Metal Identification

Titanium

Nickel

Copper

Cast Iron

. . . . . There are several Metal Identification Methods used to identify a piece of metal . . . .

1. The primary method is Visual . . . . .

Metals	Color of unfinished broken surface	Color and structure of newly fractured surface	Color of freshly filed surface
White Cast Iron	Dull gray	Silvery-white; crystalline	Silvery white
Gray Cast Iron	Dull gray	Dark gray; crystalline	Light silvery gray
Malleable Iron	Dull gray	Dark gray; fine crystalline	Light silvery gray
Wrought Iron	Light gray	Bright gray	Light silvery gray
Low-carbon and Cast steel	Dark gray	Bright gray	Bright silvery gray
High Carbon Steel	Dark gray	Light gray	Bright silvery gray
Stainless Steel	Dark gray	Medium gray	Bright silvery gray
Copper	Reddish –brown to green	Bright red	Bright copper color
Brass and Bronze	Reddish yellow, yellow-green, or brown	Red to yellow	Reddish yellow to yellowish white
Aluminum	Light gray	White; fine crystalline	White
Monel l	Dark gray	Light gray	Light gray
Nickel	Dark gray	Off-white	Bright silvery white
Lead	White to gray	Light gray; crystalline	White

Question: The most common way to identify metals is visual

True False

1. What **color** is it?

a. (i.e., Aluminum, Copper, Brass, Stainless)

2. How **heavy/dense** is it?

a. (i.e., aluminum vs. stainless)

3. What is the **surface appearance**?

a. (i.e., roughness, from molds, part numbers)

b. Feeling the surface can help identify the metal.

c. Unfinished stainless steel is slightly rough.

d. Wrought iron, copper, brass, bronze, nickel, and Monel and lead are smooth.

e. Lead has a velvety appearance.

Cast Iron **Copper** **Carbon Steel** **Stainless Steel**




4. How was the **part used**?

5. Mechanical and physical **requirements** of the job

a. (i.e., drill bit – hard enough to last but not brittle)

6. How was the **part made**?

a. Forge marks, cast marks, rolling, stamping, etc.

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Question: Many metals have distinctive coloring and surfaces that help to identify them.

True False

7. Fracture appearance

a. Texture of grain structure, color of new and old break, uniformity of grain structure, degree of bending before break

b. Cast iron and malleable iron usually show evidence of the sand mold.

c. Low-carbon steel often shows forging marks

d. High-carbon steel shows either forging or rolling marks.

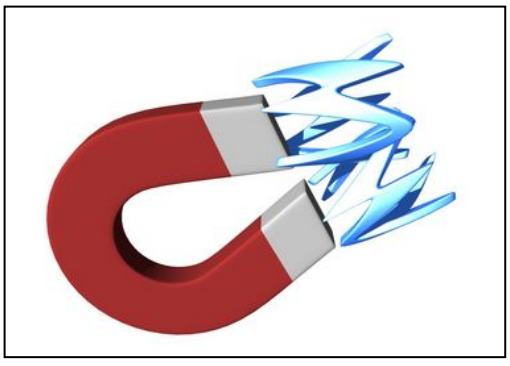
Fractured Steel

II. Magnetic Test . . . . .

1. The Magnetic Test is another method used to aid in the general identification of metals. Some metals are non-magnetic.

2. Generally ferrous metals are magnetic, and nonferrous metals are non-magnetic. This test is not 100 % accurate because some stainless steels are non-magnetic. In this instance, there is no substitute for experience.

Magnetic Force and Magnets

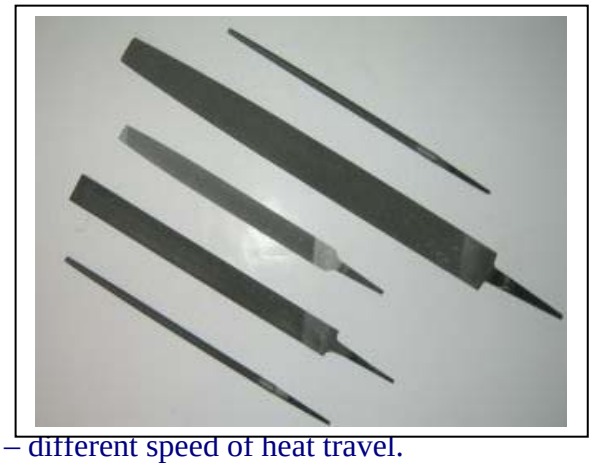


Question: Generally ferrous metals are magnetic, and nonferrous metals are non-magnetic.

