Trade of Toolmaking		
Module 5:	Press Tools, Jigs & Fixtures, Mouldmaking	
Unit 1:	Press Tool Components	
	Phase 2	

Published by



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Unit Objective

On completion of this unit you will be able to list the uses and functions of a press tool. This unit also explains the properties and heat treatment of the metal used to manufacture the punch and die components.

Introduction

Module five of this course covers Press Tools, Jigs & Fixtures, and Mouldmaking. This is the first unit in module five and explains the uses and functions of a press tool and its setup in a press. It is important to note that the press is a powerful machine and is potentially very dangerous. It should never be used without the proper guards being in place and should only be operated by a qualified person.



The main functions of a press tool are to cut or form thin metal sheet or strip. The press tool is used throughout industry to cut blanks of any shape, pierce holes, form or bend components and to mint coins. When manufacturing the punch and die components for the press tool it is important to use of the correct tool steel material and know how to harden the components prior to use. In order to manufacture a press tool, you will need to be able to use the milling machine, the lathe and the surface grinder, where the grinder is normally used to finish the workpiece after the heat treat process.

By the end of this unit you will be able to:

- Apply the appropriate safety precautions when operating a press tool
- List and describe typical uses for a press tool
- Identify and describe the function of the main parts and features of a blanking and piercing press tool
- Describe the properties and the advantages possessed by tool steel for the manufacture of press tool components such as punch/die
- Describe the cutting action of a punch and die in a blanking or piercing operation
- Describe the difference between a C frame and a H frame press

1.0 Applying The Appropriate Safety Precautions When Operating A Press Tool

Key Learning Points

Safe operation of the press tool and the hazard associated with press work – need for machine guards, protective clothing and eye protection.

1.1 Safe Operation Of The Press Tool And The Hazard Associated With Press Work – Need For Machine Guards, Protective Clothing And Eye Protection

The *Press* used to drive the *press tool* is a powerful machine and potentially very dangerous. High forces involved in the cutting or forming of metal can result in serious injury if the operator is too close to any part of the press tool or press during operation. Therefore the press should never be operated without the guards being in place. Protective clothing and eye protection should always be worn.

Ref: Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology, chapter 16, *Presswork*, sec. 16.2, *Safety*, p. 268. ISBN-13: 9780750660730

2.0 Describing Typical Uses For A Press Tool

Key Learning Points

Press tool used to cut and cold form thin metal from sheet or strip. Knowledge and understanding of presswork operations: Cutting - piercing, blanking and cropping, Forming – bending, drawing, embossing and coining. Professional attitude towards care and use of press tools.

2.1 Press Tool Used To Cut And Cold Form Thin Metal From Sheet Or Strip

Press tools are used to cut or form thin metal materials such as steel, copper, brass and aluminium, which are supplied to the press tool in the form of sheet or strip.

Ref: Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology, chapter 16, *Presswork*, sec. 16.2, *Press-tool design*, p. 269. ISBN-13: 9780750660730

2.2 Knowledge And Understanding Of Presswork Operations: Cutting Piercing, Blanking And Cropping, Forming – Bending, Drawing, Embossing And Coining

The main Cutting operations are as follows:

- Piercing describes the cutting of a hole or holes into the workpiece.
- Blanking this is when the outside shape is cut from the stock material to produce the finished blank.
- Cropping this means the cutting to length of the strip material. The cut may be straight, curved or stepped.

The main Forming operations are as follows:

- Bending a punch is used to bend or form a part that may have been previously blanked
- Drawing a punch can be used to draw a cup like shape from a disc shape.
- Embossing sheet metal is pressed between dies so that the metal is bent or stretched.
- Coining A die with an engraving on it is used to indent its shape into a sheet metal blank to form a coin, token etc.

Ref: Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology, chapter 16, *Presswork*, sec. 16.2, *Press-tool design*, p. 269. ISBN-13: 9780750660730

2.3 Professional Attitude Towards Care And Use Of Press Tools

A press tool is a precision made tool and a lot of time and patients has gone in to manufacturing them, they are also expensive. It is important that the press tool is setup and run by a qualified person. Press tools should be handled with care and stored carefully after use.

3.0 Describing The Main Parts And Features Of Blanking And Piercing Press Tool

Key Learning Points

Knowledge and understanding of functions of press tool parts: punch, die set, pillars, bushes, spigot, stripper, guiding elements and stops.

3.1 Knowledge And Understanding Of Functions Of Press Tool Parts: Punch, Die Set, Pillars, Bushes, Spigot, Stripper, Guiding Elements And Stops

The press tool is made up of various parts, which are as follows:

Die-set: This is normally a bough-in item, which holds and *guides* the press tool during use. The die-set consists of a top and bottom plate. The top plate has bushings and the bottom plate has guide *pillars*, both of which provide precise up and down movement between the two plates.

Spigot: To locate and secure the top plate of the die-set in the Press.

Ref: Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology, chapter 16, *Presswork*; *Die-sets*, fig. 16.13, p. 274. ISBN-13: 9780750660730

Punch: This is the same shape as the blank being cut and is housed in the punch plate. The cutting edges need to be sharp and it needs to fit into the die.

