SPARK TEST METHOD FOR STEELS

1. Scope

This standard covers the method of spark test (hereinafter referred to as the "test") with grinder for steel ingots, steel billets, steel materials, and other steel products (hereinafter referred to as "test specimens").

2. Objective

The aim of this test is to estimate the steel class of test specimens or determine the presence of different steels in test specimens.

3. Definitions

For the purpose of this standard, the following definitions apply:

(1) Estimation of steel class

To test a test specimen of unknown steel class and estimate its steel class.

(2) Discrimination of different steels

To examine test specimens suspected of including a different steel and determine inclusion of a different steel or ascertain no intermixture of different steels.

4. Forms and Designations of Sparks

Forms and designations of sparks shall be as shown in Fig. 1.

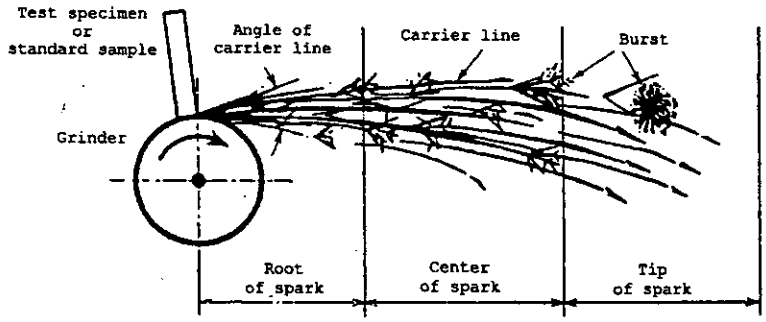

Fig. 1 Form and Designation of Spark

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5. Equipment

5.1 Test Equipment

In order to ensure consistency in test conditions, care shall be taken to use always identical equipment.

5.2 Grinder

Either an electric motor- or pneumatic air-driven, and either fixed or portable type grinder may be used. It shall be capable of producing sufficient sparks for observation and be such that grinding and observation are carried out safely.

5.3 Grinding Wheel

A grinding wheel with a grain size of 36 or 46 and bonding of P or Q or so, specified in JIS R 6210 (Vitrified Grinding Wheels), shall be used. Further, a peripheral speed of 20 m/s or over shall be reached, as a rule.

5.4 Auxiliary Equipment

If it is necessary to prevent the effect of draft, to avoid direct sunlight, or to regulate the surrounding light, black curtains, screens, or a portable dark cabinet should preferably be used.

6. Standard Samples

(1) It is recommended to prepare several steel bars or the like of known chemical composition as standard samples.

(2) The determination of the chemical composition of standard samples shall be in accordance with chemical analysis methods specified in the Japanese Industrial Standards.

(3) The standard samples shall be capable of producing the representative sparks of their steel classes, and shall be free from decarburized layers, carburized layers, nitrided layers, affected zones by acetylene cutting, scales, and the like.

(4) The standard samples shall desirably have undergone the same manufacturing processes as test specimens.

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7. Test Method

7.1 General Rules for Test

(1) The test shall always be carried out under identical conditions and with identical equipment.

(2) In general, the test shall be carried out in a suitably darkened room. Where the test is carried out in the open air or in a light place, the brightness of the background shall be regulated so as not to interfere with the color of spark or its brightness, shading the spark from direct sunlight by use of auxiliary equipment.

(3) In carrying out the test, the effect of draft shall be avoided. In particular, sparks shall not be projected against draft.

(4) The test specimen shall be ground on the portion from which sparks representing the chemical composition of its base steel are produced. The surface of steel, if it is a decarburized layer, carburized layer, nitrided layer, or affected zone by acetylene cutting, or has scales, shall be avoided as it gives off sparks differing from those of the base steel.

(5) The test specimen shall be pressed against the grinding wheel, or vice versa, at as much a uniform pressure as possible. The pressure shall be adjusted so that approximately 0.2% C steel generates a spark approximately 500 mm long, as a rule.

(6) Sparks shall be cast horizontally or in an obliquely upward direction. They shall be observed from the rear(1) or sideways(2).

Note: (1)
Sparks are thrown in the direction away from the observer so that the observer sees them from behind the carrier lines.
Note: (2)
The observer sees the carrier lines from the side.

(7) In the observation of sparks, the characteristics of carrier lines and bursts, as shown below, shall be observed carefully over each part of the root, center and tip of the spark.

(a) Carrier lines (color, brightness, length, thickness, and number)
(b) Bursts (shape, size, number, and dusts)
(c) Resistance

7.2 Testing for Estimating Steel Classes

(1) Steel classes shall be estimated by testing in accordance with Section 7.1, "General Rules for Test." The characteristics of carrier lines and bursts shall be observed and the carbon content and kinds and quantities of alloying elements shall be surmise complying with Section 8, "Criteria for Estimation of Steel Classes."

