 310,8 | 51,8 |
| 12,5 | 294,9 | 49,1 | 17,1 | 311,2 | 51,9 |
| 12,6 | 295,2 | 49,2 | 17,2 | 311,6 | 51,9 |
| 12,7 | 295,5 | 49,3 | 17,3 | 312,0 | 52,0 |
| 12,8 | 295,9 | 49,3 | 17,4 | 312,3 | 52,1 |
| 12,9 | 296,2 | 49,4 | 17,5 | 312,7 | 52,1 |
| 13,0 | 296,6 | 49,4 | 17,6 | 313,1 | 52,2 |
| 13,1 | 296,9 | 49,5 | 17,7 | 313,5 | 52,2 |
| 13,2 | 297,2 | 49,5 | 17,8 | 313,9 | 52,3 |
| 13,3 | 297,6 | 49,6 | 17,9 | 314,3 | 52,4 |
| 13,4 | 297,9 | 49,7 | 18,0 | 314,6 | 52,4 |
| 13,5 | 298,3 | 49,7 | | | |

NOTE — The values in this table were calculated using the following formulae:

a) for the mass, in grams, equivalent to 300 g at 14 % (*m*/*m*) moisture content:

$$m = \frac{25\ 800}{100 - H}$$

b) for the mass, in grams, equivalent to 50 g at 14 % (*m*/*m*) moisture content:

$$m = \frac{4\ 300}{100 - H}$$

where $H$ is the moisture content of the sample, as a percentage by mass.

in millilitres, of water corresponding to a maximum consistency of 500 FU, by means of the following formulae:

a) for a 300 g mixer,

$$V_c = V + 0{,}096\ (c - 500)$$

b) for a 50 g mixer,

$$V_c = V + 0{,}016\ (c - 500)$$

where

$V$ is the volume, in millilitres, of water added;

$c$ is the maximum consistency, in farinograph units, (see figure 1) given by

$$c = \frac{c_1 + c_2}{2}$$

where

$c_1$ is the maximum height of the upper contour of the curve, in farinograph units;

$c_2$ is the maximum height of the lower contour of the curve, in farinograph units.

NOTE — In the relatively infrequent case where two maxima are observed, use the height of the higher maximum.

Use for the calculation the mean value of duplicate determinations of $V_c$, provided that the difference between them does not exceed 2,5 ml (for a 300 g mixer) or 0,5 ml (for a 50 g mixer) of water.

The farinograph water absorption, expressed in millilitres per 100 g of flour at 14 % $(m/m)$ moisture content, is equal to

a) for a 300 g mixer,

$$(\overline{V}_c + m - 300) \times \frac{1}{3}$$

b) for a 50 g mixer,

$$(\overline{V}_c + m - 50) \times 2$$

where

$\overline{V}_c$ is the numerical value of the mean value of the duplicate determinations of the corrected volume, in millilitres, of water corresponding to a maximum consistency of 500 FU;

$m$ is the numerical value of the mass, in grams, of the test portion derived from table 1.

Report the result to the nearest 0,1 ml per 100 g.

### 9.2 Dough development time

The dough development time is the time from the beginning of addition of water to the point on the curve immediately before the first signs of the decrease of consistency (see figure 1).

NOTE — In the relatively infrequent case where two maxima are observed, use the second maximum to measure the development time.

Take as the result the mean dough development time from the two curves to the nearest 0,5 min, provided that the difference between them does not exceed 1 min for development times of up to 4 min, or 25 % of their mean value for longer development times.



