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Round steel wire for springs

Patented cold drawn, carbon steel wire for springs
Technical delivery conditions

DIN 17 223 Part 1

Runder Federstahldraht; patentiert-gezogener Federdraht aus unlegierten Stählen; technische Lieferbedingungen

Supersedes March 1964 edition

In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.

See Explanatory notes for connection with international documents.

Subclauses marked with a dot ● give specifications which are optional and may be agreed upon at the time of ordering.

1 Field of application

1.1 This standard applies to patented cold drawn round carbon steel wire, normally used for helical springs (tension, compression and torsion springs), spring washers and other wire springs.

Note. Experience suggests that reference is made to this standard also for ordering patented cold drawn wire for springs, of non-circular cross section, made of rods straightened and cut to length from spring wire and for ordering surface-treated (for example galvanized or tinned) spring wire. In such cases, it should be noted that the mechanical properties, the accuracy to size and surface finishes specified in this standard do not apply to such products and hence should be separately agreed.

1.2 This standard does not apply to:

quenched and tempered spring wire and quenched and tempered valve spring wire (see DIN 17 223 Part 2);

stainless steel spring wire (see DIN 17 224);

heat-resisting steel spring wire (see DIN 17 225).

1.3 In addition to the specifications given in this standard, unless otherwise stated below, the general technical delivery conditions for steel and steel products specified in DIN 17 010 shall also apply.

2 Concept

As described in DIN 17 014 Part 1, patenting is understood to mean a heat treatment consisting of austenization and rapid cooling to a temperature above the martensite point, in order to achieve a structure favourable for subsequent cold working.

3 Classification into grades

This standard covers the following grades of steel spring wire (referred to below as wire grades):

grade A in nominal size range from 1,00 to 10,00 mm;

grade B in nominal size range from 0,30 to 20,00 mm;

grade C in nominal size range from 2,00 to 20,00 mm;

grade D in nominal size range from 0,07 to 20,00 mm.

Wire grades A, B, C and D are distinguished on the basis of their mechanical properties; for grade D, in addition particular requirements relating to the surface condition have been specified. Information on the use of the various grades is given in clause 7 and table 6.

Note. During the discussions on this standard, the manufacturers stated that they were prepared to continue to supply wire grade II specified in the March 1964 edition of this standard withdrawn in 1984, for a transition period.

4 Designation

4.1 For products conforming to this standard, the standard designation shall give in the following order:

- the term (wire);
- the number of the dimensional standard (DIN 2076);
- the letter symbol identifying wire grade A, B, C or D (see tables 1 and 3) and
- the required nominal diameter, selected from table 3.

Example:

Standard designation of a steel spring wire with a nominal diameter of 2,5 mm, of wire grade A, conforming to DIN 17 223 Part 1:

Wire DIN 2076 – A – 2,5

4.2 The designation to be used on ordering shall, in addition to the standard designation, give the quantity to be supplied, the surface finish, if some other surface finish than bright dry drawn and phosphatized or bright wet drawn and phosphatized is required (see subclause 5.2), and any particular agreements that have been made (see subclauses marked with ●).

Example:

1000 kg wire DIN 2076–A–2,0 bright dry drawn, reddish

or

1000 kg wire DIN 2076–A–2,0 tr bk rt

Continued on pages 2 to 12

5 Requirements

5.1 Form of supply

The wire shall be supplied in the form of coils or wound onto spools in the condition described in subclauses 5.6 to 5.8.

● Unless otherwise agreed at the time of ordering, the choice between these two forms of supply shall be at the supplier's discretion.

5.2 Surface finish

5.2.1 ● The wire may be supplied with one of the following surface finishes:

bright dry drawn and phosphatized (tr bk phr as specified in DIN 1653);

bright dry drawn and grey (tr bk gr as specified in DIN 1653);

bright dry drawn and reddish (tr bk rt as specified in DIN 1653);

bright wet drawn and phosphatized (n bk phr) *);

bright wet drawn and grey (n bk gr as specified in DIN 1653);

bright wet drawn and reddish (n bk rt as specified in DIN 1653).

Unless otherwise specified in the order, the material shall be supplied at the manufacturer's discretion either bright dry drawn and phosphatized or bright wet drawn and phosphatized.

5.2.2 ● For all surface finishes, the wire may additionally be ordered with oiled surface.

5.3 Chemical composition

5.3.1 Table 1 shall apply to the chemical composition of the various wire grades as determined in the cast analysis. Wire rod specified in DIN 17 140 Part 1 shall be used as the starting product for wire grades A and B.