True False

III. File Test . . . . .

1. Observe relative ease of filing



a. Soft metal files easily, the file bites into the metal.

b. File slides over the surface of hard metal easily.

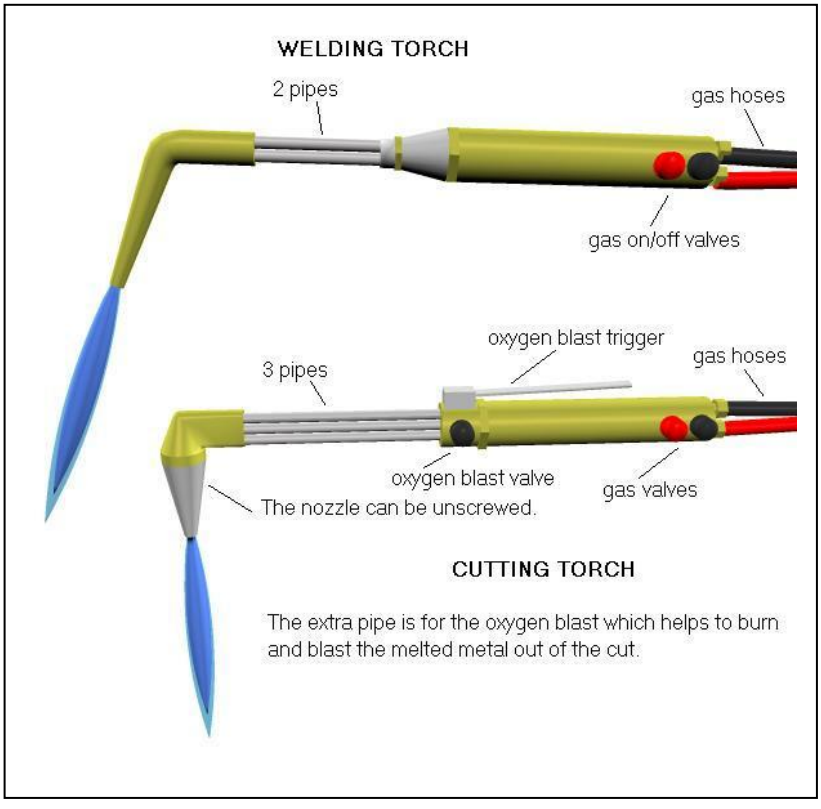
IV. Oxy-Acetylene Torch Test . . . . .

1. Use a neutral welding flame -

- Test heat conductivity, different metal – different speed of heat travel.

- Speed of melting, different metals – different melting temperatures.

- Color change, different metals – different color changes



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Question: Some Stainless steels are non-magnetic so the magnet test is not 100% accurate.

True False

Question: A file will cut hard metal easily and will slide over soft metal easily.

True False

Question: Heat from a torch affects different metals in several ways.

True False

V. Spark Test . . . . .

1. Observe sparks at grinding wheel under subdued light

a. Grinding wheel should be clean

b. Pressure on metal should be medium and uniform

c. Compare known samples to unknown samples

2**. Observe**

a. Spark Color

b. Length of spark lines

c. Number of explosions

d. Explosion shape

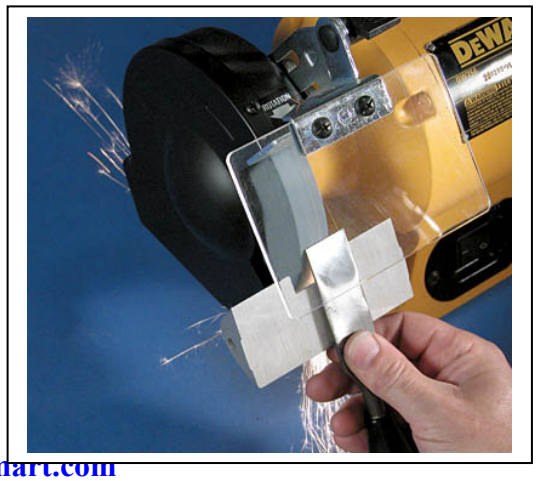
3. It is an **accurate method** of identification

a. Sparks occur relative to oxidation of the heated metal particles

b. Iron does not oxidize rapidly therefore the spark lines are long and fade out with cooling

c. **High carbon steels** have a spark with short lines and many explosions

Bench Grinders



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Question: Iron does not oxidize rapidly therefore the spark lines are long and fade out as they cool.

