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Document Release History

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14/08/06	First draft	
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Module 1 – Basic Fabrication

Unit 6 – Universal Ironworker

Duration – 12 Hours

Learning Outcome:

By the end of this unit each apprentice will be able to:

- Safely set up and operate the Universal Ironworker
- Cut sections from standard stock lengths to required dimensions
- Punch holes

Key Learning Points:

Rk	Recap shear principle.
Rk	Identification of the various shearing and punching elements of the machine.
Rk	Machine capacity – maximum metal thickness.
Rk	Material selection.
Sk	Correct use and operation.
H	Safety precautions and procedures.
M	Decimals – degree of accuracy.
P	Communication, initiative, quality awareness.

Training Resources:

Standard fabrication workshop equipment. Notes and texts. Apprentice toolkit, P.P.E.

Key Learning Points Code:

M = Maths D= Drawing RK = Related Knowledge Sc = Science

P = Personal Skills Sk = Skill H = Hazards

Standard Punch Tooling

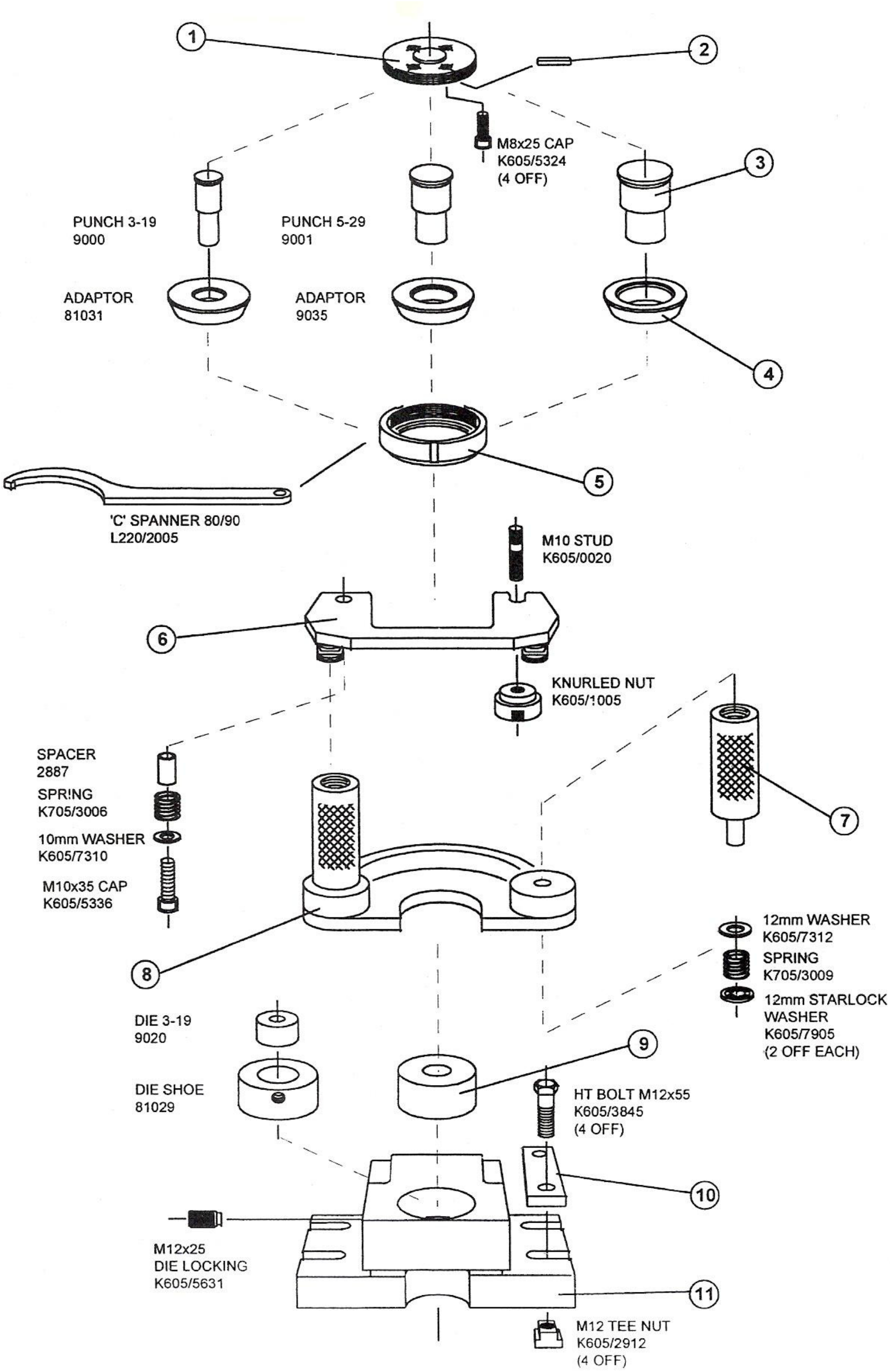


Figure 1 - Standard Punch Tooling

Punch Tooling

The Punch and Die should be checked for a1ignment prior to punching any material.

Tooling Changes

Punch:

To change punch, unscrew locking ring using 'C' Spanner from tool kit, replace punch and retighten locking ring. Adaptors are supplied to suit various punch head sizes.

Die:

To change die, slacken set screw in side of bolster, remove die and replace with new die, retighten set screw.

After replacing punches and dies, it is important that they are correctly aligned. Extra care must be taken when fitting square or shaped punches that they are correctly aligned before operating machine.