5.3.2 The values given in table 2 shall apply to any subsequent check of the chemical composition on the finished product.

5.4 Mechanical properties

5.4.1 The values given in table 3 shall apply to the tensile strength and reduction in area after fracture of grades A, B, C and D wire.

5.4.2 The tensile strength values at any point in a coil shall not exceed the following:

- for nominal diameters less than 0,80 mm: 150 N/mm^2;
- for nominal diameters from 0,80 up to but not including 1,60 mm: 100 N/mm^2;
- for nominal diameters from 1,60 mm: 70 N/mm^2.

These specifications shall apply to coils with a mass, in kg, not exceeding the value 100 × d (d is the nominal diameter of wire, in mm) or value of 500 kg, whichever is smaller.

● In the cases of coils of greater mass, appropriate agreements shall be made.

5.4.3 The modulus of elasticity is taken as 206 kN/mm^2, the shear modulus as 81,5 kN/mm^2.

For the design of springs, the values specified in the design standards shall apply.

5.5 Mechanical properties other than tensile strength

5.5.1 Behaviour in wrapping test

In order to assess the uniformity of the deformability of the wire and its surface condition, the wrapping test shall be carried out on grades B and D wires with a diameter of less than 0,70 mm. In the test as described in subclause 6.4.3, the test piece shall exhibit a perfect surface and a uniform pitch of the turns after plastic deformation.

5.5.2 Behaviour in torsion test

For assessing the deformability, fracture behaviour and surface condition, the torsion test shall be carried out on grades A, B, C and D wires in the nominal diameter range from over 0,70 to 10,00 mm. The minimum numbers of turns specified in table 3 shall be complied with up to 7,00 mm nominal diameter, for wires exceeding this size, they shall be taken as guidance values.

The obligatory number of turns shall be achieved in the test described in subclause 6.4.4 before the test piece fractures. The fracture of the torsion test piece in the case of grades A, B, C and D wire shall be perpendicular to the axis of the wire.

Recoil cracks or recoil fractures (secondary fractures) shall be ignored in the assessment. In the case of grades A, B, C and D wire, a uniform torsion shall be present in both of the fractured parts, although the pitch of the turns need not be the same in the two parts. In the case of grade D wire, no cracks visible to the naked eye shall be present after the torsion test.

5.6 Condition of coils and spools

5.6.1 The wire of a coil or spool shall be in one piece.

5.6.2 In the case of coils, the inside diameter shall at least attain the values specified in table 4.

5.6.3 In the case of coils, the wap may extend after the binding wires have been removed but shall not become smaller than the diameter of the coil.

5.6.4 The spring wire shall be drawn dead cast. This requirement shall be deemed to have been met if, in the case of wires of less than 5 mm nominal diameter, the ends of the wap tested as described in subclause 6.4.5 shall have an axial displacement of not more than

$$f = \frac{0{,}2 \cdot D}{\sqrt[4]{d}}$$

where

f is the axial displacement, in mm;

D is the diameter of a free wap, in mm;

d is the nominal diameter of the wire, in mm.

5.6.5 ● The choice of the mass of the individual coils or spools is left to the manufacturer's discretion unless otherwise agreed at the time of ordering; see also subclause 5.4.2.

5.7 Surface condition and skin decarburization

5.7.1 The surface of the wires shall be smooth.

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*) This surface finish is not specified in the January 1979 edition of DIN 1653, but a request has been made for it to be included in the next edition of DIN 1653.

5.7.2 In the case of grades A, B and C wire, the surface shall be free from scores, pits and other surface defects, which will have a noticeably adverse effect on the application of the wire.

5.7.3 The depth of surface defects in the case of grade D wire shall be determined as specified in subclause 6.4.6; the permissible values are given in table 3.

5.7.4 In the case of grade D wire, no decarburization in the edge zone shall be present; the decarburization depth determined as described in subclause 6.4.7 shall not exceed the permissible values specified in table 3.

5.8 Dimensions and permissible dimensional deviations

5.8.1 DIN 2076 shall apply for dimensions and permissible dimensional deviations, subject to the limitation given in subclause 5.8.2.

Note. The nominal dimensions given in table 3 and the permissible dimensional deviations are in agreement with DIN 2076.

5.8.2 The deviation of the wire diameter in the as delivered condition, with respect to the nominal diameter ordered, shall be within the limits specified in table 3, the specifications applying to coils with a mass, in kg, not exceeding 100 × d (d is the nominal diameter of wire, in mm) or 500 kg, whichever is smaller.

• In the case of coils of greater mass, the permissible deviations shall be agreed.

