

Effect of electricity on human body

- Burns

- Surface
- Deep tissue

- Electric Shock

- Muscular Contraction
- Asphyxia
- Respiratory Arrest
- Ventricular Fibrillation

Ventricular Fibrillation

- Factors are Current / Time & Physiological Structure of body
- Can occur at 30mA (0.03 A)
- Causes heart to 'flutter'
- Muscle cannot open / close properly
- Does not pump
- Lack of oxygen to brain - DEATH

- **0 – 0.5mA**

- This current is below the level of perception, usually resulting in no reaction.

- **0.5mA – 5mA**

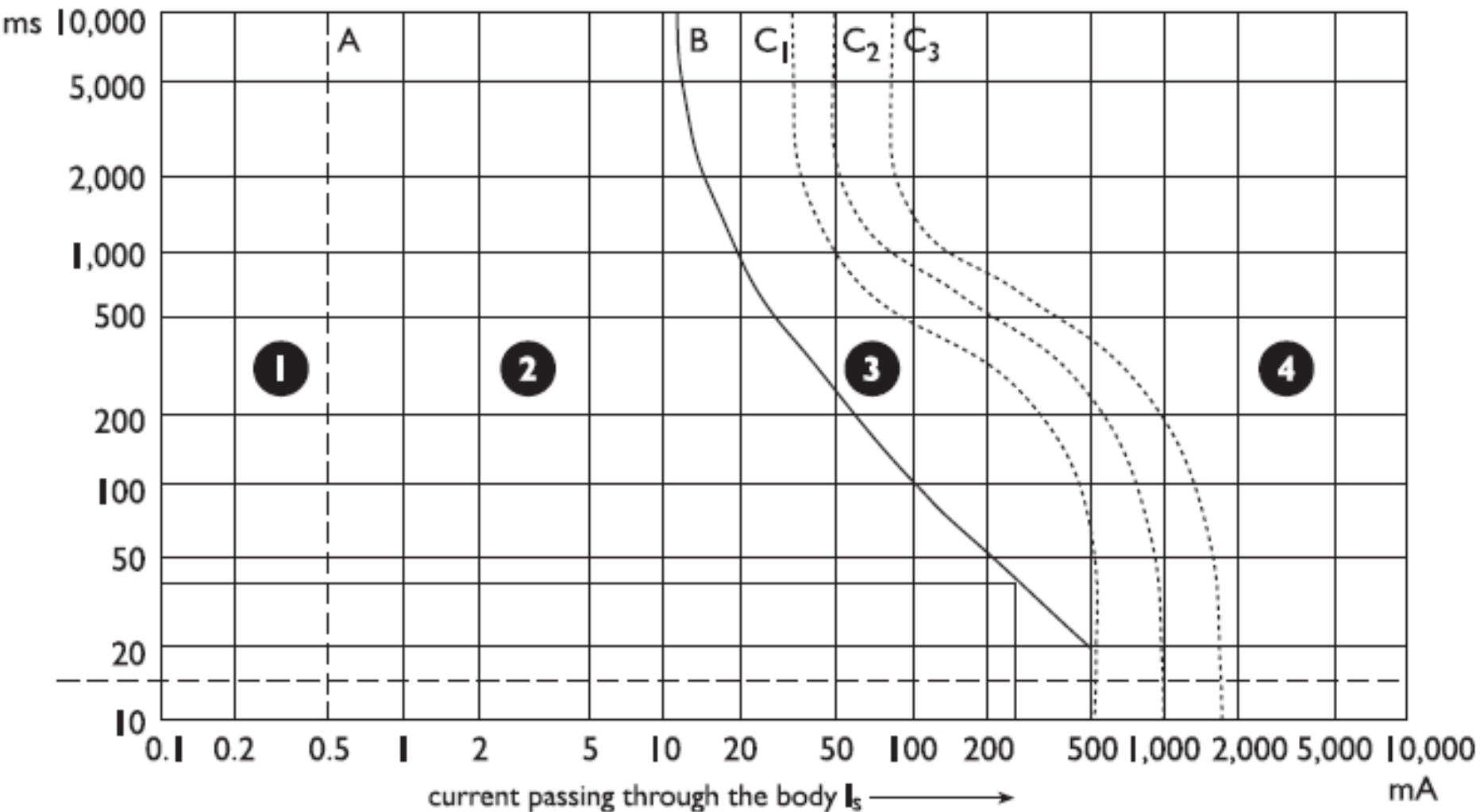
- Although there are no dangerous physiological effects, a current of this order may startle a person sufficiently to result in secondary injury due to falling, dropping items etc.

