Pocket guide to riveting technique

Atlas Copco

POCKET GUIDE TO RIVETING TECHNIQUE AND APPLIED ERGONOMICS FOR AEROSPACE INDUSTRY

INTRODUCTION

This pocket guide is intended to give a basic knowledge of rivet types and riveting technique in the Aerospace Industry. Hole preparation and faults in the rivet joint are also discussed. We are aware that different aircraft manufacturers use different systems for marking the rivet as well as different ways to perform the riveting process. Therefore, this pocket guide has been kept on a fairly basic level. Since vibration induced injuries, i.e. ergonomics is an important factor in riveting, this is discussed in two separate chapters. Today the measurement of vibration is a major issue, especially on the EC market where all power tools must conform to all applicable EC Directives. A description of the EC declaration and the measurement of riveting hammers are found in Chapter 7. The selection guide at the end of the guide provides guidance in choosing Atlas Copco riveting hammers.

1. FASTENERS IN THE AEROSPACE INDUSTRY

SOLID RIVETS

Solid rivets are still the dominating fastener in aircraft assembly.

For more than a thousand years, riveting together material has been a familiar fastening method. Riveting with the help of power tools has existed for more than a century.

In spite of recent advances in other methods, such as gluing and tightening, riveting is still a leading method in aircraft and other lightweight constructions where the high strength sheet metal is not weldable. There are several reasons for this:

- ❏ Lower installation cost because installation is faster than for threaded fasteners.
- ❏ Lower installation cost because lower requirement of hole preparation.
- ❏ No malfunctioning because of high reliability.
- ❏ Rivets allow a light yet strong joint because of their low weight.
- ❏ Rivets are resistant to fatigue due to their high elasticity, which contributes to their durability.
- ❏ High productivity because of the low costs involved, compared to other methods.

DIFFERENT TYPES OF SOLID RIVETS

STANDARD RIVETS

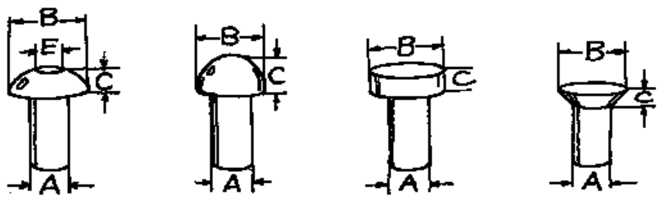
The rivet normally has an AN or MS number that describes the head type and designation letters describe the alloy, diameter and length. Several types of heads can be found depending on where the rivets are used, see fig. 1.

Two common systems are used to describe the material in a rivet, a colour code system or a head marking systems see fig. 2. The colour system is from the military standard.

Beside material and application, the military standard also specifies shear strength, heat treatment and tolerance for the rivet.

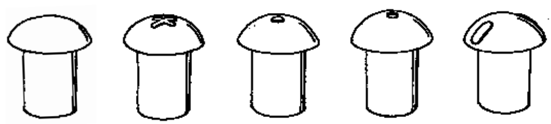
Length is measured from the top of the flush head and the underside of the universal head, see fig. 3.

A dash number gives the diameter and length of the rivet, see fig 4.



AN 470	AN 430	AN 442	AN 426
Universal head	Round head	Flat head	Flush head or countersunk head

Fig. 1 The AN number identifies the head shape of the rivet.



Common designation:	A	B	AD	D	DD
Material:	1100	5056	2117	2017	2024
Color code:	White	Blue	Orange Dimple	Yellow Teat	Red

Fig. 2 A letter, color or head marking state the alloy from which the rivet is made.

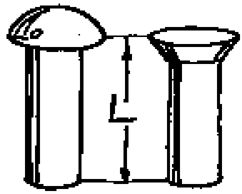


Fig. 3 Universal head Flush head

DASH NUMBERS	DIAMETER (Inches)	LENGTH (Inches)
-3-2		1/8
-3-3		3/16
-3-4		1/4
-3-5		5/16
-3-6	3/32	3/8
-3-7		6/16
-3-8		1/2
-3-10		5/8
-4-3		3/16
-4-4		1/4
-4-5		5/16
-4-6		3/8
-4-7	1/8	7/16
-4-8		1/2
-4-9		9/16
-4-10		5/8
-4-12		3/4

DASH NUMBERS	DIAMETER (Inches)	LENGTH (Inches)
-4-14		7/8
-5-4		1/4
-5-5		5/16
-5-6		3/8
-5-7		7/16
-5-8	5/32	1/2
-5-9		9/16
-5-10		5/8
-5-12		3/4
-6-5		5/16
-6-6		3/8
-6-7		7/16
-6-8	3/16	1/2
-6-9		9/16
-6-10		5/8
-6-12		3/4

Fig. 4.

Round-head rivets and flathead rivets are mainly used for interior subassemblies, and these are usually installed with automatic riveting machines. The flush head type is the dominant rivet on the outer part of the skin were aerodynamic smoothness is important. The most critical areas, where a high degree of aerodynamic smoothness is required are shown in fig. 5. In the shaded area of the picture the rivet shall be flush within tolerance 0.00 to 0.05 mm, while in other areas up to 0.18 mm is

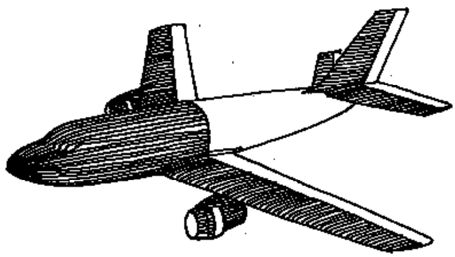


Fig.5

Rivets with no head marking are made of 1100 aluminum and called A rivets. They are mainly used for non structural applications.