(2) It is recommended to follow the procedures shown in Section 8.2 in estimating steel classes.

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(3) After rough estimation of the steel class adhering to the above procedures, the results of the estimation shall be corrected by comparing the spark with that of the standard sample of the estimated steel class.

7.3 Discrimination Test of Different Steels

(1) Carry out the test on the standard sample corresponding to the test specimens and verify the spark.

(2) Carry out the test in accordance with Section 7.1, "General Rules for Test" on all test specimens. Observe sparks complying with Section 8, "Criteria for Estimation of Steel Classes." Then, follow the procedures below.

(a) If no dissimilarity with the standard sample is detected regarding all observation items, the test specimens shall be assumed to be free of intermixture of different steels.

(b) If any obvious dissimilarities with the standard sample are detected regarding one or more observation items, the steel that presents those dissimilarities shall be assumed to be a different steel.

(c) In case of doubt about similarity regarding an observation item, a discriminating test or other test shall be additionally conducted for verification.

8. Criteria for Estimation of Steel Classes

8.1 Method for Estimating Steel Classes

Steel classes shall be estimated by making comparison with the standard sample, consulting the characteristics and example sketches of sparks shown below.

(1) Spark characteristics of carbon steels

Spark characteristics of carbon steels are shown in Table 1 and Figs. 2 and 3.

(2) Example sketches of carbon steel sparks

Examples of carbon steel sparks are sketched in Attached Figs. 1-1 through 1-8(3). Furthermore, sparks of rimmed steels are sketched in Attached Figs. 1-9 and 1-10.

Note: (3)

Example sketches of sparks are those of killed steel, unless otherwise noted.

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Table 1 Spark Characteristics of Carbon Steels

C%	Carrier line					Burst				Resistance felt by hand
	Color	Bright-ness	Length	Thickness	Number	Shape	Size	Number	Dust	
Under 0.05	Orange	Dark	Long	Thick	Few	No burst(4)				Soft
0.05						2-forked burst	Small	Few	No	
0.1						3-forked burst			No	
0.15						Multiple-forked burst			No	
0.2						3-forked burst in 2 steps			No	
0.3						Multiple-forked burst in 2 steps			Commencement of dusting	
0.4						Multiple-forked burst in 3 steps			Dusty	
0.5		Bright	Long	Thick			Large			
0.6										
0.7										
0.8										
Over 0.8	Red	Dark	Short	Thin	Many	Complex	Small	Many	Many	Hard

Note: (4)
No burst is detected, but spikes are observed.

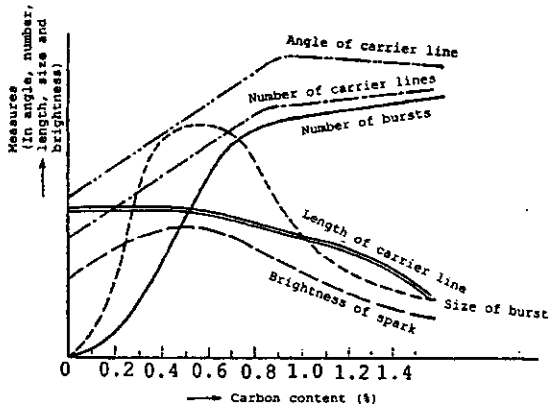

Fig. 2 Spark-Characteristic Curves of Carbon Steel

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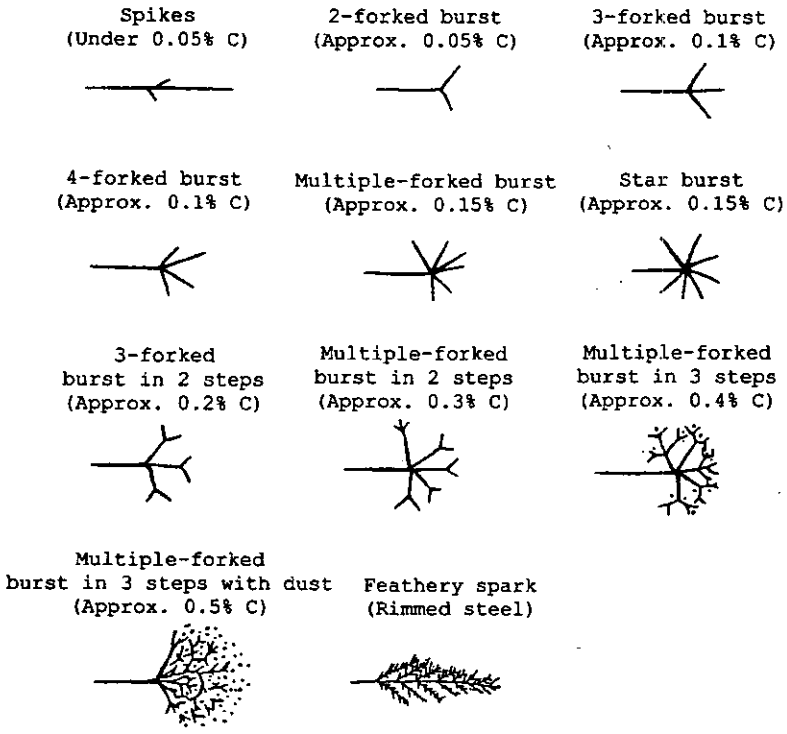