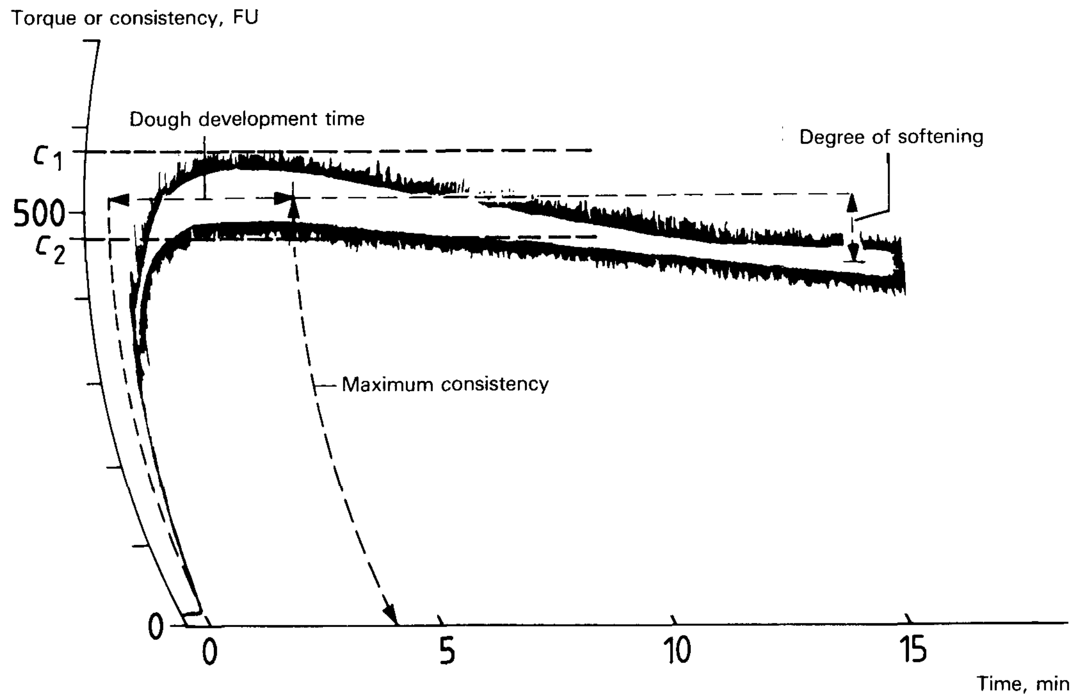



**Figure 1 — Representative farinogram showing the commonly measured indices**

### 9.3 Degree of softening

The degree of softening is the difference in height between the centre of the curve at the end of the dough development time and the centre of the curve 12 min after this point (see figure 1).

Take as the result the mean degree of softening from the two curves to the nearest 5 FU, provided that the difference between them does not exceed 20 FU for degrees of softening up to 100 FU, or 20 % of their mean value for larger values.

### 9.4 Repetition

If one or more of the differences between measurements on the two curves exceed the values specified in 9.1 to 9.3 inclusive, make another two mixings that meet the requirements of 8.4.2.

### 9.5 Precision

Data on the precision of the method have not been analysed in accordance with ISO 5725[1]. However, annex B gives information on results of some inter-laboratory tests.

## 10 Test report

The test report shall specify the method used and the results obtained. If a 50 g mixer has been used, this shall be mentioned. It shall also mention all operating details not specified in this part of ISO 5530, or regarded as optional, together with details of any incidents that may have influenced the results.

The test report shall include all information necessary for the complete identification of the sample.



1) ISO 5725 : 1986, *Precision of test methods — Determination of repeatability and reproducibility for a standard test method by inter-laboratory tests.*

# Annex A
(informative)

# Description of the farinograph

## A.1 General description

The farinograph comprises two units:

a) the farinograph unit itself, consisting of a water-jacketed mixer, a means for recording dough consistency in the form of farinograms, and a burette (A.2);

b) a thermostat for circulating water (A.3).

The components of the farinograph are illustrated diagramatically in figure A.1.