5.8.3 Ovality, i.e. the difference between the maximum and minimum diameters of the wire at the same cross section, shall not be more than 50 % of the total permissible deviation specified in table 3.

6 Testing

6.1 • Agreement on tests and documents on materials testing

6.1.1 It may be agreed at the time of ordering that one of the documents specified in DIN 50 049 be furnished for each supply.

6.1.2 If the issue of a test report is agreed, the results of the cast analysis for the elements listed in table 1 shall be given in it.

6.1.3 If the issue of an inspection certificate is agreed, the specifications in subclauses 6.2 to 6.5 shall apply with regard to the necessary tests.

The specifications on sampling (see table 5, column 8) and on the test procedure (see subclause 6.4) shall apply also to subsequent tests in the case of complaints.

6.2 • Scope of test programme for acceptance inspection

The specifications given in table 5, columns 1 to 7 shall apply for the scope of test programme.

6.3 • Sampling

The specifications given in table 5, column 8 shall apply for sampling. Sampling shall always be carried out at the ends of the coils.

6.4 Test procedure

6.4.1 The chemical composition shall be determined according to the methods given in the *Handbuch für das Eisenhüttenlaboratorium*[1]) (Handbook for the ferrous metallurgy laboratory).

6.4.2 The tensile test shall be carried out

- on wires of nominal diameters less than 6 mm, as specified in DIN 51 210 Part 1,
- on wires of nominal diameters from 6 mm, as specified in DIN 50 145,

on test pieces having the full cross section of the wire.

For calculating the tensile strength, the nominal cross section shall be used in the case of wires of nominal diameters exceeding 2,00 mm and the actual cross section in the case of wires of nominal diameters not exceeding 2,00 mm.

6.4.3 The wrapping test shall be carried out by analogy with DIN 51 215 as follows:

A test piece about 500 mm long shall be closely coiled around a mandrel of approximately 3 × d (d is the nominal wire diameter), but not less than 1,0 mm in diameter. The test piece shall then be extended and released in such a manner that the length of the released test piece is at least twice the coiled length but not more than four times the coiled length.

The surface condition of the wire and the regularity of the pitch of the turns shall be inspected with the test piece in this condition.

6.4.4 The torsion test shall be carried out by analogy with DIN 51 212. The gauge length shall however in all cases be 100 × d (d is the nominal diameter of wire), but not more than 300 mm.

6.4.5 In the test for freedom from corkscrew set, one free wap shall be taken from wire supplied in coils, after the binding wires have been removed. The wap shall be suspended and the wap diameter D and the axial displacement f of the wire ends measured.

6.4.6 The check for surface defects shall be carried out on test pieces cut from the ends of the coils, either after deep etching or microscopically on transverse sections. In the case of deep etching, the test piece to be examined shall first be degreased and stress-relieved by tempering at 500 °C. Etching shall be carried out in 1 : 1 hydrochloric acid solution at (75^{+5}_{0}) °C until the reduction in diameter is about 1 %; the reduction shall not however exceed 0,03 mm. If surface defects are detected, their depth can be measured for example by transverse sections or by the profile method. Cases of dispute shall be settled on the basis of the result of a measurement carried out on a transverse section with a magnification of × 200.

6.4.7 The depth of decarburization shall be determined by the microscopic method as specified in DIN 50 192 on test pieces cut from the ends of the coils.

6.4.8 "Go" and "Not go" gap gauges or micrometers are suitable for checking the diameter. Ovality, defined as the difference between the maximum and minimum diameters at the same cross section, shall be checked.

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[1]) For suppliers, see the "Standards and other documents referred to" clause.

6.5 Retests

DIN 17 010 shall apply to retests.

7 Notes on the use of the wires

Apart from the tensile strength determined by the chemical composition, heat treatment and cold working, wire grades A, B, C and D differ in their surface quality and deformability. The notes on use in table 6 are based on these differences.

8 Complaints

8.1 Under current law, a complaint may only be raised against defective products if the defects noticeably impair their processing and use. This shall apply unless otherwise agreed at the time of ordering.

8.2 It is normal and practical for the purchaser to give the supplier the opportunity to judge whether the complaints are justified, where possible by submitting the product objected to or samples of the product supplied.

