DIESEL MECHANIC

MINING QUALIFICATIONS AUTHORITY

CODE: TRS

DRILL AND TAP HOLES

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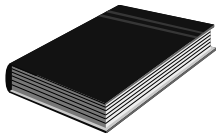
TRG 9

INDEX

The following elements are contained in this learning guide:

SOURCE REFERENCES



Demonstration by a competent person e.g. a Training Officer.

Training video - Use Hand Tools Part 2.

OBJECTIVE

You will be learning towards the outcome “Drill and tap holes”. Whilst learning towards the outcome you will be required to achieve the following:

- Drill and tap holes in mild steel.

On completion of this module, the learner must be able to:

- Drill and tap a hole in mild steel and plug it to simulate a broken off stud or bolt.
- Remove a plug out of a tapped hole with a stud extractor.

During this process you must adhere to certain specified requirements as listed in the Module.

ASSESSMENT AND EVALUATION CRITERIA

You will be assessed, when you are confident that you may achieve the outcomes as listed, to determine your competence as measured against the required criteria. This assessment will be in line with accepted best practices regarding assessment.

- Self tests and practical test will be set during the module and must be completed without using references other than thread charts, a drill speed chart and a chart showing drill sizes for stud extractors.
- The learner will be given a drawing and all the necessary tools and equipment and will be required to:
    - drill and tap a hole in mild steel,
    - plug the hole and cut off the stud, and
    - remove the stud from the hole using the correct tools and procedures.
- The following standards must be achieved:
    - The hole must be drilled to the correct size and to within ± 1mm of the specified depth and square to the work face.
    - The hole must be tapped square to the work face and to the bottom using the correct procedures as contained in this module.
    - The plug (broken stud) must be removed in one piece from the tapped hole without damage to the thread.
    - There must be no damage to tools and equipment.
- All safety procedures must be adhered to.

HAZARD IDENTIFICATION AND CONTROL (HIAC) FORM

TRS

DRILL AND TAP HOLES

STEPS IN OPERATION / PROCESS	POTENTIAL ACCIDENT / INCIDENT	CONTROLS (BY RESPONSIBLE PERSON)
1. Use hand tools.	• Using damaged tools or wrong tools for the job can cause injury and damage to equipment.	• Always use the correct tool for the job. • Ensure tools are in good condition. • Use tools correctly. • Wear appropriate PPE where necessary. • Always take good care of tools. Maintain, clean and store it properly.
2. Use a pedestal drill.	• Eye injuries due to flying particles.	• Use appropriate safety goggles.
	• Injury due to rotating chuck.	• Always allow chuck to stop before changing drills or making adjustments. Do not stop chuck by hand. Allow it to stop of own accord. • No loose clothing or loose long hair when operating machine.
	• If work piece rotates, it can cause injury.	• Securely clamp work piece in place.
	• Burrs and swarf can cause hand injuries.	• Remove burrs from drilled holes, using the correct tools. • Clean away swarf with a brush. Do not use unprotected hands.
	• Tapping compound and fluids may be toxic and could be harmful to the skin.	• Wash hands with soap and water after use.

NOTE: Before doing the practical work contained in this module, the learner must study the content of the above HIAC form again and then sign the statement below.

The above risks, which will be encountered in this module, are fully understood and will be controlled during the practical work.

Signature of learner: _____

Signature of Training Officer: _____

Date: _____

1. DRILL HOLES FOR TAPPING

ITEM / TASK: Introduction.

DESCRIPTION:

It is often necessary to drill and tap holes for various purposes in any engineering environment. In this module it will be learnt -

- how to use taps and tap wrenches to tap holes, and
- how to remove a broken stud from a tapped hole.

ITEM / TASK: Selecting tapping drills.

DESCRIPTION:

A. Consult the drawing to determine the position of the hole.
B. Mark off the position of the hole on the workpiece.
C. Check the drawing for the thread size (e.g. M10 x 1.50) which indicates it is a metric size thread with a diameter of 10mm and a 1.5mm pitch. Refer to module TS – Identify Threads, if necessary.
D. Select the correct size tapping drill from the appropriate chart for tapping drill sizes. See Tables 1a, 1b and 1c below and on the next page for tapping drill sizes.

