MISCELLANEOUS EXAMPLES OF FORGED WORK IN DIFFERENT STAGES. PLATE 96

LOCOMOTIVE LOCKING BAR (A)

PLATE 96 illustrates the method of making a locking bar, which is 5 ft. 10 ins. long.

FIG. 1 illustrates the locking bar, made from a 5-inch square bar.

First operation, FIG. 2: Punch a hole in the centre of the bar, as shown.

Second operation, FIG. 3: Fuller each side of the hole, with fullers made, as shown.

Third operation, FIG. 4: Hammer in a mandril, and stamp the eye with a pair of tools, as shown.

Fourth operation, FIG. 5: Draw down and taper the ends.

FIG. 6 shows the mandril for doing the preliminary work. This is called the starting mandril.

FIG. 7 shows the mandril for finishing the shape of the hole, known as the finishing mandril.

LOCKING BAR.

PLATE 96

FIG 1

FIG 2

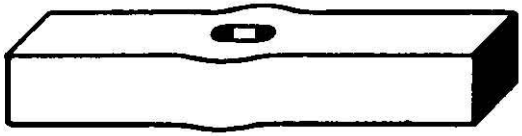

FIG 3

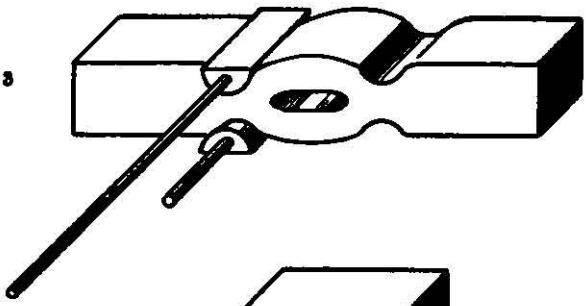

FIG 4

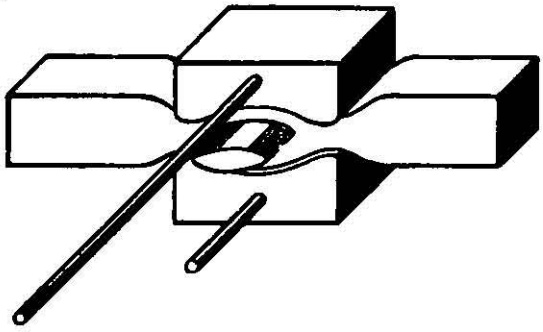

FIG 5

FIG 6

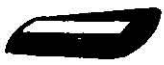

FIG 7

MISCELLANEOUS EXAMPLES OF FORGED WORK IN DIFFERENT STAGES. PLATE 97

LOCOMOTIVE LOCKING BAR (B)

PLATE 97 illustrates the beginning of the method of making a locking bar.

FIG. 1 illustrates a locking bar, of which the dimensions are given, made from a 12-inch by 6-inch bar. The length of material required is 15 ins.

First operation, FIG. 2: Side set 5 ins. from the end and 10 ins. from the end, as shown.

Second operation, FIG. 3: Draw down and taper one end as shown, then cut off the bar at the dotted line.

Third operation, FIG. 4: Draw down the opposite end, as shown.

This method is continued on the following PLATE (98).