Table 1. **Chemical composition of wire grades as determined in the cast analysis**

Wire grade	Nominal diameter mm	Chemical composition (cast analysis) % by mass C	Si [1] max.	Mn	P max.	S max.	Cu max.
A	1,00 to 10,00	0,40 [2] to 0,85	0,35	0,30 to 1,00	0,040	0,040	0,20
B	0,30 to 6,00	0,55 to 0,85	0,35	0,30 to 1,00	0,040	0,040	0,20
	6,30 to 14,00	0,40 to 0,85	0,35	0,30 to 1,00	0,040	0,040	0,20
	15,00 to 20,00	0,40 to 0,85	0,35	0,30 to 1,50	0,040	0,040	0,20
C	2,00 to 6,00	0,70 to 1,00	0,35	0,30 to 1,50	0,030	0,030	0,12
	6,30 to 20,00	0,50 to 1,00	0,35	0,30 to 1,50	0,030	0,030	0,12
D	0,07 to 6,00	0,70 to 1,00	0,35	0,30 to 1,50	0,030	0,030	0,12
	6,30 to 20,00	0,50 to 1,00	0,35	0,30 to 1,50	0,030	0,030	0,12

[1] The steel shall be killed.
[2] If the wire is used for purposes in which a tendency to set is not significant, a lower carbon content may be agreed.

Table 2. **Chemical composition of wire grades as determined in the product analysis**

Wire grades	Nominal diameter mm	Chemical composition (cast analysis) % by mass C	Si max.	Mn	P max.	S max.	Cu max.
A	1,00 to 10,00	[1]	0,38	0,26 to 1,04	0,045	0,045	0,23
B	0,30 to 6,00		0,38	0,26 to 1,04	0,045	0,045	0,23
	6,30 to 14,00		0,38	0,26 to 1,04	0,045	0,045	0,23
	15,00 to 20,00		0,38	0,26 to 1,55	0,045	0,045	0,23
C	2,00 to 20,00		0,38	0,26 to 1,55	0,035	0,035	0,14
D	0,07 to 20,00		0,38	0,26 to 1,55	0,035	0,035	0,14

[1] In the case of supplies of wire which, according to the test report or the inspection certificate (see DIN 50 049), has a carbon content of less than 0,55 % as determined by the cast analysis, the product analysis may differ from the value given in the document by ± 0,03 % C, and otherwise by ± 0,04 % C.

Table 3. **Mechanical properties[1]) and quality requirements for wire grades A, B, C and D**

1	2	3	4	5	6	7	8	9	10	11	12	13
Wire diameter d[1])												
Nominal size	Permissible deviations as specified in DIN 2076 for wire grades		Mass kg/1000 m	Tensile strength R_m for wire grades				Minimum reduction in area after fracture Z for wire grades	Minimum number of twists in the torsion test for wire grades	Permissible depth of surface defects for wire grade	Permissible decarburization depth for wire grade	Wire diameter d (nominal size)
mm	A and B mm	C and D mm	≈	A N/mm²	B N/mm²	C N/mm²	D N/mm²	A, B, C, D %	A, B, C, D	D mm	D mm	mm
0,07			0,0302				2800 to 3100					0,07
0,08			0,0395				2800 to 3100					0,08
0,09			0,0499				2800 to 3100					0,09
0,10			0,0617				2800 to 3100					0,10
0,11		±0,004	0,0746				2800 to 3100					0,11
0,12			0,0888				2800 to 3100					0,12
0,14	–		0,121		–		2800 to 3100					0,14
0,16			0,158				2800 to 3100					0,16
0,18			0,200				2800 to 3100		Wrapping test as specified in subclause 6.4.3			0,18
0,20			0,247				2800 to 3100					0,20
0,22			0,298	–		–	2770 to 3060	–		–[2])	–[2])	0,22
0,25			0,385				2720 to 3010					0,25
0,28		±0,008	0,488				2680 to 2970					0,28
0,30			0,555		2370 to 2650		2660 to 2940					0,30
0,32			0,631		2350 to 2630		2640 to 2920					0,32
0,34			0,713		2330 to 2600		2610 to 2890					0,34
0,36	±0,015		0,799		2310 to 2580		2590 to 2870					0,36
0,38		±0,010	0,890		2290 to 2560		2570 to 2850					0,38
0,40			0,985		2270 to 2550		2560 to 2830					0,40
0,43			1,14		2250 to 2520		2530 to 2800					0,43

1) For intermediate values of wire diameter, the values specified for the next higher diameter shall apply.
2) Because of the small wire diameter, measurement of the depth of defects or depth of decarburization can only be carried out with difficulty. For this reason, no maximum value is specified for this diameter range.