Note:

For the example in C above the tapping drill size is 8.5mm. Table 1(a) – metric coarse thread.

TABLE 1a - TAPPING DRILL SIZES (METRIC THREADS)

METRIC – COURSE				METRIC – FINE			
BOLT SIZE	**a**	**b**	**c**	**BOLT SIZE**	**a**	**b**	**c**
M6 x 1.00	6	1.00	5.0	M6 x 0.75	6	0.75	5.2
M10 x 1.50	10	1.50	8.5	M10 x 1.00	10	1.00	9.0
M12 x 1.75	12	1.75	10.2	M12 x 1.50	12	1.50	10.5
M16 x 2.00	16	2.00	14.0	M16 x 1.50	16	1.50	14.5
M20 x 2.50	20	2.50	17.5	M20 x 1.50	20	1.50	18.5
M24 x 3.00	24	3.00	21.0	M24 x 2.00	24	2.00	22.0

NB: a = Thread size in mm, b = Thread pitch in mm, and c = Drill size in mm.

TABLE 1b - TAPPING DRILL SIZES (IMPERIAL THREADS)

WHITWORTH								
BSW			BSF			BSP		
a	b	c	a	b	c	a	b	c
1/8"	40	2.5	1/8"	-	-	1/8"	28	8.6
1/4"	20	5.1	1/4"	26	5.4	1/4"	19	11.5
3/8"	16	7.9	3/8"	20	8.3	3/8"	19	15.0
1/2"	12	10.5	1/2"	16	11.2	1/2"	14	18.5
5/8"	11	13.5	5/8"	14	14.0	5/8"	-	-
3/4"	10	16.5	3/4"	12	17.0	3/4"	14	24.0
1 "	8	22.0	1 "	10	23.0	1 "	11	30.2

NB: a = Thread size in inches, b = Thread per inch (TPI), and c = Drill size in mm.

TABLE 1c - TAPPING DRILL SIZES (IMPERIAL THREADS CONTINUED)

ISO UNIFIED					
UNC (COARSE)			UNF (FINE)		
a	b	c	a	b	c
1/4"	20	5.10	1/4"	28	5.50
3/8"	16	8.00	3/8"	24	8.50
1/2"	13	10.80	1/2"	20	11.50
5/8"	11	13.50	5/8"	18	14.50
3/4"	10	16.50	3/4"	16	17.50
1 "	8	22.25	1 "	12	23.25

NB: a = Thread size in inches, b = Thread per inch (TPI), and c = Drill size in mm.

DO SELF-TEST 1 ON THE NEXT PAGE BEFORE CONTINUING WITH THE REST OF THE MODULE.

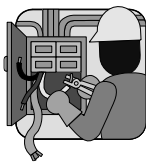
SELF TEST 1

Fill in the sizes of the tapping drills for the following threads. Refer to the tables above.

Thread size	Drill sizes
M20 x 2.50	
M12 x 1.50	
$^{3}/_{8}$" BSW	
$^{1}/_{2}$" BSF	
$^{5}/_{8}$" UNC	
$^{1}/_{4}$" UNF	

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :



ITEM / TASK: Drilling the hole.

DESCRIPTION:

A. Mark off the size of the hole on the workpiece.

B. Set up and clamp the workpiece on the drilling machine table.

C. Line the drill up with the marked off hole.

D. Consult the drill speed chart on the machine and select the recommended spindle speed.

NB:

Follow the marking off and drilling procedures described in Module MPD – Plan a Drilling Workpiece and Module MDM – Maintain and Use a Pedestal Drill.

E. Drill to the full chamfer of the drill. (Fig 1)

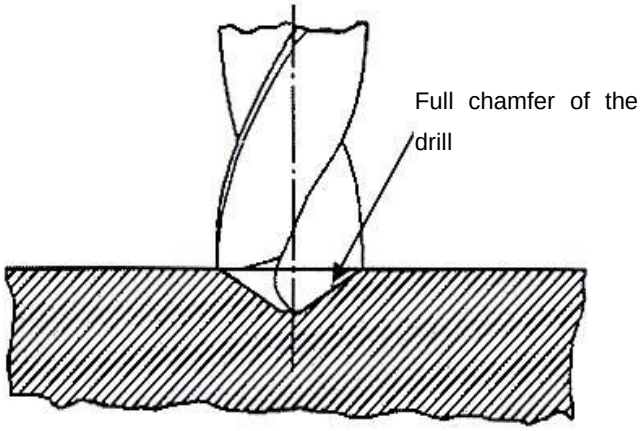


FIG 1.