Fig. 3 Spark Characteristics of Carbon Steels (Carbon Bursts)

(3) Spark characteristics of alloying elements
Spark characteristics of alloying elements are shown in Table 2 and Fig. 4.

(4) Example sketches of sparks of alloy steels
Example sketches of sparks of alloy steels are shown in Attached Figs. 2-1 through 2-30.

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Table 2 Effects of Alloying Elements on Spark Characteristics

General classification of effect	Alloying element	Carrier liner				Burst				Resistance	Characteristic	
		Color	Brightness	Length	Thickness	Color	Shape	Number	Dust		Shape	Position
Promotion of carbon burst	Mn	Yellowish white	Bright	Short	Thick	White	Complicated, fine dendritic form	Many	Yes	Soft	Dust	Center
	Cr	Orange	Dark	Short	Thin	Orange	Chrysanthemum flower shape	Constant	Yes	Hard	Flower	Tip
	V	No significant effect				No significant effect	Fine	Many	---	---	---	---
Suppression of carbon burst	W	Dark red	Dark	Short	Thin, wavy, and intermittent	Red	Droplet and foxtail	Few	No	Hard	Foxtail	Tip
	Si	Yellow	Dark	Short	Thick	White	White bead	Few	No	---	White bead	Center
	Ni	Reddish yellow	Dark	Short	Thin	Reddish yellow	Flash with blob	Few	No	Hard	Flash with blob	Center
	Mo	Reddish orange	Dark	Short	Thin	Reddish orange	Spearhead	Few	No	Hard	Spearhead	Tip

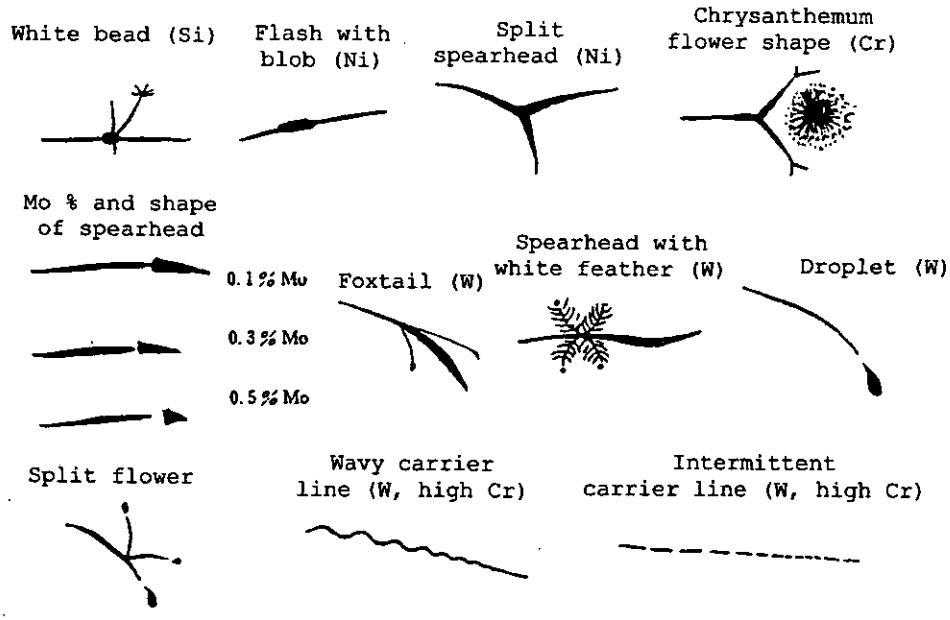

Fig. 4 Spark Characteristics of Alloying Elements

8.2 Steel Class Estimation Procedures

(1) Spark test procedures for estimating steel classes are shown in Tables 3-1 and 3-2.

(2) First of all, make a general classification into the group of carbon and low-alloy steels and that of high-alloy steels by the presence or absence of carbon bursts (the first classification in Table 3-1 and the first classification in Table 3-2).