True False

4. How to do the Spark Test

a. Do the spark test made by holding a sample of the material against an abrasive wheel. By visually inspecting the spark stream experienced metalworkers can identify metals with accurately.

b**.** The **spark test** is fast, economical, convenient, and easy.

c**.** When you **hold a piece of iron or steel in contact** with a high-speed abrasive wheel, small particles of metal are torn loose so rapidly that they become red-hot.

d. The **amount** of sparks or lack of sparks given off help identify the metal.

e. The **length** of the spark stream, **color,** and **form** of the sparks help identify the metal.

d. Steels with the same carbon content that contain different alloy are difficult to identify because the alloying elements affect the sparks.

Grinding Hardened Steel

e. The alloy may slow or accelerate the carbon spark or make the sparks lighter or darker in color.

f. Molybdenum shows up as a detached, orange-colored spearhead at the end of the sparks.

g. Nickel seems to suppress the effect of the carbon burst.

h. Nickel sparks can be identified by tiny blocks of brilliant white light.

i. Silicon suppresses the carbon burst more than nickel. If silicon is present, the sparks end abruptly in a white flash of light.

Question: Silicon causes a bright flash of white in the spark stream.

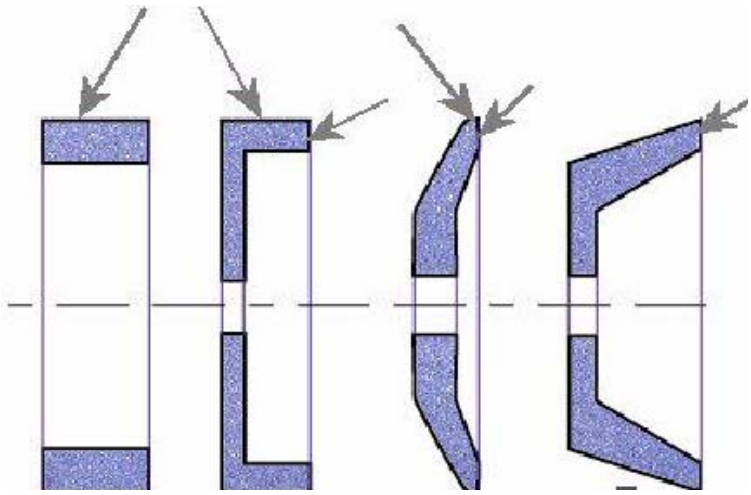
True False

j. **Spark testing** should be done with a portable or stationary grinder at no less than 4,500 feet per minute.

k. The **abrasive wheel** should be coarse, very hard, and clean to produce a true spark

l. Grinding wheels come in various shapes. Each shape is selected to perform a specific job.

Typical Grinding Surfaces



Cylindrical **Straight Cup** **Dish** **Flared Cup**

m. The **cylindrical wheel** is the most common type. Its cutting surface is located at the periphery of the wheel. Wheels of this shape are often mounted on a plate.

n. The **straight cup wheel** is designed to cut on the periphery and the side face at the same time. This type of wheel is often used to grind shoulders.

o. The **dish wheel** is a tool and cutter grinding wheel. It is typically used to regrind end mills and has a specific shape to accomplish that.

p. The **flared cup wheel** is also a tool and cutter grinding wheel. There are several cup shapes available depending on the needs of the machinist.

q. **Grinding wheels** can be custom dressed with a diamond tool to achieve nearly any shape desired.

5. Low, Medium and High Carbon Steels

a. It is difficult to distinguish these metals from each other by the spark test. Low Carbon and High Carbon steel produce a white spark stream.

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Question: Spark testing should be done with a portable or stationary grinder at no less than 500 feet per minute.

True False

6. Monel and Nickel

a. Monel and nickel have almost identical spark streams.

- The sparks are small in volume and orange in color.

- The sparks form wavy streaks with no sparklers.

- They cannot be distinguished by the spark test.

7. Stainless Steel

a. Stainless steel produces a long spark stream up to 50 inches long.

- The sparks are moderate in volume with few sparklers.

- The sparklers are forked.

- The stream next to the wheel is straw-colored, and at the end, it is white.

8. Wrought Iron

a. Wrought iron produces a spark stream up to 65 inches long.

