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Music Steel Spring Wire and Springs

SAE Recommended Practice
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MUSIC STEEL SPRING WIRE AND SPRINGS

1. SCOPE:

This SAE Recommended Practice covers a high quality, hard drawn, steel spring wire, uniform in mechanical properties, intended for the manufacturer of spring and wire forms subjected to high stresses or requiring good fatigue properties. It covers basic materials and processing requirements of springs and form fabricated therefrom.

2. MANUFACTURE AND WORKMANSHIP:

The steel shall be made by the electric furnace, open hearth, or basic oxygen process. Sufficient discard must be made to insure freedom from all pipe and undue segregation. The wire shall be properly patented and cold drawn to produce the specified mechanical properties. The wire shall be uniform in quality and shall not be kinked or improperly cast. To test for cast, a few convolutions of wire shall be cut from the bundle and placed on a flat surface. The wire shall lie substantially flat on itself and not show a wavy condition. Each unit shall be one continuous length of wire, properly coiled and firmly tied. Welds are not permitted at finished size except by negotiation between manufacturer and user.

3. FINISH:

Music steel spring wire is available in the following finishes:

1. Bright (white liquor).
2. Phosphate.
3. Tin.
4. Cadmium alloy.
5. Other finishes.

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4. CHEMICAL COMPOSITION:

The steel shall conform to the following chemical composition¹:

| Element | %, by wgt. |
|------------|------------------------|
| Carbon | 0.80-1.00 ^a |
| Manganese | 0.20-0.60 ^a |
| Phosphorus | 0.025 max |
| Sulfur | 0.030 max |
| Silicon | 0.10-0.30 |

^aCarbon and manganese may be varied from the above specified ranges by the manufacturer, by agreement with the purchaser, provided the mechanical properties specified are maintained.

6. PERMISSIBLE VARIATIONS IN DIMENSIONS:

Permissible variations in the wire diameter shall be as specified in Table 2.

7. WRAP TEST REQUIREMENT:

The wire shall wind on itself as an arbor without fracture. This test shall be conducted on wire prior to any stress relieving.

8. DECARBURIZATION:

Transverse sections of the wire properly mounted, polished, and etched shall show a maximum affected depth of partial decarburization to be no more than 1% of the wire diameter, but not to exceed 0.0015 in when examined at a magnification of 100X.

9. COILING TEST:

The coiling test shall be applied only to sizes 0.105 in and smaller in diameter. The wire shall be of good uniform mechanical properties. A length of tightly closed coil shall be wound on an arbor 3-3 1/2 times the diameter of the wire, and a 5 in length of coil shall be stretched so that it sets to approximately three times its original length. The wire so tested shall show a uniform pitch with no splits or fracture. This test should be conducted on wire prior to any stress relieving.

10. SURFACE CONDITION:

The surface of the wire specimens, which has been stress relieved at approximately 800°F for 1/2 h, shall be examined after etching in a solution of equal parts of commercial hydrochloric acid and water at a temperature of 165-175°F, for a sufficient time to remove approximately 1% of the wire diameter. This examination shall be made using a binocular microscope at a magnification not to exceed 10X for sizes 0.020 in and larger. For sizes under 0.020 in, the magnification used is subject to negotiation.

The surface of the wire shall be free from imperfections such as seams, pits, die marks, scratches, and other defects tending to impair the fatigue properties of the springs.

¹For permissible variations from specified chemical ranges and limits for steel, refer to SAE J409.

5. MECHANICAL PROPERTIES:

The tensile strength of the wire shall conform to the requirements in Table 1.

TABLE 1 - Tensile Strength of Wire

| Wire Diameter, in | Tensile Strength, ^a 10 ³ psi | | Wire Diameter in | Tensile Strength, ^a 10 ³ psi | |
|----------------------|---|-----|---------------------|---|-----|
| | Min | Max | | Min | Max |
| 0.004 | 439 | 485 | 0.055 | 300 | 331 |
| 0.005 | 426 | 471 | 0.059 | 296 | 327 |
| 0.006 | 415 | 459 | 0.063 | 293 | 324 |
| 0.007 | 407 | 449 | 0.067 | 290 | 321 |
| 0.008 | 399 | 441 | 0.072 | 287 | 317 |
| 0.009 | 393 | 434 | 0.076 | 284 | 314 |
| 0.010 | 387 | 428 | 0.080 | 282 | 312 |
| 0.011 | 382 | 422 | 0.085 | 279 | 308 |
| 0.012 | 377 | 417 | 0.090 | 276 | 305 |
| 0.013 | 373 | 412 | 0.095 | 274 | 303 |
| 0.014 | 369 | 408 | 0.100 | 271 | 300 |
| 0.015 | 365 | 404 | 0.102 | 270 | 299 |
| 0.016 | 362 | 400 | 0.107 | 268 | 296 |
| 0.018 | 356 | 393 | 0.110 | 267 | 295 |
| 0.020 | 350 | 387 | 0.112 | 266 | 294 |
| 0.022 | 345 | 382 | 0.121 | 263 | 290 |
| 0.024 | 341 | 377 | 0.125 | 261 | 288 |
| 0.026 | 337 | 373 | 0.130 | 259 | 286 |
| 0.028 | 333 | 368 | 0.135 | 258 | 285 |
| 0.030 | 330 | 365 | 0.140 | 256 | 283 |
| 0.032 | 327 | 361 | 0.145 | 254 | 281 |
| 0.034 | 324 | 358 | 0.150 | 253 | 279 |
| 0.036 | 321 | 355 | 0.156 | 251 | 277 |
| 0.038 | 318 | 352 | 0.162 | 249 | 275 |
| 0.040 | 315 | 349 | 0.177 | 245 | 270 |
| 0.042 | 313 | 346 | 0.192 | 241 | 267 |
| 0.045 | 309 | 342 | 0.207 | 238 | 264 |
| 0.048 | 306 | 339 | 0.225 | 235 | 260 |
| 0.051 | 303 | 335 | 0.250 | 230 | 255 |

^aThe tensile strength may be interpolated for intermediate sizes. Higher tensile strength music spring wire is available.

TABLE 2

| Diameter, in | Permissible Variations, ±in | Permissible Out of Round, in |
|--------------------------|--------------------------------|---------------------------------|
| 0.004 to 0.010 incl | 0.0002 | 0.0002 |
| Over 0.010 to 0.028 incl | 0.0003 | 0.0003 |
| Over 0.028 to 0.063 incl | 0.0004 | 0.0004 |
| Over 0.063 to 0.080 incl | 0.0005 | 0.0005 |
| Over 0.080 to 0.250 incl | 0.0010 | 0.0010 |

11. FINISHED PARTS:

1. The springs shall be free from rust and there shall be no marks, nicks, cracks, or gouges which will impair the serviceability of the part.
2. Springs made from this wire shall normally be stress relieved for a minimum of 30 min at heat. Typical temperatures are 450-500°F. It should be recognized that in certain applications lower than typical stress relieving temperatures may be used or omitted completely. This is also true for thin flexible spring designs to minimize distortion.
3. To relieve hydrogen embrittlement, parts which are electroplated after coiling shall be heated at 350°F minimum for a minimum of 2 h immediately after plating. Higher minimum temperatures and time may be necessary.

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RATIONALE:

Not applicable.

RELATIONSHIP OF SAE STANDARD TO ISO STANDARD:

Not applicable.

REFERENCE SECTION:

SAE J409 JUN84, Product Analysis-Permissible Variations from Specified Chemical Analysis of a Heat or Cast of Steel.

APPLICATION:

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