(3) For Carbon and Low-Alloy Steels

(a) First, estimate the carbon content in percent according to the amount of carbon bursts. Roughly classify into groups of 0.25% or under, over 0.25% to 0.5% incl. and over 0.5% carbon contents (the second classification in Table 3-1).

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(b) If the carbon content is 0.5% or under, the steel may contain Ni, Cr, Si, Mn, and Mo. If the carbon content is over 0.5%, the steel may contain W and V in addition to the aforementioned elements. Therefore, examine the presence or absence of these alloying elements, and estimate whether it is a carbon steel or low-alloy steel (the third classification in Table 3-1).

(c) If the steel is a low-alloy steel, estimate the steel class by observing spark characteristics and identifying the kinds and quantities of alloying elements.

(4) For High-Alloy Steels

Classify steels into stainless, heat-resisting, high-speed tool, and alloy tool steels according mainly to the color of carrier lines (the second and third classifications in Table 3-2). As these high-alloy steels contain Ni, Cr, Mo, W, V, Co, and the like, estimate the steel classes by observing spark characteristics and identifying the kinds and quantities of alloying elements.

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9. Steel Classes Difficult or Impossible to Discriminate by Spark Test
It is very difficult or impossible to determine the classes of some steels, as their sparks are extremely similar to each other. In such a case, it is recommended to use a chemical analysis method or other test method in addition to the spark test.

10. Safety
Adhere to provisions in the Industrial Safety and Health Law and the Ordinance on Labor Safety and Hygiene, which govern grinders and use of them.

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Table 3 Steel Class Estimation Procedures (Table 3-1)

1st classification			2nd classification			3rd classification			Estimation of steel class		
Observation	Characteristic	Classification	Observation	Characteristic	Classification	Observation	Characteristic	Classification	Characteristic		Example of estimated steel class
Presence or absence of carbon burst	Carbon burst present	Carbon burst series	Amount of bursts	Multiple-forked bursts	0.25% C or under	Special spark	No special spark	Carbon steel	---		Carbon steel (S 10 C, S 15 CK)
							Only carbon spark		Feathery form		Ordinary steel (SS 41)
									Feathery form		Rimmed steel
							Special spark	Low-alloy steel	Flash with blob, split spearhead Chrysanthamum flower shape, hard resistance, neat bursts near the root Spearhead	Ni Cr Mo	Nickel chromium steel (SNC 415) Chromium steel (SCr 420) Chromium molybdenum steel (SCM 415)
				Multiple-forked burst in multiple steps	C of over 25% to 0.5% incl.	Special spark	No special spark	Carbon steel	---		Carbon steel forging (SF 55) Carbon steel (S 30 C, S 45 C)
							Only carbon spark				
							Special spark	Low-alloy steel	Flash with blob, split spearhead Chrysanthamum flower shape, hard resistance, neat bursts near the root Spearhead	Ni Cr Mo	Nickel chromium steel (SNC 631) Chromium steel (SCr 440) Chromium molybdenum steel (SCM 440) Nickel chromium molybdenum steel (SNCM 447) Manganese chromium steel (SMnC 443)
				Many bursts in dendritic form	Over 0.5% C	Special spark	No special spark	Carbon steel	---		Carbon tool steel (SK 3, SK 5) Spring steel (SUP 3, SUP 4)
							Only carbon spark				
							Special spark	Low-alloy steel	Chrysanthamum flower shape, hard resistance, neat bursts near the root	Cr	Ball bearing steel (SUJ 1, SUJ 2, SUJ 3)
									White bead	Si	Spring steel (SUP 6, SUP 7)

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(Table 3-2)

1st classification			2nd classification			3rd classification			Estimation of steel class		
Observation	Characteristic	Classification	Observation	Characteristic	Classification	Observation	Characteristic	Classification	Characteristic	Example of estimated steel class
Presence or absence of carbon burst										
	No burst									
		Carrier line series								
			Color of carrier line							
				Orange series	Orange series	Special spark	No burst	Pure iron	---	SUY 1 (*)
						Special spark	Bulge in tip	Stainless steel	Attracted by magnet	SUS 420 J 2
				Reddish orange	Orange series				Not attracted by magnet	SUS 304
				Dark red	Dark reddish series	Special spark	No burst Bulge in tip	Heat resisting steel	---	SUH 3
				Thin carrier line			No burst Intermittent wavy carrier lines	High-speed tool steel	Split flowers, droplets	SKH 2
						Special spark			Split flowers, droplets	SKH 3
									Split flowers, no droplet	SKH 4
									Bulge in tip with flowers	SKH 9
						Special spark	Spearhead with white feather	Alloy tool steel (SKS series)	---	SKS 2, SKS 3, SKS 4
							Flashing, fine chrysanthemum flower shape	Alloy tool steel (SKD series)	---	SKD 1, SKD 11

