Chapter 5

Front axle and steering

When designing the Buggy, I tried to keep the front axle and steering components as simple as possible, whilst still being robust enough to stand up to off-road use. If you decide to modify any of the components from the designs shown here, make absolutely sure that they will be able to cope with the loads that are likely to be passing though them – the last thing you need when using your Buggy is to suddenly find that you have no steering! If in doubt, ask a qualified engineer and/or welder to check your work.

WHAT YOU NEED

Tools required

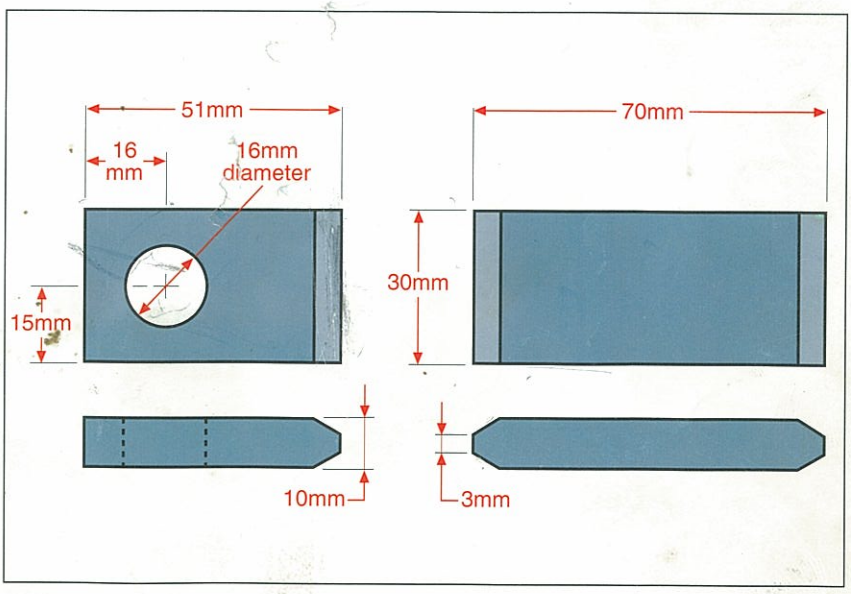
Welding set
Welding mask or goggles, gloves, overalls and safety boots
Steel tape measure
Steel ruler and set square
Hacksaw
Files – one flat, one round
Wire brush
Electric drill with a selection of drill bits
Socket set
Set of ring spanners
Set of open-ended spanners
Set of Allen keys
Hammer and centre punch

Materials required

400mm length of 30mm x 10mm flat steel bar (strip) – for front stub-axle carriers
320mm length of 25mm diameter round steel bar (or bar of a diameter to suit the front wheels/bearings you intend to use) – for front stub axles
800mm length of 19mm diameter, 1.6mm (3/4in) wall thickness steel tube – for steering
*140mm length of 22mm diameter steel tube, 3mm minimum wall thickness – for steering pivot housings, tubes U and V (see text)**
1000mm length of 13mm diameter steel tube, with internal diameter greater than the thread diameter of the track-rod ends you intend to use – for track rods
5mm steel plate (can be cut from remainder of sheet used during frame construction) – for steering arms and various brackets and plates
4 off steel washers 3mm thick with 25mm diameter holes
4 off phosphor-bronze washers with 25mm diameter holes
2 off split-pins 3mm diameter x 40mm long
*2 off M16 x 160mm long bolts for steering pivots (with self-locking nuts)**
Conduit saddle clamp block for 19mm (3/4in) diameter conduit (for mounting steering column)
4 off track-rod ends (can be fabricated – see text)
8 off nuts to fit track-rod ends
3 bolts to fit through track-rod ends (with self-locking nuts)
1 bolt for steering column (with self-locking nut)

*Note that the nuts and bolts obtained for use as stub-axle pivots must match the thick wall tube used for tubes U and V. Each bolt must be a good, but not tight fit, in the tube.

Fig. 5.1. The parts required to make the stub-axle carrier. You need four of the smaller pieces and two of the larger ones to complete the two carriers.



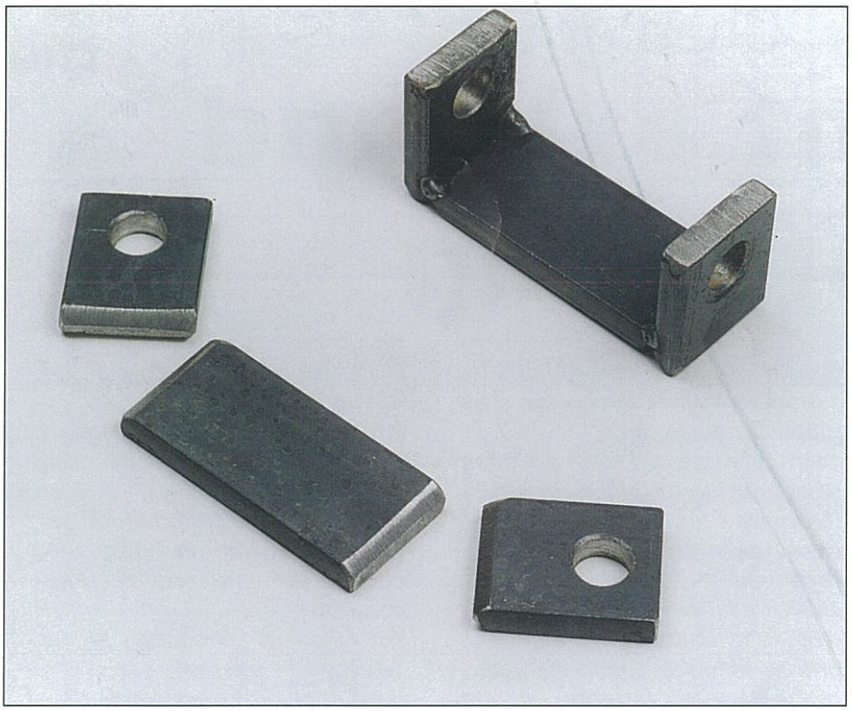


Fig. 5.2. The parts required to make the stub-axle carrier and a set of parts already tack-welded together. (Steve Williams)

MAKING THE STUB-AXLE CARRIERS

From the 30mm x 10mm flat steel bar cut two sets of the three pieces required to make the stub-axle carrier – see Fig. 5.1. The bar can be cut using a hacksaw or an electric jigsaw.

Using a centre punch, mark the position of the 16mm diameter hole (or a size appropriate for the steering pivot bolts you intend to use) on each of the four smaller pieces of metal. Working on each piece in turn, ensure that the metal is securely clamped, and then drill the hole.

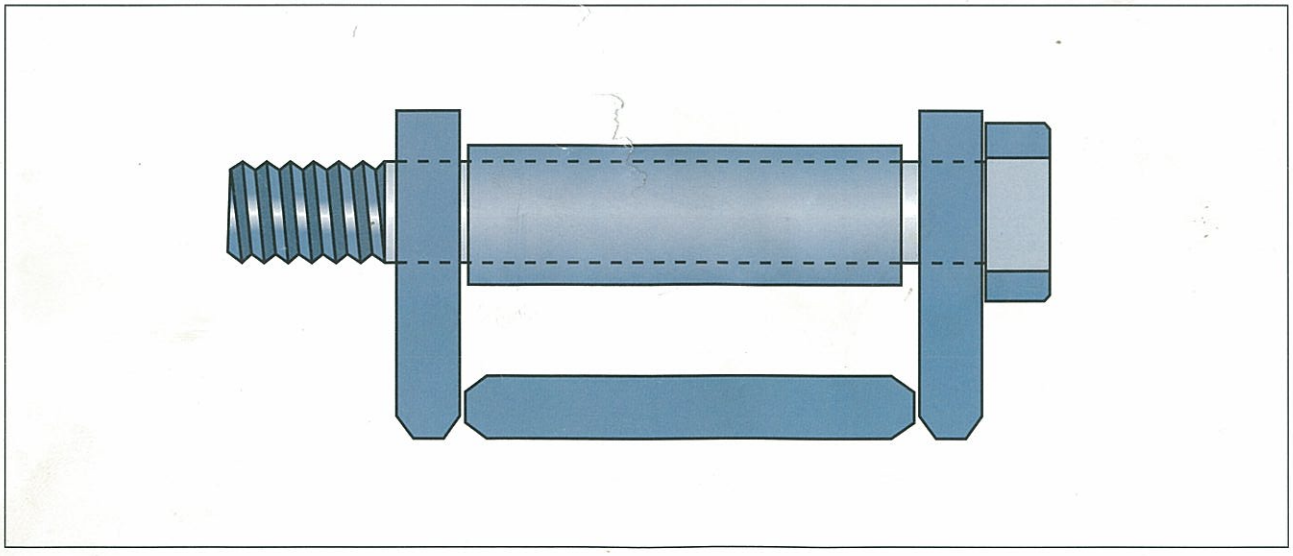
In preparation for welding, working on each of the components in turn, file or grind an approximately 45° chamfer on each of the edges shown in Fig. 5.1.

From the length of 22mm diameter steel tube cut two tubes 68mm long for the steering pivot housings, tubes U and V. Ensure that the ends of the tubes are cut square.

Carry out a trial assembly of each set of components to ensure alignment of the holes – ie, assemble one of the pivot bolts, tube U and a set of stub-axle carrier parts, then similarly assemble the remaining pivot bolt with tube V and the remaining stub-axle carrier parts. When you're happy that the holes are aligned and that the all the components are satisfactory, tack-weld each set of stub-axle carrier components together – see Fig. 5.4. When tack-welding, it's a good idea to leave the pivot bolts and tubes in place to aid alignment.

Remove the pivot bolt and tube from each assembly, and fully weld both sides of each stub-axle carrier. After welding, working on each set of components in turn, re-check the alignment of the holes and the free movement of the tube by refitting the bolt and tube. If there's been some distortion, it may be possible to straighten the carrier by clamping in a vice and bending.

Fig. 5.3. The stub-axle carrier bracket assembled with the pivot bolt and tube in place.



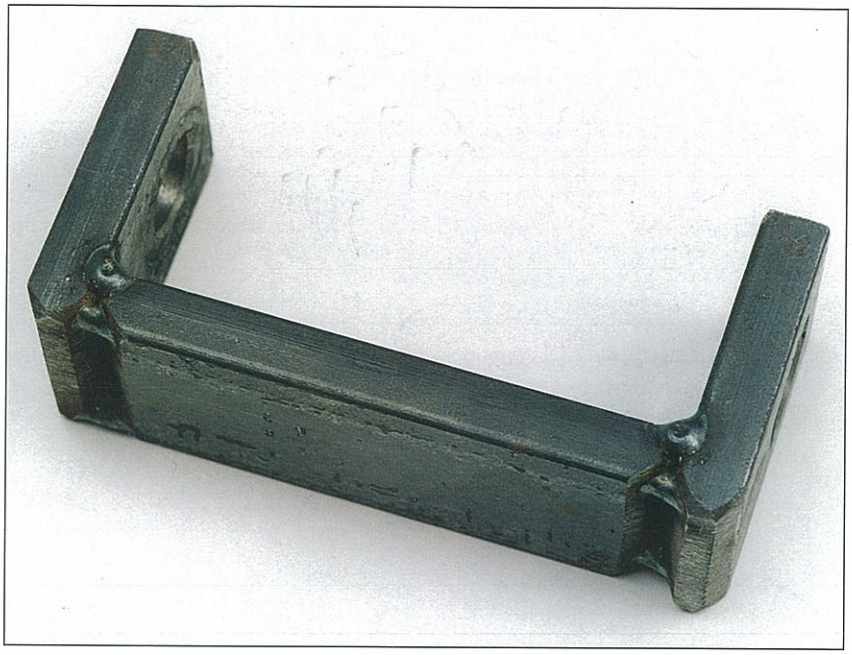


Fig. 5.4. A tack-welded stub-axle carrier showing the weld prep chamfers. (Steve Williams)

Tubes U and V can now be welded to tube D on the main frame as shown in Figs. 5.5 and 5.6. It's important to make sure that tubes U and V are welded accurately to give the correct camber and castor angles. The angle of the fish-mouthing on tube D should ensure that when tubes U and V are fitted the front wheels have a camber angle of 10° negative (ie, the tops of the wheels are inclined inwards towards the centre of the Buggy frame) and a castor angle of 15° (ie, the steering pivots are inclined forwards at the bottom). These steering angles will allow the steering to work effectively by loading up the inside front wheel during cornering, increasing its grip and helping the Buggy to turn. Although the castor angle used is high compared with that used on a car, I found that using less than 15° resulted in the Buggy having a tendency to go straight on when trying to steer left or right, and using more than 15° gave very heavy steering.

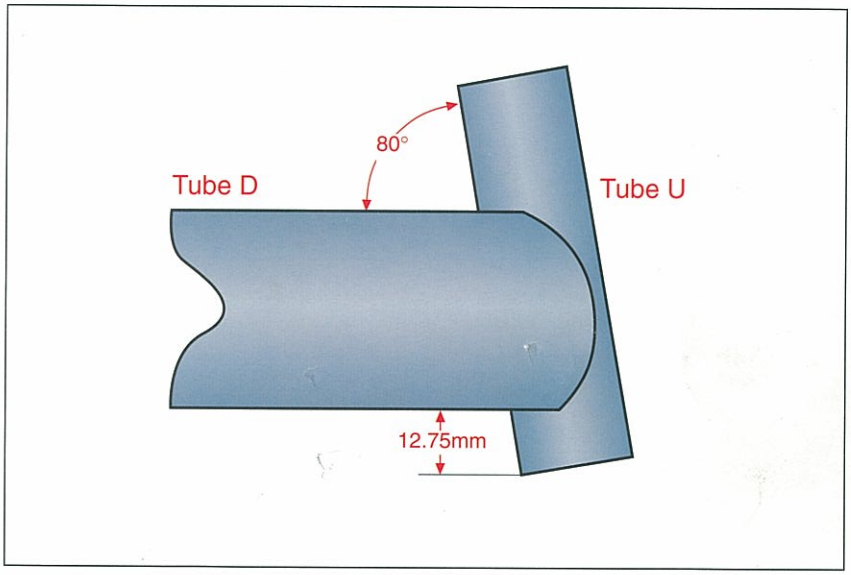


Fig. 5.5. Tubes D and U viewed from the front of the Buggy frame. Tube U should be set as shown when fixed to Tube D to give 10 degrees of negative camber.

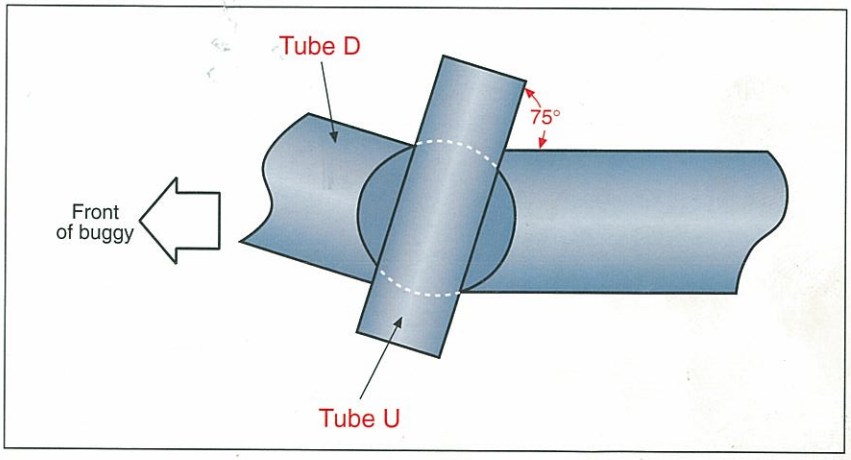


Fig. 5.6. Tubes D and U viewed from the side of the Buggy frame. Tube U should be set as shown when fixed to tube D to give a castor angle of 15 degrees.

Alternative solutions

Steering pivot bolts

Instead of drilling plain holes through the top and bottom plates of each stub-axle carrier for the steering pivot bolts, you may wish to drill and tap the bottom hole to suit the thread of the pivot bolt. The bolt can then be screwed into place in the hub carrier and secured using a Nyloc nut which will act as a locknut. This solution makes it easier to adjust the tightness of the pivot bolts to ensure that the hub carriers pivot correctly.

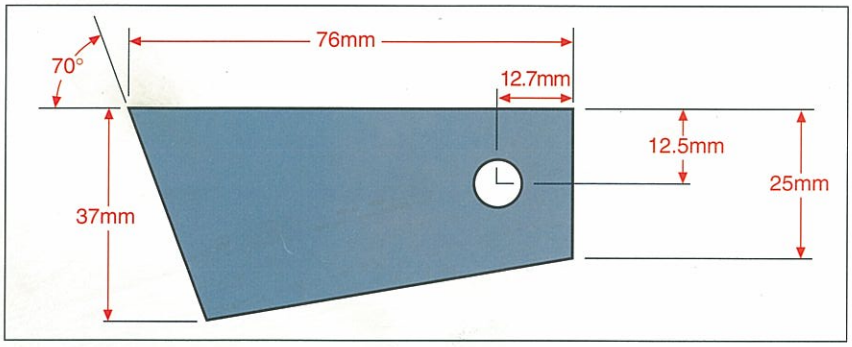


Fig. 5.7. Dimensions for the steering arms. Two steering arms are required, one for each stub-axle carrier.

