
Photos: Ben White

# Put the spark into electrical connections

With the amount of electrically-powered equipment and control systems on modern farm machinery, making reliable electrical connections has never been more important. But farmers are often forced to quickly repair wiring in less-than-ideal conditions. This month, **Josh Giumelli** looks at a range of electrical connection methods.

Most farmers have experienced the frustration of a breakdown caused by a faulty electrical connection.

With the complexity of modern machinery, it doesn't take much of a fault to bring thigs to a grinding halt. Wires separate from plugs, become pinched between moving parts, melt on hot areas or can even be chewed by rodents or birds. Whether you are modifying or repairing wiring, the ability to make a reliable electrical connection is paramount.

Firstly, a reliable electrical connection needs to be able to transmit sufficient current for its load without becoming hot. But it also needs to be strong enough to resist physical failure from stress or vibration, and well-insulated enough to keep dust and moisture on the outside and not short on earthed chassis components.

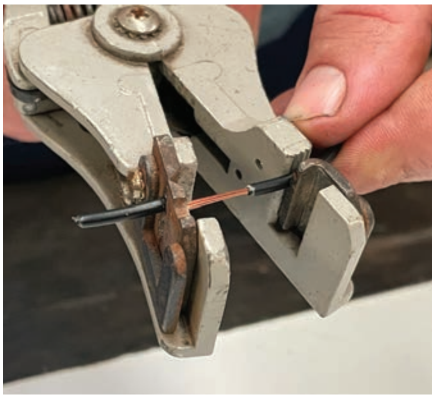
Corrosion between conductors is a particular issue. While there may still be voltage getting through, the corrosion causes a higher level of resistance across the joint. In turn, this can cause a voltage drop, or may result in increased temperature at the join.

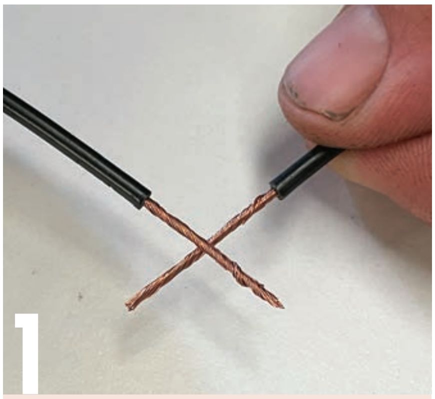
The success or otherwise failure of any accessory added to a farm vehicle can hinge solely on the reliability of the electrical connections. While many of the methods outlined in this article may appear simplistic, there are many subtle points worth noting which may make the difference between a reliable or poor electrical connection.

In the first of a three-part series, this month we look at the basics of joining electrical wires, as well as some the newer wire joining products on the market. Next month we will showcase some of the handy tools and supplies needed to put together a comprehensive electrical repair kit. And in part three, we will examine a range of common electrical plugs used in agriculture and how to wire them.

Of course, it goes without saying the methods shown in this article are only suitable for low-voltage vehicle electrical systems.

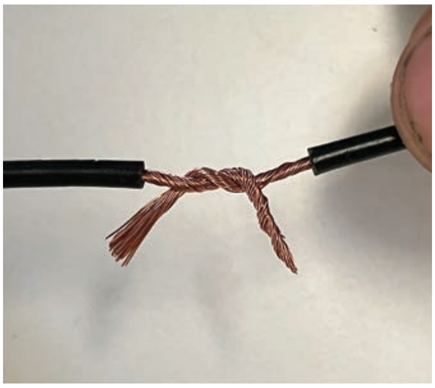
## BASIC JOINING

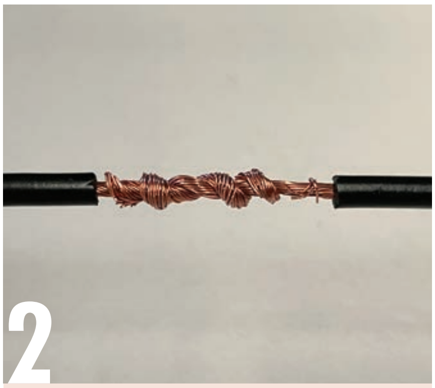




1

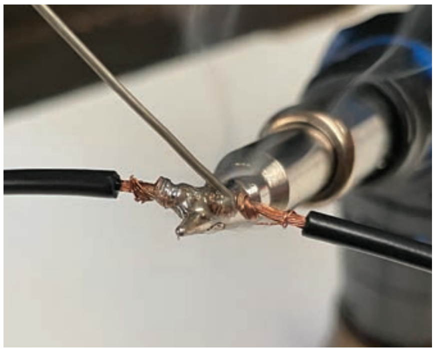
The most basic electrical connection simply involves twitching two wires together. Start by stripping the wires using pliers or a dedicated wire-stripping tool. Remove a generous amount of insulation from both wires. Twist the cores with pliers or fingers (clockwise is best) and cross over as shown. While you can join wires without twisting the cores beforehand, the joint will be stronger for it.