The B rivet with a cross on its head contains about 6 % magnesium and is used for riveting magnesium structures.

The AD or 2117 rivet, identified by a dimple in the center of its head, is by far the most common rivet in aircraft construction. This rivet is heat-treated as it comes from the supplier, but is soft enough to allow it to be driven without any further heat treatment.

D and DD rivets are known as ice box rivets.

Let us describe a rivet, for example an AN 470AD 4-6, AN 470 indicates that the rivet has a universal head.

AD indicates that the material is 2117. 4-6 that the diameter is 3/32” (2.38 mm) and the length is 3/8” (9.52 mm).

Beside these standard solid rivets, new types of plastic rivets are being developed. These are intended for fibre-reinforced materials.

ICE BOX RIVETS

Ice box rivets are heat-treated, tempered and then placed under refrigeration to delay the age hardening process.

They are kept this way until just before they are driven with the rivet gun. When the structure is ready to be riveted, the rivets are removed from the ice box and must be driven within about twenty minutes. After twenty minutes they will have aged to such an extent that they will crack when driven.

If the rivets have been allowed to harden, they may be returned to the heat-treat furnace and again heated and quenched.

In riveting it is very important to set them with a few hard blows, so as not to destroy the final properties of the joint.

OTHER COMMON TYPES OF FASTENERS

Beside rivets, different kinds of threaded fasteners can be found in the aircraft industry. See fig. 6. (Huckbolts, Blind Rivets, Cherry Rivets, Jobolts, Hi-Locks, Taper-Lock and Hi-Shear).
These other types of fasteners are mostly applied for reasons of accessibility or to diminish noise problems.
The costs of installing threaded fasteners are, however, much higher than that of rivets. Besides a higher cost for the fastener itself, better hole preparation is usually demanded.

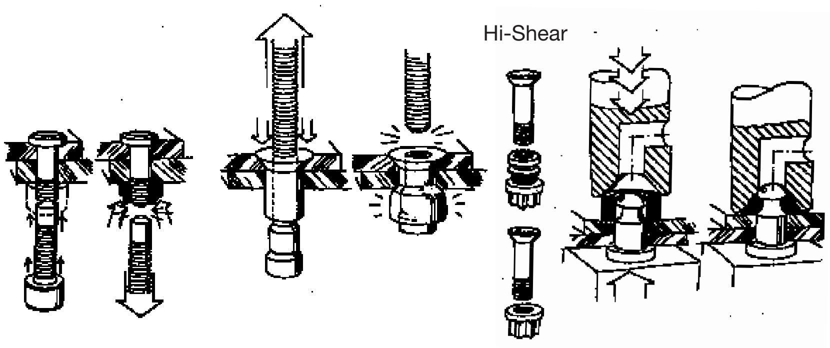


Fig. 6 Huckbolt Blind Rivet Hi-Lock Taper-Lock

2. RIVETING TECHNIQUE

SELECTING THE PROPER RIVET SIZE

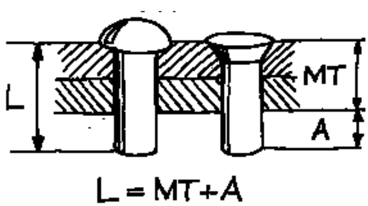
A general rule is that the rivet should have a diameter of at least three times the thickness of the thickest sheet being joined.

According to the military standard, the bucked counter head diameter of the rivet joint must then be larger than 1.4 times the diameter of the shank. The height must extend to 0.3 times the diameter of the shank. Consequently, the desired length of the rivet can be calculated. See fig. 7. The allowance is normally about 1.5D.

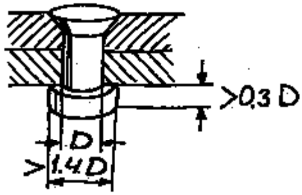
For example, two pieces of 0.050 inch (1.27 mm) sheet are to be riveted together, the proper diameter rivet would be 3 x 0.050=0.150 inch (3 x 1.27=3.81 mm). A 5/32” rivet (0.156 inch, 3.96 mm) would be used. The metal thickness is 0.050+0.050=0.10 inch (1.27+1.27=2.54 mm), and 1.5D is 0.234 inch (5.94 mm), so the total length would have to be 0.10 + 0.234=0.334 inch (1.27+5.94=7.21 mm) for the rivet.

In practical riveting such as overhaul and repair riveting, the general rule is to use the same size and head-style used in the adjacent structure. This will meet all the strength requirements for the joint.

Fig. 7.



Rivet length = Material thickness + Allowance



Allowance depends on bucked head size

HOLE PREPARATION

PROTRUDING HEAD RIVET

After the rivet size has been selected and the sheets are in place, the holes must be marked for drilling.

These hole-marks should be punched with a center punch just deep enough to start the drilling.

If the punch is too hard, the mark will be too large and the metal will be distorted.

The drill diameter depends on the type of rivet in the hole. As a rough guide the drill chart in fig. 8 can be used.

Notice in this table that the drill size is normally about three thousands of an inch larger than the rivet.

Before drilling it is important to check the condition of the drill as well as that the drill is properly attached in the chuck. For holes larger than 1/8” (3.18 mm) it can be necessary to predrill.