Table 3. (continued)

1	2	3	4	5	6	7	8	9	10	11	12	13
Wire diameter d [1]												
Nominal size	Permissible deviations as specified in DIN 2076 for wire grades		Mass kg/1000 m	Tensile strength R_m for wire grades				Minimum reduction in area after fracture Z for wire grades	Minimum number of twists in the torsion test for wire grades	Permissible depth of surface defects for wire grade	Permissible decarburization depth for wire grade	Wire diameter d (nominal size)
mm	A and B mm	C and D mm	≈	A N/mm²	B N/mm²	C N/mm²	D N/mm²	A, B, C, D %	A, B, C, D	D mm	D mm	mm
0,45	±0,015	±0,010	1,25	–	2240 to 2500	–	2510 to 2780	–	Wrapping test as specified in subclause 6.4.3	–[2]	–[2]	0,45
0,48			1,42		2220 to 2480		2490 to 2760					0,48
0,50	±0,020		1,54		2200 to 2470		2480 to 2740					0,50
0,53			1,73		2180 to 2450		2460 to 2720					0,53
0,56			1,93		2170 to 2430		2440 to 2700					0,56
0,60			2,22		2140 to 2400		2410 to 2670					0,60
0,63			2,45		2130 to 2380		2390 to 2650					0,63
0,65			2,60		2120 to 2370		2380 to 2640					0,65
0,70			3,02		2090 to 2350		2360 to 2610					0,70
0,75			3,47		2070 to 2320		2330 to 2580		25			0,75
0,80			3,95		2050 to 2300		2310 to 2560			1 % max. of wire diameter	1,5 % max. of wire diameter	0,80
0,85	±0,025	±0,015	4,45		2030 to 2280		2290 to 2530					0,85
0,90			4,99		2010 to 2260		2270 to 2510					0,90
0,95			5,59		2000 to 2240		2250 to 2490					0,95
1,00			6,17	1720 to 1970	1980 to 2220		2230 to 2470	40				1,00
1,05			6,80	1710 to 1950	1960 to 2200		2210 to 2450					1,05
1,10			7,46	1690 to 1940	1950 to 2190		2200 to 2430					1,10
1,20			8,88	1670 to 1910	1920 to 2160		2170 to 2400					1,20
1,25			9,63	1660 to 1900	1910 to 2140		2150 to 2380					1,25
1,30			10,42	1640 to 1890	1900 to 2130		2140 to 2370					1,30
1,40			12,08	1620 to 1860	1870 to 2100		2110 to 2340					1,40
1,50	±0,035	±0,020	13,9	1600 to 1840	1850 to 2080		2090 to 2310		22			1,50

1,60	±0,035	±0,020	15,8	1590 to 1820	1830 to 2050	–	2060 to 2290	40	22	1 % max. of wire diameter	1,5 % max. of wire diameter	1,60
1,70			17,8	1570 to 1800	1810 to 2030		2040 to 2260					1,70
1,80			20,0	1550 to 1780	1790 to 2010		2020 to 2240					1,80
1,90			22,3	1540 to 1760	1770 to 1990		2000 to 2220					1,90
2,00			24,7	1520 to 1750	1760 to 1970	1980 to 2200	1980 to 2200					2,00
2,10			27,2	1510 to 1730	1740 to 1960	1970 to 2180	1970 to 2180					2,10
2,25			31,2	1490 to 1710	1720 to 1930	1940 to 2150	1940 to 2150					2,25
2,40			35,5	1470 to 1690	1700 to 1910	1920 to 2130	1920 to 2130					2,40
2,50			38,5	1460 to 1680	1690 to 1890	1900 to 2110	1900 to 2110					2,50
2,60			41,7	1450 to 1660	1670 to 1880	1890 to 2100	1890 to 2100					2,60
2,80			48,3	1420 to 1640	1650 to 1850	1860 to 2070	1860 to 2070					2,80
3,00			55,5	1410 to 1620	1630 to 1830	1840 to 2040	1840 to 2040					3,00
3,20			63,1	1390 to 1600	1610 to 1810	1820 to 2020	1820 to 2020					3,20
3,40	±0,045	±0,025	71,3	1370 to 1580	1590 to 1780	1790 to 1990	1790 to 1990		16			3,40
3,60			79,9	1350 to 1560	1570 to 1760	1770 to 1970	1770 to 1970					3,60
3,80			89,0	1340 to 1540	1550 to 1740	1750 to 1950	1750 to 1950					3,80
4,00			98,6	1320 to 1520	1530 to 1730	1740 to 1930	1740 to 1930	35				4,00
4,25			111	1310 to 1500	1510 to 1700	1710 to 1900	1710 to 1900					4,25
4,50			125	1290 to 1490	1500 to 1680	1690 to 1880	1690 to 1880		12			4,50
4,75			139	1270 to 1470	1480 to 1670	1680 to 1860	1680 to 1860					4,75
5,00			154	1260 to 1450	1460 to 1650	1660 to 1840	1660 to 1840					5,00
5,30			173	1240 to 1430	1440 to 1630	1640 to 1820	1640 to 1820		11			5,30
5,60			193	1230 to 1420	1430 to 1610	1620 to 1800	1620 to 1800					5,60
6,00	±0,060	±0,035	222	1210 to 1390	1400 to 1580	1590 to 1770	1590 to 1770		10			6,00
6,30			245	1190 to 1380	1390 to 1560	1570 to 1750	1570 to 1750		9			6,30
6,50			260	1180 to 1370	1380 to 1550	1560 to 1740	1560 to 1740		9			6,50
7,00			302	1160 to 1340	1350 to 1530	1540 to 1710	1540 to 1710		9			7,00
7,50			347	1140 to 1320	1330 to 1500	1510 to 1680	1510 to 1680	30	7 [3]			7,50
8,00			395	1120 to 1300	1310 to 1480	1490 to 1660	1490 to 1660		7 [3]			8,00
8,50			445	1110 to 1280	1290 to 1460	1470 to 1630	1470 to 1630		6 [3]			8,50