LOCKING BAR. PLATE 97

FIG 1

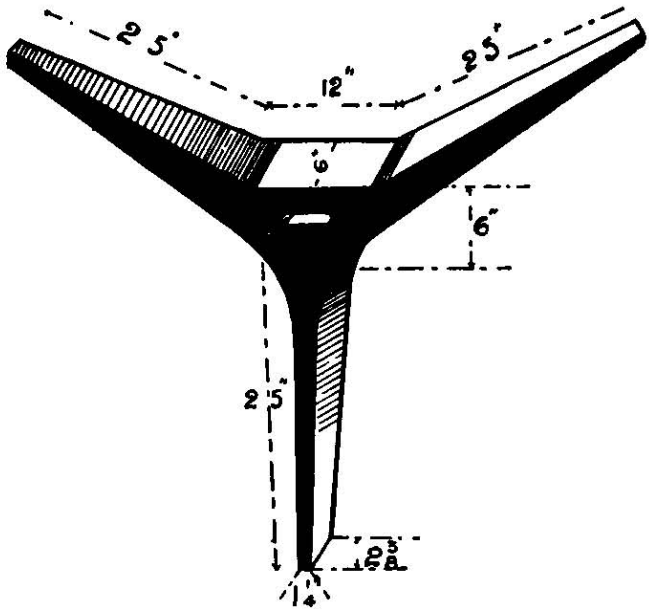

FIG 2

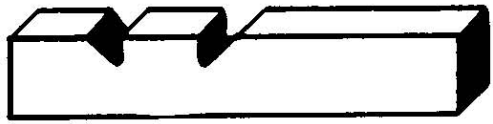

FIG 3

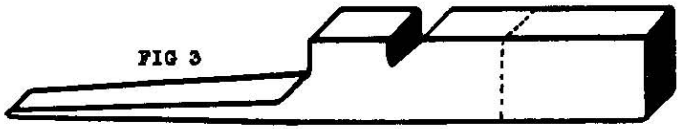

FIG 4

MISCELLANEOUS EXAMPLES OF FORGED WORK IN DIFFERENT STAGES. PLATE 98

LOCOMOTIVE LOCKING BAR (B) (*continued*)

PLATE 98 illustrates the concluding operations in the method of making a locking bar.

FIG. 5 illustrates an apparatus used for setting the arms at the required angle. This apparatus is composed of two blocks of wood placed at each side of the anvil (steam hammer), and held together, as shown.

FIG. 6 shows the result after the arms have been set with the steam hammer.

FIG. 7, fuller as shown, then draw down and taper to the length, as shown in FIG. 1 (PLATE 97).

LOCKING BAR.

PLATE 98

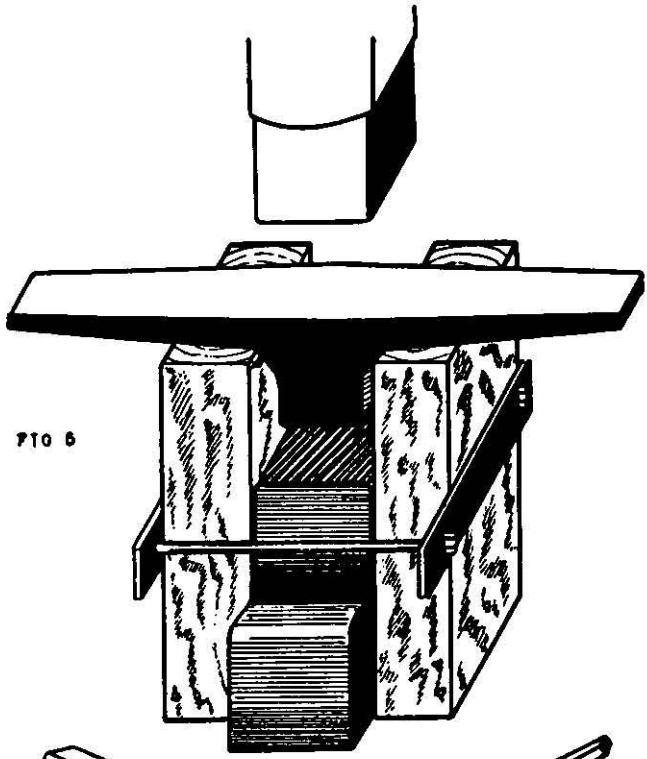

FIG 5

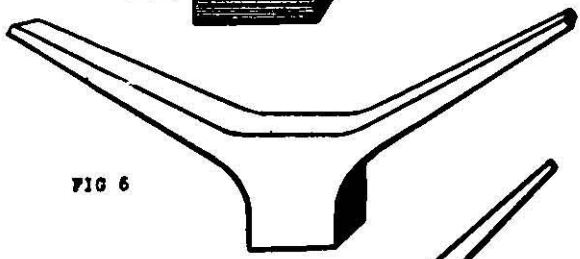

FIG 6

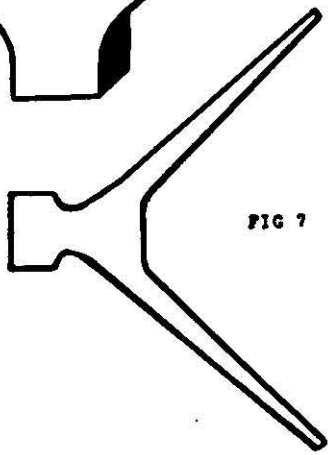

FIG 7

HARDENING AND TEMPERING. PLATE 99

Small Coil Spring

FIG. 1 illustrates a method of hardening a small coil spring. This is done by placing a small rod through the spring as shown, and heating it over the fire. When the spring is red hot plunge it, with the rod, into oil. To temper the spring, hold it with the rod over the fire, until the oil ignites and burns off.