Reaming is not necessary in normal thickness since the rivets swell. Reaming is therefore more common for other types of fasteners that lack the property of swelling.

Maximum thickness to achieve an acceptable swell is 4 times the diameter of the shaft.

After drilling, remove the burrs from the hole without chamfering the hole edge.

Stress coining of the hole is sometimes done for improving the fatigue life of highly stressed structural components, i.e. lower risk of fatigue breakdown (Developed by Douglas Aircraft Company).

In cases where the sheets can move or gap, skin pins or clamps must be used. They prevent the two holes from interfering and keep the sheets close together when it is time for riveting.

Fig.8.

Rivet size	**Rivet diameter**		**Drill bit diameter**	
	Inch	mm	Inch	mm
-3	3/32” (0,094)	2,38	0,098	2,49
-4	1/8” (0,125)	3,18	0,128	3,25
-5	5/32” (0,156)	3,97	0,159	4,04
-6	3/16” (0,188)	4,76	0,191	4,85
-8	1/4” (0,250)	6,35	0,257	6,53
-10	5/16” (0,312)	7,94	0,316	8,03
-12	3/8” (0,375)	9,52	0,377	9,58

FLUSH RIVET

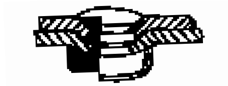
To drive a flush rivet, the hole must either be countersunk or dimpled, with the choice of method depending on the thickness of the skins involved. Fig. 9 lists the methods recommended for the various rivet sizes and skin thicknesses. In many dimpling applications a rivet gun is a useful tool. Most dimpling is done cold but for heavier skins or harder alloys, hot dimpling may be used. Most dimpling today is done in automatic machines while countersinking is more common as a manual operation. The countersinking device is normally fitted into a drill chuck.

Rivet shaving is common to adjust flush rivets to the right flushness tolerance. Care must be taken to ensure the diameter of the head does not go below stated values.

Fig. 9.

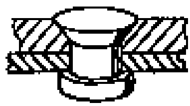
Diameter of Rivet (in.)	Top Sheet Thickness (in.)	Under Sheet Thickness (in.)	Use Countersink Method
3/32	0.032 or greater 0.025 or less 0.025 or less	 0.051 or greater 0.040 or less	a b c
1/8	0.040 or greater 0.032 or less 0.032 or less	 0.064 or greater 0.051 or less	a b c
5/32	0.051 or greater 0.040 or less 0.040 or less	 0.072 or greater 0.064 or less	a b c
3/16	0.064 or greater 0.051 or less 0.051 or less	 0.091 or greater 0.081 or less	a b c

a Countersink top sheet.
b Dimple top sheet and countersink under sheet(s).
c Dimple top and under sheets.



Dimpling preferred

Countersinking preferred



Countersinking permissable

Not acceptable
Top skin should have been dimpled

SELECTING THE PROPER DIE

Different types of sets must be used depending on the type of rivet. Two types of sets are used, the flush type and the straight type. In the latter the rivet head fits into the set to avoid damage to the rivet and the structure. See fig. 10. It is important that the set fits the head so all of the hammering action is applied to the top of the rivet. See fig. 11.

There are cases where sets form the head in operation. This is to reduce the tendency of the head to crack. This procedure can mainly be found among large sizes of rivets.

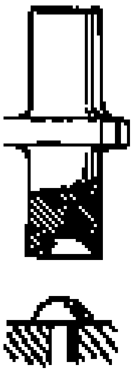
Flush type is only used for flush head type rivets.

The flush type has a large-face, polished surface with a slight curvature to prevent damage to the skin.

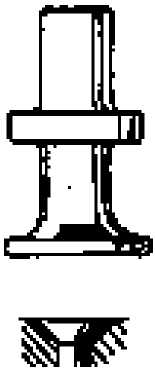
These are only used for flush heads.

The rivet sets are held in the gun with a retainer spring made of heavy-gauge steel wire. This spring allows the set to have the full travel required, yet prevents the set being driven out of the gun.

Fig. 10.

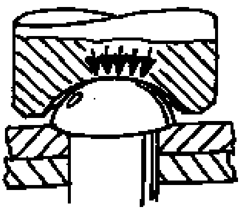


Straight type

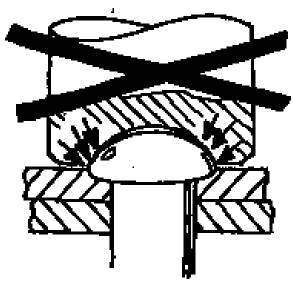


Flush type

Fig 11.



Correct shape for rivet set



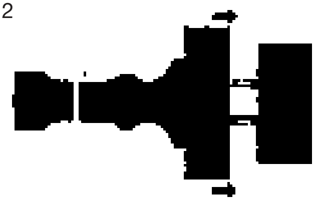
Incorrect shape

DIFFERENT RIVET TECHNIQUES

Direct Riveting means that the bucking bar is placed against the head and impact is applied to the shank to upset the rivet. See fig.12.

Direct riveting

Fig.12



Indirect riveting

Indirect Riveting, on the other hand, means that the shank is backed up and impact is applied to the rivet head. See fig.12.

Indirect riveting has one advantage but it is an important one.

The first impact drives in the rivet and ensures that the rivet head seats flush on the surface of the structure.

This advantage has made indirect riveting the dominant method now in use because great importance is placed on elimination of gapped heads. These diminish durability, reliability and the strength of the rivet joint.