Note (5): Electromagnetic soft iron

Applicable Standard

JIS R 6210 Vitrified Grinding Wheels

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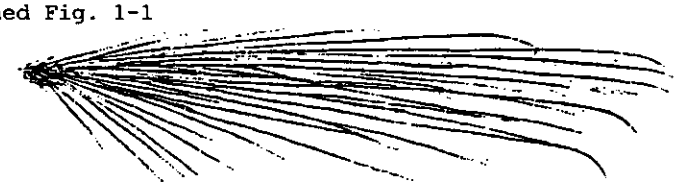
Attached Fig. 1 Example Sketches of Sparks of Carbon Steels

Attached Fig. 1-1



	C	Si	Mn
Approx. 0.05% C steel	0.05	0.14	0.28

1. The spark is mostly composed of carrier lines only, which appear thick.
2. Some 2-forked bursts are observable.

Attached Fig. 1-2

	C	Si	Mn
Approx. 0.1% C steel	0.09	0.25	0.45

1. Three- or 4-forked bursts are observable.
2. Carrier lines are conspicuous on the whole.

Attached Fig. 1-3

	C	Si	Mn
Approx. 0.2% C steel	0.23	0.23	0.43

1. Three-forked bursts in 2 steps are observable.
2. Carrier lines are conspicuous on the whole.

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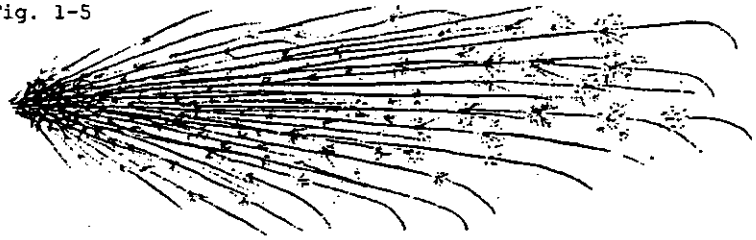
Attached Fig. 1 (Continued)

Attached Fig. 1-4

	C	Si	Mn
Approx. 0.3% C steel	0.32	0.24	0.74

1. Relatively large multiple-forked bursts in 2 steps are observed.
2. Small bursts are observed at the root.

Attached Fig. 1-5



	C	Si	Mn
Approx. 0.4% C steel	0.41	0.22	0.70

1. Multiple-forked bursts in 3 steps or more are observed. Large and complicated forms of bursts are generated.
2. Carrier lines look thin.

Attached Fig. 1-6

	C	Si	Mn
Approx. 0.5% C steel	0.51	0.26	0.75

1. Bursts are very large and accompany dust.
2. Carrier lines look thin, but large in number.

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Attached Fig. 1 (Continued)

Attached Fig. 1-7

	C	Si	Mn
Approx. 0.6 to 0.8% C steel	0.74	0.24	0.33

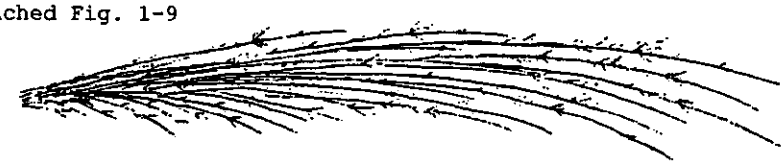
1. Many small and complicated bursts occur.
2. Carrier lines are short and reddish.

Attached Fig. 1-8

	C	Si	Mn
Approx. 0.9 to 1.2% C steel	1.03	0.21	0.34

1. Bursts are very small in size but extremely large in number.
2. Carrier lines are short and more reddish.

Attached Fig. 1-9



	C	Si	Mn
Rimmed steel (1)	0.08	0.01 max.	0.37

1. Each carrier line has spiky bursts at several places. Bursts in 2 steps are also observed at the tip of spark.
2. Carrier lines are uniform in brightness.

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Attached Fig. 1 (Continued)

Attached Fig. 1-10

	C	Si	Mn
Rimmed steel (2)	0.24	Under 0.01	0.46

1. In each carrier line, bursts are produced at several places. (Many bursts are observed, compared with killed steel containing an equal amount of carbon.)
2. Carrier lines are uniform in brightness.
3. The extreme end of the spark bursts in feathery sparklers.

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Attached Fig. 2 Example Sketches of Sparks of Alloy Steels

Attached Fig. 2-1

	C	Si	Mn	Cr
SCr 420	0.21	0.28	0.74	1.02

1. Bursts near the root are somewhat neat.
2. Below is a comparison with approx. 0.2% C steel in characteristics near the root.