F. Switch off the machine and set the depth gauge while the drill is held in the dimple.

NB:

Most drilling machines are fitted with an adjustable depth gauge. If, however, the machine has a depth gauge with a fixed pointer and scale, do the following:

- **Note the position of the pointer on the scale.**
- **Add the full depth of the hole and make a mark at that point on the scale with a pencil or a piece of chalk.**

G. Apply a strong flow of coolant and drill to the full depth of the hole. See example on the next page.

Example

If the hole has to be drilled 25mm deep and tapped for an M12 x 1.75 bolt, the tapping drill size given on the drill chart is 10.2mm diameter, and the hole is drilled as shown in Fig 2.

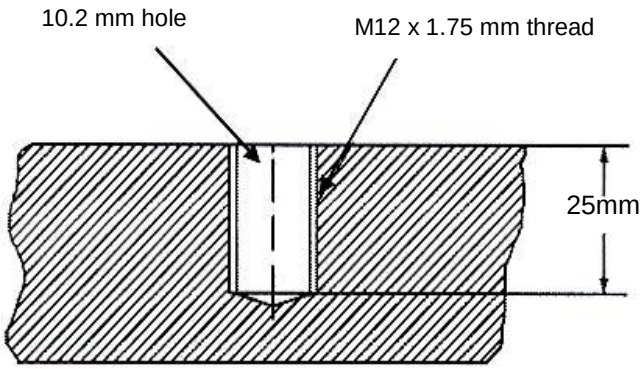


FIG 2.

H. Select a drill with the same diameter as the major diameter of the thread and countersink the drilled hole to a depth of between 1mm and 2mm. (Fig 3)

NB:

This will prevent the thread forming a burr on the face of the workpiece.

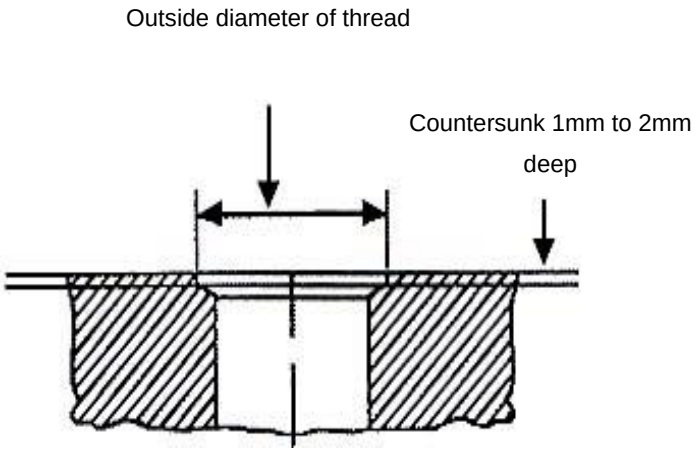
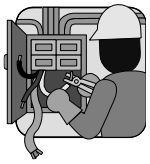


FIG 3.

DO THE PRACTICE ON THE NEXT PAGE BEFORE CONTINUING WITH THE REST OF THE MODULE.



PRACTICE

Practice drilling holes of different sizes in mild steel and preparing the holes for tapping as described in this module.

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

2. TAP A HOLE

ITEM / TASK: Tapping tools.

DESCRIPTION:

A. Select a set of hand taps to use. Fig 4 shows the two types of hand taps most often used.

Note:

Check the display board in the training centre for all the different types of taps available and all their particulars.