DRIVING THE RIVET

RIVETING HAMMER

Select the proper size of riveting hammer and bucking bar. Use the selection guide in Chapter 8 as a help.

Be sure that the right kind of retainer is used. Also that the opening in the safety loop is slightly less than the set diameter.

Check that the correct pressure reaches the tool. The tool is designed for a working pressure of 6-7 bar. Check the pressure by running the machine against a piece of wood.

Adjust the power of the rivet gun and check it again against the wood. Only experience can show the exact amount of force to use, but this is usually a good starting point.

If the frequency is too high in the riveting process, an out of time relation with the bucking bar can occur and the skin could be damaged. In that case adjust the power or change to a riveting hammer with lower frequency.

If a quick coupling is used for the air supply, it should be separated from the tool by a whip hose (approximately 0.5 m).

This is especially important for conventional riveting hammers that produce a higher level of vibrations.

BUCKING BAR

We recommend the use of a vibration damped bucking bar in all cases but in cases where there is not enough room a conventional bar must be used. The dolly or bar is normally made of hardened steel with a polished face and should form the bucked counter head without any scratches. When choosing a dolly or bucking bar be sure that it can be applied parallel with the rivet shank.

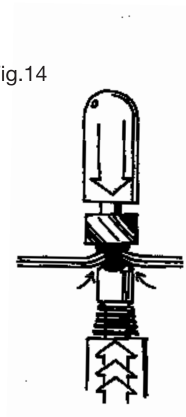
The dolly or bar must be of sufficient weight to allow the rivet to be driven in an acceptable time. Fig.13 lists the range of bucking bar weights recommended for various size rivets. This is just a rough average estimation and varies according to rivet type and differences in structures etc.

A problem that can arise through use of a bar that is too light is illustrated in fig.14.

Fig.13

Rivet diameter		Bucking bar weight	
mm	inch	kg	lb
2,5	0,098	0,8 – 1,5	1,8 – 3,3
3,2	0,126	1,5 – 2,0	3,3 – 4,4
4,0	0,157	1,5 – 2,2	3,3 – 4,8
5,0	0,197	2,0 – 2,5	4,4 – 5,5
6,0	0,236	2,5 – 3,0	5,5 – 6,6

Fig.14



Bucking bar
to light

THE RIVETING PROCESS

At indirect riveting, the piston in the riveting gun hits the die being in contact with the rivet head. A shock wave is transmitted via the die, through the rivet, to the bucking bar, where it is reflected. This shockwave starts a motion of the die and the panels. The force between the rivet shank and the bucking bar starts a plastic deformation of the rivet shank end, with the speed of the panel motion. The same force starts to accelerate the bucking bar away from the rivet shank. The feed force on the bucking bar turns it back to the rivet shank and the cycle starts again. See fig 15.

It is important that the riveting hammer operator applies higher feed forces than the bucking bar operator to avoid gapped heads.

With the forces balanced, or higher force on the hammer, pull the trigger of the rivet gun. Check the result. It will be necessary to carry out several operations before the right feeling is achieved. The feeling can either be by listening or by hand.

A flush head rivet should also be checked on the head to verify perfectly flush alignment with the skin.

To avoid the rivet being cold worked and brittle, with less strength as a result, few but powerful impacts are required. Therefore the indirect method sometimes requires more powerful riveting tools than the direct method. The typical time for a riveting process is less than one second.

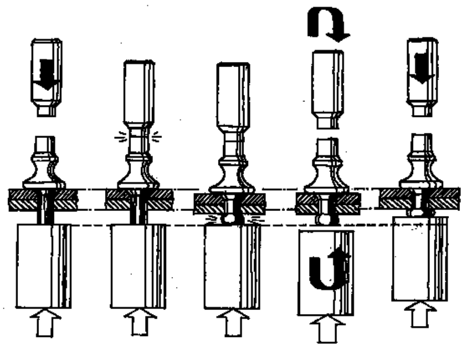


Fig.15. The riveting process

On Atlas Copco's riveting hammers the impact power can be controlled in a stepless way by turning the throttle valve knob.

Riveting is mostly performed by teams using various kinds of signals, since communication by voice is usually difficult in operations such as riveting of a fuselage.

3. THE RIVET JOINTS

POWER TRANSMISSION IN THE RIVET JOINT

The power transmissions in the rivet joint consist of two parts. See Fig. 16. The first part is the friction force that results from the preload of the rivet, creating a bearing stress.

The second part arises when the sheets start to move, trying to shear off the rivet.

When the joint reaches a critical level the rivet shears off.

FAULTS IN THE RIVET JOINT

Various kinds of fault can arise in the rivet joint. For one thing the bucked head must obtain the correct size, (see Chapter 2.1, "Selecting the proper length of the rivet"). Other common types of fault and how they can be avoided are described in fig.17. These types of fault can derive from using incorrect size of rivet or wrong hole preparation.

For removing a faulty rivet there is normally a standard procedure to be followed, described below.

Fig. 16.

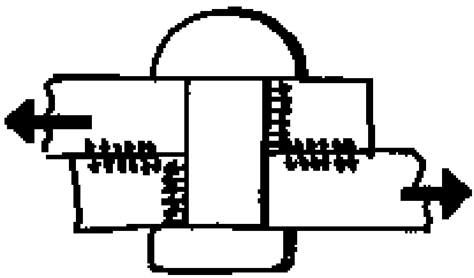
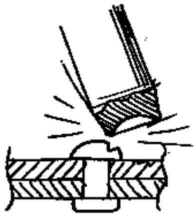
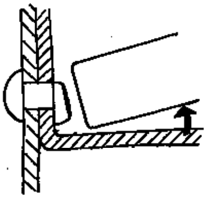


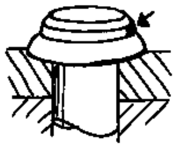
Fig. 17 Faults in the rivet joints



(1) **Marks in head or structure close to head.** Possible reason is too low feed forces, the gun is bounced off or the gun was not running at 90 degrees to the structure.