Punch Tooling – General Guides

1. The punch stripper plate must be adjusted correctly with sufficient clearance to allow positioning and removal of the material being punched.
2. Punch holes with sufficient material around the hole so contact is made on both sides of the stripper plate. Stripping forces can be severe. Unbalanced stripping forces may cause punch breakage.
3. Liberal oiling of the punch will considerably lengthen the life of the punch and die and also help reduce the stripping forces.
4. The quality of the hole (or blank) is an immediate indication of the condition of the punch and die.
5. Do not punch material thicker than the punch diameter, this overloads the punch and can result in breakage.
6. Punch full and complete holes; do not punch partial holes unless tooling is specifically designed to do so.
7. When punching small items (i.e. small pieces of plate, bar etc) these items MUST be places and extracted with suitable handling aids, extra guarding may be required too ensure operator safety.
8. Stay within the rated capacity of the machine.

Punching Capacity

The graph shows the punch capacity curves for the COMPACT 45 and COMPACT 60 machines. As an example it can be seen to punch material 15mm thick, the maximum diameter is 22mm on the COMPACT 45 and the maximum diameter on the COMPACT 60 is 28mm. As an alternative it is possible to calculate a capacity by using the machine constant. By dividing the machine constant by the material thickness will give the maximum diameter through that thickness.

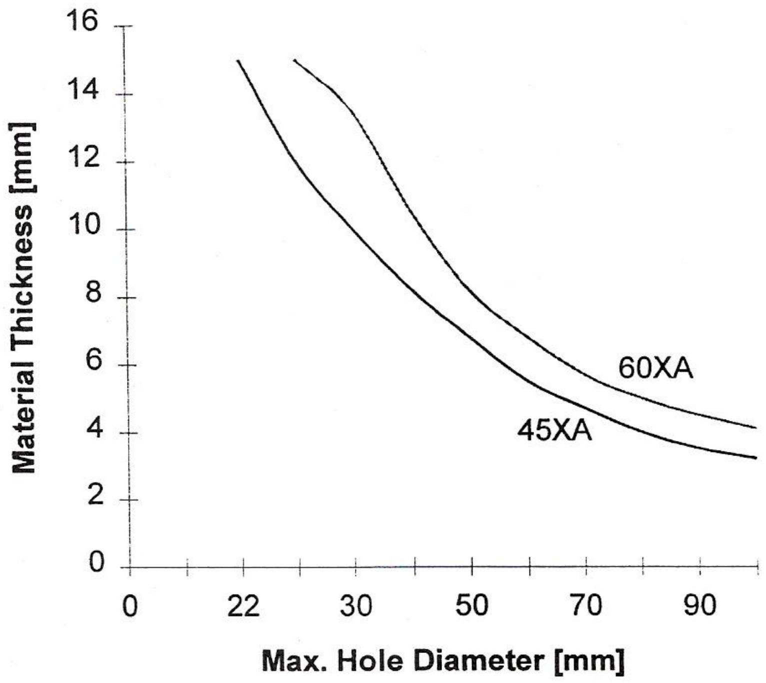


Figure 2 - Punch Capacity

The machine constants are:

