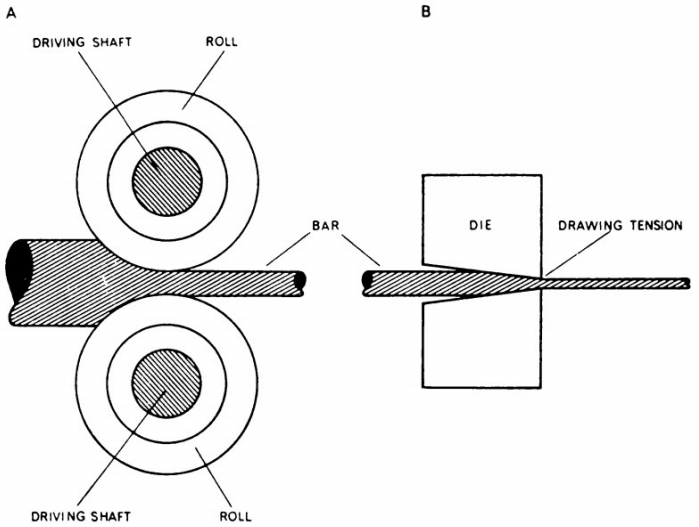
Chapter 2

Reading: Heat Treatment for steel

We can alter the characteristics of steel in various ways. In the first place, steel which contain very little carbon will be ***milder than*** steel which contains a higher percentage of carbon, up to the limit of about 1 ½ %. Secondly, we can heat the steel above a certain critical temperature, and then **allow** it **to** cool at different rates. At this critical temperature, changes begin to take place in the molecular structure of the metal. In the process known as annealing, we heat the steel above the critical temperature and **permit** it **to** cool very slowly. This **causes** the metal **to** become softer than before, and much ***easier to machine***. Annealing has a second advantage. It helps to relieve any internal stresses which exist in the metal. These stresses are liable to occur through hammering or working the metal, or through rapid cooling. Metal which we **cause to** cool rapidly contracts ***more rapidly*** on the outside ***than*** on the inside. This produces unequal contractions, which may give rise to distortion or cracking. Metal which cools slowly is ***less liable*** to have these internal stress ***than*** metal which cools quickly.

On the other hand, we can make steel harder by rapid cooling. We heat it up beyond the critical temperature, and then quench it in water or some other liquid. The rapid temperature drop fixes the structural change in the steel which occurred at critical temperature, and make it very hard. But a bar of this hardened steel is ***more liable to fracture than*** normal steel. We therefore heat it again to a temperature below the critical temperature, and cool it slowly. This treatment is called tempering. It helps to relieve the internal stresses, and makes the steel ***less brittle*** than before. The properties of tempered steel **enable** us **to** use it in the manufacture of tools which need fairly hard steel. High carbon steel is ***harder than*** tempered steel, but it is ***much more difficult to work***.

These heat treatments take place during the various shaping operations. We can obtain bars and sheets of steel by rolling the metal through huge rolls in a rolling-mill. The roll pressures must be ***much greater*** for cold rolling ***than*** for hot rolling, but cold rolling **enables** the operators **to** produce rolls of great accuracy and uniformity, and with a better surface finish. Other shaping operations include drawing into wire, casting in moulds, and forging.



(A) Roller-mill with rolls
(B) Drawing-bench

Word study

Likely, Liable, Susceptible

1. The work	***is likely to***	start early next year.
2. The new engine	***will probably***	be a good one.
3. An explosion		occur at any minute.
4. The new engine	***is able to***	be very expensive.
5. An explosion		occur at any minute.
6. The metal	***may unfortunately***	become overheated.
7. The work		be delayed until next year.
8. There is a	***risk***	of an explosion (occurring).
		that an explosion will occur.
	danger	of the engine becoming over heated.
		that the engine may become overheated.
9. This road	***is liable to***	frost damage.
10. The region	***is susceptible to***	earthquakes

Bring about, Produce, Cause, Give rise to

1. Changes in temperature	may	***bring about***	changes in the length of the bar.
2. The high temperature	will	***produce***	cracks in the furnace walls.
3. These experiments	can	***give rise to***	new methods of construction.
4. A drop in pressure		***cause***	cylinder condensation.
5. Automation			a lot of unemployment.

Expand, Contract

Most substances ***expand*** when they are heated. == They grow bigger or longer.

Most substances ***contract*** when they are cooled. == They grow smaller or shorter.