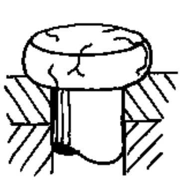


(2) **The shank is not in the centre of the bucked head. Sloping head.** The bucking bar was not at 90 degrees to the structure throughout the process. Wrong type of bucking bar.

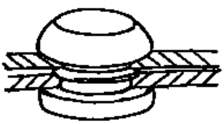


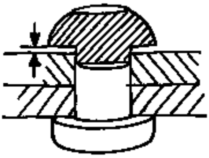
(3) **Concentric rings in head or on structure around head.** Too small hole in the die if the rings arise on head or too large if on structure.

(4) **Cracks of different forms.** The criteria here are to detect the type, location and degree of such cracks. Open types are not acceptable and often related to improper heat treatment. With closed types the location and degree are more important. As long as they do not intersect there is usually no problem. One reason for cracks can also be that the riveting process is too long.

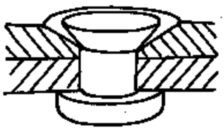


(5) **Swelled rivets that open the structure.** This is normally caused by the hole preparation where some chips have moved between the sheets. Remove the rivet and clean the joint area. A small gap may be accepted in some cases but never in tanks or pressure fuselages.





(6) **Open head or gapped head**
Often the feed force is not correctly applied i.e. too high feed forces from the bucking bar side or too low from the riveting hammer side. They are acceptable in most cases but not in integral tank section or in pressure fuselages.



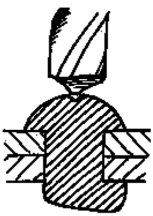
(7) **Open head on flush type rivets**
This is not acceptable and can depend on faulty countersinking. It is adjusted by using next size of rivet if possible and repeating the

countersinking. If the head is up too far some kind of rivet shaving is necessary.

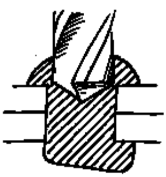
RIVET REMOVAL

When it happens as described above, that the rivet has a fault, it is in most cases possible to remove the rivet concerned without any costly results. The common procedure for rivet removal is described below.

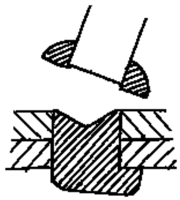
Fig.18 Rivet removal



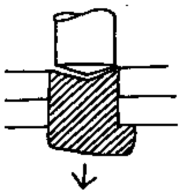
(1) Drilling to remove a solid rivet should always be done from the head side. Select a drill one size smaller than the rivet. Punch a small mark in the centre of the head. Be sure that the drill is kept in line with the rivet. Start the drilling at low speed by gently pressing the trigger. This makes it much easier to control the drill and the risk of it slipping is reduced.



(2) Drill all the way through the head into the shank so a minimum of material is left between the shaft and the head.



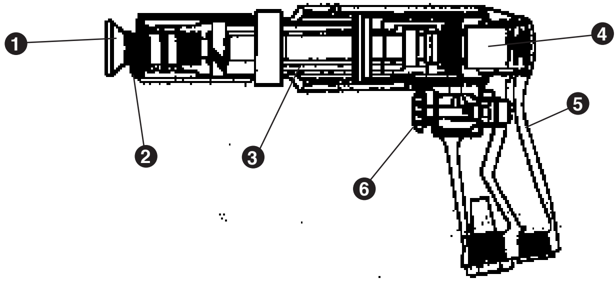
(3) Use a pin punch that fits into the hole and snap it off from the shank. A small chisel can also be used but great care must be taken to not damage the skin.



(4) For removing the rivet use a pin punch with a light hammer and knock a few times. Collect the rivet in some kind of cup. If this procedure is carefully followed, the hole should not be damaged, and a new rivet can be installed in the hole.

4. THE VIBRATION DAMPED RIVETING HAMMER

DESIGN OF THE VIBRATION DAMPED RIVETING HAMMER



The main components of a vibration damped riveting hammer are shown in this cutaway sketch.

The riveting hammer has an inserted tool called the rivet set or die ❶. The spring holding the die is called a retainer ❷, normally of quick change type. The die fits into the impact mechanism ❸ which is moveable inside the handle.

Behind the impact mechanism is the air servo system ❹. With the impact mechanism separated from the handle, which is done here by a damping system, the transmission of vibrations through the handle is limited. With this design it is possible to make the handle ❺ in aluminium, resulting in lower weight of the complete tool. The trigger ❻ is designed so that it always keeps the servo active with an air cushion when air is connected to the tool.

THE IMPACT MECHANISM

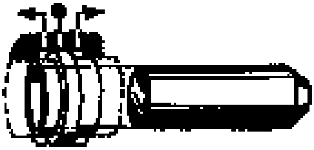
The riveting hammer functions in the same way as a chipping hammer or other percussive tools. The tubular valve is the dominant valve for riveters as opposed to the disc valve type. See fig.19

Power and efficient throttle control are important as riveting is heavy work and always involves precision. Consequently, the tubular valve is a more suitable component for the impact mechanism in a riveting hammer.