Fig. 5.8. A steering arm welded to the stub-axle carrier. (Steve Williams)

MAKING THE STEERING ARMS

From the 5mm plate cut two steering arms, as shown in Fig. 5.7. The bar can be cut using a hacksaw or an electric jigsaw.

Using a centre punch, mark on each steering arm the position of the hole for the track-rod end bolt. Drill holes to suit the bolts you're going to use to secure the track-rod ends to the steering arms.

Each steering arm can now be welded to its stub-axle carrier – see Figs. 5.8 and 5.9. Remember that the stub-axle carriers are handed, so make sure that the steering arms are welded correctly to give both left- and right-handed assemblies. Also make sure that the steering arms are parallel with the top plates of the stub-axle carriers.

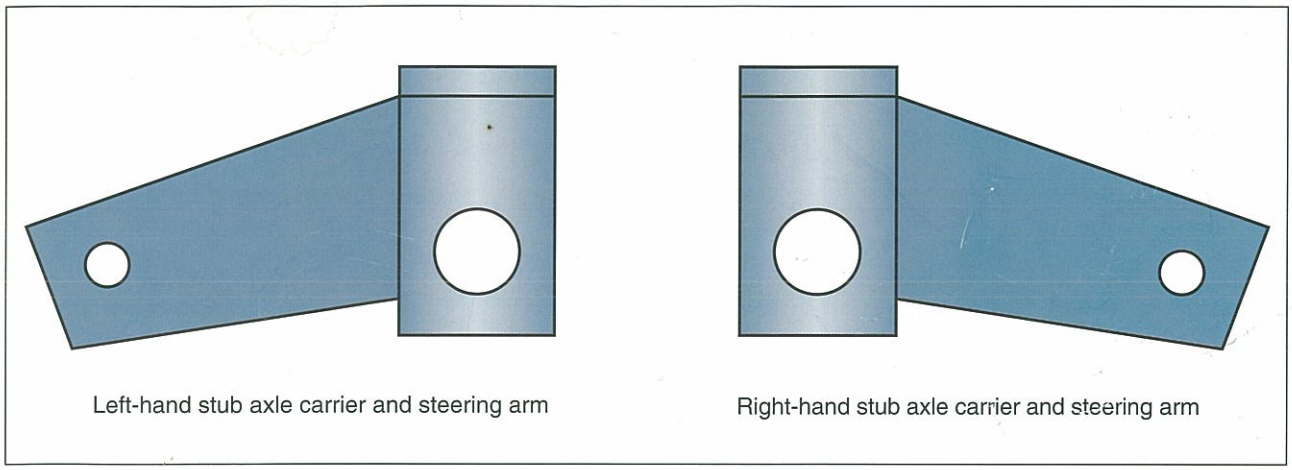


Fig. 5.9. The steering arms need to be welded on to give a left- and a right-hand stub-axle carrier.

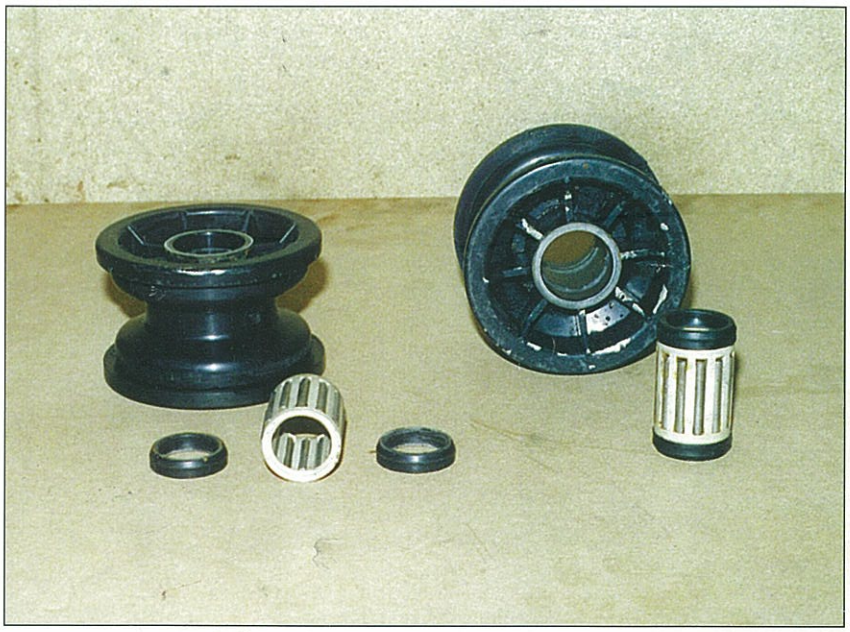


Fig. 5.10. The front wheels and needle-roller bearings used on Derek Manders's Buggy. (Derek Manders)

MAKING THE STUB AXLES

The stub axle should be made to suit the front wheels and bearings that you intend to use on your Buggy. For my Buggy, I used four quad-bike wheels and tyres, which were bought new from a farm machinery factors. The wheels run on needle-roller bearings which are pressed into tubes welded directly to the wheels. Each wheel/bearing assembly then simply slides over the stub axle and is retained by a split-pin.

From the 25mm diameter round steel bar, or the bar which you have chosen to suit your front wheels and bearings, cut two stub axles, each 160mm long. File or grind a 10° angle on one end of each stub axle – see Fig. 5.11.

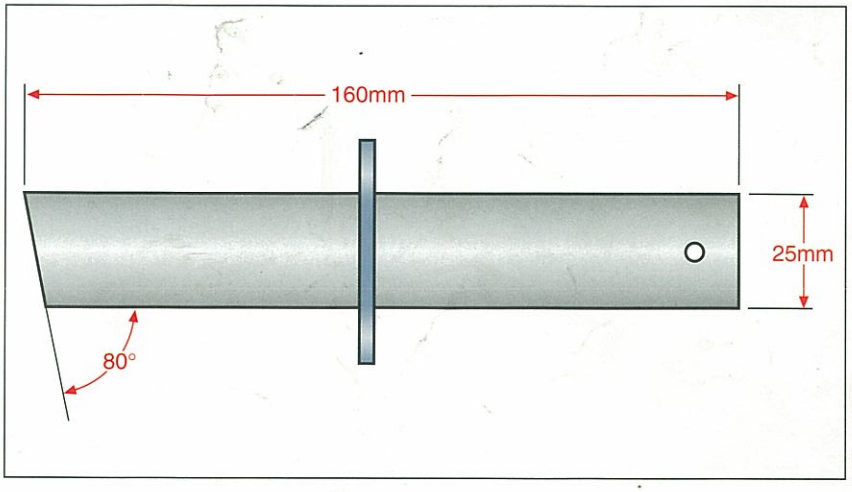


Fig. 5.11. Dimensions for stub axle. The washer needs to be welded on in the correct position for the wheels you are using.

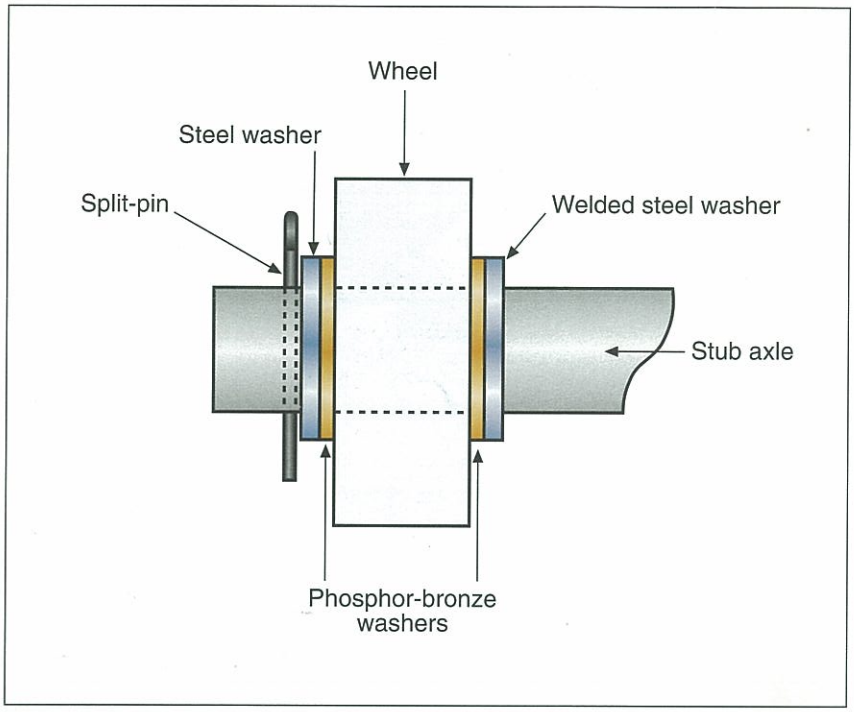
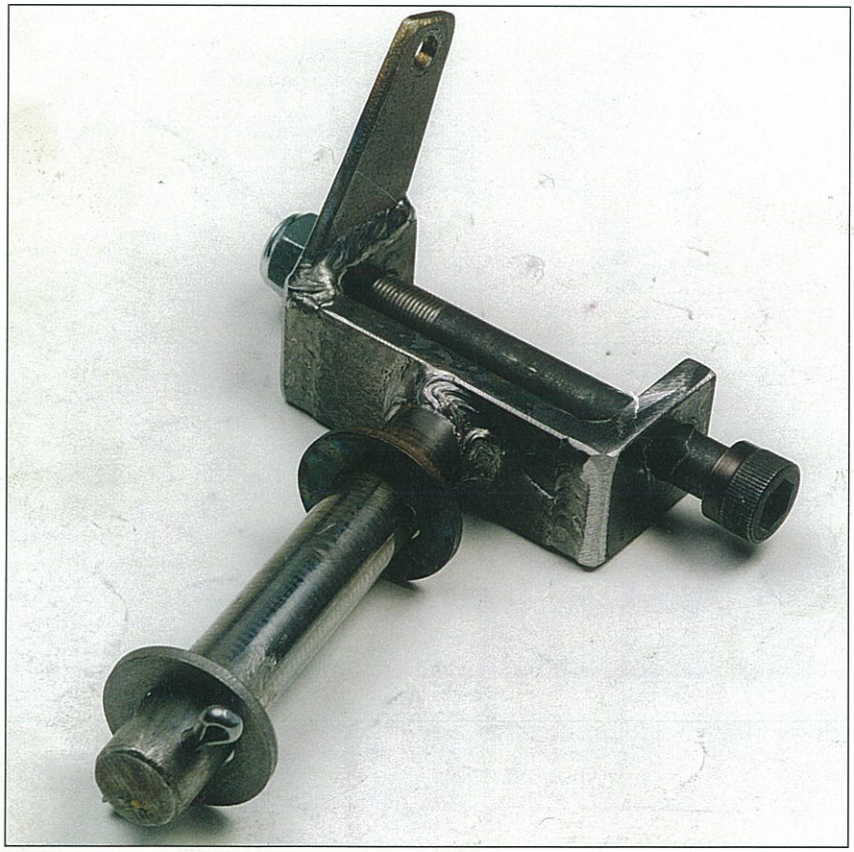


Fig. 5.12. Ideally, phosphor-bronze washers should be fitted on the stub axle either side of the wheel.

Fig. 5.13. The completed left-hand stub-axle carrier assembly. Note that phosphor-bronze washers have not been fitted here. (Steve Williams)



Weld each stub axle to the middle of the stub-axle carrier with the axle pointing down, that is, pointing away from the steering arm end of the stub-axle carrier – see Fig. 5.13.

You will now need to weld a steel washer to the inboard end of each stub axle to give the right spacing for the wheels you are going to use – the washer will act as the inner shoulder against which the wheel will rotate and, ideally, a phosphor-bronze washer should be fitted over the stub axle between the welded steel washer and the wheel. Slide the steel washer and, where applicable, the phosphor-bronze washer onto the stub axle, then slide on one of the wheels. Make sure that the rim of the wheel clears the stub-axle carrier, and also make sure that the wheel is positioned so that it will not foul the Buggy frame when the steering is turned on full lock – you may want to carry out a trial assembly of the components to check this. Once you're happy with the position of the wheel on the stub axle, mark the position of the steel washer, then remove the wheel and washers. The steel washer can now be welded onto the stub axle in the marked position, making sure that it's square with the axis of the stub axle.

Finally, you need to drill a hole in the outer end of the stub axle for the wheel retaining split-pin. Fit the inboard phosphor-bronze washer (if applicable) and the wheel to the stub axle. Ideally, a second phosphor-bronze washer should be fitted against the outer edge of the wheel, along with a second steel washer. With the wheel and washers in place, mark the required position of the split-pin hole. Depending on the type of wheel bearing you've used, the split-pin should be positioned to allow the wheel a small amount of 'float' on the stub axle, but not too much. Remove the wheel and washers, and drill the split-pin hole through the centre of the stub axle using a 3mm drill.

mounting plate to suit your saddle clamp, and weld it to the top of the steering column support shaft. At the same time, you can fully weld tube W to tube E and the steering column bottom bracket to tube D.

Refit the steering column, then calculate the length it needs to be for the driver and cut to length. Remember to take into account the size of the steering wheel and mounting boss to be used.

The front stub-axle assemblies need to be fitted to the frame at this stage and a straight-edge placed across the two steering arms. Fit the stub-axle carrier assemblies to tubes U and V on the frame, and fit the steering pivot bolts to hold them in position (if you're going to leave the components assembled for some time, fit the nuts to the steering pivot bolts). Make sure that each stub-axle carrier is fitted to the correct side of the frame – the steering arms should point towards the rear of the frame. Place the straight-edge across the steering arms, making sure that it's positioned across the centres of the holes for the track-rod end bolts at the rear of the steering arms. This will allow you to mark the position on the steering column where the straight-edge crosses the column, and gives you the centre position for the track-rod plates to be welded on the column.

From the 5mm plate, make two of the steering column track-rod plates as shown in Fig. 5.16. The plates then need to be welded either side of the marked line on the steering column, at a distance apart to suit the track-rod ends you're going to use (the two track-rod ends fit between the two plates). Make sure that the plates are welded in position at right-angles to the axis of the steering column, and make sure that the bolt holes in the plates are aligned. To check the alignment of the holes, slide the bolt you're going to use to secure the track rods to the column into position through the holes.

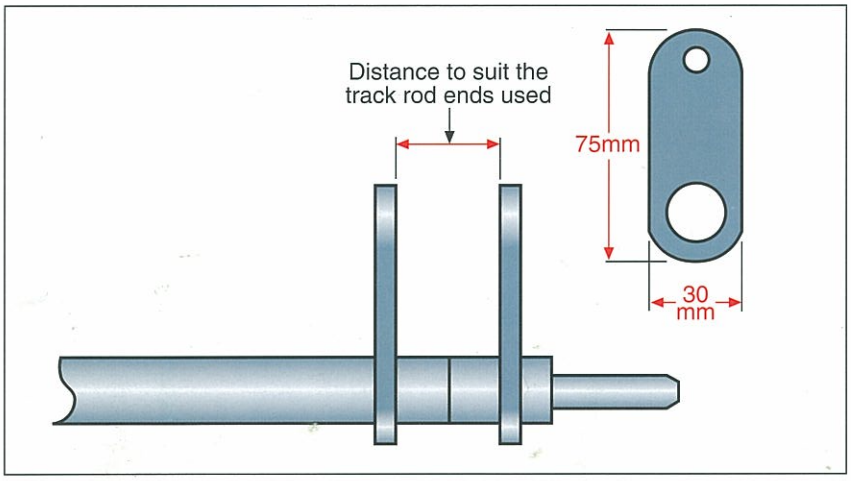


Fig. 5.16. Steering column track-rod plates. The two plates need to be welded on to the steering column at a distance apart to suit the track-rod ends you are using.

Fig. 5.17. The bottom of the steering column showing the bolt welded in place in the bottom of the tube, and the two track-rod plates in position. (Steve Williams)

Ducks and dives

Welding the stub axles

On the original Buggy I welded each stub axle to the middle of its stub-axle carrier, as this meant that the Buggy sat with the frame tubes level when the wheels I chose were fitted.

One way to ensure that the stub axles are welded in the correct position is to fit the rear wheels and front stub-axle carriers to the Buggy frame, then block up the front of the Buggy frame until the side tubes are level. Attach the front wheels to the stub axles, then offer the wheels up to the frame, with the bottom of the wheels resting on the floor, and mark the positions where the stub axles need to be welded to the carriers.

MAKING THE STEERING COLUMN

Weld the head of the bolt into one end of the 19mm diameter tube being used for the steering column tube, so that the whole of the bolt thread sticks out of the end of the tube.

From the 5mm plate cut the steering column bottom bracket, as shown in Fig. 5.14, and tack-weld it to the frame in the middle of tube D.