COMPACT 45	330
COMPACT 60	420

If you want to calculate the maximum Material thickness / maximum hole sizes use one of the following formulas:

Constants / Material Thickness = Max. Diameter

or:

Constants / Diameter = Max. Material Thickness

Note: All capacities are based on materials to be punched having a tensile strength of 45 kg/mm². Always keep within the rated capacity of the machine and never attempt to punch a hole smaller in diameter than the thickness of material being punched.

Decimals

Introduction

The invention of decimal fractions, usually called simply decimals, was a gradual process. It started around the twelfth century and was completed in 1585, when Simon Stevin, a Flemish scientist, published a treatment called La Disme (English title: The Art of Tenths).

Stevin's symbolism was, however, very complicated and, although numbers written with a decimal point had first appeared in print in 1492, decimals were not generally adopted until the late seventeenth century. In fact, even today, the symbolism is not standardised. While the United Kingdom and the United States use a decimal point, many European countries use a comma instead.

Although Lord Randolph Churchill, Sir Winston's father, complained that he "never could make out what those damned dots meant", the use of decimals brought many benefits, including making commercial processes easier and, in mathematics, the development of logarithms.

Place Value

In the decimal system, the place of a digit in a number tells you the value of that digit. The value of the digit in each of the first three columns is,

hundreds tens units

Each value is $1/10$ of the value on its left. You can continue this pattern to the right of the units column with column values of **tenths**, **hundredths** and **thousandths**.

The value of each digit in the number 654.739, which is read as six hundred and fifty four point seven three nine, is shown in the following table.

Decimals

hundreds	tens	units		tenths	hundredths	thousandths
6	5	4	•	7	3	9

Table 1 – Decimals

The decimal point acts as a marker which separates the whole number part from the part which is less than 1.

For example, the value of the 7 is $7/10$ and the value of the 9 is $9/1000$.

The number 654.739 has three decimal places. The digit 7 is in the first decimal place, 3 is in the second decimal place and 9 is in the third.

With decimals which are less than 1, it is usual, but not essential, to write a zero on the left of the decimal point. Thus, you write 0.53 rather than .53 to draw attention to the decimal point.

If two decimal numbers have equal whole number parts, you can find which is larger by comparing their tenths digits, their hundredths digits and so on. For example, 4.23, which has a tenths digit of 2, is greater than 4.19, which has a tenths digit of 1. It does not matter that 4.19 has a greater hundredths digit than 4.23.

Example

Which decimal fraction is greater, 0.506 or 0.512?

Start from the decimal point and work to the right. The tenths digits are equal. 0.506 has a hundredths digit of 0 and 0.512 has a hundredths digit of 1. As 1 is greater than 0, 0.512 is greater than 0.506.

The symbol > means 'is greater than'. Example 5.2.1 shows that 0.512 > 0.506. The symbol < means 'is less than'. Thus 0.506 < 0.512.

Principles of Punching

Punching is a method of rapidly removing metal to form round, square, elliptical or other shaped holes by using a top punch and bottom die. The punch is usually driven by mechanical, hydraulic or manual force, dependent on the thickness of metal. A line diagram of the punching arrangement is shown in Figure 3.