Repeat this operation three times, then cool off in oil. This method of tempering can be applied to larger springs if necessary.

Another method of hardening spring steel is by heating to 820° C., then cooling off in oil. To temper, reheat to 380° C., and cool off in air.

FIG. 2: *To harden and temper a Die.*

Heat to a cherry-red, then plunge into water or oil. When cold, polish the die and lay on a hot bar, as shown. When the die turns dark brown, cool off in water or oil.

FIGS. 3, 4: *To harden a square or round bar.*

Dip vertically as shown, but not quickly, into the liquid.

FIG. 5: *To harden a wedge-shaped bar.*

Holding the narrow side uppermost, dip into the liquid, keeping the bar slightly sloped, as shown.

FIGS. 6, 7: To harden and temper a small drill, as shown in FIG. 6. After heating the drill to a cherry-red, plunge it into oil till cool, then polish it. Fill a metal pot with lead and heat the contents until red hot, then, to temper the drill, hold the cutting end with the tongs, and dip into the lead up to the neck, as shown in FIG. 7. Quickly withdraw the drill, and plunge it into oil to cool.

HARDENING.

PLATE 99

FIG 1

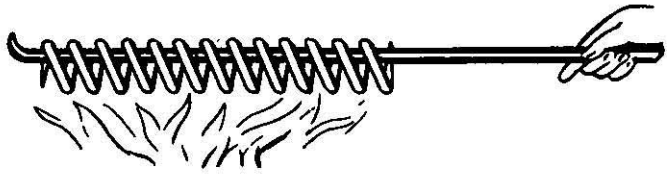

FIG 2

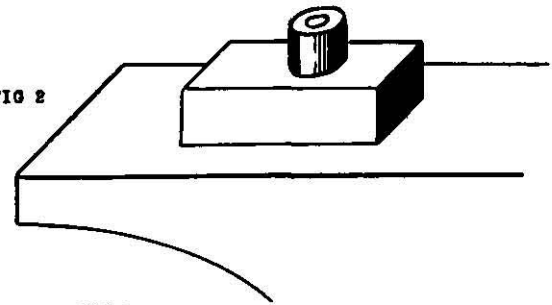

FIG 3

FIG 4

FIG 5

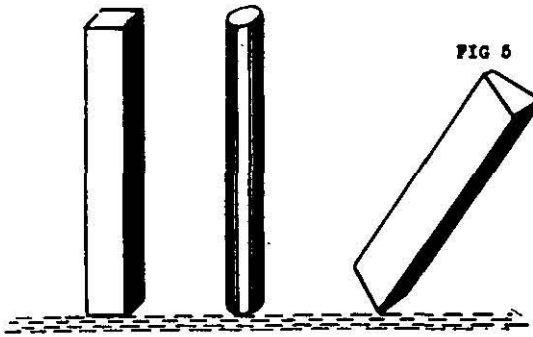

FIG 7

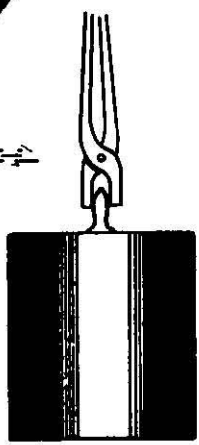

FIG 6

HARDENING AND TEMPERING. PLATE 100

FIG. 1 illustrates a method of hardening small drills, e.g. $\frac{1}{16}$ in. diameter. Place the drills on a shallow tin tray, heat the tray and its contents to a dark red, and then plunge into oil to cool.

FIG. 2 illustrates the method of polishing the drills after hardening by gripping in the vice and polishing with emery paper, as shown. To temper, place on a black hot surface, keeping the drills in motion until they turn dark brown, then plunge into oil.

FIG. 3, twist drills. Heat to cherry-red, then dip vertically into the water till cool. Polish, as shown in FIG. 2. Temper by laying on a hot surface until dark brown, then plunge in oil to cool.

FIG. 4, shear blades. Heat the blade to a full red and plunge in water or oil, as shown. Polish and lay on a hot bar until the colour changes to a violet hue.