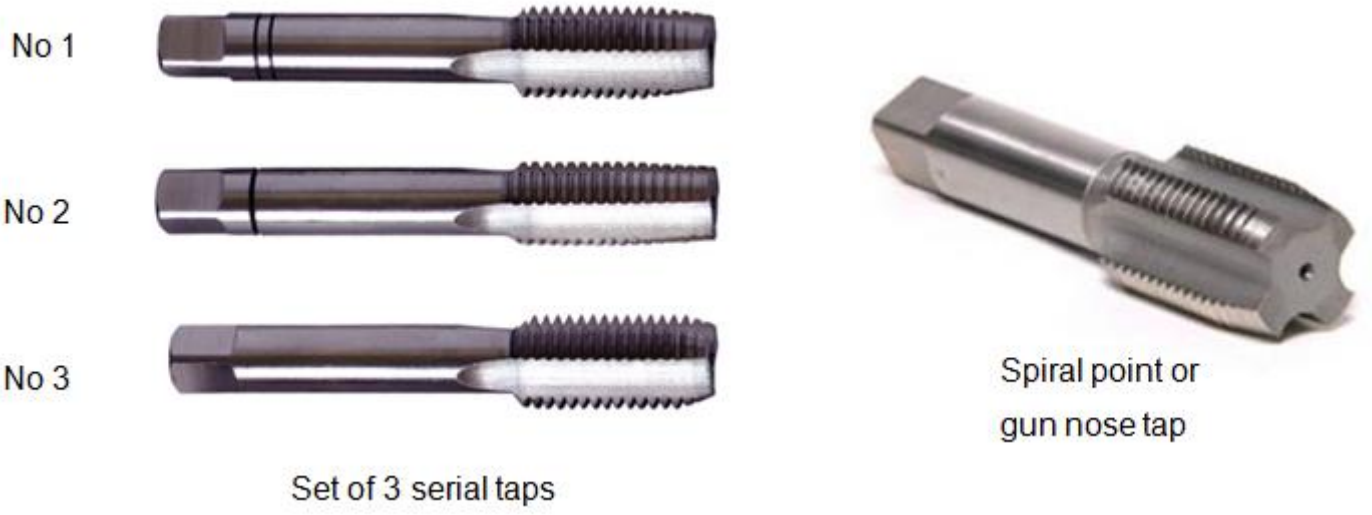


FIG 4.

B. The set of three taps shown in Fig 4 is used for hand tapping “through holes”, “deep holes” or “blind bottoming holes”. (Fig 5)

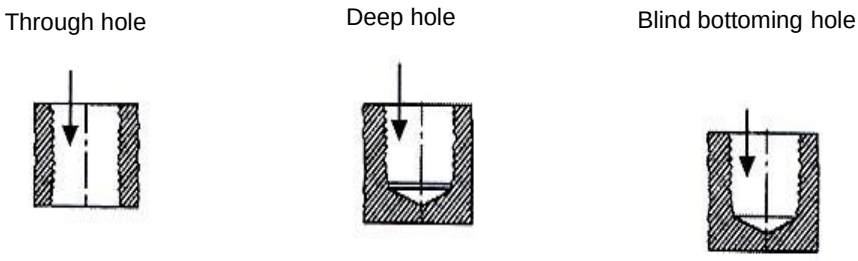


FIG 5.

NB:

These taps must be used in sequence.

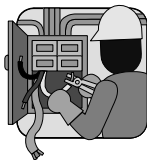
C. Fig 6 & Fig 7 shows the two main types of tap wrenches for hand tapping.

- **The "T" wrench** is available in various sizes but is used mainly on the smaller series of taps. (Fig 6)
- **The flat wrench** is available in sizes to take both the smaller series and larger series of taps. (Fig 7)

FIG 6.

FIG 7.

ITEM / TASK: Tap a blind bottoming hole.



DESCRIPTION:

A. Fit the number one tap, also referred to as the taper tap, into the tap wrench.

B. Apply a tapping compound to the teeth of the tap.

Note:

Some of the tapping compound and fluids are toxic and could be harmful to your skin. Wash hands with soap and water after use.

C. Screw the tap into the hole, clockwise for right-hand taps and anti-clockwise for left-hand taps.

D. Check the tap for squareness to the workpiece with an engineer's try square after 1½ to 2 full turns of the tap. See Fig 8 on the next page.