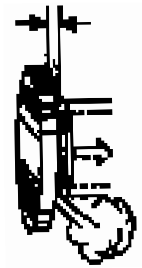
Manufacturing a tubular valve involves precision finishing. This makes it relatively expensive. The tubular valve must also move a greater distance in performing its regulating function. A tubular valve mechanism is therefore slower than a disc valve mechanism of the same size. Impact frequency is correspondingly lower.

It does, however, have advantages that disc valve mechanisms lack. Impact energy is considerable and precision throttle regulation is easy. Air economy is also good.

Fig.19



Tubular valve



Disc valve

THE AIR SERVO SYSTEM

A common method for vibration damping is some form of mass-spring system designed to isolate vibrations from the handle of the riveting gun.

A problem with a simple passive spring is that when made softly enough to absorb vibrations, it will prove difficult to use different feed forces, and thus the tool becomes difficult to control.

A way to get around this complication is an Air Servo System, (see fig. 20), with properties of vibration control for hand tools.

The air servo is installed between the handle and the vibrating parts of the tool.

The system consists of two different functions:

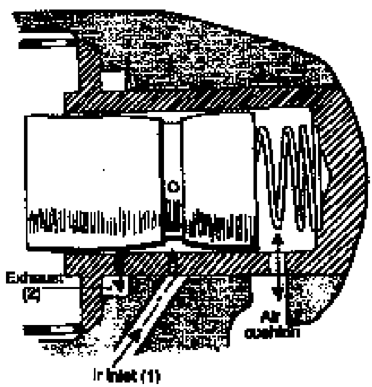


Fig.20.

The air servo system acts like a stiff spring for slow variation in forces, making it easy to control the process. For forces which quickly vary, such as vibration, it acts as a soft spring and therefore gives efficient damping.

When the tool is pressed against a rivet, the cylinder and its valve mechanism move the sleeve inside the housing. The air servo follows this motion and air is let into the chamber, (see fig 20), behind the servo (1). Simultaneously a venting hole (2) closes and the air pressure in the chamber increases. The air pressure multiplied by the servo area is equal to the feed force. This change in pressure occurs when the feed force changes.

For quicker changes, such as vibrations, the air pressure will not have time to change; in this case the air volume will act as a soft spring and the handle is the mass.

5. THE VIBRATION DAMPED BUCKING BAR

Vibration values are always higher on the bucking bar side than on the hammer side. The smaller the mass of the bucking bar, the higher the vibrations. Aircraft designers have not always remembered to leave enough space for the bucking bar. Vibrations will also increase with each blow during the riveting process due to the increase in hardness of the rivet material.

THE DESIGN

The operator is isolated from the bucking bar mass by the use of a mass spring system. The spring can either be a mechanical one or an air spring of the same design as in the hammer.

A mechanical spring design can be seen in fig 22. The advantage with this design is that there is no need for an air hose. This bucking bar is specially designed for cramped spaces. The mass is at minimum, which prolongs the riveting process and increases the vibrations to twice the value as for bucking bars provided with a dolly with an air spring.

Fig 21 shows a design with an inbuilt servo system similar to the one used in the hammer, (described on page 20).

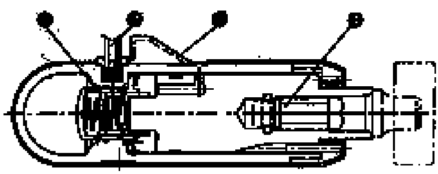


Fig. 21   Mass air system

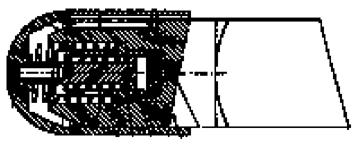
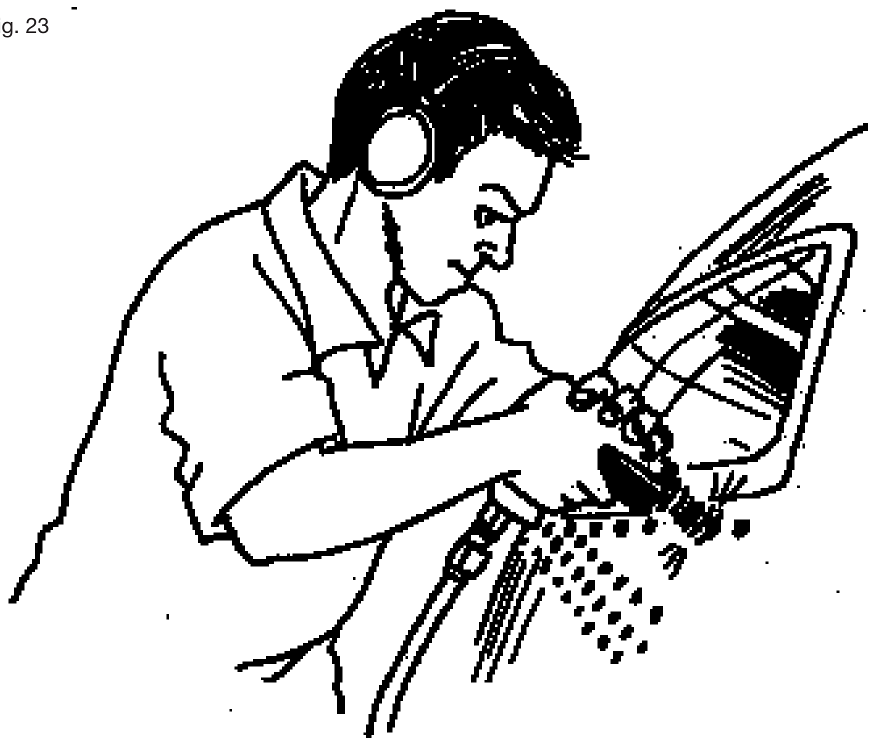


Fig. 22   Mass spring system

6. VIBRATION INDUCED INJURIES

Working with "conventional" percussive tools for a long period of time gives rise to different types of injuries.