HARDENING

PLATE 100

FIG 1

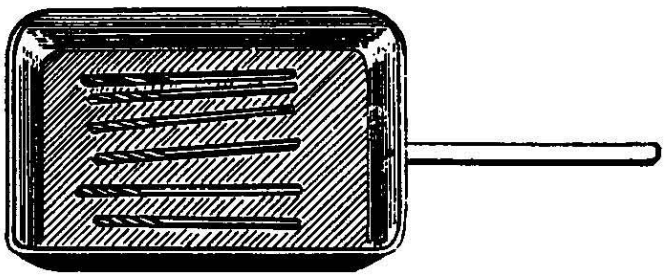

FIG 2

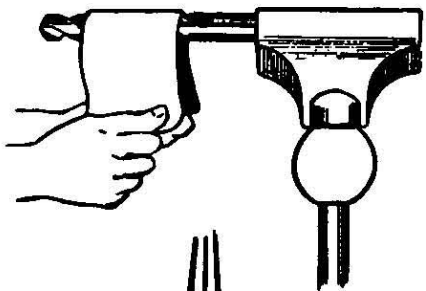

FIG 3

FIG 4

HARDENING AND TEMPERING

The process of hardening, as commonly understood by smiths, is by heating steel to a definite temperature and suddenly cooling in water or oil. This treatment causes the steel to become dead hard or glass hard, and steel in this condition is too brittle for use, therefore it has to be tempered. This can be done by heating to a certain temperature, and then cooling, or the temper can be gauged by watching the colours which appear on the surface as the heat increases. Before tempering the surface should be polished, to enable the smith to see the colours clearly. The steel is then laid on a hot surface, and as the temper increases, various colours appear on the polished surface. Immediately the desired colour is obtained, fix by plunging in water or oil. (The temperature corresponding to the different colours and shades are given in the table on temperatures and temper colours.)

Cast steel, as understood by the smith, denotes carbon steel. As regards the classification of cast steel, its carbon usually varies between ·5 and 1·5 per cent.

Steel containing ·6 to ·7 per cent. carbon is most suitable for blacksmiths' tools, such as cold chisels, hot chisels, punches, and hammers.

Points to Remember in the Treatment of Steel

Cut all tool-steel bars hot; when cut cold they are liable to crack at the end.

Always heat slowly, thoroughly, and uniformly.

When quenching tools to be hardened, keep the tool moving after immersion, thus avoiding any chance of a sharp line between the hard and soft parts of the tool.

To harden and temper a cold chisel, heat the cutting edge to a cherry-red, and immerse the chisel vertically

in water. When cool, it should be slowly taken out of the water. Its internal heat will then produce the tempering colour, and this can be seen by polishing the hardened part with emery or sandstone. When the cutting edge shows the correct tempering colour (in this case purple), the chisel should be plunged at once into the water to cool. Other examples of hardening and tempering are shown on PLATES 99 and 100.

HIGH-SPEED STEEL

When forging high-speed steel, heat gradually to a bright red colour or between 990° C. and 1040° C., and then forge in the ordinary way. Do not continue the forging after the temperature has dropped to between 760° C. and 820° C. and the colour is below cherry-red.

ANNEALING HIGH-SPEED STEEL TOOLS

Place the tools in an iron box of sufficient size to allow at least one-half inch of packing between the tools to be annealed and the sides of the box. (Packing can consist of powdered charcoal or fine dry lime.) Cover the contents with an air-tight lid. Place the box in a furnace and heat gradually to between 760° C. and 820° C. Maintain this temperature for four hours or more, according to the quantity of steel charged, and then allow the box and its contents to remain in the furnace until cold.

HARDENING HIGH-SPEED STEEL

To harden turning and planing tools. Heat the cutting end of the tool, slowly and uniformly, to a temperature of about 760° C. or a cherry-red colour, and then bring the heat quickly to between 1250° C. and 1280° C. or a white heat, after which the tool should be cooled in a strong air-blast.

CASE HARDENING

Case hardening is a process of introducing carbon into the surface of low carbon steel, to harden the exterior like "cast steel" and allow the interior to retain its original properties.