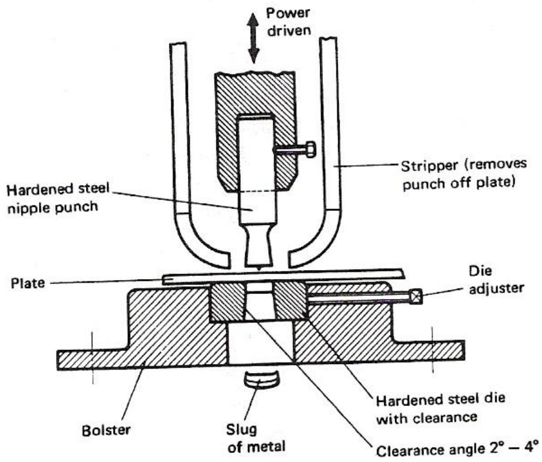


Figure 3 - Punching Arrangement

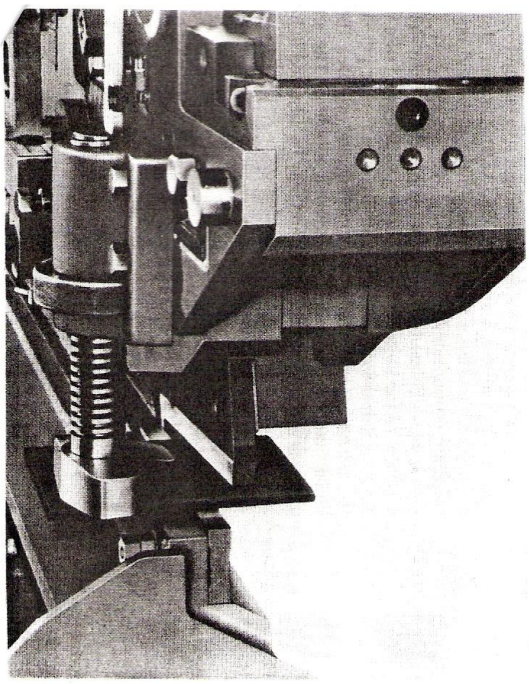
The action of the punch in forcing the slug of metal through the die is, first, plastic flow of the material due to the compressive load, then one of shearing and tearing as the grains of the metal are elongated and ruptured. This results in severe work hardening and an increase of stress around the hole. Specifications for certain types of work forbid punching and others only allow it if the holes have been reamed through to remove this highly stressed work-hardened metal. B.S. 449 does not recommend the punching of holes in plates above 15 mm thick and as a rule it is not possible to punch holes smaller than the plate thickness without damage to the punch.

A clearance between the punch and die of approximately one-tenth of the plate thickness is usual to prevent excessive burr and roll over.

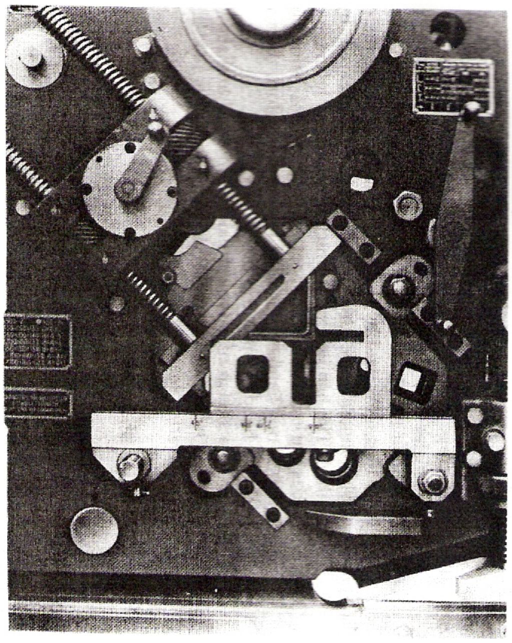
Safety

Before using any power-operated machine for material removal such as punching, shearing, notching or nibbling, etc., it is essential that the following is understood:

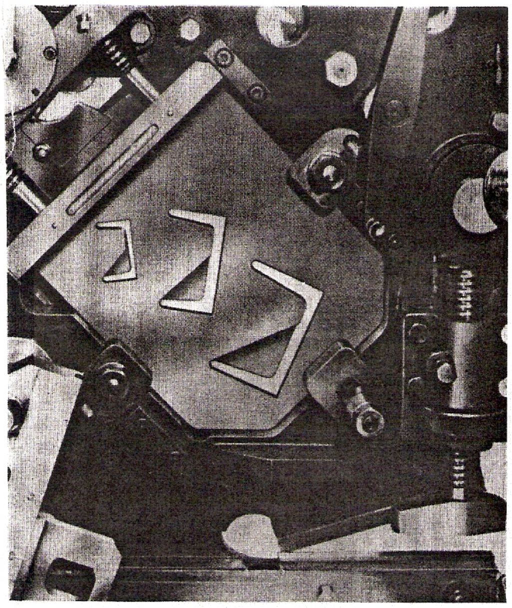
1. Do not use any machine unless you have had operating instructions from a responsible person.
2. You should know the position and operation of emergency stop buttons or switches.
3. Before starting a machine, ensure that no one is at the back in a dangerous position, and that all guards are in place.
4. Keep fingers clear of blades, hold down stops and stripper (see Figure 3).
5. Ensure that the work is held down tight during shearing.
6. When handling plates having a sharp burr, wear leather hand protectors.