## A.2 Farinograph unit

**A.2.1** The farinograph unit is mounted on a heavy cast-iron base plate having four levelling screws, and consists of:

a) a detachable, water-jacketed mixer (A.2.2);

b) an electric motor, driving the mixer (A.2.3);

c) a gear and lever system, acting as a dynamometer to measure the torque on the driving shaft between the gear and the mixer (A.2.3);

d) a dash-pot to damp the movements of the dynamometer (A.2.3);

e) a scale, the pointer of which is actuated by movements of the dynamometer (A.2.3);

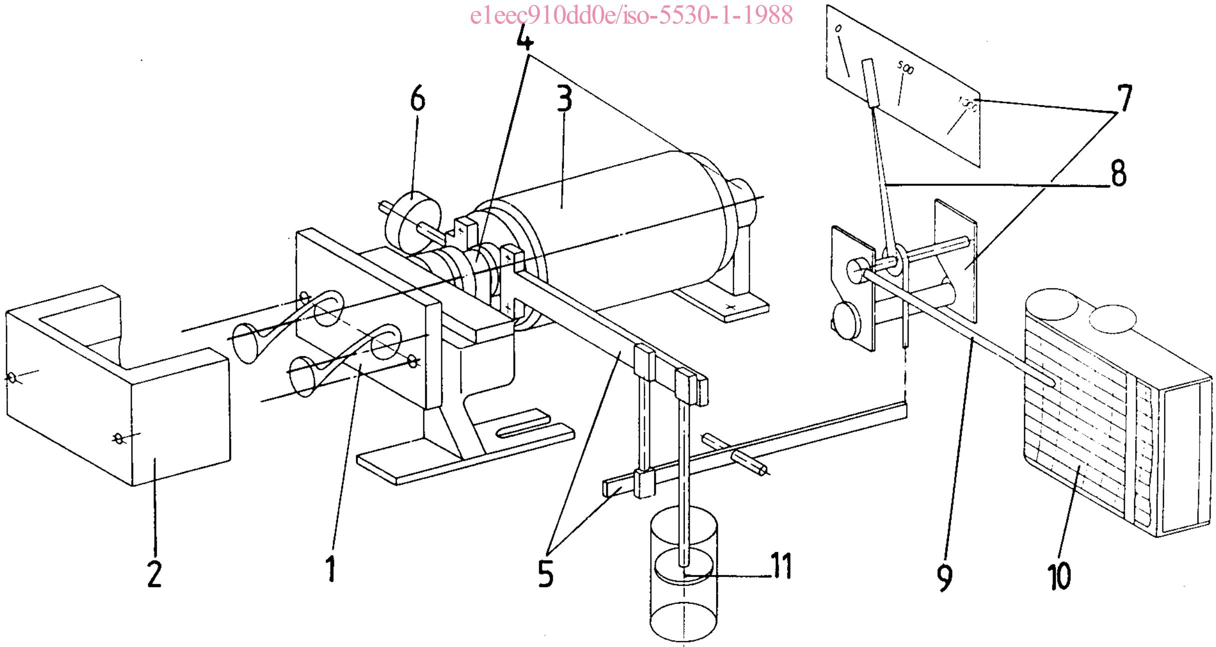
f) a recorder, the pen of which is actuated by the movements of the dynamometer (A.2.4);

g) a burette to measure the volume of water added to the flour.

**A.2.2** The mixer is two-bladed and is designed to mix doughs from either 300 g or 50 g of flour. It is in two parts:

a) a hollow back-plate, through which water from the thermostat circulates, and, at the back, a gear-box driving the two mixer blades that project forward through this back-plate;






1 Back wall of mixer with mixing blades
2 Remainder of mixer
3 Housing of motor and gears
4 Ball-race bearings
5 Levers
6 Counter-weight
7 Scale head
8 Pointer
9 Pen arm
10 Recorder
11 Dash-pot damper

**Figure A.1 — Diagram of farinograph**

b) the remainder of the mixer, i.e. two sides, front and bottom in one piece, through which water from the thermostat circulates.

The two parts are held together by means of two bolts and wing nuts, and can be dismantled for cleaning.

The slower mixing blade is driven directly by the shaft from the gear; it rotates at a frequency of 63 $min^{-1}$ in recent farinographs. The faster mixing blade is geared, by cog-wheels, to rotate at a frequency that is 1,5 times that of the slower blade.

NOTE — Previous farinographs were made with rotational frequencies of the driving shaft that differ from the presently standardized value of 63 $min^{-1}$. The effect of the rotational frequency on the determination can be neglected if it is within the range 59 $min^{-1}$ to 67 $min^{-1}$.