- **5mA – 10mA**

- This produces the same effect as above but, in addition, muscular reaction may cause inability to let go of equipment. In general the female body is more susceptible to this condition than the male. Once current flow ceases, the victim can let go.

- **10mA – 40mA**
- Severe pain and shock are experienced as current increases. At currents over 20mA the victim may experience breathing difficulties with asphyxia if current flow is uninterrupted. Reversible disturbance to heart rhythm and even cardiac arrest are possible at higher values of current and time.
- **40mA – 250mA**
- Severe shock and possibility of non reversible disturbances to the normal cardiac cycle, referred to as “ventricular fibrillation”, occur at this level. The possibility of fibrillation increases as current and time increase. It is also possible to experience heavy burns or cardiac arrest at higher currents.

duration of current flow t



Zone	Limits	Physiological effects
1	Up to line A	Usually no reaction
2	Line A up to line B	Usually no physiological effects
3	Line B up to curve C ₁	Usually no organic damage to be expected. Likelihood of muscular contractions and difficulty in breathing, reversible disturbances of formation and conduction of impulses in the heart, including atrial fibrillation and transient cardiac arrest without ventricular fibrillation increasing with magnitude and time.
4	Above curve C ₁ C ₁ – C ₂ C ₂ – C ₃ Beyond curve C ₃	Increasing with magnitude and time, dangerous pathophysiological effects such as cardiac arrest, breathing arrest and severe burns may occur in addition to the effects of Zone 3: Probability of ventricular fibrillation increasing up to about 5%. Probability of ventricular fibrillation increasing up to about 50%. Probability of ventricular fibrillation above 50%.

Electric Shock - Treatment

- Isolate supply immediately – Dial 000
- If you cannot isolate DO NOT attempt to touch casualty
- Physically remove victim using non-conducting implements
- Check for pulse / breathing, give artificial respiration if necessary

Electrical circuits

- Consist of
 - Power Source
 - Connecting cables
 - Electrical equipment (energy converter)

Electrical circuits - Earthing

- Very important for safety !
- Prevents conducting parts of equipment (ie. metal frames or lids), which do not normally conduct electricity from becoming live during faults.

No earthing of equipment

- No bonding
- Person can receive an electric shock if equipment becomes faulty

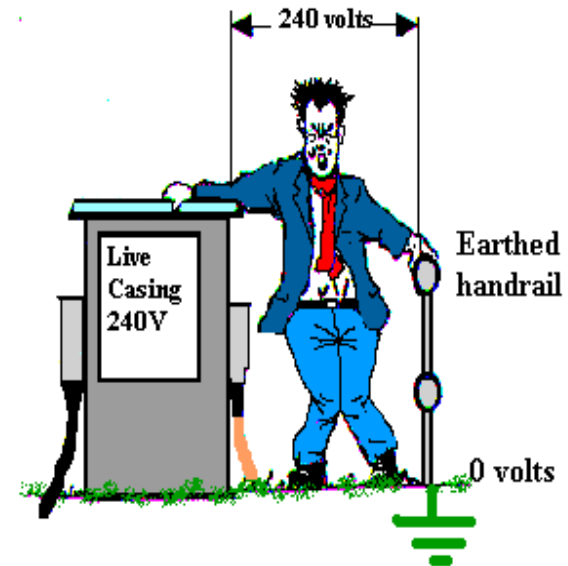


Fig. 2 No Bonding - UNSAFE

Equipment bonded together

- All equipment bonded together
- No potential (voltage) difference between live casing and handrail
- If case becomes live fuse should blow
- Equipotential Bonding