Approx. 0.2% C steel SCr 420

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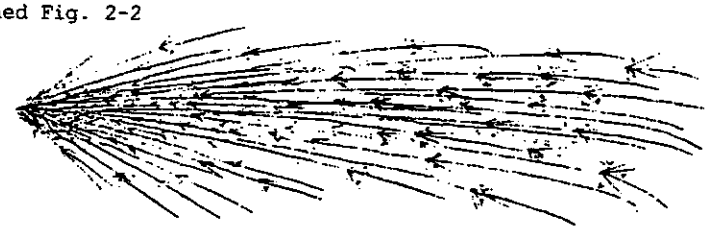
Attached Fig. 2 (Continued)

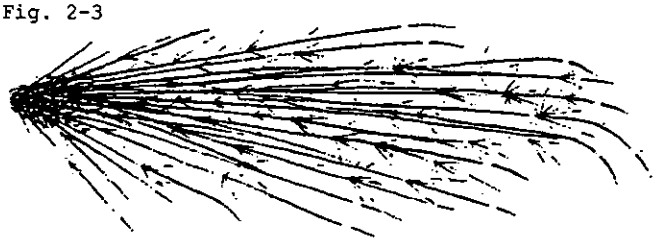
Attached Fig. 2-2



	C	Si	Mn	Cr
SCr 440	0.39	0.22	0.70	1.01

1. Bursts near the root are somewhat neat.

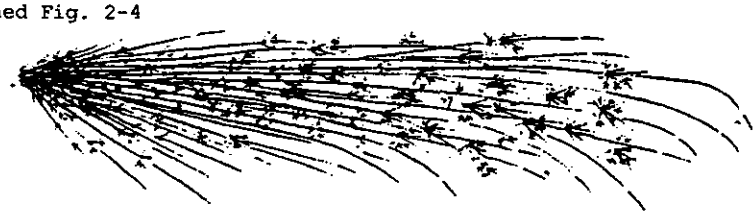
Attached Fig. 2-3



	C	Si	Mn	Cr	Mo
SCM 420	0.20	0.26	0.74	1.06	0.17

1. In addition to the characteristics of approx. 0.2% C steel, spearheads are observed, which are the characteristics of Mo.

Attached Fig. 2-4



	C	Si	Mn	Cr	Mo
SCM 440	0.40	0.25	0.77	1.04	0.15

1. In addition to the characteristics of approx. 0.4% C steel, spearheads, which are the characteristics of Mo, are observed. However, the characteristics of Mo are somewhat obscure being affected by the carbon bursts.

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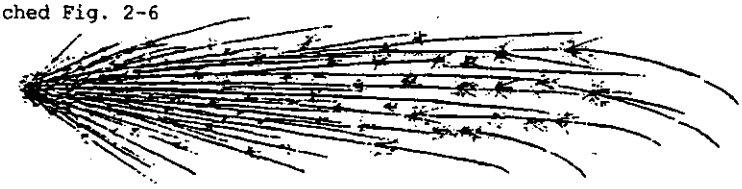
Attached Fig. 2 (Continued)

Attached Fig. 2-5

	C	Si	Mn	Ni	Cr
SNC 415	0.16	0.26	0.56	2.04	0.37

1. Flashes with blobs, the characteristics of Ni, are observed over the root and center.
2. Carrier lines look relatively reddish on the whole.

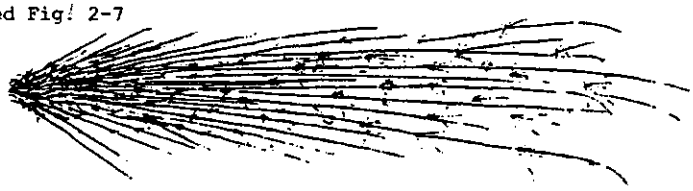
Attached Fig. 2-6



	C	Si	Mn	Ni	Cr
SNC 631	0.32	0.29	0.49	2.68	0.66

1. The spark looks reddish on the whole. Carrier lines are not so long.
2. It is somewhat difficult to distinguish flashes with blobs, which is the characteristics of Ni.

Attached Fig. 2-7



	C	Si	Mn	Ni	Cr	Mo
SNCM 420	0.18	0.30	0.53	1.70	0.52	0.20

1. Characteristic flashes with blobs are observed over the root and center.
2. Below is a comparison of flashes with blobs over the root and center.

   Other steels containing Ni SNCM 420

3. Carrier lines are slightly dark at the root. Noticeable spearheads caused by Mo are present.

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Attached Fig. 2 (Continued)

Attached Fig. 2-8

	C	Si	Mn	Ni	Cr	Mo
SNCM 447	0.48	0.33	0.90	1.85	0.71	0.16

1. Bursts are small. Carrier lines look reddish on the whole.
2. Flashes with blobs, the characteristics of Ni, are observed. However, the characteristics of Mo are not distinct.