The method to adopt in case hardening is as follows: Pack the articles, with a reliable casing compound, in an iron box, putting a layer of the casing compound 1½ in. deep in the bottom of the box, and laying the articles on top, leaving a 1½ in. space between each article. Place another layer of casing compound on top, and repeat as above until the box is filled to within 1½ in. from the top. Place a lining of fireclay round the inner edge of the box, and seal the box by placing a lid in the inside. This can be made air-tight by placing another layer of fireclay around the edges of the lid. The box and its contents are placed into the furnace and heated to 900° C. to 950° C., and kept at this temperature until a sufficient depth of casing is obtained. If a casing $\frac{1}{10}$ in. is required, heat for about four hours. After the desired penetration has been obtained, the box should be withdrawn from the furnace and put aside to cool. When cold the articles are taken out of the box and heated to 780° C., and then quenched in cold water to obtain a refined and glass-hard casing.

Colour	Temperature Centigrade	Fahrenheit
Dark red	600°	1112°
Dull red	650°	1202°
Cherry-red	700°	1292°
Bright red	800°	1472°
Dark orange	850°	1562°
Orange-lemon	1100°	2012°
Lemon	1200°	2192°
Straw	1300°	2372°
White	1350°	2462°

Tempering Colours

Colour	Centigrade	Fahrenheit
Pale yellow	210°	410°
Dull yellow	221°	430°
Crimson	256°	493°
Violet-purple and dull blue	261°	502°
Bright blue	290°	554°
Dark blue	320°	608°

Example: To convert 520° Centigrade to Fahrenheit.

$$(520 \times \tfrac{9}{5}) + 32$$

$$= 936 + 32 = 968° \text{ Fahrenheit.}$$

Example: To convert 1148° Fahrenheit to Centigrade.

$$(1148 - 32) \times \tfrac{5}{9}$$

$$= 1116 \times \tfrac{5}{9} = 620° \text{ Centigrade.}$$

Temperature Conversion Table

Centigrade—Fahrenheit

C.	F.	C.	F.	C.	F.	C.	F.	C.	F.	C.	F.	C.	F.
38	100	63	145	88	190	165	329	400	752	720	1330	970	1778
39	102	64	147	89	192	170	338	420	788	730	1348	980	1798
40	104	65	149	90	194	175	347	440	824	740	1366	990	1814
41	106	66	151	91	196	180	356	460	860	750	1384	1000	1832
42	108	67	153	92	198	190	374	480	896	760	1402	1010	1850
43	109	68	154	93	199	200	392	500	932	770	1420	1020	1869
44	111	69	156	94	201	210	410	520	968	780	1438	1030	1886
45	113	70	158	95	203	220	428	540	1004	790	1454	1040	1904
46	115	71	160	96	205	230	446	550	1021	800	1472	1050	1922
47	117	72	162	97	207	240	464	560	1040	810	1490	1060	1940
48	118	73	163	98	208	250	482	570	1058	820	1508	1070	1958
49	120	74	165	99	210	260	500	580	1076	830	1526	1080	1978
50	122	75	167	100	212	270	518	590	1094	840	1544	1090	1996
51	124	76	169	105	221	280	536	600	1112	850	1562	1100	2014
52	126	77	171	110	230	290	554	610	1130	860	1579	1110	2030
53	127	78	172	115	239	300	572	620	1148	870	1600	1120	2052
54	129	79	174	120	248	310	590	630	1166	880	1618	1130	2068
55	131	80	176	125	257	320	608	640	1184	890	1636	1140	2086
56	133	81	178	130	266	330	626	650	1202	900	1652	1150	2102
57	135	82	180	135	275	340	644	660	1218	910	1670	1160	2122
58	136	83	181	140	284	350	662	670	1240	920	1687	1170	2138
59	138	84	183	145	293	360	680	680	1254	930	1706	1180	2158
60	140	85	185	150	302	370	698	690	1272	940	1724	1190	2172
61	142	86	187	155	311	380	716	700	1292	950	1742	1200	2192
62	144	87	189	160	320	390	734	710	1312	960	1758		