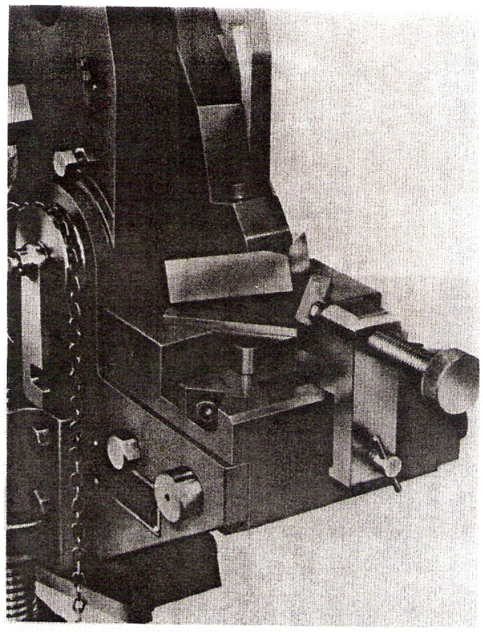
Shearing arrangement for straight cuts for flat bar and angle legs. Note the position of the hold-down stop immediately above the section being cut. (*Courtesy Henry Pels Ltd.)*



Cropper for cutting mitres and straight cuts on angle section. Note the setting angle for various mitre cuts and the hold-down stop in position on the angle. The square and round hole right and below are for cutting bar stock. (*Courtesy Henry Pels Ltd.)*



Cropper with special blades for cutting channel sections. Note the removal of the angle cropper arrangement on left. (*Courtesy Henry Pels Ltd.)*



Notching arrangement for square and mitre cutting of flat section and angle legs. Note how the blades may be interchanged, and the backstop screw which may be removed or adjusted. *(Courtesy Henry Pels Ltd.)*

Operating Instructions

The Flat Shear

With the aid of a reversible wedge the upper blade can be selectively adjusted to either 2° or 5° rake.

The machine is supplied from the factory with the blades set to 5°. The maximum shearing capacity is achieved with the blades set to 5°. In order to obtain distortion-free cuts adjust the blades to 2° rake.

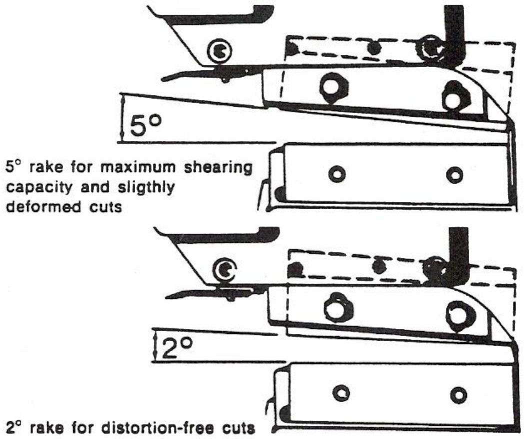


Figure 4 - Flat Shear

Blade Clearance

In order to achieve a burr-free cut, a clearance between the upper and lower blades must be allowed which corresponds to $^1/_{10} - ^1/_{20}$ of the material thickness. When shearing very thin material, the blades must be adapted to the material thickness by applying shims.

The diagram shows the required blade clearance for various material thicknesses.

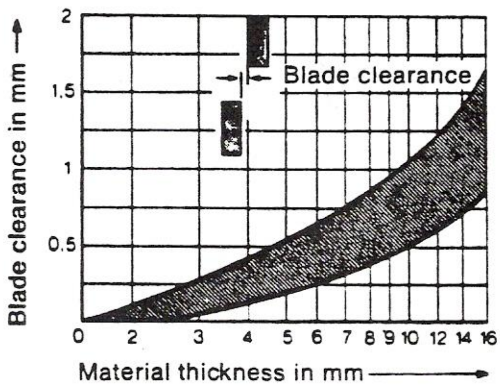


Figure 5 - Required Blade Clearance for Various Material Thickness

Adjustment of the Hold-Down

Before the shearing operation is performed the hold-down is to be carefully adjusted.