Tack-weld the steering column support tube W (cut from the frame tube stock – see Chapter 4) in the centre of tube E, leaning towards the front of the Buggy at an angle of approximately 10° from the vertical (see Fig. 4.2 in Chapter 4). Temporarily fit the seat in the frame and trial fit the steering column. The bolt at the bottom end of the column should pass through the steering column bottom bracket on the frame. Note that when securing the column to the bottom bracket, two nuts should be

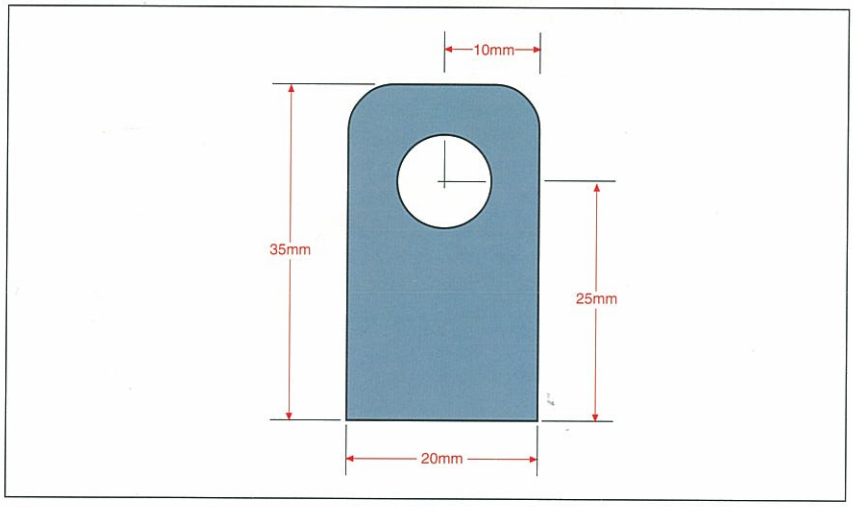


Fig. 5.14. Dimensions for steering column bottom bracket. This needs to be welded in the middle of frame Tube D.

screwed onto the end of the bolt in the column and tightened against each other – this will secure the lower end of the column, whilst still allowing it to rotate. When the column is in the best position – in other words at the correct height and angle – for the intended driver (take into account the size of the steering wheel), mark the place at which the support tube W needs to be cut. You may also need to adjust the angle of the steering column bottom bracket to suit the angle of the column – the bracket should be exactly at right-angles to the end face of the column tube.

Cut the steering column support tube at the correct angle to enable the saddle clamp to line up with the steering column, and approximately 10mm below the place marked to take account of the thickness of the saddle clamp and mounting plate.

From your 5mm plate make a

Fig. 5.15. Two nuts tightened against each other are used to secure the lower end of the steering column to the bracket on the frame. (Steve Williams)

Alternative solutions

Adapting a car steering column

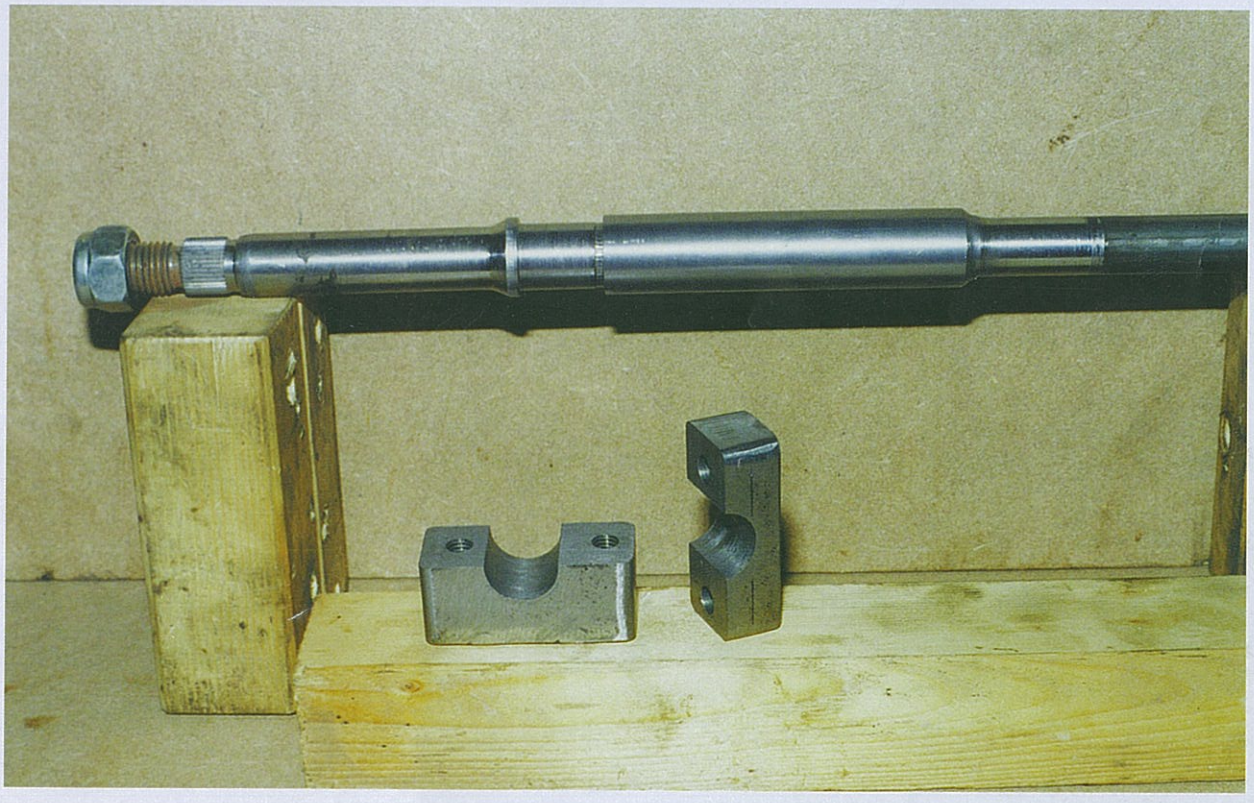
A car steering column can be adapted for use on the Buggy, although it will almost certainly have to be shortened. Once the column has been cut to length, a bolt can be welded to the lower end to secure it, as described in the main text.

If desired, a saddle clamp can be made from solid block to suit the column from the car, and the clamp can then be secured to the Buggy frame as described in the main text. To provide positive location, the solid column can be turned down in a lathe at the appropriate place to suit the hole in the clamp (20mm in the case of the Escort column shown here).

The clamp shown here was made from a piece of 60mm x 45mm x 25mm block. The top (60mm x 25mm) face was marked out for two clamping bolts, then pilot holes were drilled, followed by drilling out to 6.8mm. On the front face (60mm x 45mm) a line was scribed across the block 20mm down from the top. The block was then sawn along this line to give two pieces. The two 6.8mm clamping bolt holes in the top piece were drilled out to 8mm, and the 6.8mm holes in the bottom piece were tapped for M8 bolts. The two pieces were then bolted together using the M8 bolts. Again working on the front face, a mark was made with a centre-punch halfway along the join, pilot drilled and then opened up to 20mm using a pillar drill.

The column and clamp can be assembled as described in the main text, and the steering wheel can be fitted using the appropriate boss for the car.

An adapted car steering column and saddle clamp. (Derek Manders)



MAKING THE TRACK RODS

First, cut the 13mm diameter tube in half to give two pieces approximately 500mm long. Next weld a nut which suits the track rod ends onto one end of each of the two tubes.

Reassemble the steering column and place it in the straight-ahead position, that is, with the two steering column track-rod plates pointing straight down. Position the front stub axles in the straight-ahead position as well.

Screw a track-rod end about half-way into each of the nuts welded onto the ends of your two track rods (remember to screw a

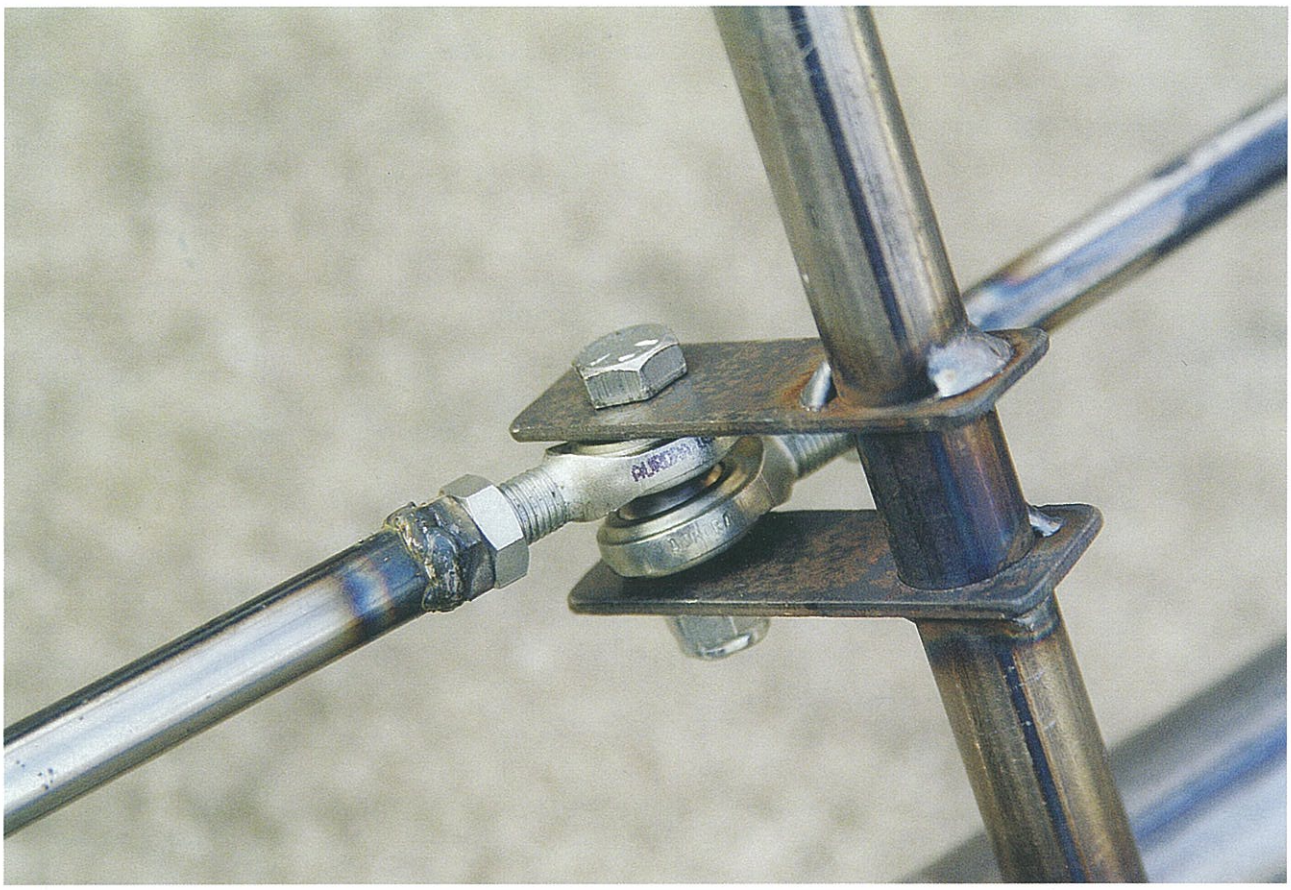


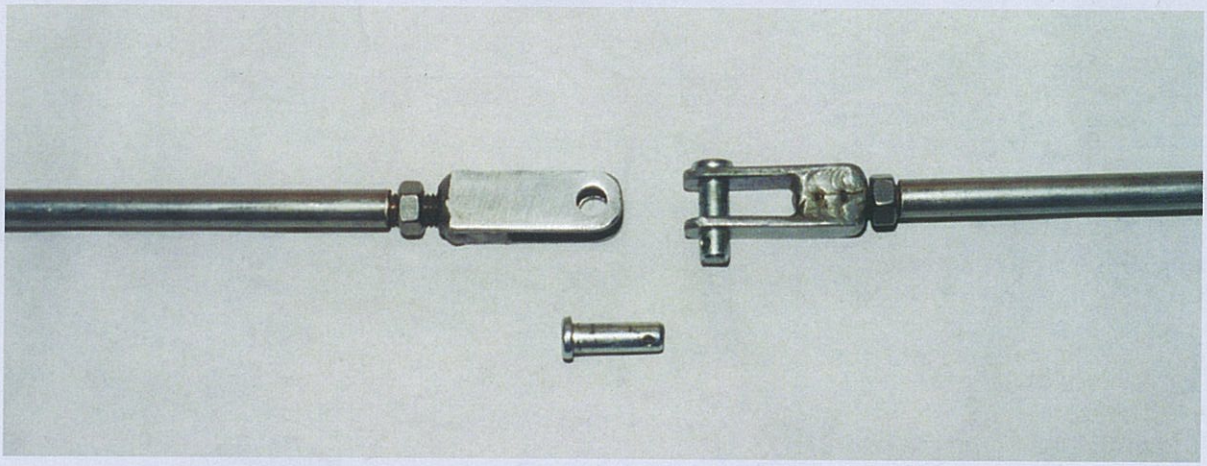
Fig. 5.18. Track-rod inner ends secured to steering column track-rod plates. (Steve Williams)

locknut onto the threads of the track-rod end before fitting it), and then fit the bolt to secure the track-rod ends to the plates on the steering column. At this stage the required length of each track rod can be calculated by offering it up to the steering arm on the stub-axle carrier and marking on the track rod the position of the track-rod end fixing hole in the steering arm. Assuming that you're using track-rod ends at the outer ends of the track rods, remember that an allowance has to be made for the length of the track-rod end and the nut which will need welding onto the outer end of the tube once it has been cut to the required length. You should calculate the length required in order to enable the track-rod end to be screwed about half way into the track rod, leaving some exposed thread to give the possibility of adjustment later.

Fig. 5.19. On the original Buggy, the track-rod ends have threaded pins which are secured to the steering arms by Nyloc nuts. (Paul Buckland)

After cutting the track rods to the required length, you can weld the nuts onto the outer ends of the track rods, screw in the track-rod ends (again, remember to fit locknuts to the threads of the track rods before fitting), and secure the track-rod ends to the steering arms. On the original Buggy, the track-rod ends have threaded pins which are secured to the steering arms by Nyloc nuts.

Alternative solutions



DIY track-rod ends. Note how the strips of steel plate are welded to the bolt head and nuts. (Derek Manders)

DIY track-rod ends

If you can't find suitable proprietary track-rod ends, alternatives can be made up as follows. For each track-rod end, select a long M8 bolt, threaded along its full length, then thread two nuts onto the bolt and screw them up tight against the bolt head so that the flats on the nuts and the bolt head are aligned. Working on two opposite sides of the bolt, grind off a section from the flats of the bolt head and two nuts. Weld a strip of steel plate onto each of the ground flats, then mount the assembly in a vice and drill through the two steel plates to suit the bolts or pins to be used to secure the track-rod ends to the steering column and/or steering arms. As an alternative to using bolts, the track-rod ends can be secured to the steering arms using clevis-pins and split-pins.

Before fitting each track-rod end, screw a lock nut onto the bolt thread, then screw the bolt thread into the end of the track rod. After final assembly, the lengths of the track rods can be adjusted, and the lock nuts can then be tightened.

Note that if rose-jointed track-rod ends are not used, it will be necessary to bend the steering arms very slightly so that the bolt/pin holes in the steering arms and track-rod ends are aligned (rose joints can cope with this slight misalignment).

Note also that as the track rods need to pivot to a significant degree, it would be unwise to use DIY track-rod ends at both ends of the track rods. To avoid the risk of overstressing the pivots, it is advisable to use rose-jointed track-rod ends at the inboard (steering column) ends of the track rods.

DIY track-rod end connected to steering arm using a clevis-pin and split-pin. (Steve Williams)

FITTING THE STEERING WHEEL

Finally, weld a boss to the top of the steering column to allow your chosen steering wheel to be securely attached. In many cases a suitable boss will be supplied with your steering wheel. As an alternative, if you use a steering wheel from a scrap car, you could salvage the car steering column, saw off the top splined section, and weld it to the top of the Buggy column. The steering wheel can then be attached to the column using the original nut or bolt from the car. On the original Buggy I used a quick-release steering wheel, and welded the boss supplied to the top of the column.

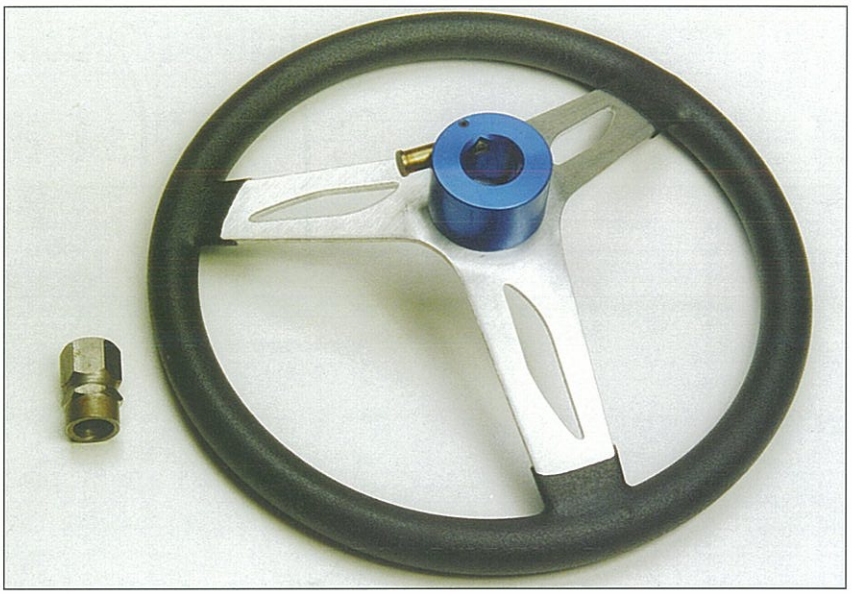


Fig. 5.20. Steering wheel with quick-release boss used on the original Buggy. Any steering wheel can be used provided it can be securely fixed to the steering column. (Steve Williams)

Chapter 6

The engine and gearbox

The exact way in which the engine/gearbox assembly is mounted will of course depend on the engine/gearbox being used. Although actually installing the engine/gearbox is a fairly straightforward task, it's important to make sure that all the controls are correctly connected and adjusted before using the Buggy.