For [1] and [2], see page 5.

[3] Guideline values; not mandatory for acceptance inspection.

Table 3. (continued)

1	2	3	4	5	6	7	8	9	10	11	12	13
Wire diameter d [1]												
Nominal size	Permissible deviations as specified in DIN 2076 for wire grades		Mass kg/1000 m	Tensile strength R_m for wire grades				Minimum reduction in area after fracture Z for wire grades	Minimum number of twists in the torsion test for wire grades	Permissible depth of surface defects for wire grade	Permissible decarburization depth for wire grade	Wire diameter d (nominal size)
mm	**A** and **B** mm	**C** and **D** mm	≈	**A** N/mm²	**B** N/mm²	**C** N/mm²	**D** N/mm²	**A, B, C, D** %	**A, B, C, D**	**D** mm	**D** mm	mm
9,00	±0,070	±0,050	499	1090 to 1260	1270 to 1440	1450 to 1610	1450 to 1610	30	6 [3]	1 % max. of wire diameter	1,5 % max. of wire diameter	9,00
9,50			559	1070 to 1250	1260 to 1420	1430 to 1590	1430 to 1590		5 [3]			9,50
10,00			617	1060 to 1230	1240 to 1400	1410 to 1570	1410 to 1570		5 [3]			10,00
10,50	±0,090	±0,070	680	–	1220 to 1380	1390 to 1550	1390 to 1550	–	–			10,50
11,00			746		1210 to 1370	1380 to 1530	1380 to 1530					11,00
12,00			888		1180 to 1340	1350 to 1500	1350 to 1500					12,00
12,50			963		1170 to 1320	1330 to 1480	1330 to 1480					12,50
13,00			1042		1160 to 1310	1320 to 1470	1320 to 1470					13,00
14,00			1208		1130 to 1280	1290 to 1440	1290 to 1440					14,00
15,00			1387		1110 to 1260	1270 to 1410	1270 to 1410					15,00
16,00	±0,12	±0,080	1578		1090 to 1230	1240 to 1390	1240 to 1390					16,00
17,00			1782		1070 to 1210	1220 to 1360	1220 to 1360					17,00
18,00	±0.15	±0,100	1998		1050 to 1190	1200 to 1340	1200 to 1340					18,00
19,00			2225		1030 to 1170	1180 to 1320	1180 to 1320					19,00
20,00			2466		1020 to 1150	1160 to 1300	1160 to 1300					20,00

[1]) See page 5.
[3]) Guideline values; not mandatory for acceptance.

Table 4. **Wire diameter ranges and associated minimum coil inside diameters**

Wire diameter mm	Minimum permissible inside diameter of coils mm
$> 0{,}18$ to $\leq 0{,}28$	100
$> 0{,}28$ to $\leq 0{,}50$	150
$> 0{,}50$ to $\leq 0{,}70$	180
$> 0{,}70$ to $\leq 1{,}60$	250
$> 1{,}60$ to $\leq 4{,}50$	400
$> 4{,}50$	500

Table 5. **Scope of test programme and sampling for acceptance inspection and summary of data relating to test procedures and requirements**