If the hold-down is incorrectly adjusted the cutting edges of the blades can easily break off. Moreover the machine frame will be additionally subjected to excessive bending forces.

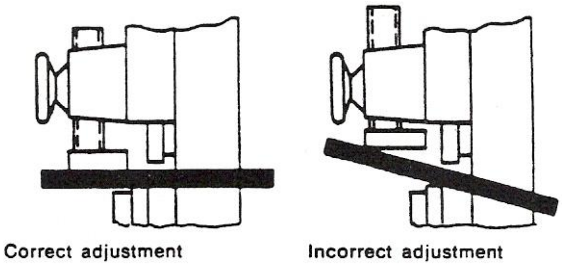


Figure 6 - Adjustment of the Hold-Down

The Ledge Table on the Flat Shear

The ledge table facilitates the precise 90° and mitre shearing operations.

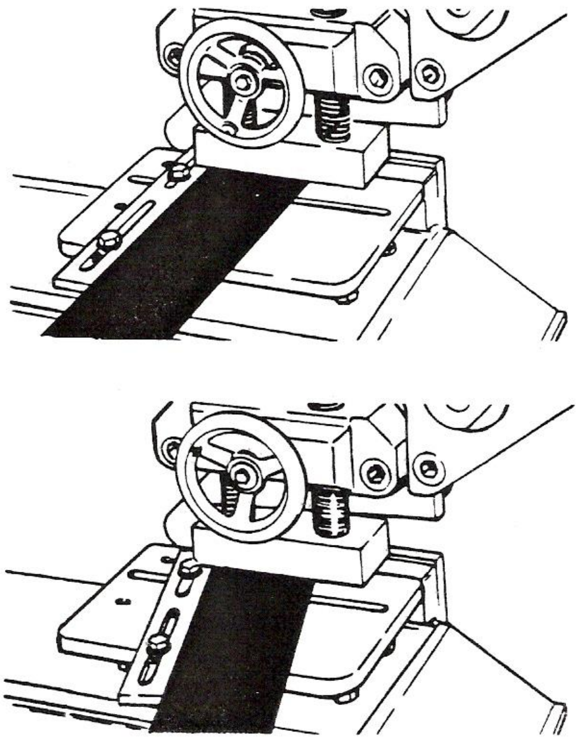


Figure 7 - Ledge Table on the Flat Shear

The Section Shear

The section shear is optionally equipped with automatic or hand adjustable section shear blades.

Setting the Automatic Hold-Down

The automatic hold-down clamps the workpiece automatically, before each shear stroke. By pulling out the hand wheel - A - the automatic mechanism is disengaged so that the adjustment can be made by hand. In order to pass the workpiece through the blade orifice without hindrance, there must be a clearance of approx. 5 mm between the workpiece and the hold-down rider - B -. By pressing in the hand wheel - A - up to the stop the hold-down is once again ready for automatic operation.

Faults

If the automatic hold-down becomes jammed, remove the hand wheel - A -, wind rider back with the aid of a spanner, replace hand wheel and disengage. In order to reduce excess pressure in oil pipe system, trip machine twice.

Straight Cut 90º

90° and 45° marks are punched in the bevel gauge rail. The letter - A - is for automatic knives and the letter - Z - for hand adjustable knives.

1. Feed angles or tees through the bevel gauge (900 - A - or - Z- mark) at a right angle into the blade apertures.
2. Wind the hold-down rider on to the material.
   On tees and angle iron with unequal legs use the hold-down wedge.
3. Engage the machine by depressing the foot pedal.