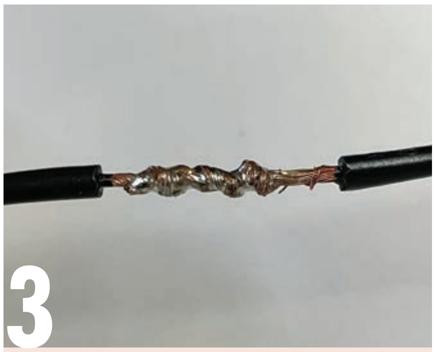




2

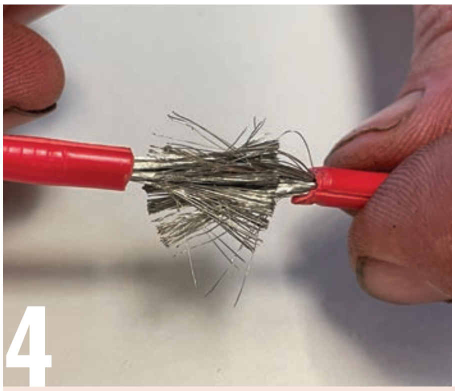
Twist both ends over to for a 'K' shape as shown. Now continue to wrap the cores along the length on each side, making sure both cores are fully wrapped over the exposed copper and don't extend past the insulated section. As a plain twisted joint, this will generally prove to be least reliable over a period of time as it is susceptible to separation, and there is not tight enough contact to prevent corrosion between the conductors.

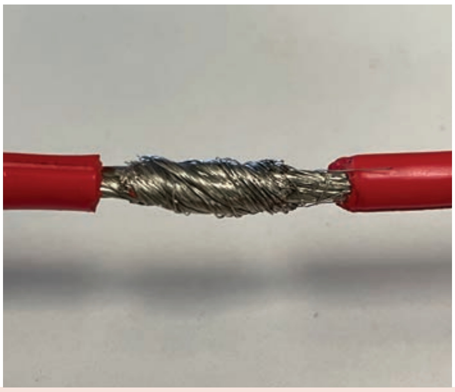


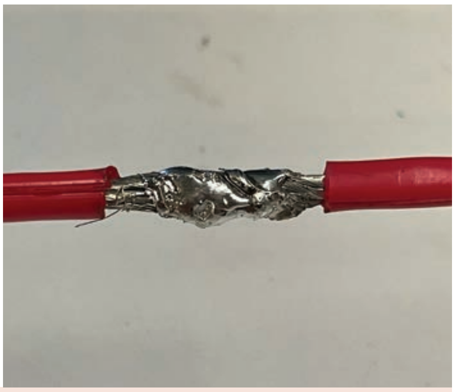


3

The most obvious method to improve the reliability and strength of this join is to simply solder it. We've covered this in several workshop articles in the past, but a few quick pointers: tin the end of the soldering iron with rosin-core solder and wipe off any excess with a damp sponge. Heat the joint with the soldering iron and apply solder to the wires, not the iron. If the joint is of sufficient temperature the solder should melt on contact with the wire and flow into the joint through capillary action. A correctly soldered joint is easily the most reliable method for joining two wires.







4

Thicker wire can be clumsy to for a twitched and soldered joint, especially if you have limited length. Splice the ends together as shown then twist and wrap to form a neat join. Now apply solder to complete the job. Note this joint will fail if not soldered.

## INSULATING THE JOIN

1

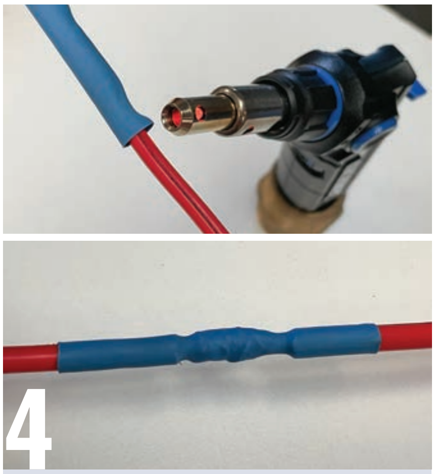
No electrical join is complete without insulation. Even joins in earth wires on vehicles need to be insulated to prevent moisture ingress and resistance in the joint. A quality insulation tape is the base standard for insulating the join. Wrap well, overlapping by half the width of the tape, and extend the wrap either side by at least the double the width of the join.

2

Self-vulcanising or amalgamating electrical tape is a little hard to find and quite expensive compared to the standard type ($25 a roll), but forms an excellent seal against moisture. Cut off a section of tape and stretch it out to twice its original length. Now wrap the joint, overlapping by half. The tape will bond tightly to itself and will not unravel.

3

Heatshrink is a great option for protecting the joint and is available in pre-cut sleeves or long lengths which can be cut to size as pictured. If needed, make sure you slip the heatshrink on the wire *before* making the join. Take care to avoid using a sleeve of too large a diameter as it may not contract sufficiently to seal the join. Generally, expect a reduction of at least 50 per cent.



4

Heat the heatshrink sleeve around its circumference and along its length to contract the sleeve as evenly as possible without charring the surface. While we are using a butane-powered burner, any heat source such as a hot air gun, matches or cigarette lighter will do the trick for small diameter sleeves.