WHAT YOU NEED

Tools required

Welding set
Welding mask or goggles, gloves, overalls and safety boots
Steel tape measure
Steel ruler and set square
Hacksaw
Files – one flat, one round
Wire brush
Electric drill with a selection of drill bits
Socket set
Set of ring spanners
Set of open-ended spanners
Set of Allen keys
Centre punch

Materials required

5mm steel plate – can be cut from remainder of sheet used during frame construction
Selection of nuts, bolts and washers to suit components removed from donor motorcycle
Suffolk Colt lawnmower fuel tank, complete with on/off tap, fuel pipe and vented screw cap
Two hose clips to suit fuel pipe
Engine and gearbox (complete with carburettor, ignition system, exhaust system and clutch)

FITTING THE ENGINE AND GEARBOX

Refit the engine/gearbox assembly to your frame, and bolt securely to the mounting plates welded in place when you made the frame.

The fuel tank needs positioning above the carburettor, as most older small-capacity motorcycle engines do not have fuel pumps and rely on gravity to feed fuel to the engine. For safety's sake you need an on/off tap on the fuel tank, or in the fuel feed pipe, and a screw-on ventilated fuel tank cap. I found all these features came as standard with the lawnmower fuel tank I'd purchased.

On the original Buggy, the tank was fitted to the frame by fabricating a suitable bracket out of the 5mm plate and welding it to the frame on tube L. I also had to weld a bolt to the frame to secure the fuel tank top mounting bracket. Some lawnmower fuel tanks are designed to be mounted on the mower handle tubes, in which case you can mount the tank on the Buggy by welding a suitably bent tube to the frame.

Once the tank is in position on the bracket, fit the fuel feed pipe

Fig. 6.1. The petrol tank on the original Buggy, showing the simple bracket made to fix it in position on the frame tube. Note also the bolt which secures the tank's top bracket. (Steve Williams)

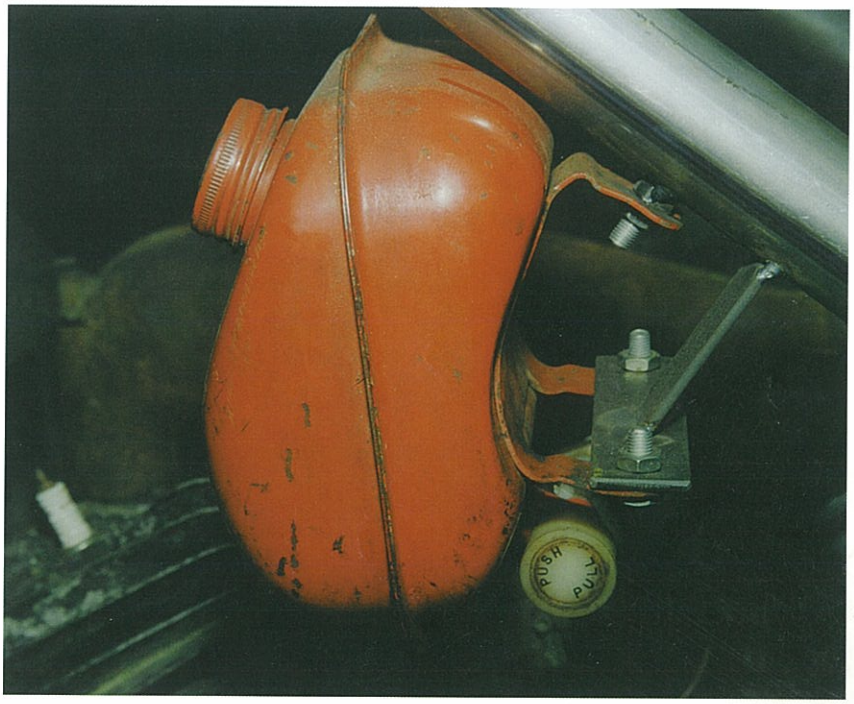


Fig. 6.2. An alternative type of lawnmower fuel tank mounted on a bent tube welded to the Buggy frame. (Derek Manders)

from the tank to the carburettor, making sure that the pipe is secure and held clear of any moving parts with which it could tangle. Secure the pipe with a hose clip at each end.

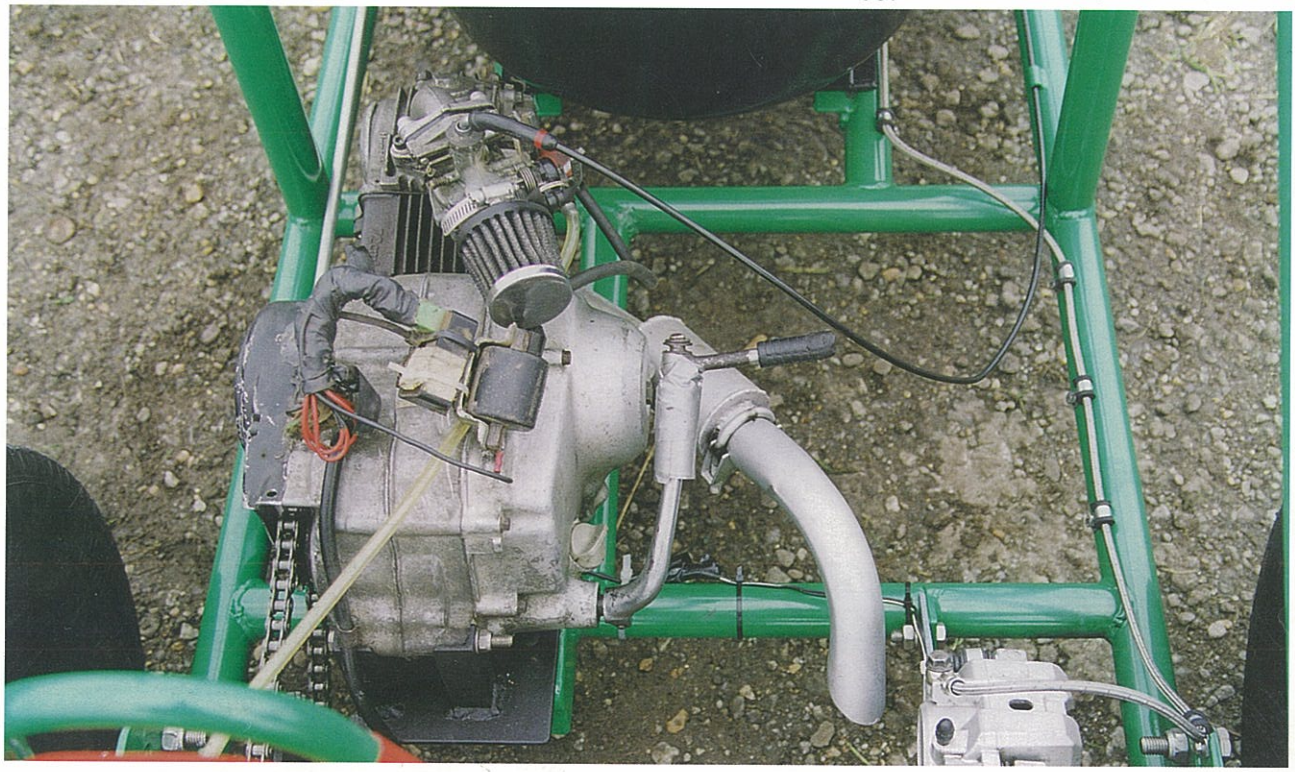
With the Yamaha 175cc engine I fitted, it was necessary to make a slight modification to the exhaust pipe so that it would exit to the back of the Buggy. A single cut was made, on the outlet pipe near the cylinder head, to allow the silencer and tail pipe to be rotated. The pipe was then re-welded. An important point to note if your engine is a 2-stroke unit is that the overall length and internal volume of the exhaust pipe for a 2-stroke engine is precisely calculated and designed to ensure that the engine runs properly. On no account should the length of the exhaust be changed.

Fix the exhaust to the engine and, if necessary, make up a bracket or brackets to support the exhaust and attach it to a suitable frame tube such as tube H.

Fig. 6.3. The exhaust was cut, rotated and re-welded so it exited at the back of the buggy. We were careful not to change the length or volume of the exhaust. (Steve Williams)

Fig. 6.4. On the original Buggy two brackets were welded to the frame to mount the exhaust. (Steve Williams)

Fig. 6.5. The Honda 70 engine/gearbox installation on Derek Manders's Buggy. (Steve Williams)



Ducks and dives

Exhaust heat shield

Having completed the Buggy illustrated in this book, whilst running the engine, I was leaning across and accidentally burnt a running hole in my new trousers. She who must be obeyed was not amused! One of the first modifications will be a heat shield, probably made from perforated aluminium, which will protect skin – far more precious than trousers!

Ducks and dives

2-stroke petrol/oil mix

Some 2-stroke engines have a separate oil tank, with a device on the engine which automatically feeds in the correct mix of oil and petrol. On some motorcycles the tubular frame itself is used as an oil tank. If your donor motorcycle uses two tanks, you have two options. Either fit two separate tanks, or mix the oil and petrol in the correct proportions before filling the fuel tank – the original manufacturer of the motorcycle will give the required proportions.

If you're using an oil/petrol mix in the fuel tank, then the oil and petrol can separate out if the Buggy is not used for some time. If your Buggy has been stood for a while, give it a shake to mix the oil and petrol before you try and start it. Always make sure that the two-stroke oil/petrol mix is correct.

If a two-stoke petrol/oil mix is used in the fuel tank, instead of an auto-feed petrol/oil system, it would be as well to check whether the oil supply pipes need blocking off and/or whether the oil pump needs to be removed to avoid air being pumped into the engine. I do know that this was necessary on some Japanese bikes that I worked on years ago. This is where a *Haynes Service and Repair Manual* would come in handy.

This is what happens if you use too much oil in a two-stroke oil/petrol mix – smoke! (Steve Williams)

Chapter 7

Drivetrain and brake

As with the other components of the Buggy, it's important to make sure that work on the drivetrain and brake components is carried out safely and accurately. Don't try to improvise as far as rear axle and brake component mountings are concerned, as the safety of the driver is at stake. If you're lucky enough to succeed in obtaining any proprietary kart components for use on your Buggy (eg, rear axle, wheels hubs, etc), always follow the manufacturer's recommendations for fitting.

WHAT YOU NEED

Tools required

Welding set
Welding mask or goggles, gloves, overalls and safety boots
Steel tape measure
Steel ruler and set square
Hacksaw
Files – one flat, one round
Wire brush
Electric drill with a selection of drill bits
Socket set
Set of ring spanners
Set of open-ended spanners
Access to a metalworking lathe
Screwdrivers

Materials required

Chain, sprockets, front brake disc and front brake caliper from donor motorcycle
Four Ford differential flanges (on my Buggy these came from Ford Capris)
2 self-centring bearings for rear axle
*1000mm length of 30mm diameter solid steel bar – for rear axle**
5mm steel plate – can be cut from remainder of sheet used during frame construction
38mm diameter tube off-cut – for gear linkage support
Selection of nuts, bolts and washers to suit components removed from donor motorcycle
Chain oil
3 off M6 or M8 bolts and self-locking nuts to secure drive sprocket flange and wheel hub flanges to axle – optional (see text)

* The rear axle on the original Buggy was made from 30mm solid bar steel stock. When buying material to make the axle, take advice from the stockholder – hard steel must be used, not malleable steel, as if the axle is malleable, it may bend after rigorous off-road use. Proprietary axles can be bought from karting specialists, in which case bearings and wheel mounting flanges can be bought to suit, although this is likely to be a more expensive option than making your own axle. Kart axles are designed to withstand the rigours of karting, so should be perfectly adequate for the Buggy.

MACHINING THE HUBS

If you have access to a metal-working lathe, bore out the centres of the four differential flanges to fit the axle shaft. If you don't have access to a lathe, a local

Fig. 7.1. The rear differential flange obtained from a scrap Ford Capri. (Steve Williams)

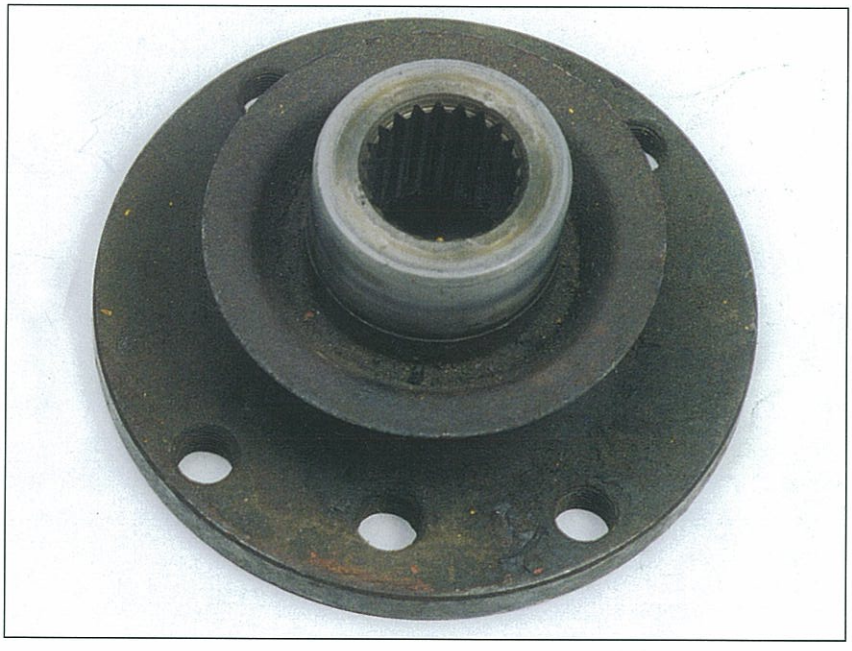


Fig. 7.2. The Ford rear differential flanges will need to be machined to suit the rear axle, sprocket, brake disc and wheels you are going to use. (Steve Williams)

Fig. 7.3. Proprietary hubs can be obtained from go-kart specialist suppliers, but are likely to be quite expensive. (Steve Williams)

engineering shop can easily do this.

One of the hubs needs to be fitted to the sprocket. Either the flange can be drilled to fit the holes already in the sprocket or the sprocket can be drilled to fit the holes in the flange.

A second flange needs to be fitted to the brake disc – again the flange can be drilled to fit the holes already in the sprocket or the sprocket can be drilled to fit the holes in the flange.

The remaining two flanges must be drilled to suit the pitch circle diameter (PCD) of the rear wheels to be used – in other words the flanges must be drilled to accept the wheel fixing bolts. It goes without saying that you need to make sure that the holes drilled are concentric with the flange and the wheel. For my Buggy I was fortunate to be given two proprietary aluminium go-kart hubs, but not many builders will be this lucky and these hubs are rather expensive to buy new.

Bolt the drive sprocket and the brake disc to their respective flanges.

FITTING THE BRAKE DISC AND CALIPER

When mounting the brake disc and caliper, note that the caliper will probably have been designed to work with the disc rotating in a specific direction. When mounting the disc and caliper on the Buggy, make sure that the caliper is mounted so that it operates with the disc rotating in the same direction as it did when fitted to the donor motorcycle.

Loosely bolt the two self-centring bearings into the axle bearing mounting plates on the frame, then slide the axle shaft through one of the bearings. Slide the brake disc and drive sprocket onto the axle, before sliding the axle through the second bearing on the opposite side. Finally, slide on the two wheel hubs.