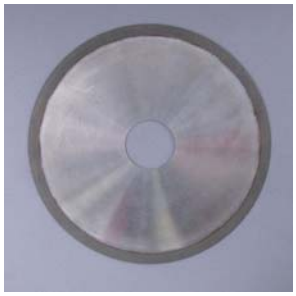
- The stream has a large volume with few sparklers.

- The sparks appear near the end of the stream and are forked.

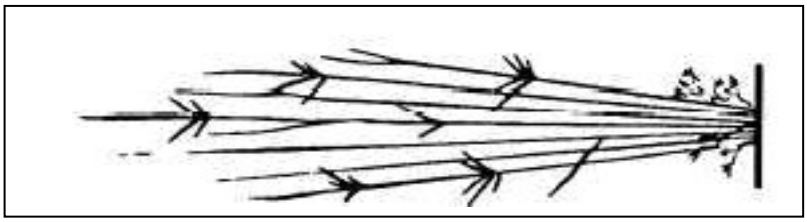
- The stream next to the wheel is straw-colored, and the outer end of the stream is a brighter red.

Choose the Right Wheel for the Job – Type and Media

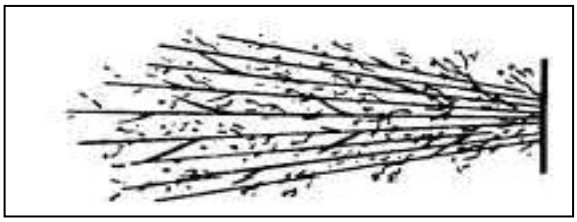
Cup Wheel **Straight Wheel** **Diamond Wheel**



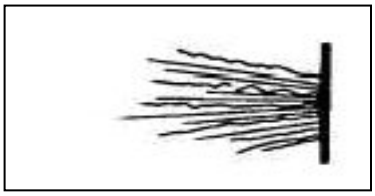
Low Carbon and Cast Steel



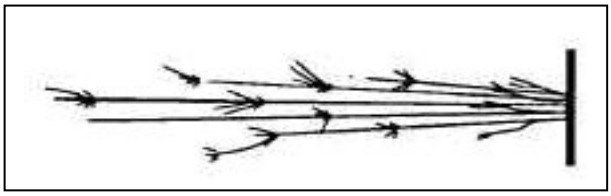
High Carbon Steel



Monel and Nickel

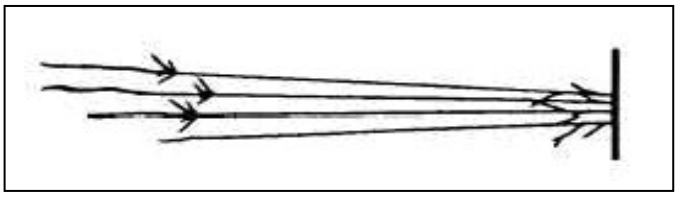


Stainless Steel



Gray Cast Iron

Wrought Iron



VI. Chip Test . . . . .

1. The chip test is done by removing a small amount of material from the test piece with a sharp, cold chisel.

2. The **Chip Test** shows chips from small, broken fragments to a continuous strip.

3. The **chip** may have smooth, sharp edges or it may be coarse or fine-grained.

4. The **chip** may have saw tooth edges.

5. The **chip** size is important in identifying the metal.

6. The ease of the **chipping** process is a factor in identifying the metal.

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Question: A cold chisel is the best way to do the chip test.