5

Liquid electrical tape is a little hard to source but very handy for repairing damaged insulation or insulating tricky connectors (see www.jaycar.com.au). For insulating a standard joint, it may take a couple of applications to get sufficient thickness.

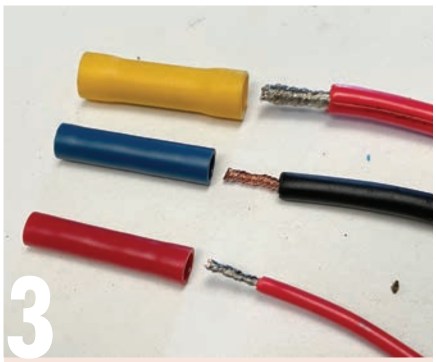
## USING CRIMP CONNECTORS

1

Crimp connectors are a convenient way of quickly and reliably joining wire or adding a suitable end connector for connection to another electrical device such as a switch, relay, earthing point or battery terminal. They work well in situations where not exposed to the weather, such as inside a sealed terminal box, engine bay or behind the dash in a vehicle. From left, female and male spade connectors, male and female bullet connectors, ring connector, fork connector.

2

Certain styles of connectors, such as rings (pictured) and forks are available in several sizes, and it pays to have a selection of a few of them to suit different sized applications. Rings and forks are largely interchangeable for securing wire to screw or bolted terminals. The advantage of fork connectors is they can be installed or removed without having to completely remove the screw but are also more likely to pull out.



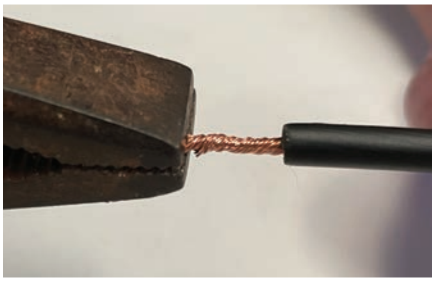
3

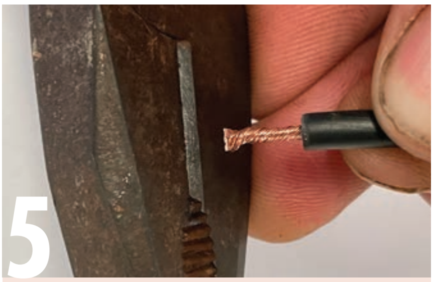
Butt connectors are possibly the most useful style of crimp connectors, and they are ideal for when wires need to be connected in a quick and reasonably reliable fashion. Use red connectors for wires of 0.75mm to 1mm core, blue for 1.5–2.5mm and yellow for 4–6mm.

## USING CRIMP CONNECTORS (continued)

4

Crimp connectors are commonly bought in kits, but inevitably you end up using up all the butt connectors first. It pays to buy these connectors separately in packs of 100, which will invariably be of better quality. Good quality connectors should have a separating hoop in the centre to avoid inserting one wire too far. Note the seam along the inside of the connector – it is best to orient the crimp so this at the bottom of the crimping tool jaws.



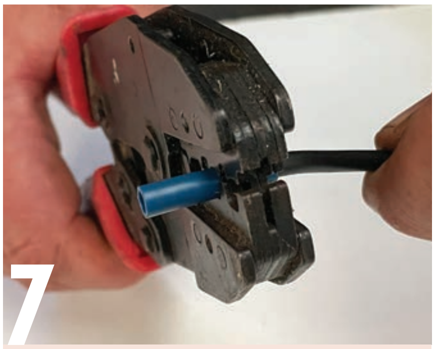


5

For best results, strip a longer section of wire than is actually needed. Then twist with the pliers and cut to a length of about 5mm. The twist in the wire will actually help the crimp grip the core better than if it was left straight.

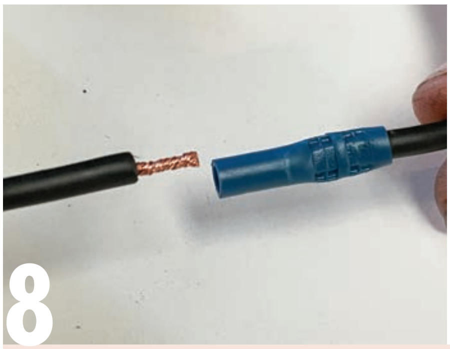
6

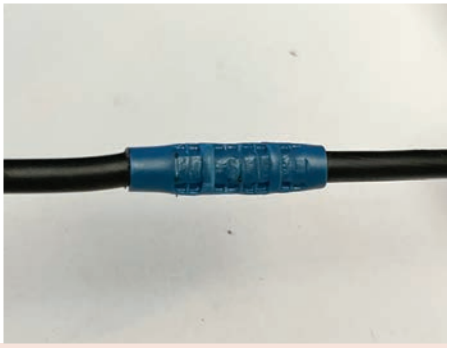
A quality set of crimping pliers is a worthwhile investment. Note the coloured dots which correspond to the three different types of connectors.