	1	2	3	4	5	6	7	8	9	10
Line number	Test method	To be carried out for wire grades	[1]	Acceptance unit	Number of test pieces per acceptance unit	Number of test lengths per test piece	Number of specimens per test length	Sampling	For test procedure, see subclause	For requirements, see subclause (or table)
1	Product analysis	A B C D	n.V.[2]	Quantity of wire supplied per cast	1	1	1	As specified in SEP 1805[7]	6.4.1	(2)
2	Tensile test	A B C D	o	Quantity of wire supplied per production batch[3]	10 %[4]	1	1	On test pieces taken from the ends of the coils	6.4.2	(3)
3	Wrapping test[5]	B D	n.V.		The scope of test programme shall be agreed at the time of ordering.				6.4.3	5.5.1
4	Torsion test[6]	A B C D							6.4.4	5.5.2 and (3)
5	Test for freedom from corkscrew set	A B C D							6.4.5	5.6.4
6	Check for surface defects	D							6.4.6	5.7.3 and (3)
7	Check for decarburization	D							6.4.7	5.7.4 and (3)
8	Dimensional inspection	A B C D							6.4.8	5.8 and (3)

[1] o = the test shall be carried out in any case if the issue of an inspection certificate or inspection report has been agreed; n.V. = the test shall be carried out, even where the issue of an inspection certificate or inspection report has been agreed, only when specially agreed at the time of ordering.
[2] If an acceptance inspection has been agreed, in all cases, the purchaser shall be informed on the result of the cast analysis for the elements listed for the relevant steel grades in table 1.
[3] A production batch shall consist of a production quantity originating from the same cast, subjected to the same heat treatment conditions and exhibiting the same reduction in cross section and the same surface finish.
[4] 10 % of the coils or spools contained in the production batch, but not less than 2 and not more than 10 coils or spools.
[5] Only for diameters up to 0,7 mm.
[6] Only for diameters over 0,7 up to 10 mm.
[7] For suppliers, see the "Standards and other documents referred to" clause.

Table 6. **Notes on use**

Wire grade	To be used for
A	tension, compression, torsion or shaped springs subject to low static stresses or rarely to dynamic stresses
B	tension, compression, torsion or shaped springs subject to medium static and low dynamic stresses
C	tension, compression, torsion or shaped springs subject to high static and low dynamic stresses
D	tension and compression springs subject to high static and a medium dynamic stresses, and torsion and shaped springs subject to high static and high dynamic stresses

Other standards and documents referred to

DIN 1653 Surface condition of commercial steel wires; nomenclature and abbreviations

DIN 2076 Round spring wire; dimensions, masses, permissible deviations

DIN 17 010 General technical delivery conditions for steel and steel products

DIN 17 014 Part 1 Heat treatment of ferrous materials; technical concepts

DIN 17 140 Part 1 Wire rod for cold drawing; technical delivery conditions for basic steel and quality carbon steels

DIN 17 223 Part 2 Round steel wire for springs, quality specifications; quenched and tempered carbon steel spring wire and quenched and tempered carbon steel valve spring wire

DIN 17 224 Stainless steel spring wire and spring strip; technical delivery conditions

DIN 17 225 High temperature steels for springs; quality properties

DIN 50 049 Documents on materials testing

DIN 50 145 Testing of metallic materials; tensile test

DIN 50 192 Determination of depth of decarburization

DIN 51 210 Part 1 Testing of metallic materials; tensile test on wires without using an extensometer

DIN 51 212 Testing of metallic materials; torsion test on wires

DIN 51 215 Testing of metallic materials; wrapping test on wires; general information

Stahl-Eisen-Prüfblatt (Iron and steel test sheet) 1805[2]) *Probenahme und Probenvorbereitung für die Stückanalyse bei Stählen* (Sampling and sample preparation for the product analysis of steels)

Handbuch für das Eisenhüttenlaboratorium[2]);
volume 2: *Die Untersuchung der metallischen Stoffe* (Investigation of metallic materials); Düsseldorf 1966;
volume 5 (supplementary volume): A 4.4 – *Aufstellung empfohlener Schiedsverfahren* (List of recommended arbitration procedures);
B – *Probenahmeverfahren* (Sampling procedures);
C – *Analyseverfahren* (Methods of analysis);
latest edition in each case.

Previous editions

DIN 2076: 02.44; DIN 17 223: 04.55; DIN 17 223 Part 1: 03.64

Amendments

The following amendments have been made in comparison with the March 1964 edition:

a) Wire grade II has been deleted, wire grade D has been included for the first time.

b) For wire grade A, the diameter range from 0,30 to 0,95 mm has been dropped and for wire grade C, the diameter range from 0,07 to 1,90 mm has been dropped. For wire grades B and C, the diameter range has been extended up to 20,00 mm.