True False

Summary Test

1. Question: The most common way to identify metals is visual

True False

2. Question: Many metals have distinctive coloring and surfaces that help to identify them.

True False

3. Question: Generally ferrous metals are magnetic, and nonferrous metals are non-magnetic.

True False

4. Question: Some Stainless steels are non-magnetic so the magnet test is not 100% accurate.

True False

5. Question: A file will cut hard metal easily and will slide over soft metal easily.

True False

6. Question: Heat from a torch affects different metals in several ways.

True False

7. Question: Iron does not oxidize rapidly therefore the spark lines are long and fade out as they cool.

True False

8. Question: Silicon causes a bright flash of white in the spark stream.

True False

9. Question: Spark testing should be done with a portable or stationary grinder at no less than 500 feet per minute.

True False

10. Question: A cold chisel is the best way to do the chip test.

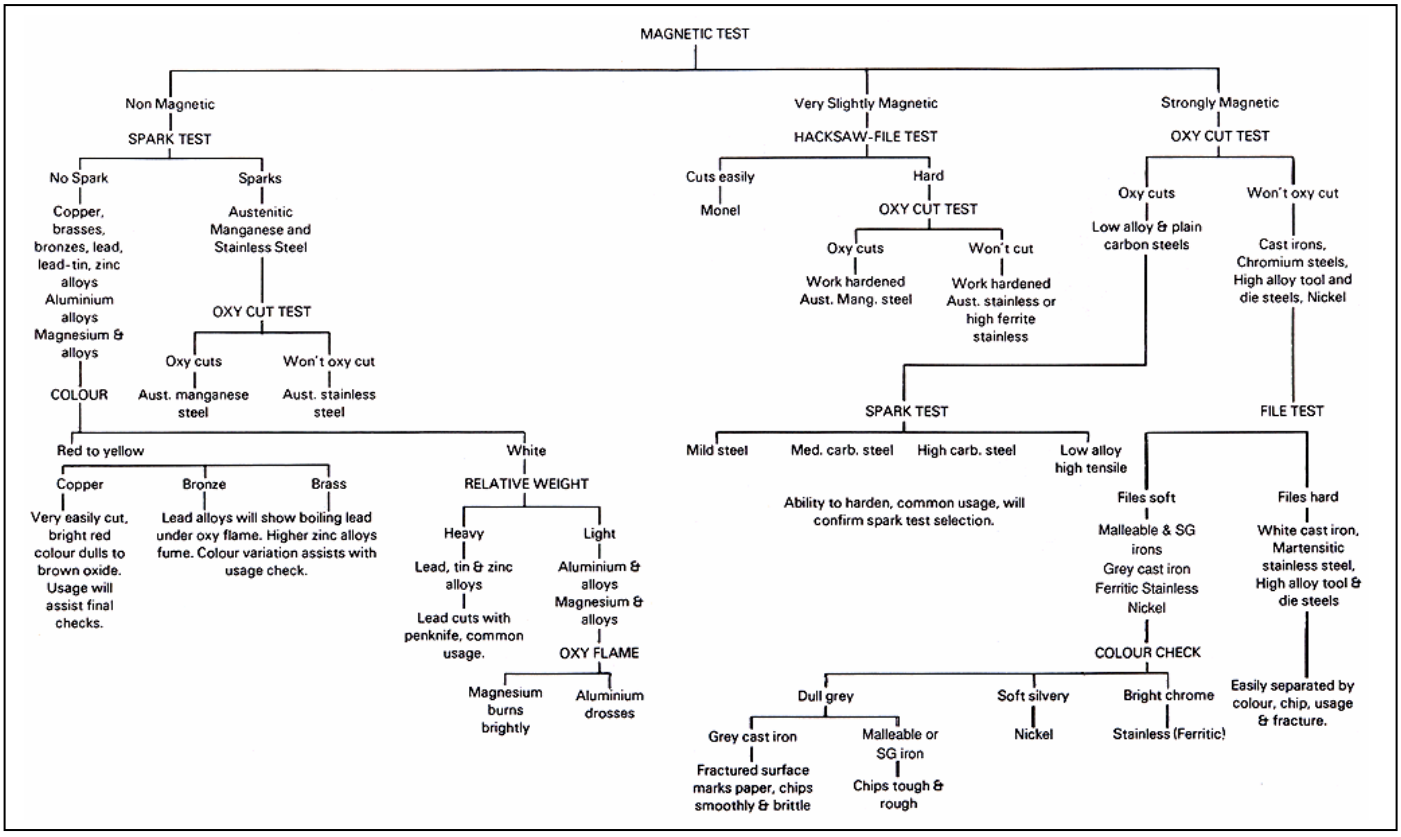
True False

Addendum I

Metal	Chip Characteristic
White Cast Iron	Small brittle fragments, chipped surfaces are not smooth.
Gray Cast Iron	About 1/8th "long, does not chip easily so chips break off and are not smooth.
Malleable Iron	Vary from 14" to ¾" long, metal is tough and hard to chip.
Wrought Iron	Smooth edges, metal is cut easily and chips are long continuous strips.
Low Carbon and Cast Steel	Smooth, easy to cut, long and continuous.
High Carbon Steel	Fine grain structure. Metal is hard. Can be cut in a long continuous strip. The chip edges are lighter color than low and medium carbon steel chips.
Copper	Smooth with saw tooth edges. It cuts easily in long continuous strips.
Brass and Bronze	Smooth with saw tooth edges. More brittle than copper. Cuts harder than copper. Difficult to cut in long continuous strips.
Aluminum	Smooth with saw tooth edges, chips easily in long continuous strips.
Monel	Smooth chips, easy to cut with long continuous strips.
Nickel	Smooth chips, easy to cut with long continuous strips.
Lead	Easy to cut, any. Very soft can be cut with a knife.