Bar Steel. Weight per Lineal Foot

Square.		Round.		Octagon.	
Size.	Pounds.	Size.	Pounds.	Size.	Pounds.
⅛	·05	⅛	·04	⅛	·04
¼	·21	¼	·17	¼	·18
⅜	·48	⅜	·38	⅜	·40
½	·85	½	·67	½	·70
⅝	1·33	⅝	1·04	⅝	1·10
¾	1·92	¾	1·50	¾	1·58
⅞	2·60	⅞	2·04	⅞	2·16
1	3·40	1	2·67	1	2·82
1⅛	4·30	1⅛	3·38	1⅛	3·56
1¼	5·31	1¼	4·17	1¼	4·40
1⅜	6·43	1⅜	5·05	1⅜	5·32
1½	7·65	1½	6·01	1½	6·34
1⅝	8·98	1⅝	7·05	1⅝	7·32
1¾	10·40	1¾	8·18	1¾	8·64
1⅞	11·90	1⅞	9·38	1⅞	9·92
2	13·60	2	10·71	2	11·28
2⅛	15·40	2⅛	12·05	2⅛	12·71
2¼	17·20	2¼	13·60	2¼	14·24
2⅜	19·20	2⅜	15·10	2⅜	15·88
2½	21·20	2½	16·68	2½	17·65
2⅝	23·50	2⅝	18·39	2⅝	19·45
2¾	25·70	2¾	20·18	2¾	21·28
2⅞	28·20	2⅞	22·06	2⅞	23·28
3	30·00	3	24·10	3	25·36
3⅛	33·13	3⅛	26·12	3⅛	27·50
3¼	35·90	3¼	28·30	3¼	29·28
3⅜	38·64	3⅜	30·45	3⅜	32·10
3½	41·60	3½	32·70	3½	34·56
3⅝	44·57	3⅝	35·20	3⅝	37·05
3¾	47·80	3¾	37·54	3¾	39·68
4	54·40	4	42·72	4	45·12
4¼	61·40	4¼	48·30	4¼	50·84
4½	68·90	4½	54·60	4½	56·96
4¾	76·70	4¾	60·30	4¾	63·52
5	85·00	5	66·80	5	70·60
5¼	93·70	5¼	73·60	5¼	77·80
5½	102·80	5½	80·80	5½	85·15
5¾	112·40	5¾	88·30	5¾	93·12
6	122·40	6	96·10	6	101·45
6½	143·60	6½	113·20	6½	117·12
7	166·40	7	130·80	7	138·24
8	217·60	8	170·88	8	180·48
9	275·60	9	218·40	9	227·84
10	340·00	10	267·20	10	282·40
11	411·20	11	323·00	11	340·60
12	489·60	12	384·40	12	405·80

INDEX

CONVERSIONS

—page 207—

Alternative formula

°C × 1.8 + 32 = °F
°F – 32 ÷ 1.8 = °C

—page 208—

1″ = 25.4 mm
1lb = 0.4536 kg
1m = 3.28 ft

Pounds to kilograms multiply by 0.4536

1/8″ = 3.175 mm

1/4″ = 6.35 mm

3/8″ = 9.25 mm

1/2″ = 12.7 mm

5/8″ = 15.875 mm

3/4″ = 19.05 mm

7/8″ = 22.225 mm

1″ = 25.4 mm

2″ = 50.8 mm

3″ = 76.2 mm

5″ = 127 mm

12″ = 304.8 mm

3′ = 915 mm

SAFETY AT WORK

FIRE

Fire can be the main hazard in the forge. It must be the responsibility of each member of staff to familiarise themselves with the fire drill procedure.

Ensure that you know the location and type of the nearest fire extinguishers and how to use them correctly. Be sure that you are aware of the location of the nearest fire alarm to your workspace.

In the event of a fire, shout a clear warning. Operate the nearest fire alarm. Close all windows and doors. Ensure that you only attempt to fight small fires and with the correct fire extinguisher. Keep calm and do not endanger yourself.

If in doubt, get out. Be alert. Know what you are doing and why.

EYE PROTECTION

There is always a high risk of damage to the eye or eyesight, especially when working with hot metal (forging). Always ensure that safety spectacles are worn.

MACHINERY

Safety precautions are essential when operating machinery. Remember that any injury is generally severe. Death and amputation are often the result of machinery accidents. Dangerous parts of machinery must be guarded. Guards must always be in place and correctly adjusted. Abrasive wheels must only be mounted by authorised personnel.

GENERAL SAFETY

Never try to do someone else's job. Don't tamper with equipment that you do not understand. Never throw things or play practical jokes on your workmates. Remember to walk – don't run. Wash your hands often throughout the day. Do not wear clothing that is loose and flaps about. Wear suitable footwear which is in good repair. Always report unsafe conditions. Do not carry or move any object which obstructs your field of vision. Do not lift any heavy workpieces or equipment manually.