With the axle positioned centrally in the frame, the brake

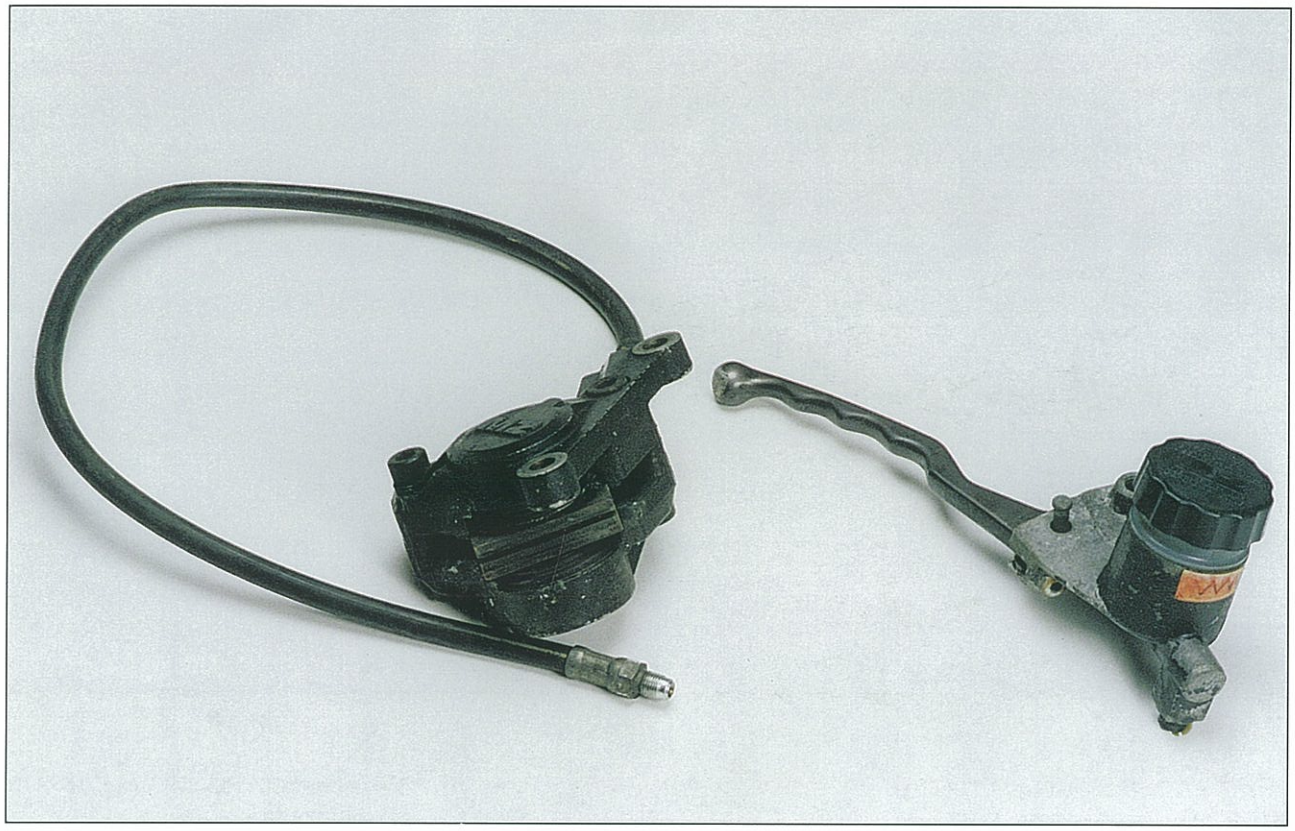


Fig. 7.4. The brake master cylinder and caliper from the donor motorcycle. It's unlikely that the flexible brake pipe will be suitable for use on the Buggy. (Steve Williams)

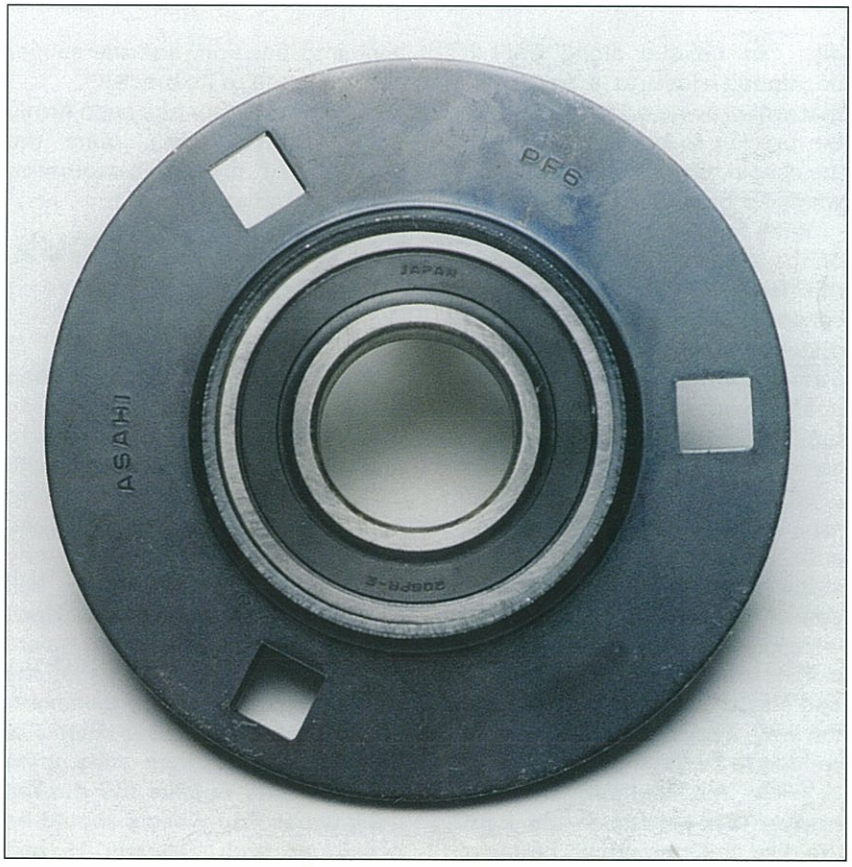


Fig. 7.5. One of the two proprietary self-centring bearings we bought for the rear axle of the buggy. The inside diameter of the bearing must match the axle you intend to use. (Steve Williams)

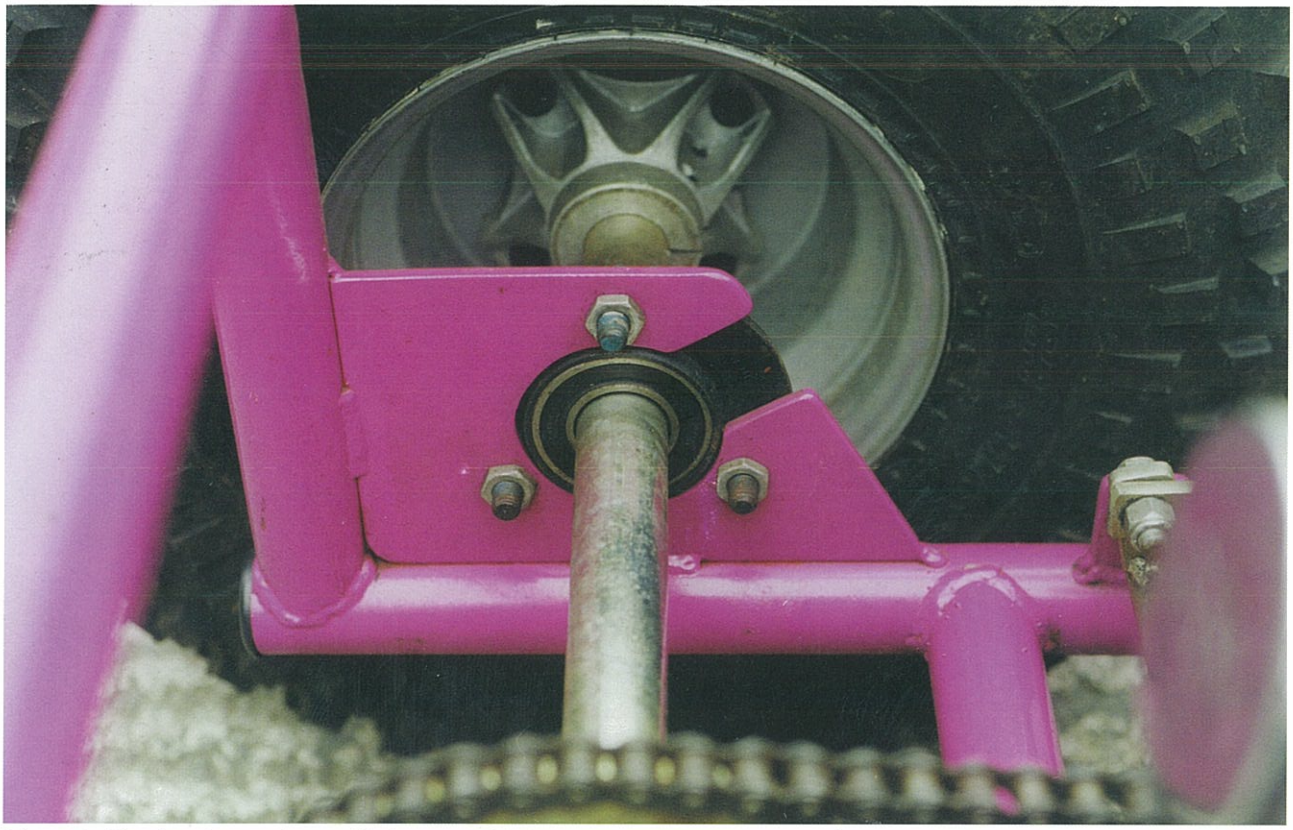


Fig. 7.6. The bearing, axle and hub assembled on the completed Buggy. (Paul Buckland)

disc can be slid along until it's positioned close to a frame tube that will provide a firm location for the bracket to be used to support the caliper. On the original Buggy, I welded a bracket to frame tube B.

With the brake disc in position on the axle, and the axle in place in the frame, offer up the brake caliper to the disc and measure the distance from the appropriate frame tube to the caliper. This will enable you to design a suitable bracket to hold the caliper in the correct position. For my bracket I used an off-cut from the 38mm tube used to make the frame, along with two strips of 5mm plate. The strips of plate were welded to the end of the tube off-cut, and holes were drilled in the plate to suit the caliper mounting bolts. The caliper and disc where then moved out of the way, and the bracket was tack-welded to frame tube B.

With the caliper mounting bracket tack-welded to the frame, the disc and caliper can be moved back into position, and the caliper can be bolted to its bracket.

Once the caliper has been firmly bolted into position, mark the position of the disc-mounting flange on the axle shaft.

FITTING THE DRIVE SPROCKET AND WHEEL HUBS

Place a straight-edge against the end face of the drive sprocket on the engine/gearbox, and use it to position the drive sprocket on the axle. It's critical that the two sprockets run exactly in line, because if there is any misalignment the Buggy will continuously throw the chain. Once you're happy that the sprockets are aligned, mark the position of the drive-sprocket flange on the axle.

Bolt your chosen rear wheels to the hub flanges, then slide them onto the axle to give the desired track width. The wheels should be positioned with between 15 and 20mm clearance between the inside edge of the tyre and the Buggy frame. Again mark the position of the hub flanges on the axle.

Unbolt the bearings from the axle bearing mounting plates on the frame, then remove the bearings and axle, and cut off any excess length that protrudes beyond the hub flanges at each end of the axle. The brake disc and flange can now be placed back on the axle in the marked position and fully welded to the axle. At the same time, you should also fully weld the brake caliper support bracket to the frame.

You now have to take a decision on how to fix the drive sprocket and the wheel hubs to the axle. The flanges can be welded to the axle, or they can be secured using bolts. If bolts are used, each bolt will act as a shear pin which should break if excessive load is applied to the drivetrain, preventing serious damage to the engine/gearbox.

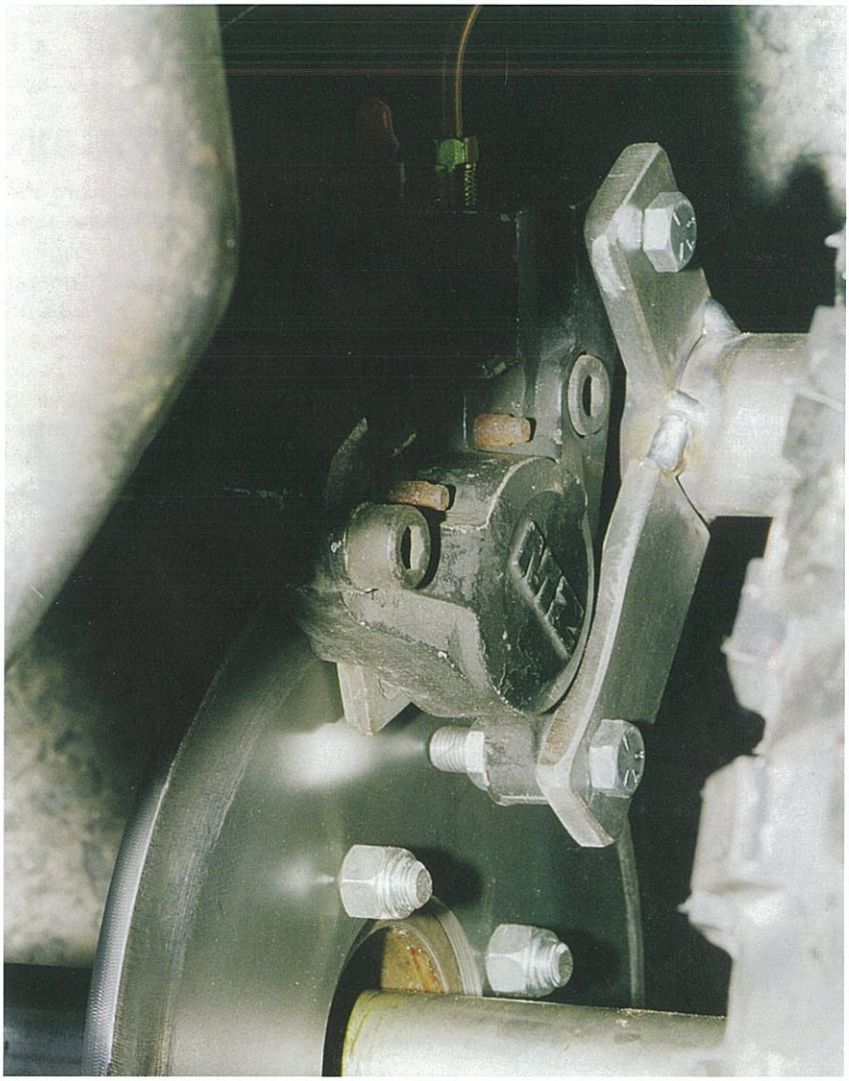


Fig. 7.7. I made the caliper mounting bracket from two pieces of 5mm plate welded to an off-cut of the 38mm frame tube. This was then welded to frame tube B. (Steve Williams)

The choice is up to you, but if you decide to use bolts, don't be tempted to fit larger than 8mm bolts as this will weaken the axle as well as providing less protection against overloading the drivetrain, and don't be tempted to secure the brake disc flange to the axle using a bolt – this could result in no braking just when you need it most! I strongly recommend that you use bolts to secure the wheel hub flanges, as if the flanges are welded to the axle, you'll have problems if you need to change the wheel bearings, or indeed if you decide to use wheels with a different PCD (possibly needing new hubs), at a later date. If you do decide to weld the wheel hub flanges to the axle, make sure that you slide the bearings onto the axle first – you will not be able to fit them once the flanges have been welded in position!

When you've decided on your chosen method of securing the drive sprocket flange and wheel hub flanges to the axle, either fully weld them in position, or secure them with bolts as follows. With the drive sprocket and hubs removed from the axle, drill holes through the flanges for the fixing bolts. Place the flanges in their correct positions on the axle and, using the holes already drilled in the flanges as a guide, drill through the axle. Make sure that the bolts are long enough to pass all the way through both sides of the flange, leaving sufficient thread exposed to fit the nuts.

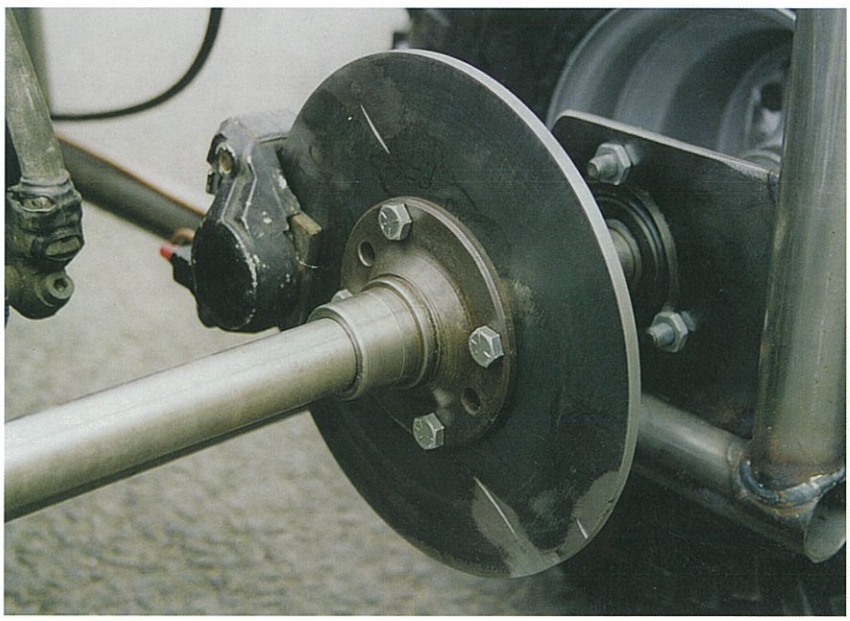


Fig. 7.8. The completed brake disc and caliper assembly fitted to the Buggy. (Steve Williams)

Reassemble the axle with the drive sprocket and bearings. Slip the motorcycle drive chain onto the axle before refitting the axle and bearings in the frame. Tighten the bearing fixing bolts, then check that the axle rotates freely in the bearings.

On the original Buggy, the axle is prevented from moving from side to side in the bearings by using grub screws, threaded through holes in the bearing inner races, which engage with indentations in the axle. If you have similar bearings to the ones I used, and you want to use this method of locating the axle, you need to make sure that the grub screws locate securely. With the axle in position on the Buggy, tighten the grub screws to make marks on the surface of the axle. Remove the axle and drill shallow indentations in its surface to provide locations for the grub screws. Refit the axle, then apply a little thread-locking compound to the threads of the grub screws, and tighten them securely, making sure that they engage with the indentations in the axle.

FITTING THE CHAIN

You'll find that the chain from the donor motorcycle will be too long for the Buggy, as the engine/gearbox is mounted much nearer to the drive sprocket than it was on the motorcycle. With the chain fitted over both the engine and axle sprockets, work out the required length of the chain, and calculate how many chain links need to be removed. You'll probably need to remove the axle and chain again to split the chain and remove links. This can usually be done using a hammer and punch to knock out the chain-link pins. If you're having difficulty, your local motorcycle dealer/ repairer should have the special tools required to do it for you.