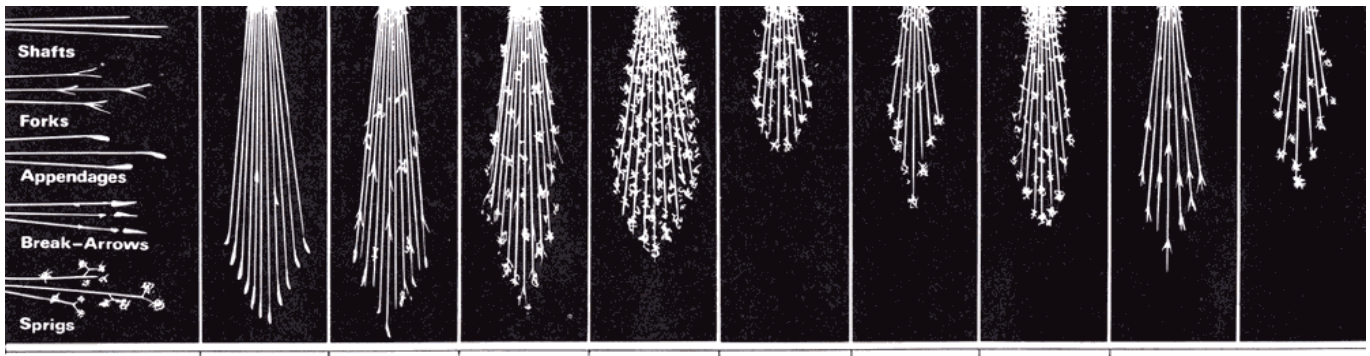
Addendum II

Magnetic Test Chart



Addendum III

Spark Test Chart



CHARACTERISTICS OF SPARK TEST	LOW C. STEEL (0.1%C)	MILD STEEL (0.25%C)	MED. C. STEEL (0.4%C)	HIGH C. STEEL (0.7%C)	GREY CAST IRON	MALLEABLE CAST IRON	AUSTENITIC MANG. STEEL	HIGH ALLOY STEELS 18/18 Stain	Die Steel
Volume of Stream	Large	Large	Large	Med. Large	Small	Moderate	Mod. Large	Moderate	Small
Relative Length	1.6m	1.8m	1.6m	1.4m	0.6m	0.75m	1.1m	1.3m	0.9m
Colour at Wheel	Straw	White	White	White	Red	Straw	White	Straw	Red
Colour at end	Straw-white	White	White	White	Straw	Straw	White	White	
DESCRIPTION OF SPARK STREAM (COMPARE WITH KNOWN SAMPLES)	As carbon increases in iron, spark changes from long straw shafts with appendages to forked shafts and some sprigs, number of sprigs increasing with carbon content.			Mass of small fine repeating sprigs.	Many small repeating sprigs.	Longer shaft than grey iron, small repeating sprigs.	Many fine repeating sprigs.	Alloys reduce spark length of comparable carbon steel.	

CHIP AND FRACTURE

White Cast Iron: Brittle hard small fragments, silvery fracture.
Grey Cast Iron: Small chips, smooth groove, dark grey fracture can mark finger on paper.
Malleable Cast Iron: Tough rough chips larger than Grey Iron.
Cast Steel: Chips easily to continuous smooth groove, coarser crystalline fracture than rolled steel.
High Carbon Steel: Chips hard than MS with lighter coloured edges, very light fine fracture.
Aluminium, Copper, Bronzes: Smooth easily produced chips leaving saw edged groove.

MAGNETISM

The following reactions to a magnet are useful for separation.
Magnetic: Nickel, Mild Steel, Carbon and Low Alloy Steels, Grey Iron, Malleable Irons, Straight Chromium Steels.
Non-Magnetic: Austenitic Manganese or Austenitic Stainless Steels and all non-ferrous metals.
Slightly Magnetic: Monel 4, Work-Hardened Aust. Mang. Steel and Work-Hardened Stainless Steels.