Die: This is the same shape as the punch, but has adequate clearance to allow the punch to pass through. The die tapers outwards underneath to allow the blanks or slugs to fall downwards.

Stripper: This is a plate that sits above the die and has clearance to allow the punch to pass through. It prevents the metal strip lifting up with the punch when it returns upwards.

Guide: This ensures that the stock or strip metal is correctly located as it is feed through.

Stop: Stops and correctly locate the strip as it is being fed through.

Spigot: To locate and secure the top plate of the die-set in the Press.

Ref: Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology, chapter 16, *Presswork*, sec. 16.3, *Blanking, piercing and bending*, p. 275.

ISBN-13: 9780750660730

4.0 Describing The Properties Of Tool Steel For The Manufacture Of Press Tools

Key Learning Points

Composition and properties of tool steel. Advantages of tool steel: mechanical properties, corrosion resistance. Heat treatment of tool steel: annealing, normalising, hardening and tempering.

4.1 Composition And Properties Of Tool Steel

Tool steel can be machined in its softer annealed state and can then hardened by heat treatment. This alloy tool steel contains carbon, manganese, tungsten and chromium.

Ref: Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology, chapter 13, *Materials*, sec. 13.4, *Plain carbon steel*, p. 215. ISBN-13: 9780750660730

4.2 Advantages Of Tool Steel: Mechanical Properties, Corrosion Resistance

High carbon steels are used for applications such as springs, spring collets, chisels, punchers and files. The carbon content is up to 0.9%. This is an excellent material for punches and dies and will not crack or distort when it is being heat treated.

Ref: Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology, chapter 13, *Materials*, sec. 13.4, *Plain carbon steel*, p. 215. ISBN-13: 9780750660730

4.3 Heat Treatment Of Tool Steel: Annealing, Normalising, Hardening And Tempering

Heat treatment of tool steel: *Annealing* -Tool steel can be annealed by heating in a furnace and cooling slowly, which softens the material and relieves stresses. *Normalising* - This refines the structure of the steel and removes strains caused by cold working. The material is heated slowly and cooled in air. *Hardening* – the tool steel workpiece is heated in a furnace to a critical temperature. It is then quenched in water to produce a hardened tool steel. *Tempering* – Hardened tool steel is a brittle material and can chip easily, therefore it needs to be heated again to a temperature below the critical range and then quenched.

Ref: Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology, chapter 13, *Materials*, sec. 13.5, *Heat treatment*, p. 217. ISBN-13: 9780750660730

5.0 Describing The Cutting Action Of A Punch And Die In Blanking And Piercing

Key Learning Points

Compressive and tensile loads. Cutting action of punch – load/shear actions. Calculation of forces required for cutting. Importance of sharp tooling to reduce cutting forces.

5.1 Compressive And Tensile Loads

When the press tool is in use, the metal strip is subjected to both tensile and compressive stresses, where the metal is stretched beyond its elastic limit, then plastic deformation occurs and finally it fractures.

5.2 Cutting Action Of Punch – Load/Shear Actions

In a punching or piercing operation the punch cuts into the material to approximately one third of its thickness and then the remaining two thirds of the material then breaks away. The cutting of a metal strip between a punch and a die is a shearing process where the metal strip stressed to the point of fracture or beyond its ultimate strength.

5.3 Calculation Of Forces Required For Cutting

The following formula is used to calculate the force required for cutting:

F = metal thickness x the perimeter of blank x ultimate shear stress of the metal strip

Ref: Timings, R.L. 1998, *Manufacturing technology, vol. 1, 3rd edn, Pearson Education Limited,* chapter 1, *Alteration of shape*, ex. 1.1, p. 50. *ISBN-13:* 9780582356931

5.4 Importance Of Sharp Tooling To Reduce Cutting Forces

It is important that cutting edge of the punch and die are sharp so that the blank is sheared as efficiently as possible.

6.0 Describing The Difference Between A C Frame And A H Frame Press

Key Learning Points

Press types including C and H frames. Operation of a C Press and cycle of operation.

6.1 Press Types Including C And H Frames

The press is a large metal framed machine, of which there are two main types, a C frame and a H frame. The C type has a shape similar to that of a milling machine, where a hydraulic ram or a flywheel is positioned at the top foremost. The frame then extends behind the working area and comes back in to form the bed of the machine. The H type has pillars at each side of the working area and forms a complete circle with the ram centred within the frame. It is much a more rigid hydraulically driven press and can be used for much heavier work.

Ref: Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology, chapter 16, *Presswork; Power presses*, p. 265. ISBN-13: 9780750660730

6.2 Operation Of A C Press And Cycle Of Operation

The open fronted design allows access from the front and from either side. The power press can be mechanical or hydraulically driven. The mechanically driven press derives its energy from a rotating flywheel, which is driven by an electrical motor. The flywheel is connected to a crankshaft, which can be set for single or continuous stroking. The maximum force is available at the bottom of the stroke. With the hydraulic press the ram is driven by high pressure hydraulic pumps, where the load applied is independent of the length of stroke.