7

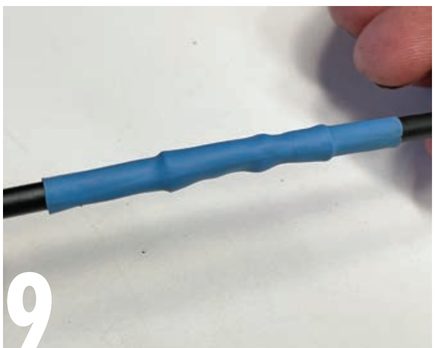
Place the wire into the appropriate sized crimp making sure the insulation slides inside the sleeve. Squeeze the jaws down fully until the point at which they pop back open.





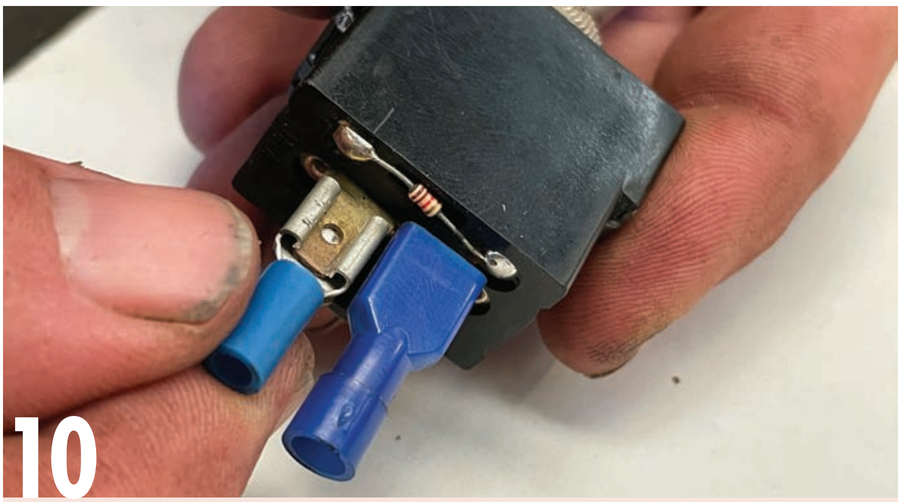
8

Now insert the other wire and crimp the other side. Note the crimp should be placed in the jaws so that they align either side of the centre line of the crimp, and not too close to the outer edges which are just plastic with no metal underneath. It should only be necessary to crimp the connector twice – once for each wire. Multiple crimps simply weaken the connector. Also, make sure both crimps are aligned in the same plane.



9

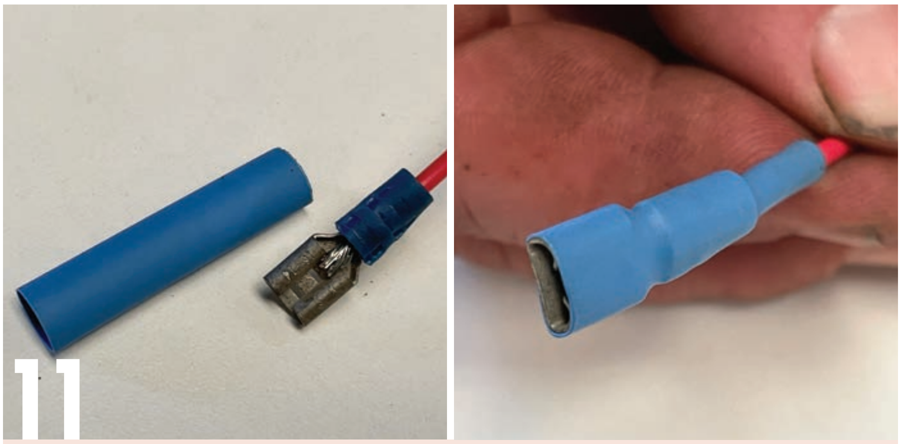
When done correctly, crimp connectors provide good mechanical strength and electrical conductivity, provided they are not affected by moisture. The insulating sleeve will stop the shorting out on other components but does not seal against dust and moisture. The application of a heatshrink sleeve will go a long way towards improving the join. Another option is to smear a silastic sealant over the rear of the sleeve.



10

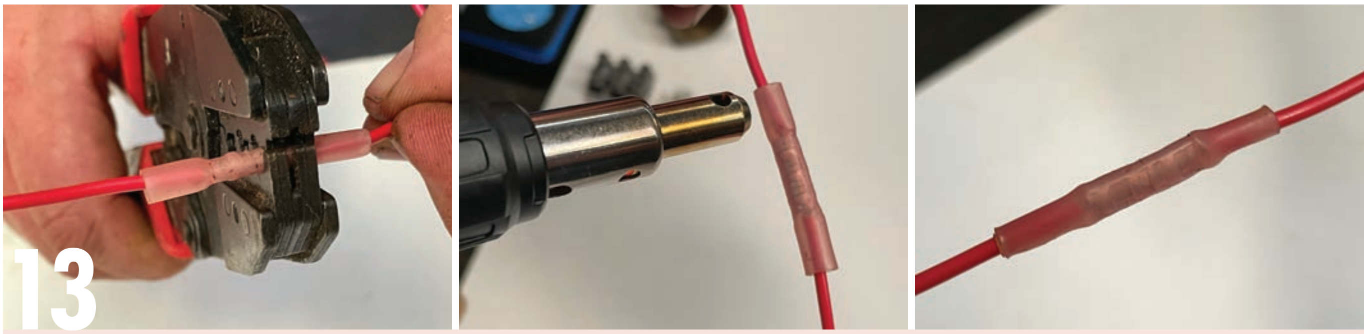
Not all crimp connectors are created equal. Shown here attached to the rear of a switch, the shielded spade connector (right) is preferable to the cheaper unshielded type (left) as there is no exposed end when it is installed, reducing the chance of an accidental short.