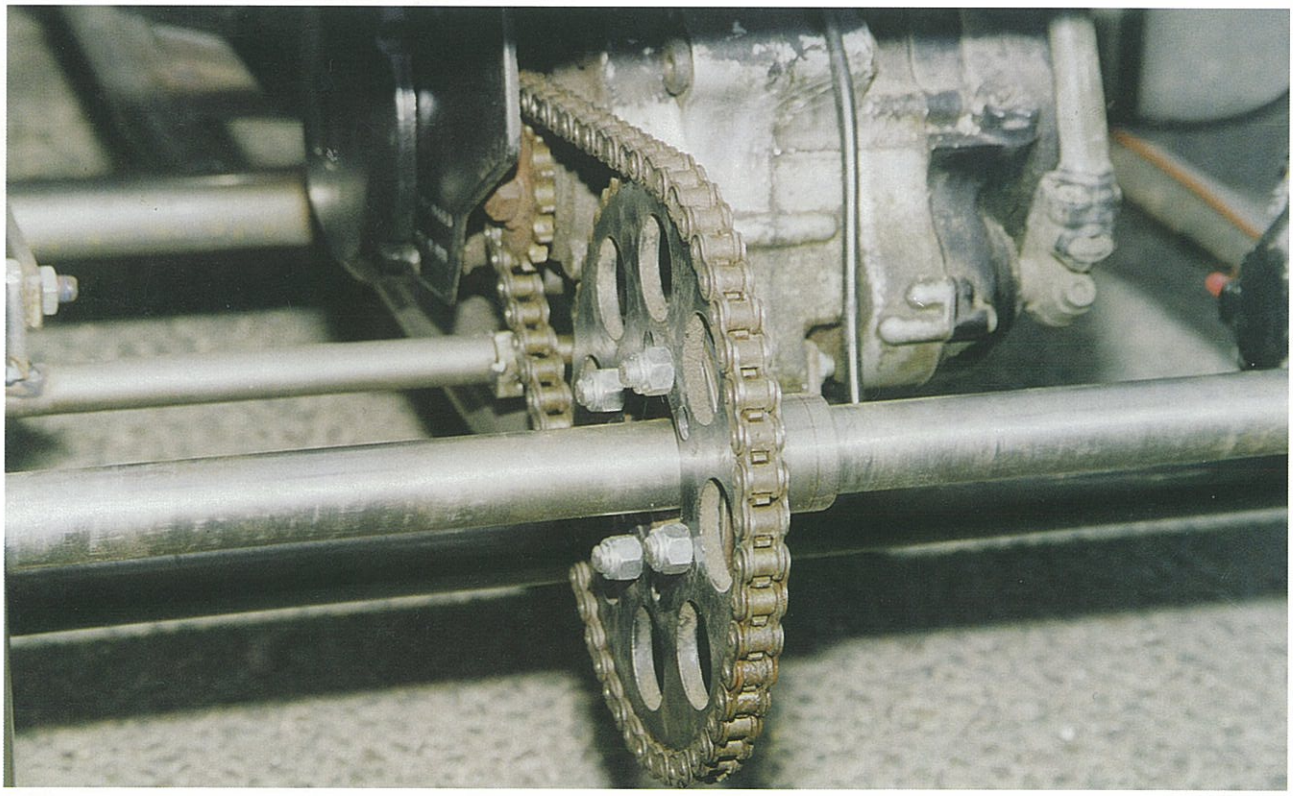
Once your chain is the right length, slip it over the axle and refit the axle and bearings, remembering to make sure that the chain is correctly fitted round both the engine/gearbox and axle sprockets before the bearings are bolted to the support plates on the frame. Where applicable, align the fixing bolt holes in the sprocket and wheel hub flanges with those in the axle, and fit and tighten the fixing bolts and nuts.

Lubricate the chain well with chain lubricant available from motorcycle accessory and repair shops.

If you've incorporated a method of chain adjustment into the design of your Buggy, either by means of adjusting the position of the engine/gearbox or the rear axle, now is the time to make the adjustment. Take care not to over-tension the chain, as this will cause excessive wear of the chain and sprockets.

Finally, if you haven't done so already, fit the hubs and wheels to the Buggy.

Fig. 7.9. The sprockets and drive chain in position. You're likely to have to shorten the chain to suit your Buggy. (Steve Williams)



Chapter 8

Controls and starting devices

The Buggy is controlled much like a car, rather than a motorcycle, with three pedals, one for the accelerator, one for the clutch and one for the brake. We therefore have to modify the controls to suit. When building the original Buggy, I decided to keep all the controls very simple, and therefore straightforward and cheap to make. There's plenty of scope for customising the components here, adding your own individual touches to, for instance, the pedal and gear-change designs.

WHAT YOU NEED

Tools required

Welding set
Welding mask or goggles, gloves, overalls and safety boots
Steel tape measure
Steel ruler and set square
Files – one flat, one round
Wire brush
Electric drill with a selection of drill bits
Socket set
Set of ring spanners
Set of open-ended spanners
Hammer
Pliers/wire cutters
Brake pipe flaring tool

Materials required

*2000mm length of 20mm x 5mm flat steel bar – for pedals and gear-change linkage**
Length of steel tube to fit from gear-change splined shaft on gearbox to outer frame tube – see text
Hand-brake and master cylinder from donor motorcycle
Selection of nuts, bolts and washers
2m of 3/16in copper brake pipe and suitable fittings
Assorted tension springs (to use as pedal return springs)
Clutch cable from car – see text
Accelerator cable from car – see text
Cable ties

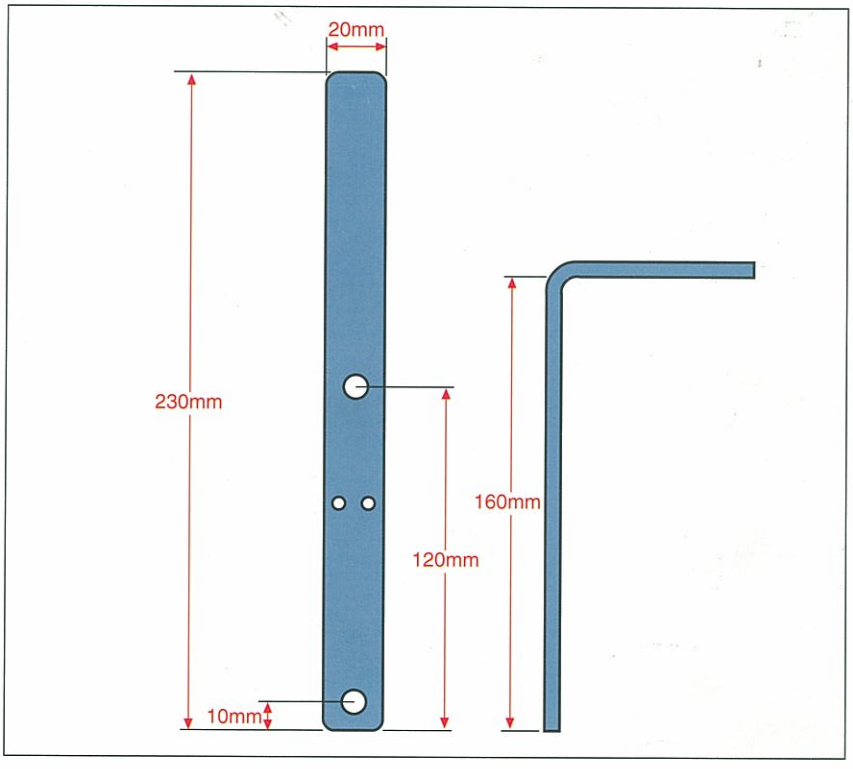
*While you can use 5mm plate for these parts, securing flat bar will reduce the amount of cutting required.

If you're using an engine with electric start in your Buggy, you'll need to take the associated wiring, a battery, and ideally an acid-proof battery box from the donor motorcycle.

PEDALS

From the 20mm x 5mm flat bar, make 3 pedal blanks as shown in Fig. 8.1 and then cut and bend them, as shown, in a vice to produce the three pedals required. The cut should be made along the bend line to aid bending, but take care not to make the cut too deep.

Fig. 8.1. You can make the pedals to suit your requirement. These are the dimensions of the ones I made. The two small holes are for the return springs.



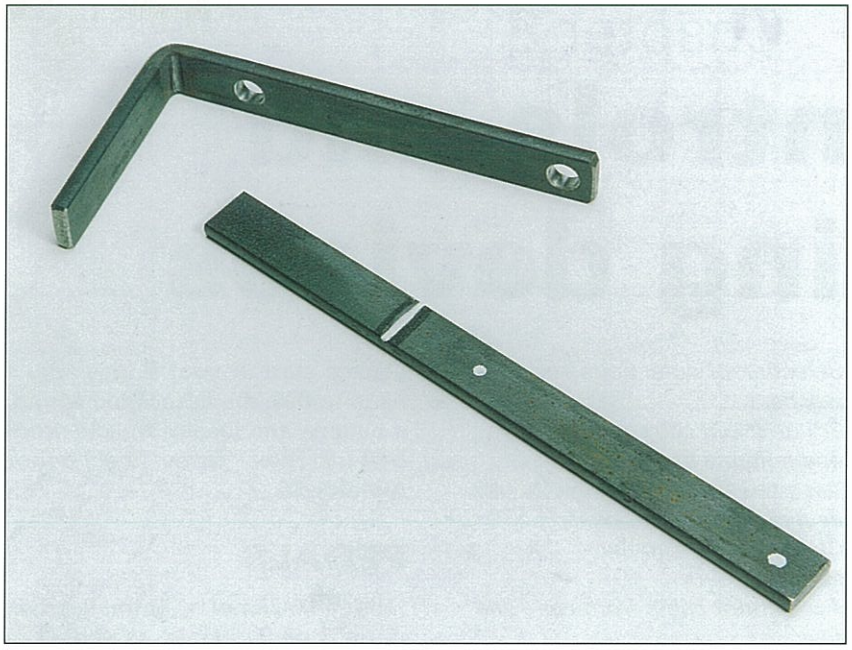


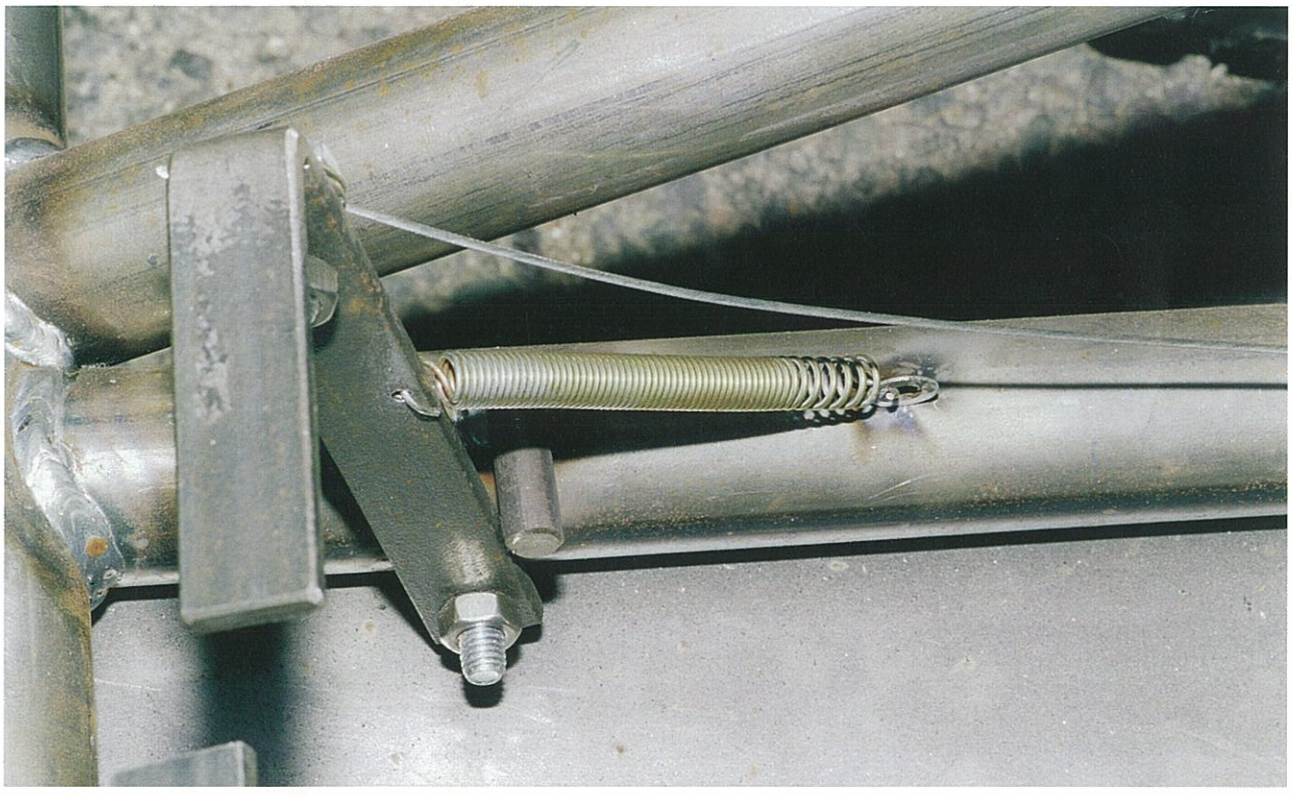
Fig. 8.2. After marking out and cutting the pedal blank it can be bent over at 90 degrees using a vice and hammer. (Steve Williams)

The pedals are fixed to the frame by welding bolts to tubes N, O and P in positions to suit the length of the driver's legs, and to give the necessary pedal movement. A back-stop should be fitted to prevent each pedal from moving too far back, and to position the pedals correctly for the driver's feet. These back-stops can be made from surplus tube, plate, another bolt or round bar, as shown in Fig. 8.3. When you've welded the pedal mounting bolts and back-stops in place, the pedals can be fitted to the frame ready for the cables to be attached.

It's a good idea to fit a return spring to each of the three pedals, and it's essential for the accelerator pedal. Drill a hole in the pedal to take one end of the spring, and a washer can be welded to the frame to secure the other end – see Fig. 8.3.

Bear in mind that the higher the cable attachment up the pedal, the greater the leverage and the less the effort will be required to operated the brakes, clutch or accelerator.

Fig. 8.3. A return spring and stop should be used on each pedal to give a better 'feel' and positive action. In this photograph you can see the method by which the spring has been attached to the frame tube, and the round bar welded to the frame to make the pedal stop. (Steve Williams)



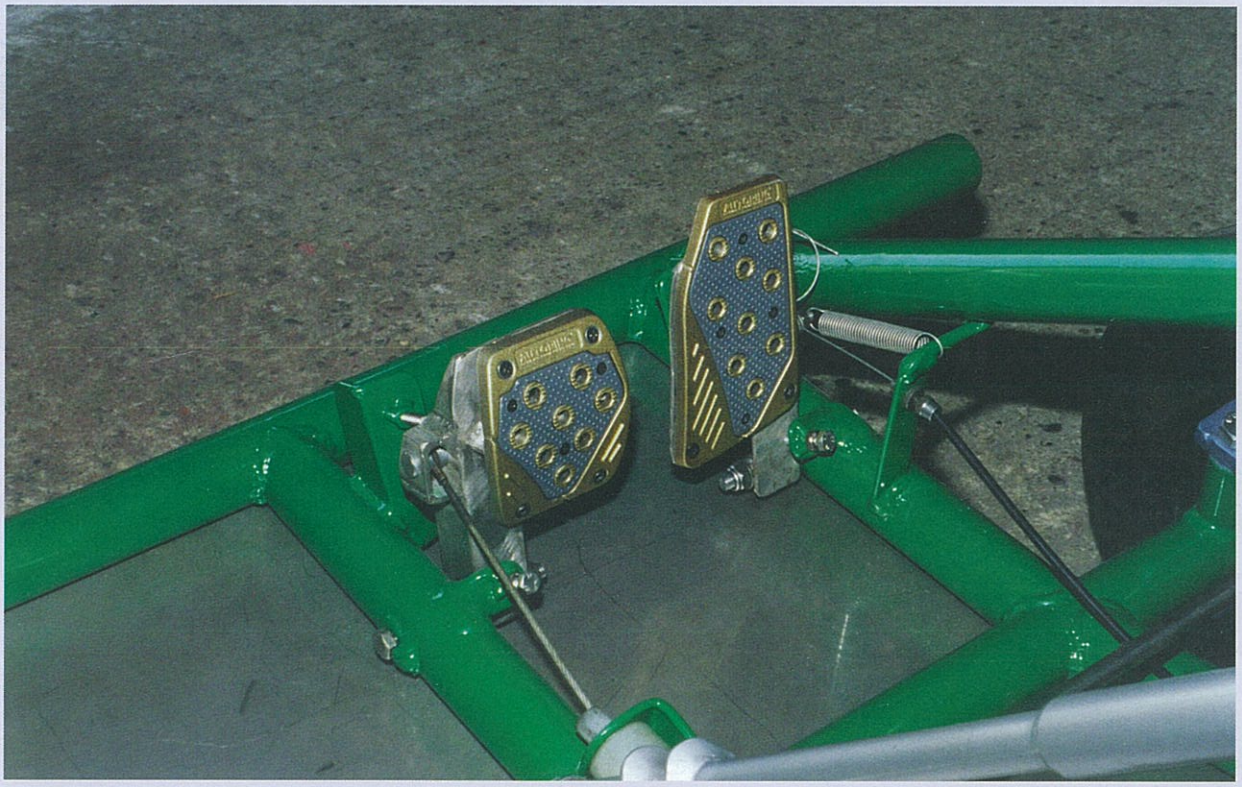
Alternative solutions

Pedals

More substantial pedal mountings can be made by drilling through the frame tubes and welding in a length of thick-walled 8mm tube, through which the pedal pivot bolts are passed. The main pedal arms themselves can be made from 25mm angle, with a piece of tube welded in place to accept the pivot bolt. For the finishing touch, race-style pedal pads can be fastened to the pedals.