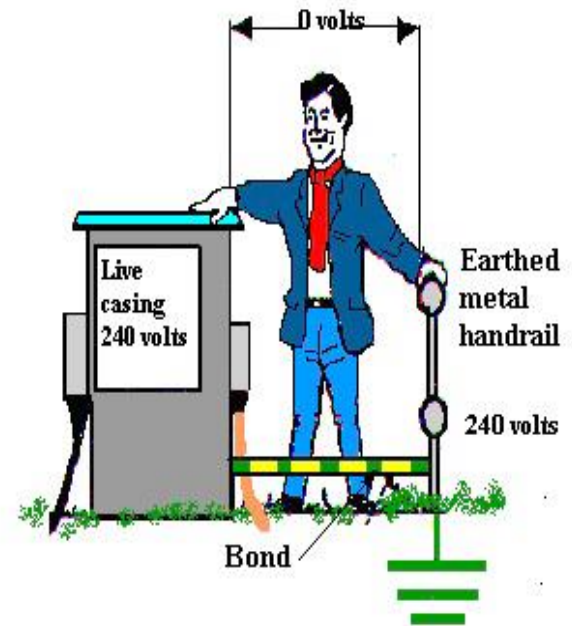


Fig.3 Earthed equi-potential Bonding - SAFE

Fuses and RCD's

■ Fuses

- essential for safety, will cut off supply at a certain current level i.e. 13A, 5A, 3A mains supply fuse
- Fuse has a 'fuseable' wire element which heats up when current flows
- Excessive current = excessive heat & wire melts preventing current flow

■ RCD's

- Residual current device
- Compares current in Live & Neutral if different and above a certain value supply switched off

Double Insulation

- Lots of portable equipment is Double Insulated
- Extra layer of insulating material over live conductors to prevent exposure of conductors
- Can mean that an earth conductor is not required – risk reduced by additional insulation.