## USING CRIMP CONNECTORS (continued)




If you are applying a heatshrink sleeve to an unshielded spade connector, it is good practice to make it a little longer so that it covers the end, turning it into a shielded type.

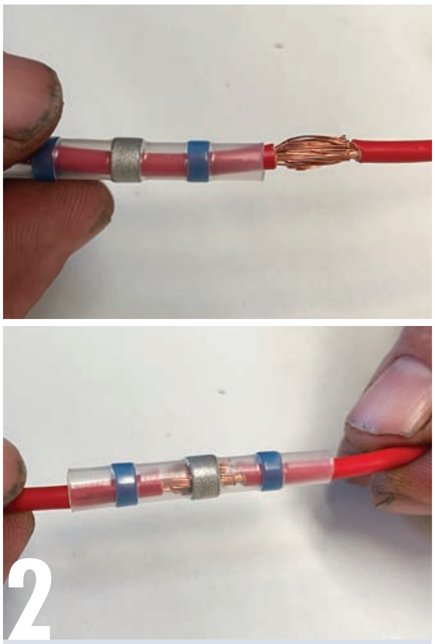

If you need a more compact connector, or a superior joint, consider removing the vinyl sleeve and soldering the connector to the end of the wire.



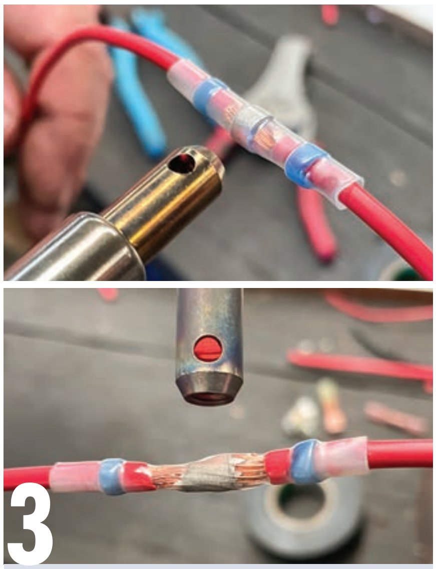

These butt crimp connectors have a heatshrink outer shroud in place of the vinyl shroud of the connectors previously featured. They are far more suited to use in areas exposed to moisture and dust, and the shroud provides additional mechanical strength, not just insulation. They are simply crimped as with the previous connectors, then heated to shrink the shroud. There are also other types of connectors such as spade and bullet connectors available.

## SPLICE CONNECTORS


These splice connectors are a more recent innovation and feature a low melting point solder ring inside a heatshrink shroud. A band of sealant each side of the ring also melts to enclose the join. These connectors are relatively expensive when purchased in small packs of 10, but we were able to source a kit of 400 pieces online from an Australian retailer for less than $30.

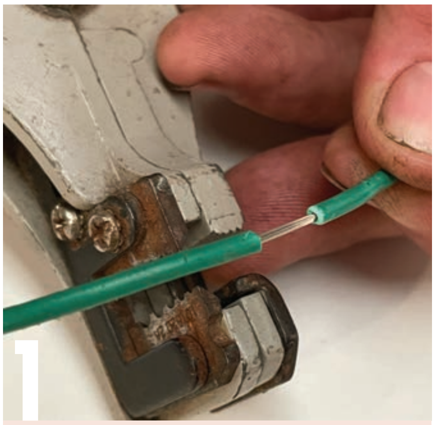



Strip the cable ends, slide the connector over one cable and form a splice as shown. This needs to be reasonably compact so that it doesn't extend past the glue rings when the connector is slid over the join.

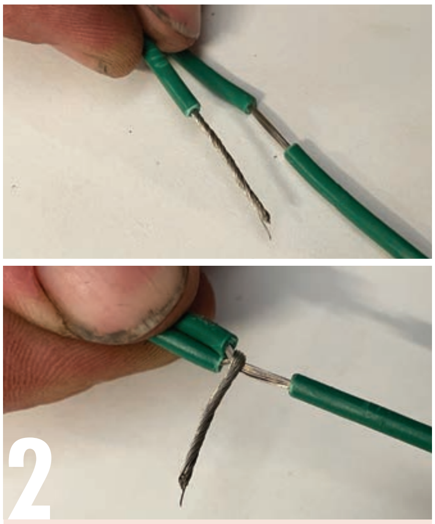



Heat the connector as you would for heat shrink, concentrating the heat in the centre. After a moment the solder will melt and should wick into the wire strands. Make sure the rest of the shroud has contracted fully and the job is done. While these connectors are not as quick to install as the standard crimp connectors, they certainly form a more impervious joint.