Attached Fig. 2-9

	C	Si	Mn	Cr	Mo	Al
SACM 645	0.44	0.44	0.54	1.48	0.18	0.92

1. Few and small bursts are generated.
2. Spearheads, the characteristics of Mo, are distinct.

Attached Fig. 2-10

	C	Si	Mn	Ni
3.5% Ni steel	0.12	0.31	0.86	3.66

1. Reddish and thick carrier lines are observed.

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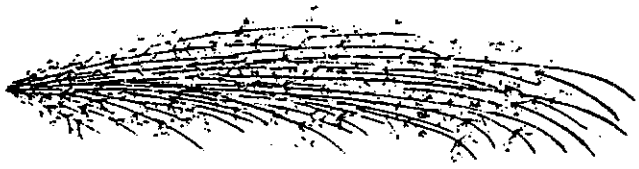
Attached Fig. 2 (Continued)

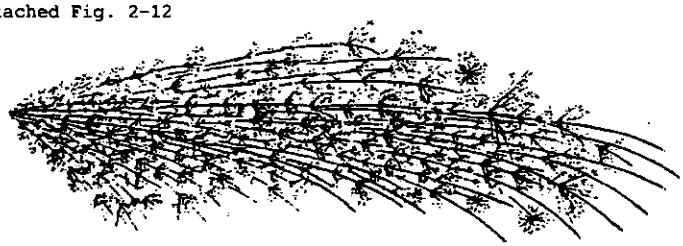
Attached Fig. 2-11



	C	Si	Mn
SUP 6	0.63	1.57	0.85

1. Extreme ends of the carrier lines become somewhat thick.
2. The spark is yellow on the whole.
3. White beads, the characteristics of Si, are produced, although they are unclear.
4. Fine bursts are generated.

Attached Fig. 2-12



	C	Si	Mn	Cr
SUP 9	0.59	0.30	0.91	0.85

1. The spark is somewhat bright on the whole.
2. Bursts are brisk and sharp in shape.
3. Star-shaped bursts are observed.
4. Bursts look uniform in size.

Attached Fig. 2-13

	C	Si	Mn	Cr
SUJ 2	0.98	0.17	0.30	1.33

1. Numerous and brisk carbon bursts are produced.
2. Carrier lines appear thin.
3. Bursts accompany dust in the range from the center to the end. Bursts are neat at the root of the spark compared with those of approx. 0.9% C steel.

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Attached Fig. 2 (Continued)

Attached Fig. 2-14

	C	Si	Mn	Cr
SUJ 3	0.97	0.52	1.07	1.08

1. Carbon bursts are smaller than those of SUJ 2.
2. The spark is more reddish in color and abundant in dust than that of SUJ 2.

Attached Fig. 2-15

	C	Si	Mn	Cr	W
SKS 2	1.05	0.25	0.52	0.56	1.10

1. No carbon burst is produced.
2. Carrier lines are thin and dark red in color.
3. Spearheads with white feathers are observed.

Attached Fig. 2-16

	C	Si	Mn	Cr	W
SKS 3	0.99	0.30	0.99	0.59	0.54

1. More split flowers are produced than with SKS 2.
   With regard to other characteristics, SKS 2 and SKS 3 are the same.

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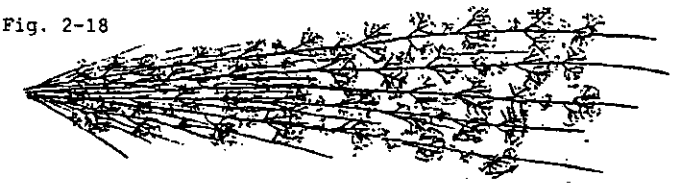
Attached Fig. 2 (Continued)

Attached Fig. 2-17

	C	Si	Mn	Cr	W
SKS 4	0.47	0.26	0.47	0.68	0.75

1. Compared with SKS 2 and SKS 3, SKS 4 presents somewhat fewer split flowers and thicker carrier lines.

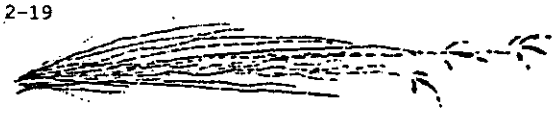
Attached Fig. 2-18



	C	Si	Mn	Cr	V
SKS 43	1.02	0.11	0.13	0.05	0.15

1. The spark of SKS 43 resembles to that of SK 3, but is brighter. Numerous and large sparklers are generated. Small flowers with dust are also present.

Attached Fig. 2-19



	C	Si	Mn	Cr	W	Mo	V	Co
SKH 2	0.77	0.23	0.33	4.08	17.60	0.54	0.86	0.25

1. The spark consists only of intermittent wavy carrier lines and is short.
2. Split flowers with droplets in their extreme ends are observed.
3. The spark is dark red on the whole. No carbon burst is observed.