When substances are heated, ***expansion*** takes place.

When substances are cooled, ***contraction*** takes place.

The ***coefficient of expansion***, which tells us how much a substance will ***expand*** for each degree rise in temperature, is different for different substances.

Relieve (= to make less severe)

When the pressure in a boiler becomes too great, we can ***relieve*** it by allowing some of the steam to escape.

We can ***relieve*** the stress in a steel bar by tempering it.

Critical

1. = decisive (point or stage) and therefore important or serious.
   The sick man going through a ***crisis***. He is in a ***critical*** condition.
   There is a political ***crisis***. The situation is ***critical***.

2. = a decisive point in temperature, pressure or angle at which something is about to happen.
   The ***critical*** temperature of steel: above or below this temperature the molecular structure changes.
   The ***critical*** temperature of a gas: above this temperature it cannot be liquefied by pressure.
   The critical pressure: the pressure at which a gas can be liquefied.

Help, Assist, Facilitate

1. Annealing ***helps to remove*** (***helps or assists in removing***) internal stresses from the metal.
2. Safety devices ***help to prevent*** (***help or assist in preventing***) accidents in the machine shop.

3. A good transport system	***facilitate***	the distribution of goods.
4. Prefabrication of the wall	***(makes easier)***	rapid erection of houses.
5. The use of standard components		replacement when they worn.

Conducive

1. Regular maintenance is	***conducive to***	better performance of the machine.
2. Good labour relations are	***(helpful to)***	improved production.
3. Turbulence in the cylinder is		more efficient burning of the gases.

Patterns

1. Enable, Allow, Make, etc. + Infinitive

Note: ***Enable really*** means to ***make possible***, but it is often used in the same sense as ***allow*** and ***permit***. ***Let*** is spoken, but not often written in this sense. With ***let*** and ***make***, the word 'to' is not used before the infinitive.

1. The microscope 2. A thermometer	***enables***	scientists the doctor	***to***	examine very small objects. measure body temperature.
3. Helicopters 4. Good production methods	***enable***	passengers the factory	***to***	land in the city centre. manufacture more ars.
5. Expansion joints 6. Safety valve 7. We	***permit*** ***allow***	the pipes the steam the matel	***to***	expand or contract. escape from the boiler. cool slowly.
8. The heat 9. Weakness in the metal	***caused***	the metal it	***to***	melt. fracture under tension.
10. The heat 11. Weakness in the metal	***made***	the metal melt. it fracture under tension.		

2. Comparative

Here are some of the most useful patterns for comparing two things:

Steel	is	stronger / far stronger / slightly stronger / more expensive / much more expensive / a much more expensive material / a much more expensive material to produce	than	cast-iron.
Cast-iron	is	weaker / less expensive / much less expensive / a much less expensive material / a much less expensive material to produce	than	steel.
Cast-iron	is	not so expensive / not quite so expensive / not quite such an expensive material / not quite such an expensive material to produce	as	steel.
Cast-iron	is	as useful / almost as useful / almost as useful a material	as	steel.

3. Maximum and Minimum

1. a. The ***maximum*** temperature / The ***upper*** temperature ***limit*** — in this country is about — 35° Centigrade.
   b. The ***minimum*** temperature / The ***lower*** temperature ***limit*** — in this country is about — 0° Centigrade.
   c. The ***average, mean*** temperature — in this country is about — 17.5° C.
   d. The temperature ***range*** — in this country is about — 35° C.
   e. The temperature in this country ***ranges, varies*** from 35° C to 0° C.

2. a. In summer the temperature {***rises.*** / ***increases.***} There is {***a rise*** / ***an increase***} in temperature.
   b. In winter the temperature {***falls.*** / ***drops.*** / ***decreases.***} There is a {***fall*** / ***drop*** / ***decrease***} in temperature.
   c. By {***heating*** / ***cooling***} a substance, we can {***raise*** / ***lower***} in temperature to {***boiling*** / ***freezing***} point.

3. a. The maximum ***pressure*** in the oiler is 500 lb/in^2.
   b. The maximum ***speed*** of the aircraft is 800 m.p.h. (miles per hour).
   c. The maximum ***fuel consumption*** of the engine is 30 m.p.g. (miles per gallon).
   d. The maximum ***speed*** of the turbine is 8000 r.p.m. (revolutions per minute).
   e. The maximum ***diameter*** of the tube is 9/16 inch.