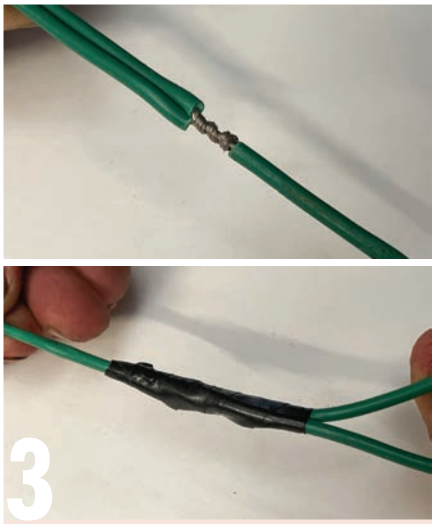
## TAPPING INTO EXISTING WIRING



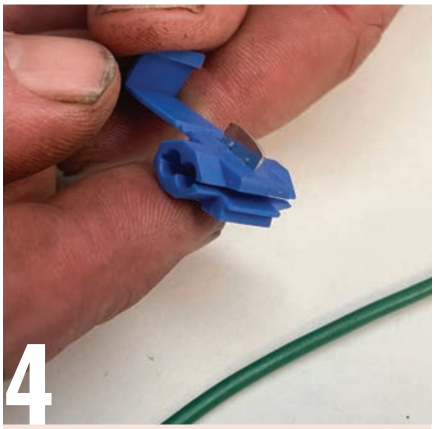

Wires often need to be tapped into to draw current for additional equipment or accessories. While they can be cut and rejoined, this is less than desirable, especially in vehicle wiring harnesses. The best method is to pair back the insulation and solder the branch wire into place. A decent wire stripping tool will be able to pull back the insulation sufficiently to allow connection. If not, carefully cut out the insulation with a utility knife.



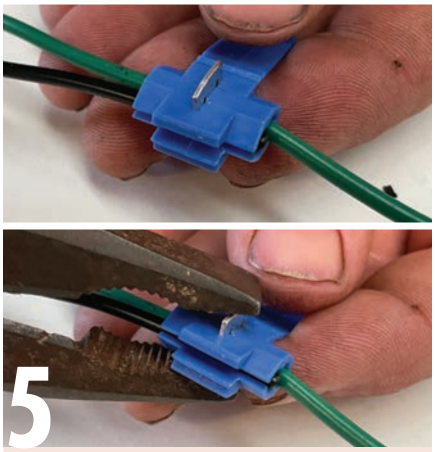

Strip the insulation from the branch wire, roughly twice the distance already stripped from the existing wire. Twist the stripped section of the branch wire together. Holding the two wires parallel, bend the branch wire at right angles as shown.



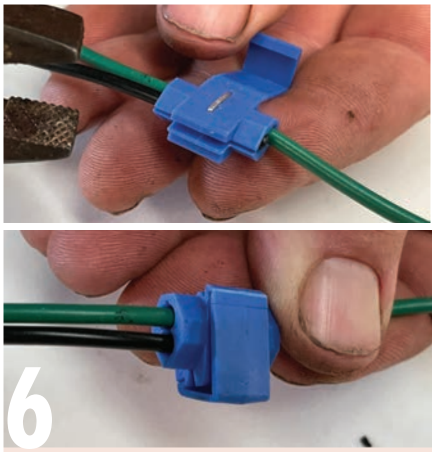

Now wrap the branch wire tightly around the main wire as shown. The end should not extend onto the insulation of the main wire. Solder the join and wrap in insulation tape (or heatshrink) and the job is done.




Splice connectors or scotch locks are a quick and easy way to splice a wire into an existing harness, such as connecting a signal wire to a vehicle's high beam circuit when wiring in a pair of spotlights. But they are not the most reliable method of splicing wires, and will quickly fail if exposed to moisture.

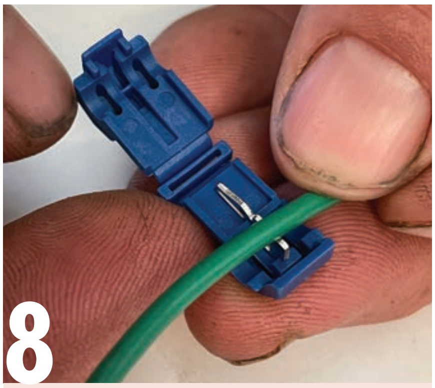



Open the scotch lock up (a flat-bladed screwdriver may be needed) and slip it over the harness wire. Now insert the branch wire into the outer passage. There is no need to strip either wire. Squash down the blade with a pair of pliers until it is flush with the top surface.