Ref: Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology, chapter 16, *Presswork; Mechanical presses*, p. 266. ISBN-13: 9780750660730

Summary

Applying the appropriate safety precautions when operating a press tool: The *Press* used to drive the *press tool* is a powerful machine and potentially very dangerous. High forces involved in the cutting or forming of metal can result in serious injury if the operator is too close to any part of the press tool or press during operation. Therefore the press should never be operated without the guards being in place. Protective clothing and eye protection should always be worn.

Describing typical uses for a press tool: Press tools are used to cut or form thin metal materials such as steel, copper, brass and aluminium, which are supplied to the press tool in the form of sheet or strip. The main Cutting operations are Blanking, Piercing and Cropping. The main forming operations are Bending, Drawing, Embossing and Coining.

Describing the main parts and features of blanking and piercing press tool:

Die-set: This is normally a bough-in item, which holds and guides the press tool during use. The die-set consists of a top and bottom plate. Punch: This is the same shape as the blank being cut and is housed in the punch plate. The cutting edges need to be sharp and it need to fit into the die.

Die: This is the same shape as the punch, but has adequate clearance to allow the punch to pass through. The die tapers outwards underneath to allow the blanks or slugs to fall downwards.

Stripper: This is a plate that sits above the die and has clearance to allow the punch to pass through. It prevents the metal strip lifting up with the punch when it returns upwards.

Guide: This ensures that the stock or strip metal is correctly located as it is feed through.

Stop: Stops and correctly locate the strip as it is being fed through.

Spigot: To locate and secure the top plate of the die-set in the Press.

Describing the properties of tool steel for the manufacture of press tools: Tool steel can be machined in its softer annealed state and can then hardened by heat treatment. This alloy tool steel contains carbon, manganese, tungsten and chromium. This is an excellent material for punches and dies and will not crack or distort when it is being heat treated.

Describing the cutting action of a punch and die in blanking and piercing: In a punching or piercing operation the punch cuts into the material to approximately one third of its thickness and then the remaining two thirds of the material then breaks away. The cutting of a metal strip between a punch and a die is a shearing process where the metal strip stressed to the point of fracture or beyond its ultimate strength. The metal strip is subjected to both tensile and compressive stresses, where the metal is stretched beyond its elastic limit, then plastic deformation occurs and finally it fractures.

Describing the difference between a C frame and a H frame press: The press is a large metal framed machine, of which there are two main types, a C frame and a H frame. The C type has a shape similar to that of a milling machine, where a hydraulic ram or a flywheel is positioned at the top foremost. The frame then extends behind the working area and comes back in to form the bed of the machine. The H type has pillars at each side of the working area and forms a complete circle with the ram centred within the frame. It is much a more rigid hydraulically driven press and can be used for much heavier work.

Suggested Exercises

- 1. Draw a freehand isometric sketch of a press tool for punching circular blanks and label the main components.
- 2. Sketch components that have been Pierced, Blanked, Cropped, Bent, Drawn, Embossed and Coined.
- 3. Mill a slot 10mm wide x 5mm deep in both a mild steel plate and into a tool steel plate, using the hand feed. Calculate the correct spindle speed prior to milling the slots. Note the difference between the cutting actions of the two types of steel plates.
- 4. List the main elements used to tool steel alloy.

Questions

- 1. What is the purpose of a Press Tool?
- 2. List two cutting and two bending operations that are performed by a press tool.
- 3. Explain the following press tool operations: (i) Piercing, (ii) Blanking, (iii) Drawing and (iv) Coining.
- 4. Explain briefly the meaning of the following: (i) Punch and (ii) Die.
- 5. What are the two main types of Presses used in industry?

Answers

- 1. Press tools are used to cut or form thin metal materials such as steel, copper, brass and aluminium, which are fed into the Press Tool in the form of sheet or strip.
- Cutting operations: (i) Piercing, (ii) Blanking and (iii) Cropping. Bending Operations:
 (i) Drawing, (ii) Embossing and (iii) Coining.
- 3. (i) Piercing: describes the cutting of a hole or holes into the workpiece
 (ii) Blanking: this is when the outside shape is cut from the stock material to produce the finished blank.

(iii) Drawing: a punch is used to bend or form a part that may have been previously blanked.

(iv) Coining: A die with an engraving on it is used to indent its shape into a sheet metal blank to form a coin, token etc.

- 4. Punch: This is the same shape as the blank being cut and is housed in the punch plate. The cutting edges need to be sharp and it needs to fit into the die. Die: This is the same shape as the punch, but has adequate clearance to allow the punch to pass through. The die tapers outwards underneath to allow the blanks or slugs to fall downwards.
- 5. The two main types of presses are: (i) a C frame and (ii) a H frame.

Recommended Additional Resources

Reference Books

Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology.

ISBN-13: 9780750660730

Bird, John 2005, *Basic engineering mathematics*, 4th edn, Elsevier Science & Technology.

ISBN-13: 9780750665759

Timings, R.L. 1998, *Manufacturing technology*, vol. 1, 3rd edn, Pearson Education Limited. ISBN-13: 9780582356931