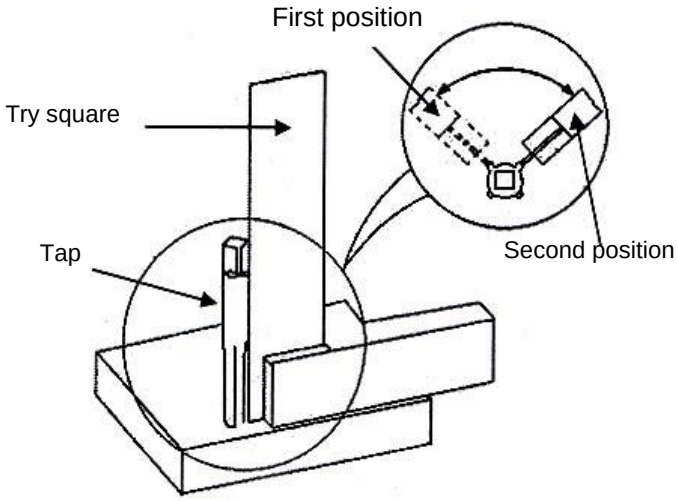


FIG 8.

NB:

Also check at 90° to the first position checked.

The following is an alternative method of ensuring the squareness of the tapped hole:

- Without moving the workpiece, remove the drill after the hole has been drilled and replace it with a centre as shown in Fig 9 below.
- Follow all the steps given previously except for squaring up the tap with an engineer's square.

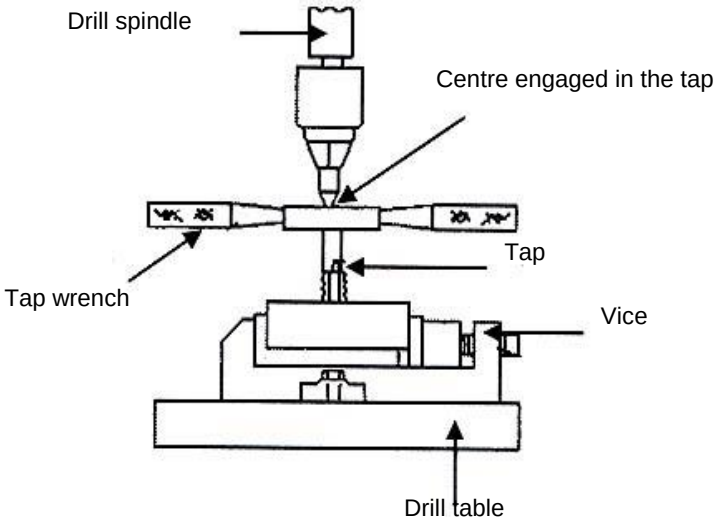


FIG 9.

E. If the tap is out of square, remove the tap and incline it to bring it square.
F. Screw the tap into the hole for two to three full turns and re-check it for squareness.
G. Reverse the rotation of the tap after every four to six full turns with the tap wrench to break the swarf formed by the teeth of the tap. A half to one full reverse turn should be sufficient.
H. If the swarf builds up in the bottom of the hole, remove the tap altogether and blow the hole out with compressed air.

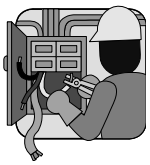
NB:

Protect your eyes by wearing goggles and do not blow in the direction of other persons.

I. Continue in this way until the point of the tap touches the bottom of the hole.
J. Remove the tap and repeat all the steps using the second and third taps of the series in sequence.

NB:

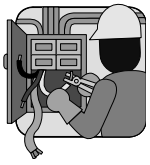
If the first tap was square to the face of the workpiece it should not be necessary to square up the second and third or bottoming tap.



ITEM / TASK: Tap a deep hole.

DESCRIPTION:

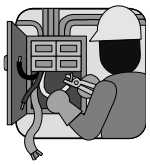
A. It is only necessary to use the taper tap and second tap in the series to tap a deep hole.
B. Follow the same procedures as described for tapping a blind bottoming hole.



ITEM / TASK: Tap a through hole.

DESCRIPTION:

Follow the same procedures as described for tapping a blind bottoming hole.



ITEM / TASK: Use a gun nose (spiral) tap.

DESCRIPTION:

A. Use the same method of squaring the tap up as described previously.

B. Apply a tapping compound to the teeth of the tap.

C. Turn the tap wrench at an even rate without reversing the rotation.

NB:

This tap is not recommended for tapping blind bottoming holes or thin material.

ITEM / TASK: Causes for tap failure.

DESCRIPTION:

Taps fail mostly because of either chipped or snapped teeth.