RELATIVE WEIGHTS

Approximate kilograms per cubic metre are shown for various metals and alloys:

1.74×10^3	Magnesium
2.70×10^3	Aluminium and its alloys
7.20×10^3	Cast Iron, Tin, Zinc
7.85×10^3	Steel, Stainless Steel
8.85×10^3	Copper, Nickel, Monel, Brass
11.35×10^3	Lead
15.20×10^3	Sintered Tungsten Carbides

Addendum IV.

Glossary

Aluminum - light weight, good strength, high electrical conductivity, excellent heat transfer, corrosion resistant.
- Trailers, airplanes, food handling equipment

Brass - alloy of copper and zinc, harder than copper.
- Hinges, screws, other hardware

Brittleness - The ability of the material to absorb shock or impact.

Bronze - alloy of copper and tin, tough, wear resistant, highly corrosion resistant.
- Machinery parts, bearings

Cast Iron – Contains more than 1.7% Carbon

Compression strength - The ability of a metal to withstand a compression force before deforming.

Copper - excellent conductor of electricity and heat, very workable (ductile).
- Wire, water pipes, radiators

Corrosion Resistance - The ability of a metal to resist chemical action.

Ductile cast (Nodular) - addition of magnesium increases ductility, high strength.
-Replaces gray and malleable cast.

Ductility - The property of a metal to be formed into shapes without breaking (drawn into wire).

Elastic Range of Limit - The maximum stress the metal will support without permanent deformation.

Electrical Resistance - The ability of metal to resist carrying an electric current (opposite of conductivity).

Ferrous Metal - Made up of Iron and Carbon. Classification is based upon amount of carbon and the finish process

Fusibility - Measure of ease of melting.

Gray cast iron - containing free carbon and silicon; brittle, resists rust. Slow cooling – graphite flakes.
- Agricultural machinery, engine blocks

Gold - 24 karats is pure gold.
- Plating and jewelry

Hardness - The characteristic of metal which resists scratching, abrasion or indentation.

High carbon steels - Respond well to heat treating to obtain any degree of hardness, temper or strength; special welding rods are required.
- Screw drivers, pliers, drive shafts

High speed steel (Alloy Steel) - contains carbon with cobalt, molybdenum and tungsten. Withstands heat from high speed operations.
- Drills, milling cutters, taps, dies

Lead - heavy and soft, considered a health hazard
- Soldering

Low carbon steels - tough, ductile, easily formed, machined and welded.
- Bolts, nails, sheet metal

Magnesium - lightest weight, has low strength in pure form, produces magnesium oxides when burned.
- Wheels, lawn mower frames

Malleable cast iron - white cast annealed to produce a steel skin ;bends without breaking.
- High strength Agricultural Machinery parts, some tools.

Medium carbon steels - strong and hard, but not as easily forged or welded as low carbon.
Agricultural Machinery, bars, plates

Modulus of Elasticity - The ratio of stress to strain used to compare elasticity of metals.

Nickel - increases hardness and improves resistance to corrosion in steel.

Physical – behavior of the structure and composition of the metal (shaping, fabricating, heat treating, welding)

Process - The art and science of extracting metals from their ores, refining them, and processing them for use (including compounding alloys)

Shear strength - The ability of metal to withstand shearing pressure.

Steel – Contains less than 1.7% Carbon

Strain - Elongation that occurs during the pulling action.

Stress - The load pressure (measured in 1000psi) of a metal before it stretches.

Silver - very soft, excellent conductor of electricity; sterling silver is 92.5% silver and 7.5% copper.
- Metal alloys

Thermal Expansion - Increase in size of metal from changes in temperature.

Tin - very high corrosion resistant.
- Solder, brass, bronze and pewter

Torsion - The ability of metal to withstand a turning or twisting motion.

Toughness - The ability of a metal to absorb repeated abuse before failing.

Tungsten - high melting point, tungsten carbide is very hard.
- Cutting and piercing tools

Ultimate Strength - The maximum load the metal will support in tension.

Very high carbon - mechanical characteristics are similar to high carbon.
- Chisels, punches, dies, taps, files, metal cutting saws.

White cast iron - carbon does not separate, very hard, white or silvery when broken, high wear resistance. Quick cooled.
- Disc bearings

Wrought iron - Very ductile, easily worked cold, high corrosion resistance.
- Rivets, ornamental work

Yield Point - Amount of force required to stretch the metal until it is permanently deformed

Zinc - used for galvanizing, very corrosion resistant.