An alternative arrangement for the pedals. Lengths of thick-walled 8mm tube have been welded into the frame tubes to carry the pivot bolts. Note also the brackets with nuts welded to them to carry the pedal-stop bolts. (Derek Manders)

For the finishing touch, race-style pedal pads have been added. (Derek Manders)



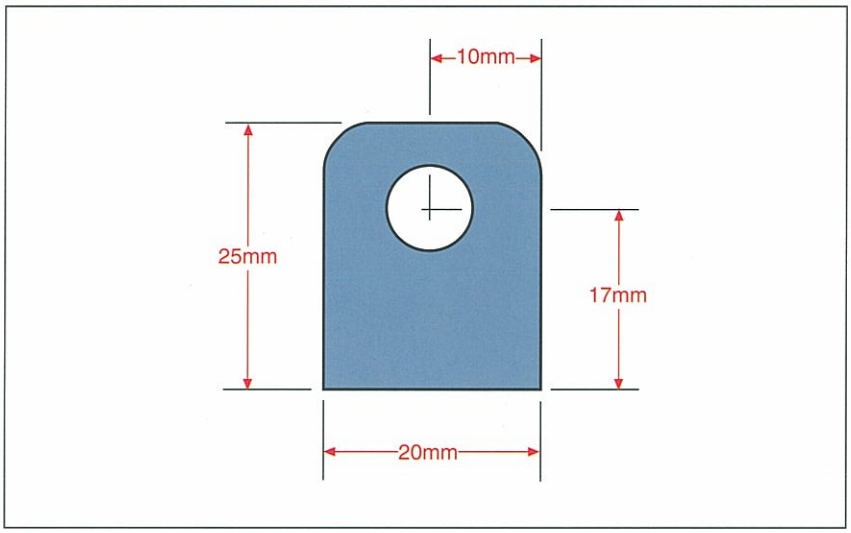
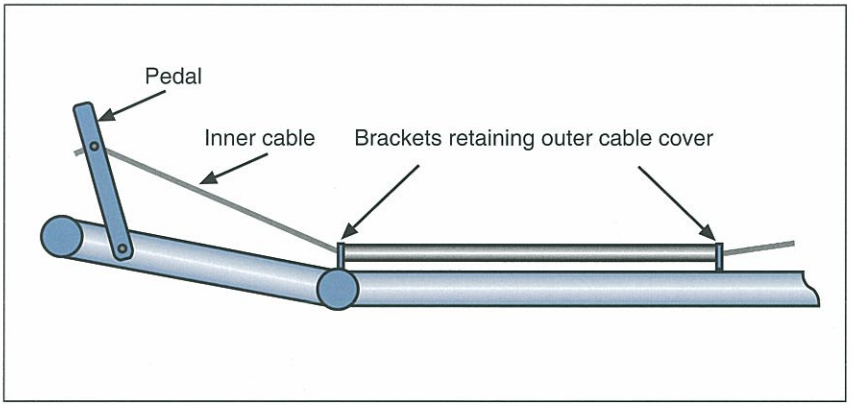


Fig. 8.4. This is typical of the mounting brackets you will require to fit the control cables. The hole in the bracket should be large enough to let the inner cable pass through easily but smaller than the diameter of the cable sheath.

Fig. 8.5. This is a schematic view of how you should set-up your control cables and brackets.



SOURCING THE CONTROL CABLES

The control cables from the donor motorcycle are generally too light duty to cope with being used with a foot pedal, as they're only intended for hand use. To avoid the problems of snapped cables, for my Buggy I obtained car clutch and accelerator cables which are heavier duty. Make sure the cables you obtain are long enough and that the outer sheathing is long enough to fit between the support brackets which you will weld to the frame near to the pedals and the engine/gearbox. You may decide to use suitable 'off-the-shelf' Bowden cable (such as cycle brake cable) rather than car cables, but make sure that whatever you use is up to the job.

MOUNTING BRACKETS

From the 5mm flat bar (or plate) make 4, 5 or 6 mounting brackets as shown in Fig. 8.4. The number you require depends on whether suitable brackets already exist on the engine/gearbox for the accelerator and clutch cables. The holes for the cables in the brackets should be drilled at a size which allows the inner cables you are going to use to pass through, but smaller than the diameter of the cable sheathing.

Alternative solutions

Securing the control cables

To keep the control cables tidy and secure on the Buggy frame, in addition to the cable mounting brackets, short lengths of tube can be welded to the frame and the cable can then be fed through the tubes.

Here, short lengths of tube have been welded to the frame, and the accelerator cable has been fed through the tubes. (Derek Manders)

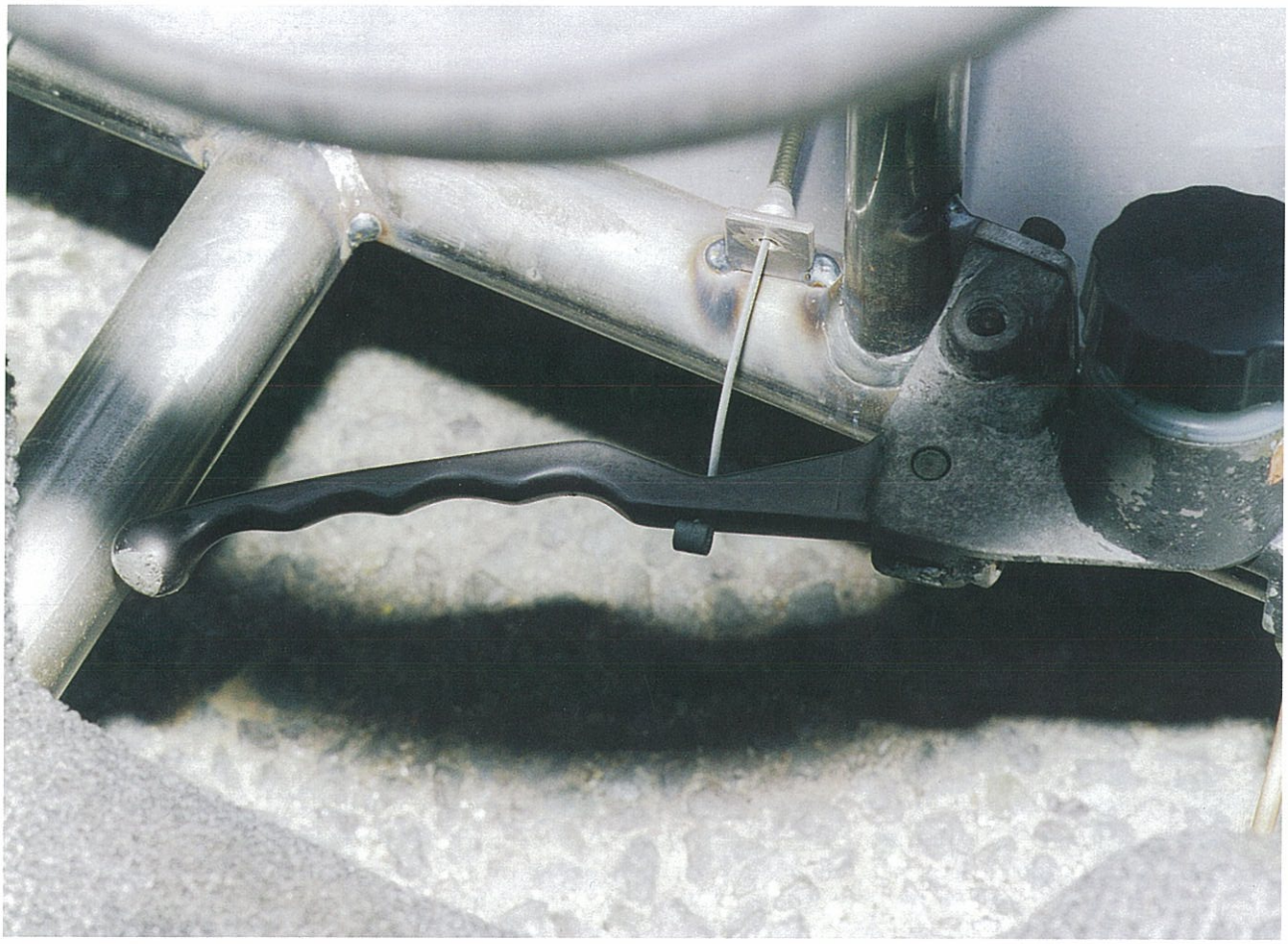


Fig. 8.6. Drill the hand-brake lever on the motorcycle brake master cylinder to take the brake operating cable. I left the handle in place for emergency operation of the brake. (Steve Williams)

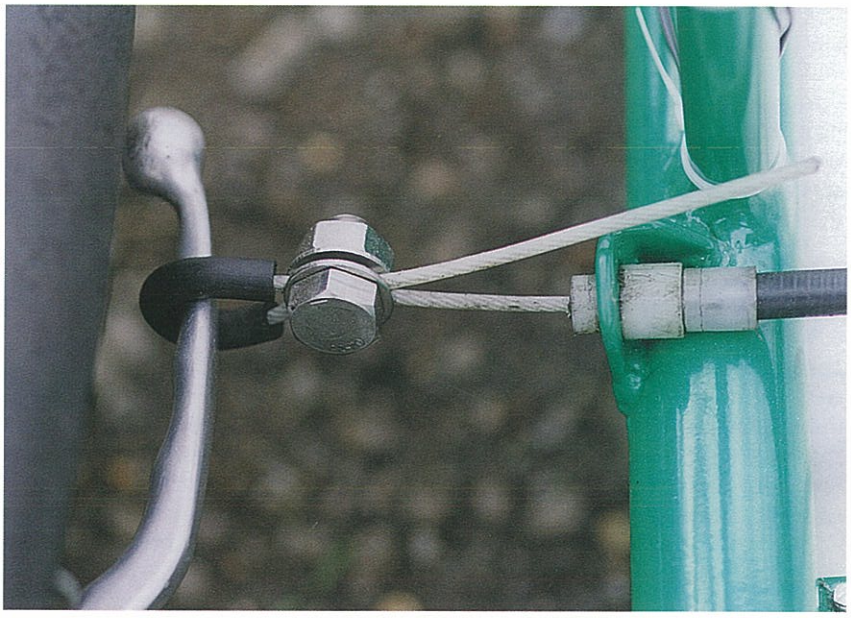
BRAKE MASTER CYLINDER AND CABLE

From the 5mm plate, make up a bracket to mount the motorcycle brake master cylinder and hand-brake lever at the bottom of the steering support tube W. Drill the plate to suit the master cylinder and lever mountings, then weld the plate in position on the frame. Note that when fitted to the Buggy, the master cylinder fluid reservoir should be upright – if this is not possible, make sure that the reservoir cap has a good seal to prevent fluid spillage.

Weld one of the cable mounting plates to the frame tube E, then weld another plate to tube D in line with the brake foot pedal.

Drill a hole big enough for the inner brake cable to pass through in

Fig. 8.7. An alternative method of fixing the brake operating cable to the hand-brake lever. (Derek Manders)



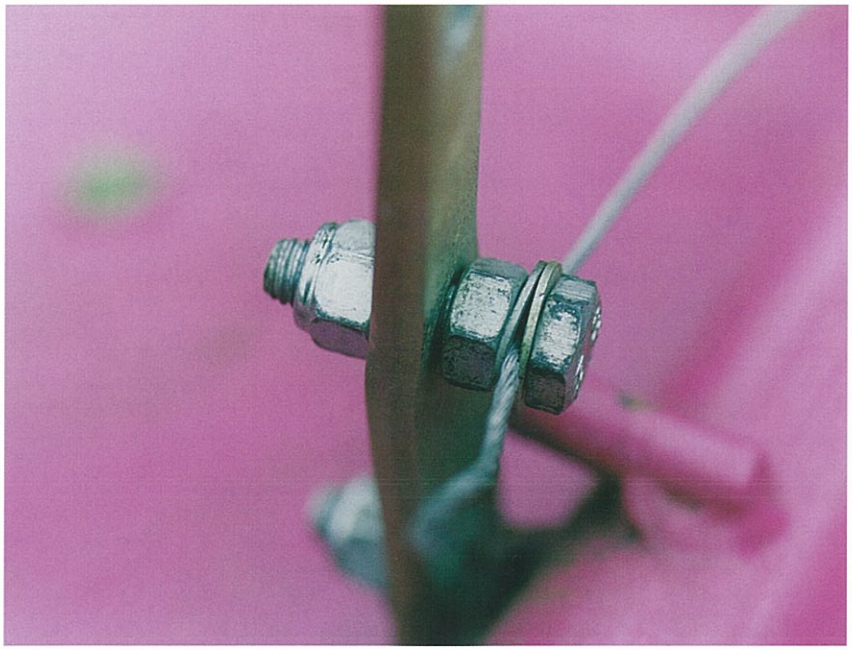


Fig. 8.8. The cable is fixed to the pedal using a bolt, two washers and two nuts. The nut holding the cable should be tight, but the other should be left slightly loose to allow the bolt to rotate. (Steve Williams)

the hand-brake lever approximately 25mm from its pivot point.

There may already be a ball or other end fitting swaged onto the end of the cable you're using – if so this can be used to prevent the cable pulling through the drilled hand-brake lever. If not, a cable end fitting can be made using a drilled-through bolt, a nut and two washers. Put one of the washers on the bolt and then drill a hole through the bolt, as close as possible to the washer, big enough for the inner cable to pass through. Feed the cable through the hole in the bolt and fit the second washer, then clamp the cable by screwing the nut tightly up against the second washer.

Thread the cable through the hand-brake lever and through the mounting bracket as shown in Fig. 8.6. Slide the outer sheath onto the cable – this needs to be long enough to fit tightly between the mounting bracket on tube E and the mounting bracket on tube D in line with the brake pedal. Cut the cable sheath to length if necessary.

The cable is secured to the pedal by a bolt, 2 nuts (one Nyloc) and two washers. Put one of the washers on the bolt, and then drill a hole through the bolt, as close as possible to the washer, big enough for the inner cable to pass through. Feed the cable through the hole in the bolt and fit the second washer. Run the first nut up the bolt and tighten it against the washer to securely clamp the cable. Put the bolt through the hole in the pedal and secure using the Nyloc nut, but do not tighten down – the bolt needs to be free to rotate as the pedal is operated.

Rather than cut off the hand-brake lever, I left it in place so that it would be available for emergency hand operation of the brake if the cable ever snapped.

ACCELERATOR CABLE

The accelerator cable is fitted in much the same way as the brake cable. At the carburettor end the cable is threaded through the carburettor throttle lever. If necessary, weld a cable mounting bracket to a suitable frame member to retain the cable outer sheath. You may find that there's a suitable bracket already in position on the engine which was used for the original cable.

Weld another cable mounting bracket in line with the accelerator pedal on frame tube D. Thread the accelerator cable through the throttle lever on the carburettor (if necessary make up a cable end fitting, as described for the brake cable), through the bracket at the carburettor end, and then slip on the outer sheath and cut to length if necessary to get a good fit between the bracket at the carburettor end and the bracket on tube D. Thread the inner cable through the bracket on tube D and fix to the accelerator pedal as described for the brake cable.

CLUTCH CABLE

The clutch cable is attached in the same way as the brake and accelerator cables. One end of the inner cable is first attached to the clutch actuating arm at the engine/gearbox. Again you may find that there's a suitable bracket already in position on the engine, otherwise weld a cable mounting bracket to a suitable tube on the frame, or it may be necessary to fit a bracket to a suitable location on the engine/gearbox.

Weld a cable mounting bracket in line with the clutch pedal on frame tube D. Thread the clutch cable through the bracket at the engine/gearbox end, fit the outer sheath and cut to length if necessary to get a good fit between the bracket at the engine/gearbox end and the bracket on tube D. Thread the inner cable through the bracket in tube D, and fix to the clutch pedal as described previously for the other cables. The clutch cable I used has the advantage of a screw thread on the pedal end of the cable. I designed a modified pedal fixing for the cable by welding a nut with a suitable thread onto a bolt through the pedal – see Fig. 8.9. This means that there is an easy method of adjusting the clutch cable.