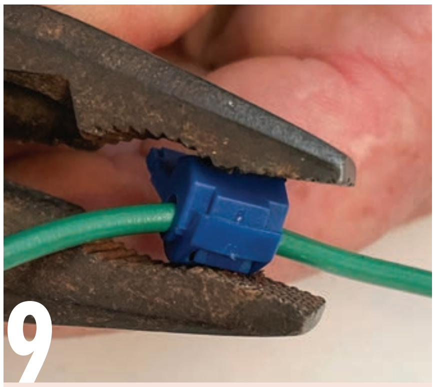



All that remains is to flip the top cover over and click it into place. The application of insulation tape will help the reliability of the scotch lock and stop it popping open. If you are chasing a wiring fault in a circuit with a scotch lock, this is the first place to check.


A recent innovation are these 'T-Tap' connectors, which are similar in principle to the scotch lock shown previously, but the branch wire is attached using a crimped-on spade connector. We purchased this 260 piece kit from an online retailer for $25, and it includes standard red, blue and yellow sizes.



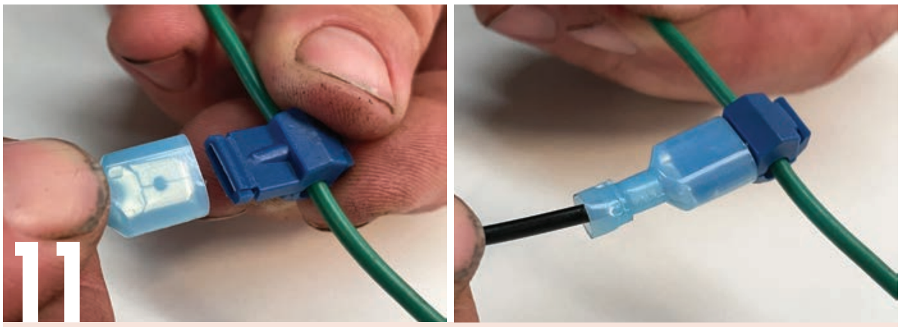

Open the connector and place over the harness wire as shown. The wire should sit down in the groove in the metal blade.




Close the connector over and compress with the pliers until it snaps shut. This will force the wire down into the blade, piercing the insulation.

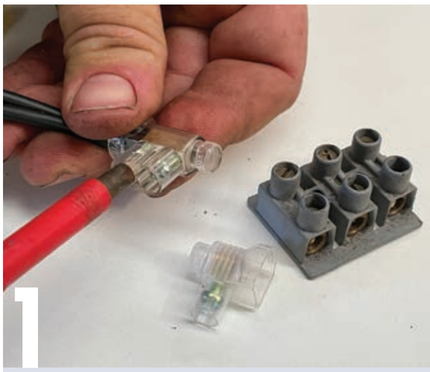
## TAPPING INTO EXISTING WIRING (continued)

**10** Now strip the insulation from the branch wire and crimp on the spade fitting as per usual method.



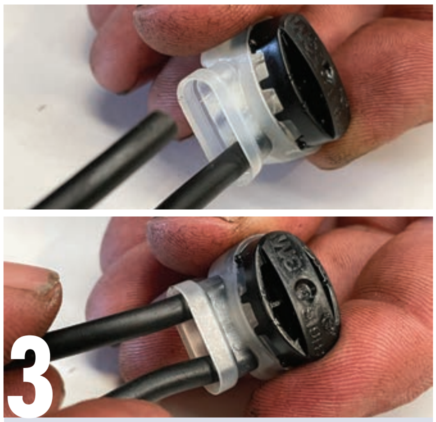
**11** Now simply insert the spade terminal into the T-Tap and the job is done. The shape of the shroud over the spade connector is designed to help lock the T-Tap in place. These connectors, while not waterproof, are potentially more reliable than the standard style of scotch lock and are easier to install where access is limited. As a bonus, the attached branch can be easily removed if need be.

## OTHER CONNECTORS

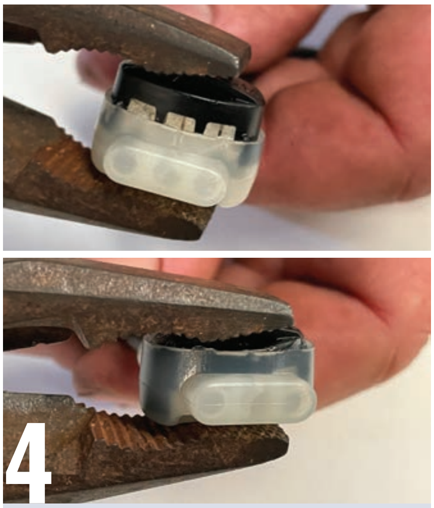


**1** There are plenty of screw-type connectors available that can be used in situations where they are shielded from the elements. The single and twin screw connectors (left and middle) are designed for 240V use but are also handy for 12 or 24V applications, and can be purchased in packs of 100 for $30 to $35. The strip terminal block (or 'chocolate block', right) can be cut to the desired number of terminals but is not suitable for harsh operating environments.