Fig. 23



VASCULAR INJURIES

High vibration levels may cause vascular injuries, i.e. a thickening of the walls of the vessels in the fingers. As a consequence, the passage available for the blood is decreased.

The hands serve as the radiators of the body. In other words, if the body wishes to lose heat, a large flow of blood through the hands is permitted, whereas if we are cold the blood flow is reduced to a minimum. The ratio between the maximum and minimum blood flow is in the order of 200 to 1.

If the body wishes to reduce the blood flow by constricting the vessels (which is accomplished via the central nerve system) a damaged vessel which already has a narrower passage may become completely blocked up.

No blood is able to pass through and consequently the vessels and skin turn pale. This phenomenon has given this particular vascular injury the name “white fingers” or Raynaud’s phenomena, VWF (vibrations induced whitefingers), TVD (traumatic vasospastic disease) etc.

The attack of “white fingers” is revealed as a loss of feeling and in numbness and tingling on account of the shortage of nourishment and oxygen for the nerve cells. After a while, the fingers may turn blue (cyanosis), the reason being that the tiny amount of blood that succeeds in passing the vessels transfers all its oxygen to the tissues. The duration of the attack can be reduced by rubbing the hands, thereby activating the muscles and supplying heat.

The attacks are triggered by general cooling of the body and not by the fact that we are working with a vibrating machine.

NERVE INJURIES

The fact that nerves can also be influenced by vibrations is demonstrated by, among other things, a decline in the ability to interpret through feeling two adjacent pressure points acting on the skin of the fingers as two and not as one. This can be tested by making the finger run along two non-parallel rulers and attempting to decide when the sensory impressions from the two rulers coincide into one (or vice versa).

If we measure the sensory threshold for a vibration, and then hold on to a vibrating object for a short time, and once again measure the sensory threshold, we will find that it has been raised. The difference will be greater in relation to fingers already injured by vibration than for healthy fingers.

SKELETAL AND JOINT INJURIES

High vibration amplitudes (at low frequencies) in combination with high feed forces cause wear on the surfaces of the joints. Impacts can cause micro fractures in the skeletal bones and thus interfere with the supply of nutrition of the joints.

WHAT CAN BE DONE

There are two ways to reduce the risk of injuries. One is to reduce the exposure for the operator, the other is to reduce the magnitude of the vibration.

As manufacturer of power tools we can not influence the organisation of the workplace but we can, in our design work, give priority to solutions with good ergonomics. The development of the vibration damped riveting system by Atlas Copco Tools is an example of successful product development in order to solve vibration problems.

7. HOW TO MEASURE VIBRATIONS

The dominating reasons for doing vibration measurements are comparison of different machines or for the assessment of risks. In the first case a laboratory test code ISO 8662 is used. In the second case an exposure test code is used, ISO 5349. It is important to notice that the result from a laboratory test can not be used for the assessment of risks and vice versa. The main reasons for this is that in the laboratory test, very often the machines are artificially loaded to be able to reach repetitive measurements that can be repeated from lab to lab. At an exposure measurement a real working situation is studied which is unique and can not be repeated from place to place.

NEW STANDARD TO DECLARE TOOLS ON THE EC-MARKET

After 1st January, 1995, all machines placed on the EC market must be in conformity with all applicable EC Directives. The Machinery Directive 89/392/EEC gives the minimum requirement on safety and it has become one of the most important directives.

No machine manufacturer is allowed to sell products on the EC market unless the product is in conformity with the Machinery Directive. The manufacturer or his authorized representative established in the Community must, in order to certify that machinery is in conformity with this Directive, draw up an EC declaration of conformity for all machinery manufactured.

To comply with the Machinery Directive, vibration figures must be stated in the machine instructions.

Fig. 24 Tools sign according to EC standards.

The sections of the directive that relate to vibration are worded as follows:

“The instructions must give the following information concerning vibrations transmitted by hand-held and hand-guided machinery:
The weighted root mean square acceleration value to which the arms are subjected, if it exceeds 2.5 m/s^2 as determined by the appropriate test code (EN/ISO 8662). Where the acceleration does not exceed 2.5 m/s^2 this must be mentioned.

The standards used for measuring pneumatic handtools are covered by EN/ISO 8662-1/17.

There is good reason to believe that a tool with a low vibration value in a laboratory test will also have a low vibration value in an exposure test.”

For more detailed information about the different standards, please contact Atlas Copco.