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[2]) Obtainable from: *Verlag Stahleisen mbH*, Postfach 82 29, D-4000 Düsseldorf 1.

c) The permissible deviations in diameter as given in DIN 2076 have been adopted.

d) For designation of wire grades, only letter symbols are now used and no material numbers.

e) The wire may be supplied either in coils or wound onto spools. The possible surface finishes have been listed.

f) As regards the chemical composition, limits for the elements C, Si and Mn have also been specified; for wire grades A and B, the maximum percentage of Cu has been reduced from 0,25 to a maximum percentage by mass of 0,20.

g) A table for the percentages by mass permissible in the product analyses for the elements C, Si, Mn, P, S and Cu has been included for the first time.

h) The tensile strength values and minimum values for reduction in area after fracture and the number of turns in the torsion test have been specified for the first time (see Explanatory notes).

i) For wire grade A, the wrapping test has been dropped. Apart from this, the limiting nominal size for the wrapping test (and, as a consequence, for the torsion test) has been raised from 0,50 to 0,70 mm. The procedure to be followed in the wrapping test has been modified.

j) The data for freedom from corkscrew set have been specified for wires of less than 5 mm nominal diameter by adopting a formula for the maximum axial displacement (see Explanatory notes).

k) For wire grade D, the maximum permissible depths of surface defects and skin decarburization have been specified (see Explanatory notes).

l) A definite scope of test programme has been specified for acceptance inspection. Clear specifications have also been given for sampling.

m) Minimum inside diameters of coils have been specified as a function of the wire diameter.

n) The notes on use of the various grades of wire have been revised.

Explanatory notes

The tensile strength values have been specified for the first time in comparison with the draft for this standard, taking into account agreements reached in the European Community. On the basis of the state of discussions at the time the present standard was published, on the corresponding EURONORM now being prepared, the same tensile strength values are being specified in the EURONORM as in DIN 17 223 Part 1; DIN 17 223 Part 1 however covers a greater range of nominal diameters for wire grades B and D. The tensile strength values specified in DIN 17 223 Part 1 were proposed for the ISO Standard on patented cold drawn steel wire for springs, also being prepared. The discussions in the relevant ISO Subcommittee, TC 17/SC 17, on this proposal had not taken place at the time the present standard was published.

The tensile strength values R_m specified in this standard can be calculated from the following equations:

grade A wire from 1,00 to 10,00 mm nominal diameter:

– lower limit: $R_m = 1720 - 660 \times \log d$;
– upper limit: $R_m = 1970 - 740 \times \log d$;

grade B wire from 0,30 to 20,00 mm nominal diameter:

– lower limit: $R_m = 1980 - 740 \times \log d$;
– upper limit: $R_m = 2220 - 820 \times \log d$;

grade C wire from 2,00 to 20,00 mm and
grade D wire from 0,20 to 20,00 mm nominal diameter:

– lower limit: $R_m = 2220 - 820 \times \log d$;
– upper limit: $R_m = 2470 - 900 \times \log d$.

With regard to the minimum number of turns in the torsion test specified in table 3, it should be noted that the gauge length has been reduced from a maximum of 500 mm to a maximum of 300 mm.

The discussions on the permissible depth of surface defects and skin decarburization encountered particular difficulties, because, on the one hand, users in some cases required values so low that they could not be measured with normal test instruments (except metallographically) and because, on the other hand, the steel wire manufacturers said that, on a percentage basis, it was only possible for them to concede defect depths equal to those permitted for the wire rod. The wire rod manufacturers stated that even with special treatment of the starting product, it was not possible in the present state of production and test technology to exclude the possibility that a batch of wire supplied might contain partial quantities that were defective with regard to the limiting value for the crack depth.

All participants considered the previous specifications inadequate, according to which the steel spring wire, after removal the binding wires, should not spring up above the plane of the coil. The spring manufacturers stated that the equation adopted in this standard for the axial displacement had been derived from measurement results; on the basis of their experience, it was applicable for wire up to 5 mm nominal diameter in the drawn condition but not in the tempered condition, but in any case it was not applicable to subsequently straightened wires. It had been found that wire exhibiting bad also did not satisfy the equation. Since the time had come to replace the term "drawn dead" by a measureable quantity and since freedom from corkscrew set is an essential factor in processing, it was desirable to adopt the equation in the standard. Even the wire manufacturers conceded that it would be desirable to have detailed specifications although they preferred simplified specifications, especially as the equation could not be used for larger diameters.

International Patent Classification

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