If it is outside this range, an approximately correct water absorption can be obtained by substituting a consistency $c$ for the standard consistency of 500 FU. The value of $c$ can be calculated from the actual rotational frequency $n$, in reciprocal minutes, of the driving shaft or slower mixing blade, by means of the equation

$$c = 500 + 200 \ln\left(\frac{n}{63}\right)$$

If a consistency $c$ has to be substituted for the standard consistency, the development time varies according to the equation

$$t_0 = t - 320\left(\frac{1}{n} - \frac{1}{63}\right)$$

where

$t_0$ is the development time, in minutes, that would be measured with a farinograph that is in accordance with 6.1.1;

$t$ is the development time, in minutes, that is read on the curve actually recorded.

Insufficient data are available to make a similar correction for the degree of softening.

The mixer can be closed by a lid which, in recent farinographs, consists of two parts:

a) a bottom part, to be opened only to place the flour into the mixer. When it is opened, the security system switches off the instrument. This part has slots, to allow dough to be scraped down from the sides of the bowl with a spatula. The water has to be added through the front end of the slot at the right-hand side of the mixer;

b) a top part, to be placed on the bottom part to close its slots. It is to be opened only for adding water or scraping down the dough.

In older farinographs the mixer is closed by a flat plastic plate, which is laid on top of the mixer. It is removed to add water and scrape down the dough.

**A.2.3** The motor and its reduction and dynamometer gears are placed together in a housing. From the front and rear ends of this housing, shafts protrude that are supported by ball-race bearings; the housing can pivot on these shafts.

The shaft from the front end drives the mixing blades. The resistance of the dough to being mixed causes a torque on this shaft which, if not balanced, would cause rotation of the motor housing.

The motor housing carries an arm, one end of which is connected by the lever system to the scale and recorder pen. This causes a counter-torque on the motor housing, which is linearly related to the deflection of the scale pointer and recorder pen. As a result, the deflections of the scale pointer and recorder pen are, if the two torques balance one another, proportional to the torque on the driving shaft, i.e. to the resistance of the dough to being mixed. The operator can choose the correct torque per unit deflection (6.1.1) by selecting

— the appropriate effective counter-weight in the scale head; this is done by a handle that can lift a counter-weight, and so make it ineffective;

— the appropriate effective length of the front part of the lower lever arm; this is done by varying the position of the link between the lower lever arm and the motor housing lever arm.

In recent instruments, both possibilities for adjustment are used. In older instruments there is only the second possiblity.

Movements of the motor housing, lever system, scale, and recorder pen are damped by a piston immersed in oil; the piston is connected to the right-hand end of the arm of the motor housing. The extent of damping can be adjusted; more damping results in a narrower curve.



**A.2.4** The paper for the recorder is supplied in the form of a roll. It is moved by an electric clock-type motor at a rate of 1,00 cm/min. Along its length it bears a printed scale in minutes. Across its width it bears a circular scale (radius 200 mm) with arbitrary units, running from 0 to 1 000 farinograph units.



## A.3 Thermostat

The thermostat normally consists of a tank with water, and contains the following parts.

a) An electric heating element.

b) A thermoregulator that controls the heating element; they shall be capable of maintaining the temperature of the mixing bowl at (30 ± 0,2) °C. Under adverse conditions, a slightly higher water temperature may be necessary; it shall be controlled with the same accuracy.

c) A thermometer.

d) A motor-driven pump and stirrer. The pump is connected to the water jackets of the mixing bowl by means of flexible tubing. It shall have sufficient capacity to maintain the temperature of the walls of the mixing bowl at (30 ± 0,2) °C; for a 300 g mixer, the flow of water through the jackets shall be at least 2,5 l/min, preferably 5 l/min or more, and for a 50 g mixer at least 1 l/min. Except in some earlier models of the farinograph, the dash-pot damper can also be connected to the pump; however, temperature control of the dash-pot damper is not really necessary if the viscosity of the oil in it is only slightly sensitive to temperature.