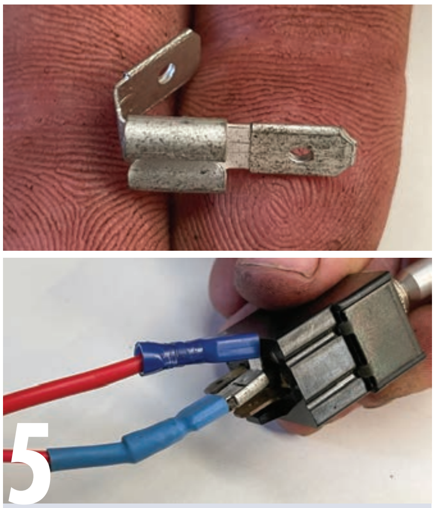
**2** These gel connectors have been typically used in low current applications such as connecting telecommunication lines, but larger units are now available from manufacturers such as 3M. They are ideally suited to harsh environments and exposure to moisture but have little mechanical strength and are not suited for use on vehicles. Applications include irrigation solenoids, low voltage lighting or underground connections.



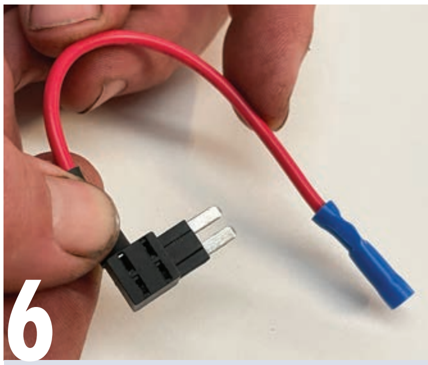
**3** The connectors are filled with an insulating gel-like grease, and contain a blade which cuts through the insulation, forming an electrical connection between two or three wires. Simply insert unstripped wire into the holes, making sure they are pushed all the way in. Fortunately the body of the connector is translucent so you can see if the wires are correctly installed.



**4** Now squash the button down on the top of the connector with a pair of pliers. This will join the two or three wires and pump sealing gel around the join, making it moisture-proof. (See www.3m.com.au for more information).



**5** Piggy-back adapters are handy for adding an additional spade terminal without having to cut and join wiring. Simply remove the original spade terminal, slip it into place and attach the two wires.



**6** On a similar theme, the double blade fuse wire tap allows you to run an additional power supply from your vehicle's fuse box, and is a quick and easy way to provide power for in-cab accessories without having to splice into the wiring harness. Simply remove a fuse, install the tapping wire, replace the original fuse and a new fuse of sufficient rating for the accessory. The tapping wire can then be crimped onto the supply wire for the accessory. They come in standard, mini and micro blade fuse sizes and cost around $6 each.

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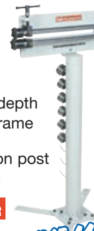

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- 108 MJ/h forced air convection
- Heavy duty high output fan
- Economical and clean burning heat

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Order Code: F003
**$561** SAVE $33

### DCE-8 - Digital Caliper
- 200mm / 8"
- Metric, inch & fraction
- 4-way measuring
- Includes battery

Order Code: M739
**$56** SAVE $10

### X8 - Industrial Bench Grinder
- Ø200mm wheels
- Fine/coarse grit
- 1hp, 240V motor

Order Code: G159
**$209** SAVE $27.50

### D1285 - Metric Precision HSS Drill Set
- 51 piece set
- Precision ground flutes
- 1-6mm in 0.1mm increments
- HSS M2 grade

alcock

Order Code: D1285
**$121** SAVE $22

### HS-32 - Hand Lever Guillotine
- 800 x 1.2mm capacity
- 765mm cutting height
- Hardened tool steel blades
- Spring assisted top blade

Order Code: S1885
**$440** SAVE $55

### ABR-7P - Auto Panel Restoration Kit Professional
- Precision ground & polished faces
- 1 x pick + finishing hammer
- 1 x straight pein + finishing hammer
- 1 x reverse curve hammer
- 1 x utility dolly, 1 x curved dolly
- 1 x heel dolly, 1 x thin toe dolly

Order Code: H886
**$198** SAVE $44

### BSC-900 - Industrial Storage Cabinet
- 900 x 450 x 900mm
- 150kg shelf load capacity
- 3-point key lock doors
- Height adjustable shelves

Order Code: T774
**$308** SAVE $44

### PSW-100 - Adjustable Pin Spanner Wrench Set
- 8 x drive pins sizes Ø2.5, Ø3, Ø4, Ø5, Ø6, Ø7, Ø8 & Ø9mm
- Adjustable pin centres 20mm - 100mm
- Chrome vanadium forged steel
- Includes spanner

Order Code: P001
**$99** SAVE $22

### MPB-2SH - Hydraulic Pipe Bender
- 6 cast steel water pipe formers, Ø1/2", Ø3/4", Ø1", Ø1-1/4", Ø1-1/2", Ø2"
- 2 stage hydraulic pump

Order Code: P064
**$396** SAVE $33

### ITB-3036 - Industrial Tool Box Set (30", 36")
- Lifting handles
- Powder coated
- 30" Box 762 x 356 x 254mm 1.2mm steel
- 36" Box 915 x 432 x 540mm 1.5mm steel Gas strut lid

Order Code: T736A
**$297** SAVE $33

## BUY & INSTALL BEFORE JUNE 30TH

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