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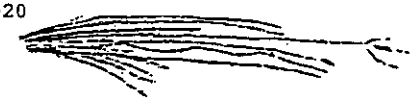
Attached Fig. 2 (Continued)

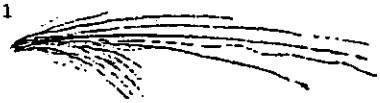
Attached Fig. 2-20



	C	Si	Mn	Cr	W	Mo	V	Co
SKH 3	0.81	0.27	0.29	4.10	18.00	0.74	0.85	4.52

1. Intermittent and wavy carrier lines are produced, which are somewhat fewer and shorter than those of SKH 2.
2. Some split flowers and droplets are observed, but are slightly smaller than those of SKH 2.
3. The spark is dark red in color on the whole. No carbon burst is observed.

Attached Fig. 2-21



	C	Si	Mn	Cr	W	Mo	V	Co
SKH 4 A	0.74	0.23	0.28	4.10	17.25	0.56	1.13	9.15

1. No split flower or droplet is observed.
2. Intermittent and wavy carrier lines are somewhat shorter than those of SKH 3.
3. The spark is dark red in color on the whole. No carbon burst is observed.

Attached Fig. 2-22

	C	Si	Mn	Cr	W	Mo	V
SKH 9	0.85	0.20	0.30	4.10	6.06	4.90	1.89

1. Flowers are produced at the tip. Blobs are observed at the extreme end.
2. No droplet is observed.
3. The spark is dark red. Intermittent and wavy carrier lines are somewhat thicker and brighter than those of SKH 2.

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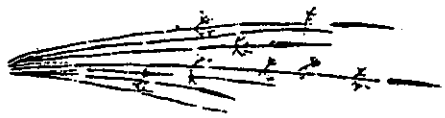
Attached Fig. 2 (Continued)

Attached Fig. 2-23



SKD 6	C	Si	Mn	Cr	Mo	V
	0.32	1.02	0.40	4.85	1.44	0.30

1. Carrier lines are broken into long segments and are somewhat thick.
2. Carrier lines bulge and flower at the extreme ends.

Attached Fig. 2-24

SKD 11	C	Si	Mn	Cr	Mo	V
	1.48	0.22	0.41	11.60	0.88	0.26

1. Carrier lines are thin and short.
2. Numerous small chrysanthemum flower shapes are observed.

Attached Fig, 2-25

SUH 3	C	Si	Mn	Ni	Cr	Mo
	0.38	1.94	0.38	0.41	10.64	0.82

1. No carbon burst is present.
2. Carrier lines are dark red and short. Intermittent carrier lines are also included.
3. White blobs are seen at the center and tip.

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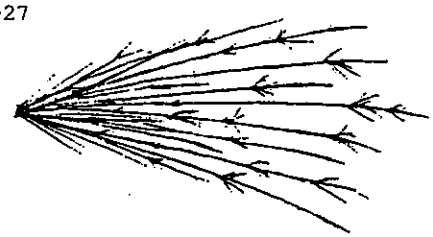
Attached Fig. 2 (Continued)

Attached Fig. 2-26

	C	Si	Mn	Ni	Cr	W
SUH 31	0.41	1.75	0.53	13.85	15.10	2.33

1. No carbon burst is present.
2. Carrier lines are dark red and short.
   Intermittent carrier lines are also included.

Attached Fig. 2-27



	C	Cr
SUS 410	0.12	12.25

1. Multiple-forked bursts are observed
   in the center-to-tip range and are thick at ends.
2. Among stainless steels, carrier lines are thick,
   long, and large in number.

Attached Fig. 2-28

	C	Cr
SUS 430	0.06	16.00

1. Carrier lines extend about half as long as those of SUS 410.
2. Three-forked bursts are observed somewhat ahead of the center.

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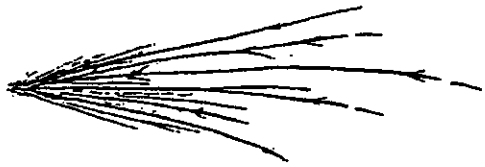
Attached Fig. 2 (Continued)

Attached Fig. 2-29



SUS 304	C	Ni	Cr
	0.07	8.66	18.12

1. The spark consists mostly of carrier lines.
   A few spikes are observed in the center-to-tip range.
2. Dark red intermittent carrier lines and wavy carrier lines are observed occasionally near the root.

Attached Fig. 2-30

SUS 316	C	Cr	Ni	Mo
	0.07	17.28	12.26	2.32

1. The spark is very similar to that of SUS 304, but few spikes are observed.

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