MEASURING OF RIVETING HAMMERS ACCORDING TO EN/ISO 8662

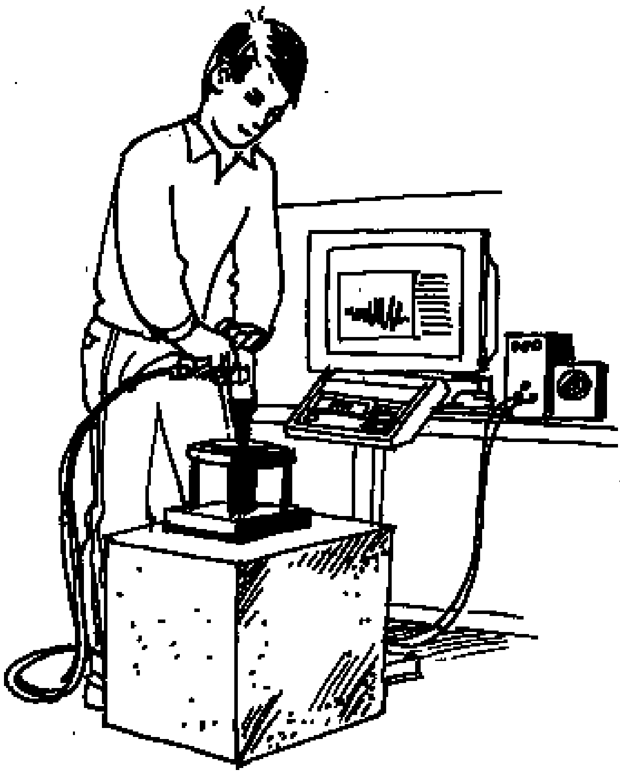
EN/ISO 8662-2 is used when measuring riveting hammers. All percussive, non rotary tools (with inserted tool) are covered by this standard i.e. chipping hammers, scalers, etc.

These tools are run on a steel ball energy absorber. During the test the energy absorber shall be arranged so that the operator can have an upright posture and work the machine while performing the test. The feed force to be applied in addition to the weight of the power tool shall ensure that it operates at its normal level of performance.

The steel ball energy absorber is a tube filled with steel balls. An inserted test tool is working on the balls.

The dimensions of the tube depend on the diameter of the shank of the test tool.

Fig. 25



EN/ISO 8662-2. Chipping hammers and riveting hammers
Measurement location: On the middle of the handle
Measurement direction: Parallel with the hit direction
Procedure: Running in energy absorber
Feedforce, F=40 x tool mass [N], $80 < F < 200$
For vibration controlled tools, the manufacturer shall state the optimal feedforce.
No. of measurements: 5 for each operator
Measurement time: ≤ 16 s

The vibrations value is a hand-arm weighted (ISO 5349) rms value. Three skilled operators shall load the tool during the measurements. In order to make this presentation as understandable as possible the standards are presented in four different load cases.

Declaration of vibration emission values *Determination of vibration emission values to be declared* The declared value = measured value + $\sqrt{1.5 \times (\text{spread in production})^2 + (\text{spread in method})^2}$. The spread in method is defined in each part of the measurement standards.

8. SELECTION GUIDE

Selection guide - Riveting

Recommendations for using and choosing riveting hammers

The number of blows delivered and the power expended are critical in detecting the strength of a riveted joint. A few powerful blows, correctly delivered, are needed to fill out the hole and form a head when upsetting the rivet.

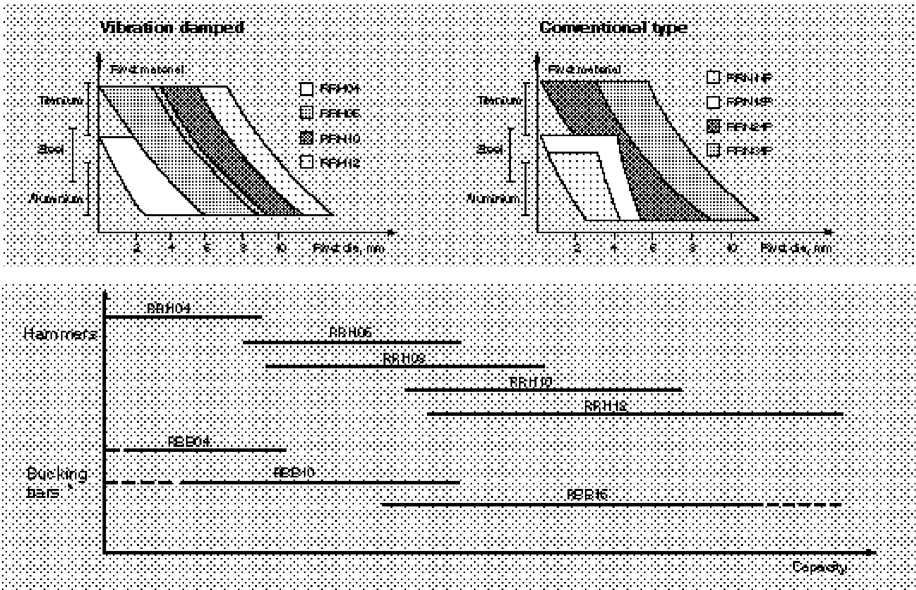
If the impact energy is insufficient, and too many blows are required, the rivet will become ”cold-worked”. This makes the rivet brittle, resulting in inferior fatigue strength, etc. This is especially true for aluminium alloys.

To obtain a riveted joint of the optimum strength, it is essential to choose a correctly sized riveting hammer. The following factors are important:

❑ Rivet material ❑ Rivet diameter ❑ Rigidity of the structure

This choice always involves an element of uncertainty. The diagrams below can provide useful basic guidance in choosing Atlas Copco riveting hammers.

Fig. 26



* Bucking bar capacity is dependent on dolly weight

9833 1124 01 Recyclable paper. TR Tryck 2008:1. Printed in Sweden

Atlas Copco

www.atlascopco.com