Figure 1

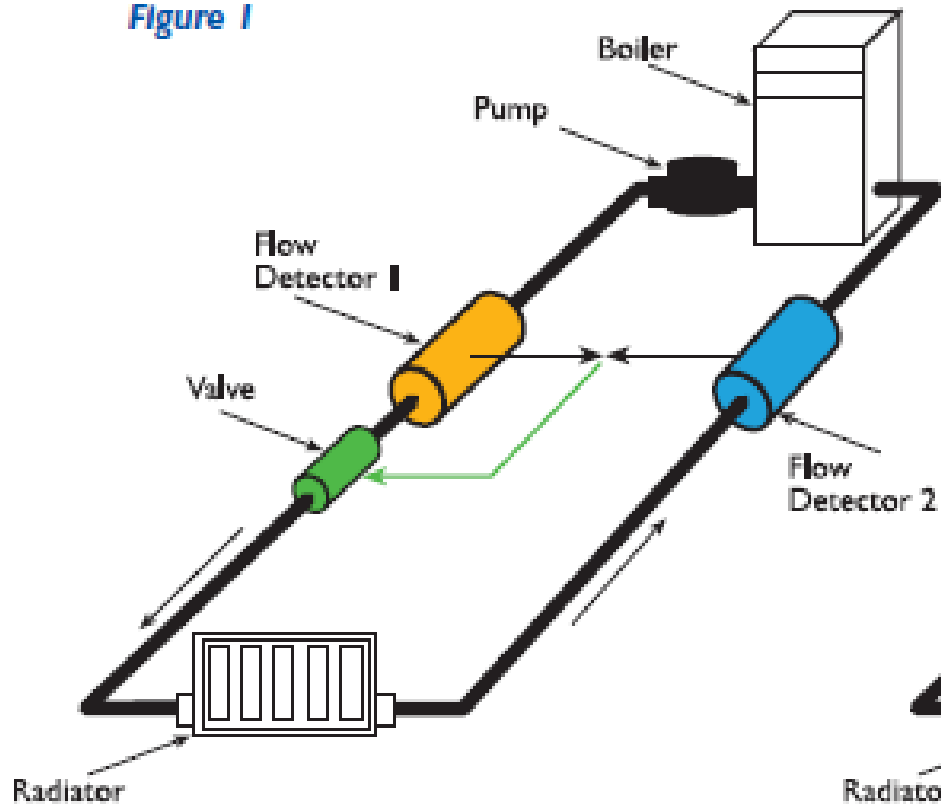


Figure 2

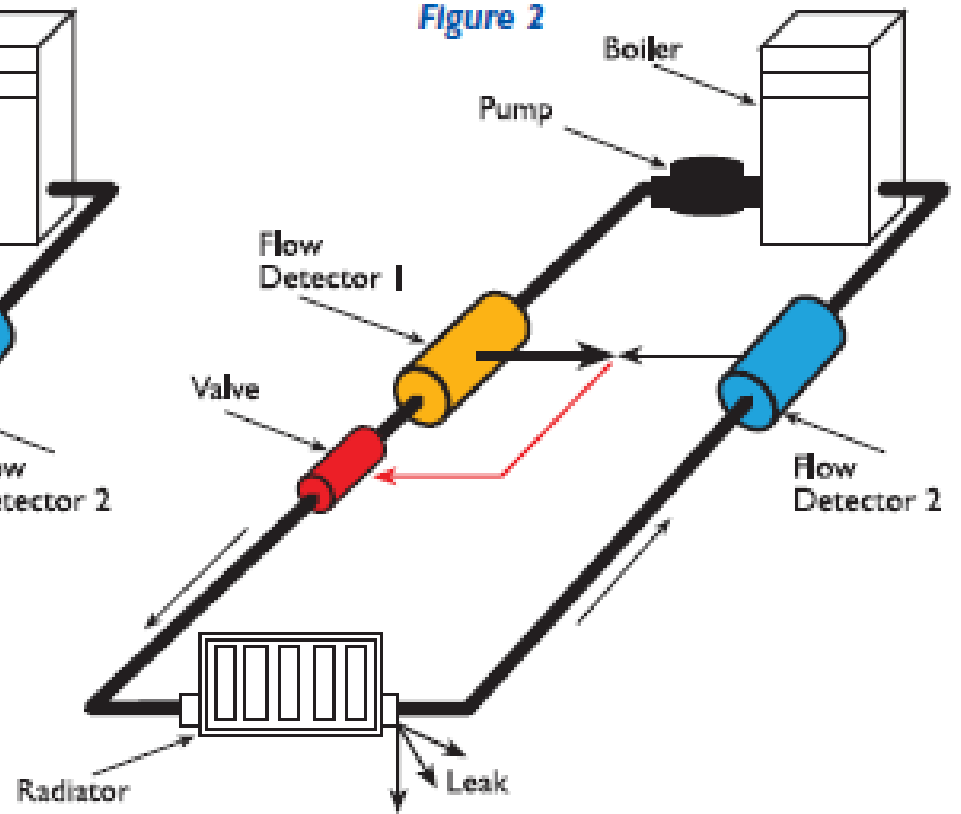


Figure 3

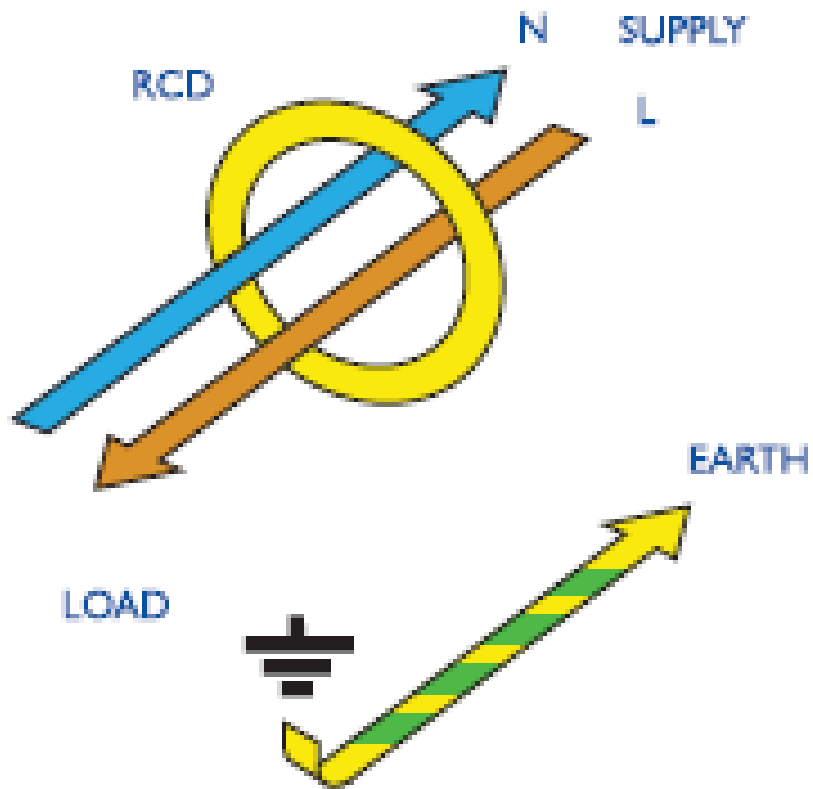
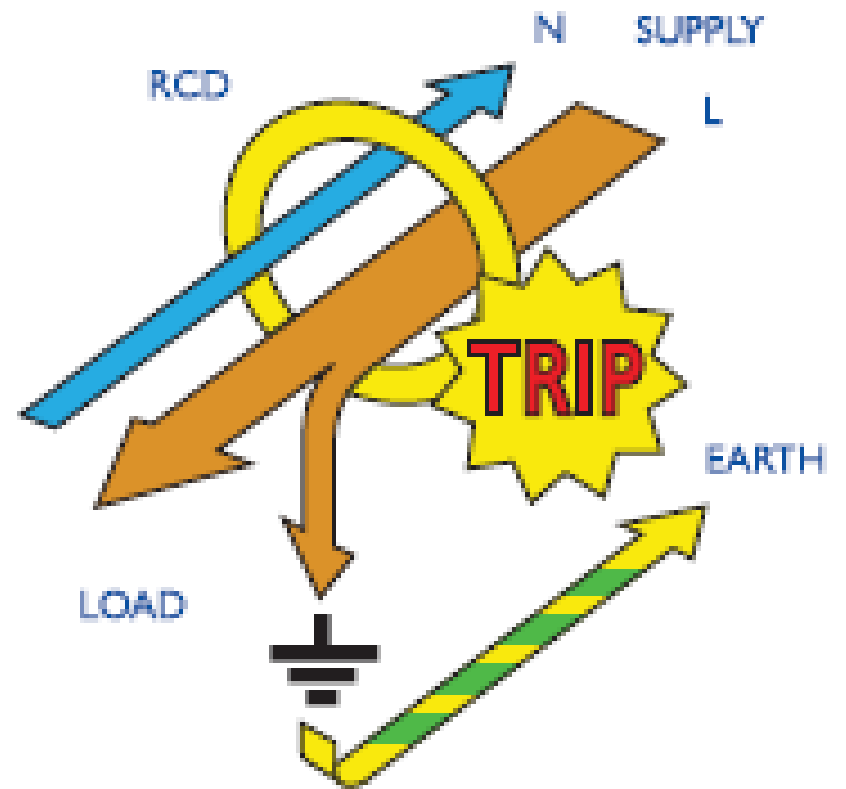


Figure 4



The Bath

A teenage boy liked playing music while taking his bath. On a cold winter morning he also connected a portable electric heater to the extension lead in the bathroom.