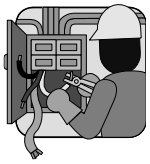
The reasons for both types of failure could be the following:

- Blunt taps.
- Incorrect size tapping hole.
- Tap not square to the hole.
- Insufficient or incorrect tapping compound.
- Build-up of swarf (chips) in the hole.
- Too much force used on the tap.

DO SELF-TEST 2 AND THE PRACTICE BEFORE CONTINUING WITH THE REST OF THE MODULE.

SELF TEST 2

1. Name the two types of hand taps described in this module.
   - _____
   - _____
2. Name the two tap wrenches described in this module.
   - _____
   - _____
3. Name the six common reasons for tap failure.
   - _____
   - _____
   - _____
   - _____
   - _____
   - _____



PRACTICE

Practice tapping through holes, deep holes and blind bottoming holes, using both a set of serial taps and a gun nose tap. Follow the procedures described in this module.

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

3. REMOVE BROKEN STUDS

ITEM / TASK: Stud extractors.

DESCRIPTION:

A. Stud extractors work on the same basic principle, namely, a hole is drilled into the stud and the extractor is then forced into the hole tight enough to allow for the stud to be unscrewed.

B. One type of extractor is in the form of a taper thread tool made of hardened steel, which is screwed into the hole in the stud. To remove a right-hand thread stud, the tool will have a left-hand thread, which bites into the stud and unscrews it.

C. Fig 10 shows a fluted stud extractor with a sliding nut. This particular type of extractor, which is described in detail in this module, is manufactured by the Rigid Tool Co, and the method described using it to remove broken studs will not necessarily apply to other makes of stud extractors.

FIG 10.

D. It is important to select the correct size drill and extractor for the size stud that has to be removed. Consult Table 2 on the next page for this purpose.

ITEM / TASK: Prepare a practice workpiece.

DESCRIPTION:

Simulate a broken stud in the following manner:

- Screw a piece of screwed rod into the tapped hole and tighten it with a pair of vice grip pliers or a Stillson wrench.
- Cut the screwed rod off to protrude 1mm to 2mm above the face of the workpiece with a hacksaw and without damaging the face. (Fig 11)

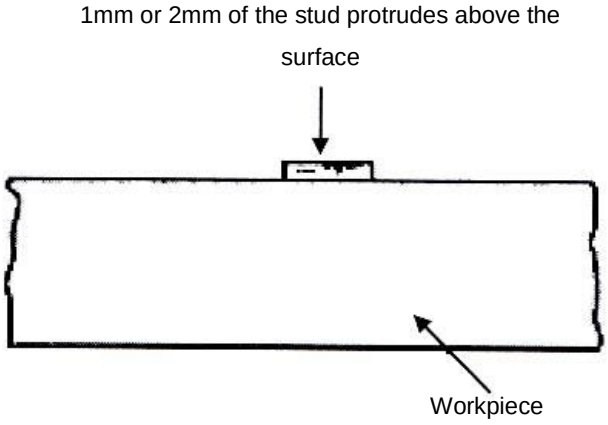


FIG 11.

TABLE 2: DRILL SIZES FOR STUD EXTRACTORS

a	b	c
6	3 mm	3.5 mm
8	5 mm	5.2 mm
10	6 mm	6.9 mm
12	8 mm	8.6 mm
16	11 mm	12 mm
20	13 mm	13.7 mm
24	16 mm	16.9 mm

NB: **a - Diameter of screw / stud.**
b - Diameter of drill.
c - Diameter of stud extractor.

ITEM / TASK: Remove a stud.

DESCRIPTION:

A. Find the centre of the stud and centre pop mark it.
B. Consult Table 2 on the previous page and select the recommended drill and stud extractor.
C. Drill a hole through the centre of the stud. (Fig 12)

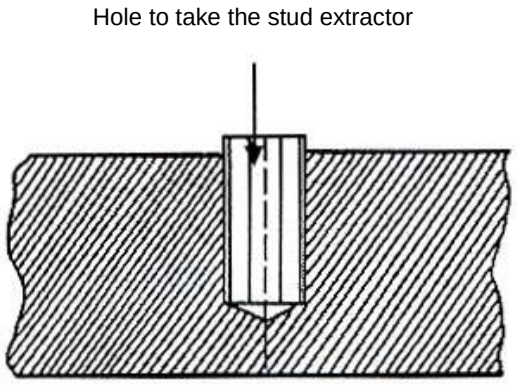


FIG 12.