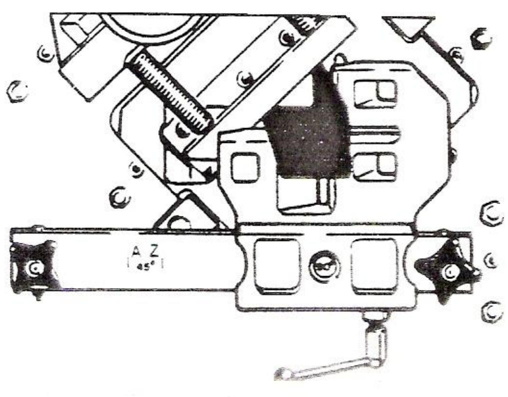


Figure 8 - Straight Cut 90º

Mitre Cut 45º

1. Slide the bevel gauge to the left up to the 45° mark (- A - or - Z -) and tighten.
2. Feed material at 45º through the bevel gauge into the blade aperture.
3. Wind down the hold-down on to the material.
4. Engage the machine by depressing the foot switch.

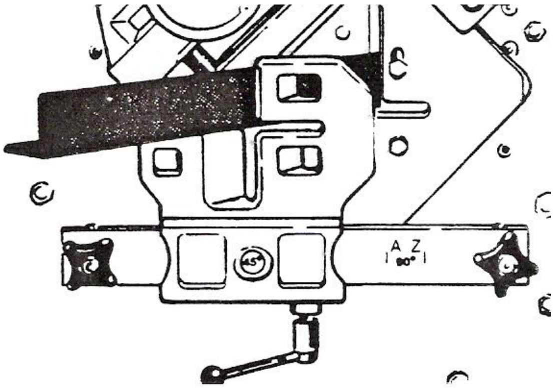


Figure 9 - Mitre Cut 45º

The Automatic Section Blades

They enable angle iron and T-iron to be sheared at 90º and in mitre. The insert blades automatically adjust themselves during the shear stroke to the dimensions of the work piece irrespective of whether angles or tees are being sheared.

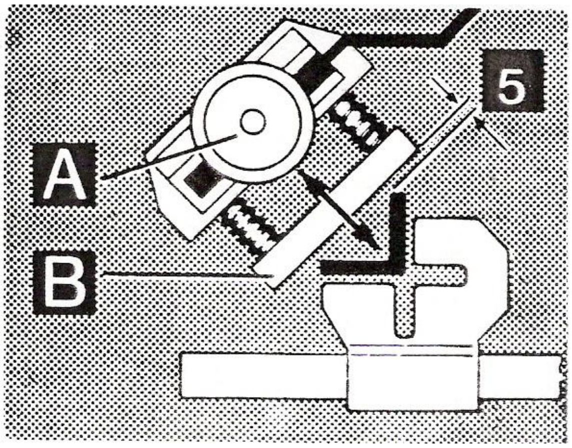


Figure 10 - Automatic Section Blades

Self Assessment

Questions on Background Notes – Module 1.Unit 6

1. List two types of material removal and give an example of each.

2. When using the Guillotine list the three main factors that will affect it
And briefly explain one.

3. List two safety points when using the Guillotine.

4. How many sides does an Octagon have?

Answers to Questions 1-4. Module 1.Unit 6

1.

a. Chip –Forming: Drilling, Hack sawing

b. Non – Chip Forming: Tin snipes, Guillotine.

2.

1. **Blade Clearance:**
   The distance between the top blade and the bottom blade.

2. **Rake Angle:**
   This is the angle of the top blade.

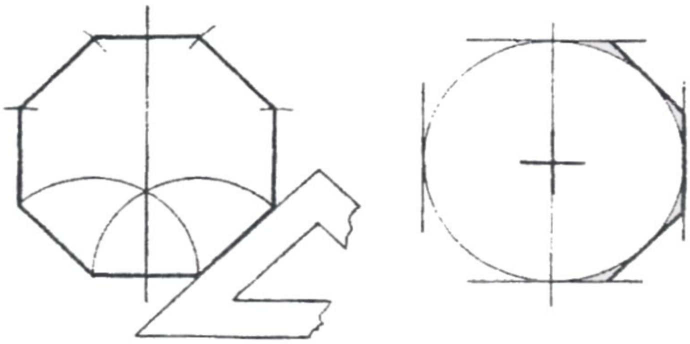
3. **Relief Angle:**
   This is the second angle on the top blade depending on the material being sheared.

3.

1. Know where the emergency stops are located.
2. Make sure nobody is at the rear of the guillotine.

4.

Figure 7. Octagon



Bibliography

Books:

Reg. Trade Mark of Hodder Headline

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