His father came home to hear the usual loud pop music issuing from the bathroom and thought nothing of it until some time had elapsed and he wanted to use the toilet. When persistent banging on the door and unplugging the extension lead produced no response, he burst open the door to find his son slumped in the bath. All efforts to revive him failed.

A subsequent investigation revealed a fault in the electric heater making the case live. The boy had touched the heater while lying in the bath with a foot on the metal tap, making a direct path for the electric current to flow to earth through his body.

The Lawn

On a summer day a husband returned home from work and went into the garden where he expected to find his wife relaxing. To his horror he saw her lying on the lawn beside the electric mower. He was unable to revive her.

By her side was the mower cable with the live conductor exposed. Whilst mowing the lawn to surprise him and save him a job, she had cut through the cable. A pair of scissors still in her hand and some insulation tape starkly indicated that she had attempted to repair the electric lead without switching off the supply. She had somehow grasped the live conductor. Dressed only in a bikini and with no shoes on her feet, her body presented an easy path to earth for the fatal electric current.

The Toddler

A two year old, left playing with his battery powered toy, was found by his father who initially thought he was asleep. Sticking out of the live and earth of a socket-outlet were two skewers that he had presumably tried to use to power his toy, with tragic consequences.

The Pond

A man arrived home one evening to find the fountain in his garden pond was not working. He was about to plunge his hand into the water to grab the pump and check why it was not working when he remembered that he had installed an RCD. He checked this and found that it had tripped, breaking the supply to the pump. He reset the RCD but it immediately tripped again.

Having made sure the power was off, he removed the pump from the pool and removed the access covers. He could find nothing wrong. He replaced the covers, returned the pump to the pool and reset the RCD. As soon as he switched the supply on the RCD tripped again. Repeating the previous procedure he took the pump apart again. Shaking the main motor body of the pump, he could hear water inside. The seal had broken.

Water in a ceiling rose

On smelling smoke in a utility room a homeowner fortunately noticed the discoloration of the ceiling rose and the surrounding area of the ceiling and took quick action to isolate the electricity supply. Subsequent investigation showed that a leak had occurred in the flat roof and that rainwater had penetrated into the ceiling void and the ceiling rose. The effect of the dampness had created surface tracking in the ceiling rose which, because of the small fault current, was not detected by the fuse in the consumer unit. In this instance, although not necessary for protection against electric shock, a 100mA RCD would have tripped before burning occurred.

Electrical Fires / Arcs / Explosions

■ Fires

- Overheating, arcing & sparking

■ Arcs

- Generated during faults / flashover (Lightning)
- Very high temperatures / causing burns

■ Explosions

- Flammable substances give off vapours
- Electrical sparks can ignite (ie. domestic light switch)

Maintenance of Portable Electrical Equipment

- Many accidents result from 230 volt portable equipment
- Pressure Washers / Vacuum Cleaners
- Resulting from
 - Incorrect selection
 - Inadequate maintenance / poor repairs
- Most important checks are easy to do !

Maintenance of Portable Electrical Equipment

■ Visual Inspection

- Check flexible mains cable for damage to insulation
- If insulation is damaged – REPLACE
- DO NOT wrap conductors together and tape up
- So called 'Electrical Insulation Tape' will not provide a sufficient barrier between you and a potentially fatal electric shock – as has been proven on many occasions

Maintenance of Portable Electrical Equipment

■ Plug

- Check that only the outer insulation has been clamped / gripped. Clamping inner conductor insulation will potentially lead to exposure of live terminals.
- Is fuse correct rating (Instructions should advise correct current value – DO NOT use a nail)
- Check that all 3 pins are present and in good condition