D. Drive the fluted extractor with a hammer into the hole drilled in the centre of the stud.
E. Slide the nut that will fit the flutes over the extractor. (Fig 13)

NB:

Fluted stud extractors for removing studs of 16mm diameter and larger do not have sliding nuts.

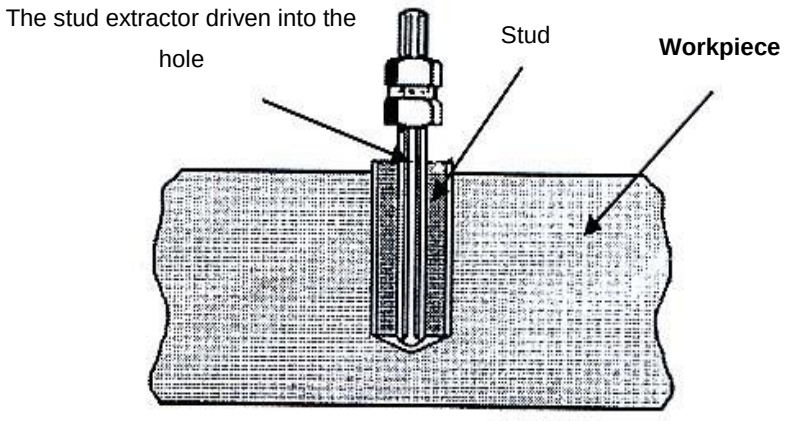


FIG 13.

F. Select a flat or ring spanner that will fit the hexagon of the sliding nut and turn the nut in an anti-clockwise direction to remove a broken stud with a right-hand thread, and clockwise for a left-hand thread.

G. Open the jaws of a vice sufficiently to take the extractor with the stud resting on the jaws and tap the extractor out with a hammer and a pin punch. (Fig 14)

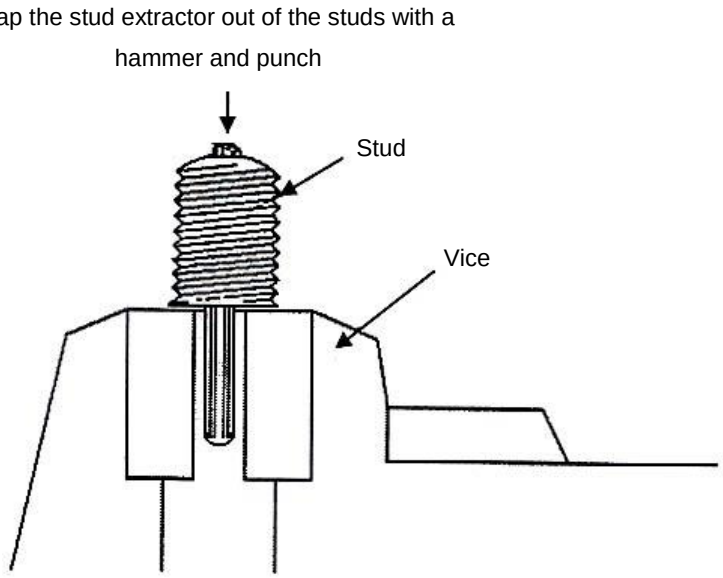


FIG 14.

DO SELF-TEST 3 AND THE PRACTICE BEFORE ATTEMPTING THE ASSESSMENT FOR THE MODULE.

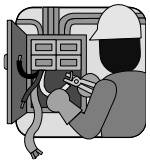
SELF TEST 3

Write down the drill diameters and extractor diameters to remove the following size broken studs.

a. 8 mm drill dia _____ Extractor dia _____

b. 12 mm drill dia _____ Extractor dia _____

c. 16 mm drill dia _____ Extractor dia _____



PRACTICE

Practice the following:

- Drilling and tapping holes from M6 x 1.0 to M16 x 2.0 in the coarse series of threads.
- Plugging the holes in the manner described in this module.
- Removing the plugs (broken studs) by using stud extractors.

Ask your Training Officer to check your work and if it is correct, to sign below.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

<u>REMEMBER ALWAYS WORK SAFE</u>

Once you have passed the entire self tests and practices, you are now at liberty to request a Formative Assessment from your Assessor.