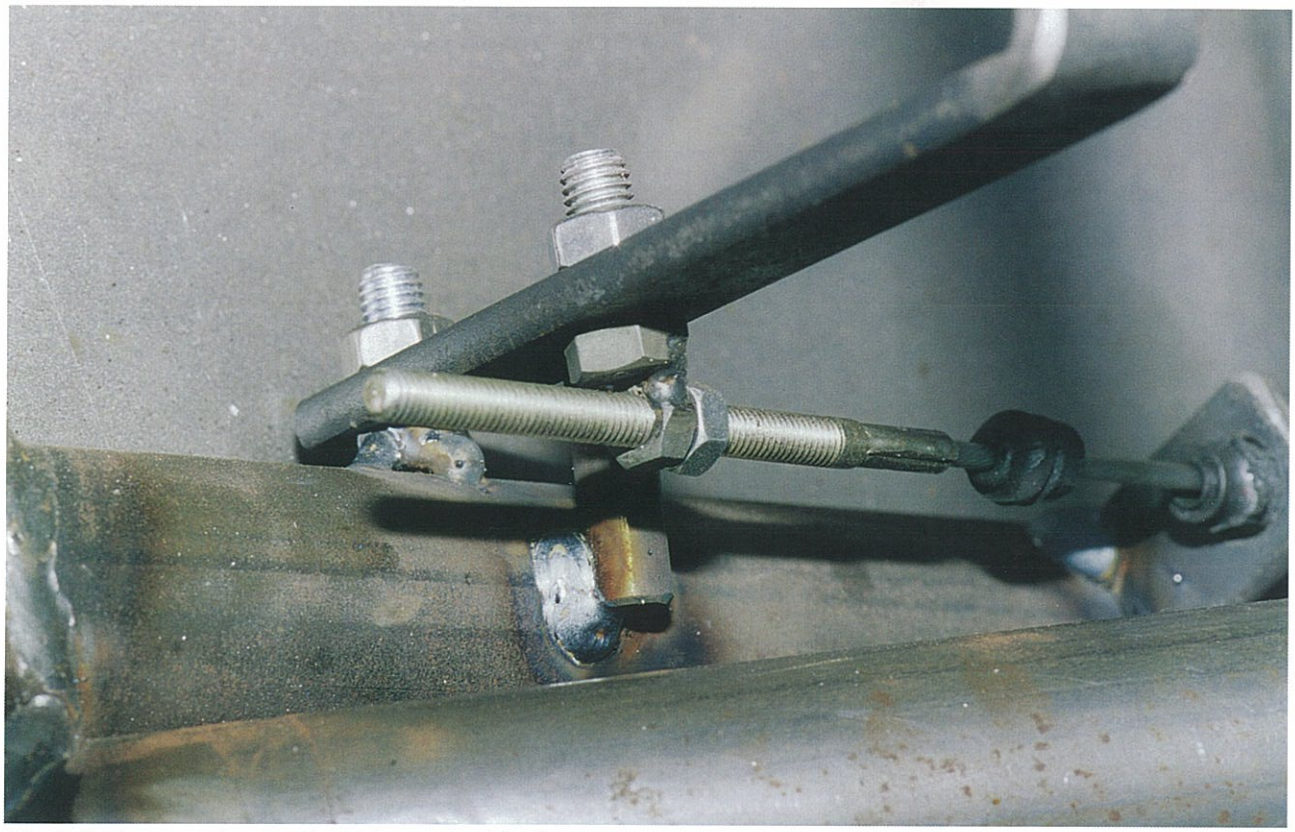


Fig. 8.9. Because the clutch cable we used had a screw thread on one end, I adapted the fixing to give a more easily adjustable cable. (Steve Williams)

BRAKE HYDRAULIC PIPE

You'll need to run a length of hydraulic pipe from the brake caliper to the motorcycle brake master cylinder which you've fixed to the frame. It's likely that the donor motorcycle had a flexible pipe which is too short for using on the Buggy. It's cheaper and safer to use copper or steel brake pipe in place of the flexible pipe.

Brake pipes have a special flare and fitting on either end. Brake pipe flaring tools can be purchased, but for the single pipe you require for your Buggy it's cheaper to have the flaring done by a local garage. Measure the length of pipe required, remembering it's wise to route the pipe along the frame tubes for protection. For example, you may wish to run the pipe along tubes R, F and B, so allow extra length for this. Take the old flexible pipe from the motorcycle with you, so the garage can see what thread size and what type of flare is required at each end of the new pipe.

Once you have a brake pipe of the correct length, with the end fittings in place, you can gently bend the pipe by hand to give the required shape. Take care not to kink the pipe, as this will restrict the fluid flow and prevent the brake from working properly. When the pipe is the right shape, screw the end fittings into the master cylinder and caliper, and secure the pipe to the frame tubes at intervals with cable ties.

Once the pipe and all the components are secured, you can fill the fluid reservoir on the master cylinder with the correct hydraulic fluid and bleed the system to remove air. The relevant workshop manual for you donor motorcycle should give details of the bleeding procedure. When you're bleeding the system, make sure that the master cylinder is higher than the caliper, to avoid trapping air in the system – tilt the Buggy and support it on an axle stand if necessary.

GEAR CHANGE

Unlike a car, the gear change on a motorcycle is foot operated and sequential. The gear-change pedal normally has an internally splined split boss, which fits on a splined shaft from the gearbox. The boss is clamped down onto the shaft using a pinch-bolt. For the Buggy, the gear change needs to be adapted to hand operation.

Start by removing the gear-change pedal boss from the pedal by hacksawing it off – see Fig. 8.12. Cut a length of steel tube, of a diameter to suit the gearbox splined shaft (in my case 19mm diameter – I used an off-cut from the steering column tube), of sufficient length to reach from the splined shaft to the outer frame

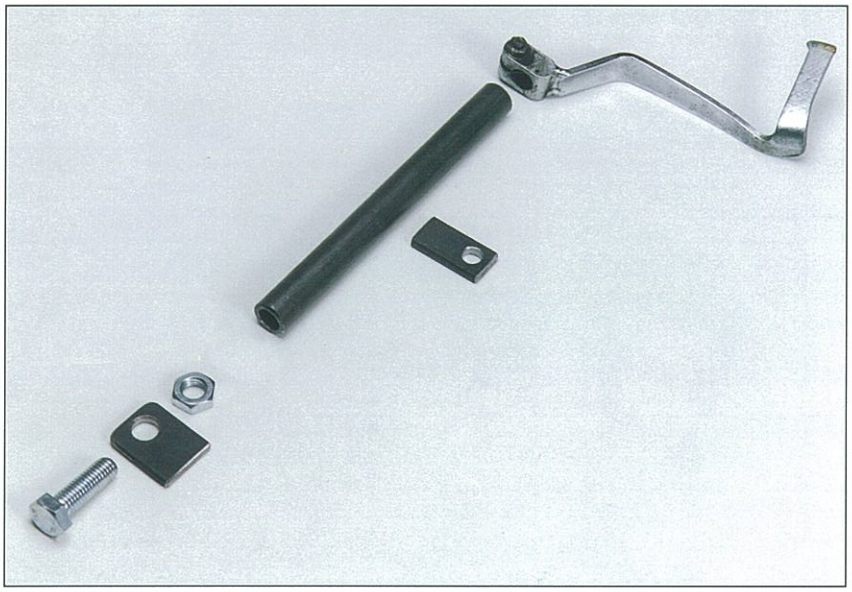


Fig. 8.10. The parts required to make the gear-change shaft. (Steve Williams)

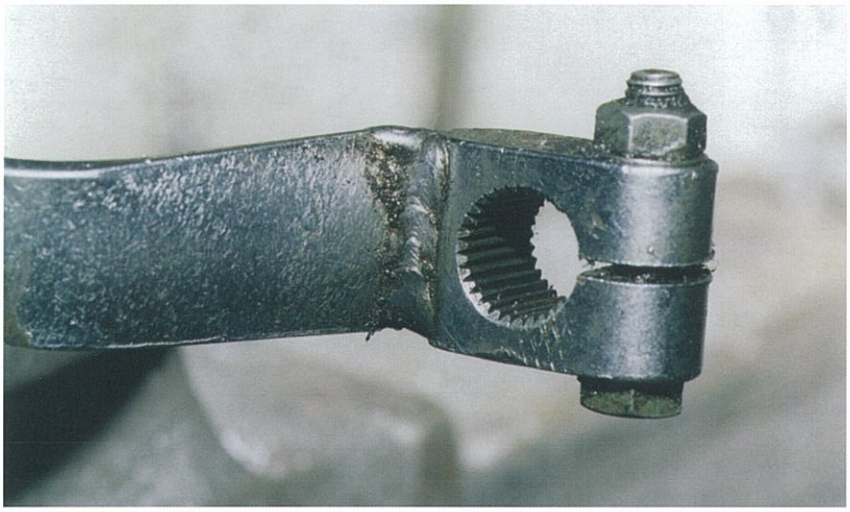


Fig. 8.11. The splined split boss from the donor motorcycle, showing it welded to the gear-change pedal. (Steve Williams)

Fig. 8.12. Remove the boss from the pedal using a hacksaw. (Steve Williams)

tube A or B. The side of the engine/transmission from which the splined shaft exits will determine on which side of the Buggy you fit the gear-change. In one end of the tube cut a slot approximately 30mm long and 3mm wide to match the slot in the splined boss removed from the pedal, then weld the boss onto the end of the tube with the slots lined up. The slot is to allow the end of the tube to close down as the pinch-bolt in the boss is tightened.

The gear-change tube will be secured at the outer end by a bolt, which will pass through a bracket welded to the Buggy frame, and screw into a nut welded to the end of the tube.

From your 5mm bar or plate, make a mounting bracket similar to the one shown in Fig. 8.13 to support the outer end of the gear-change tube. This bracket will be welded to the top of the outer frame tube A or B, and the position of the hole must be such that the gear-change tube is horizontal when bolted in position. Weld your mounting bracket to the frame tube in the correct position, then cut the gear-change tube to the required length, so that with the splined boss in the end of the tube fitted over the end of the gearbox splined shaft, the gear-change tube reaches the bracket on the outer frame tube. When cutting the tube, allow for the width of the nut which will be welded onto the end of the tube to secure it to the bracket on the frame. With the tube cut to length, weld the nut onto the outer end of the tube.

Now make up a gear-change link bracket and weld it to the gear-change tube. This bracket should be long enough to make sure that the gear-change link will clear frame tube F, and should be

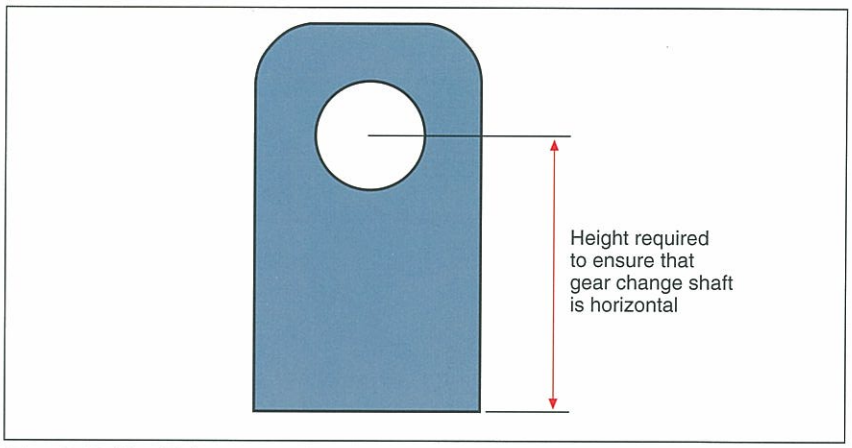


Fig. 8.13. You'll have to adapt this basic bracket to give the required height to make sure that the gear-change tube is horizontal.

Fig. 8.14. Gear-change tube splined boss fitted over the end of the gearbox splined shaft. (Steve Williams)

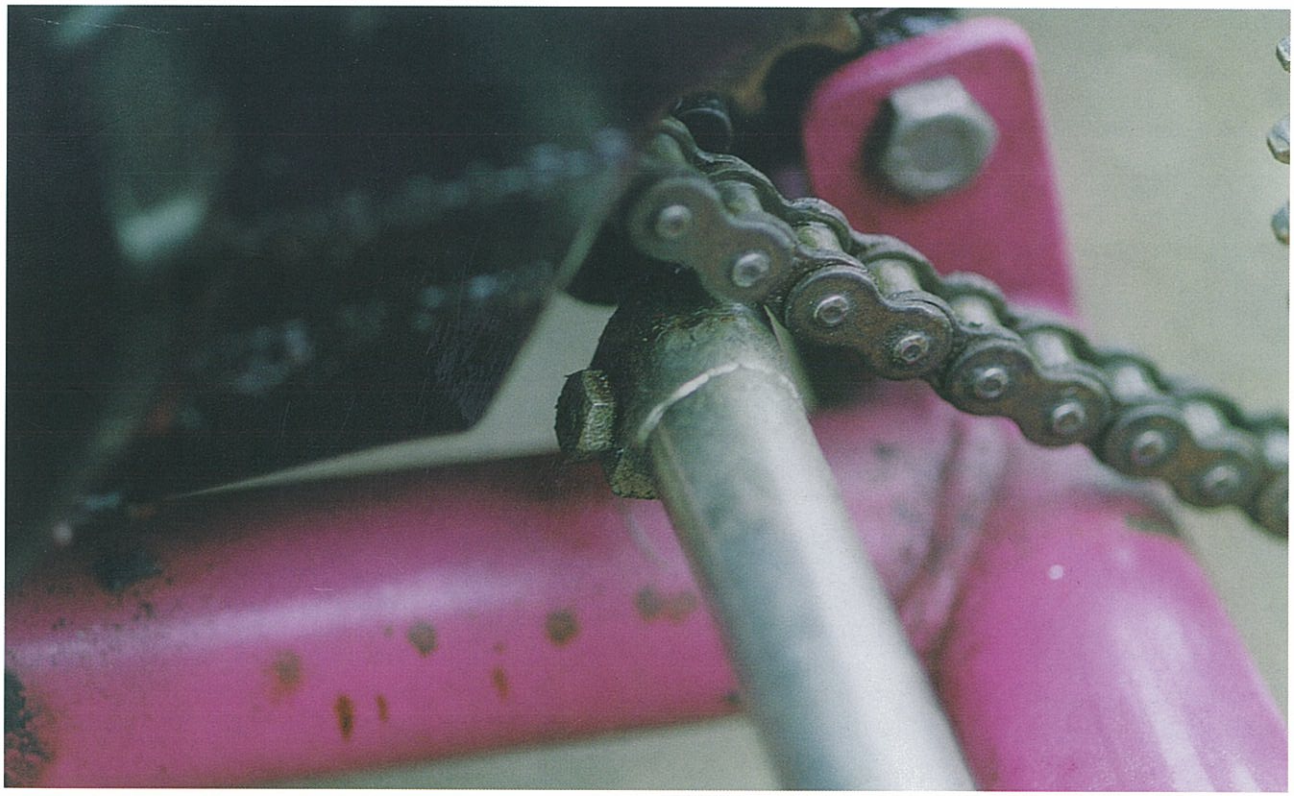
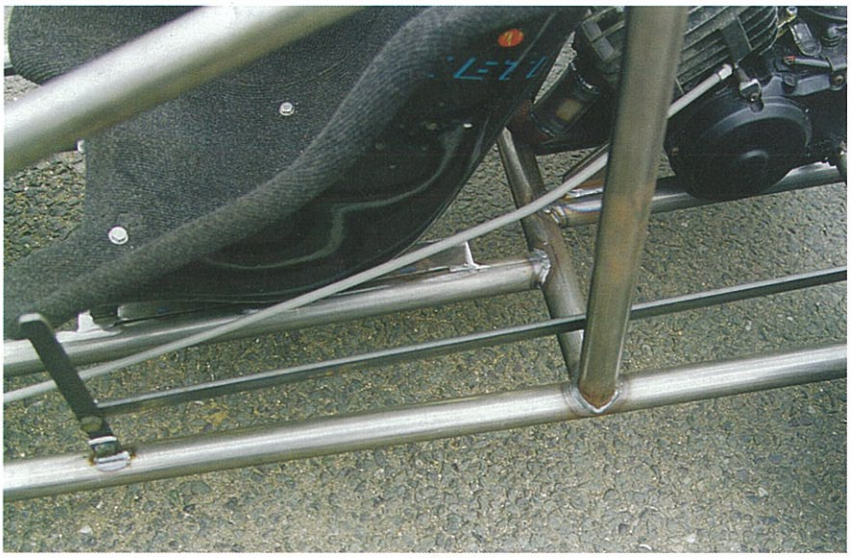


Fig. 8.15. The gear-change lever assembly in position on the Buggy frame. (Steve Williams)

Fig. 8.16. The gear-change link in position between the gear-change lever and the gear-change tube. (Steve Williams)



positioned sufficiently 'inboard' on the gear-change tube to ensure that the link clears the frame roll-bar tube K – see Fig. 8.16. The link bracket will have to be drilled at its top end for the link bolt.

Again from the 5mm plate or bar, make a mounting bracket for the gear-change lever, and cut a length for the gear-change lever itself. The bracket should be similar in style to that shown in Fig. 8.13. The lever should be of a length that is comfortable for the intended driver, with a hole in the lower end to allow it to be bolted to the bracket on the frame, and second hole to allow it to be bolted to the gear-change link – see Fig. 8.15.

Mark the desired position of the gear-change lever support bracket on the frame, then weld the bracket to the frame. Bolt the gear-change lever to the bracket, and secure it with a Nyloc nut – see Fig. 8.15. Do not tighten the nut hard against the lever, as you have to be able to move the lever freely.

Fit the inner end of the gear-change tube to the gearbox splined shaft, with the link bracket on the tube positioned vertically up, and bolt the outer end of the tube to the bracket on the frame. Make sure that the gear-change lever is in the vertical position, then measure the distance between the gear-change lever and the link bracket on the gear-change tube to determine the required length of the link. Make the link out of 5mm flat bar, and bolt it into position between the gear-change lever and the link bracket on the tube, using bolts and Nyloc nuts – again do not overtighten the nuts, as there must be free movement.

Fit the pinch-bolt to the boss on the gearbox splined shaft, and tighten it. Check that there is free movement of the gear-change linkage backwards and forwards. Once the Buggy is completed, you can check that all the gears can be engaged, and the gear-change linkage can be adjusted if necessary by altering the position of the boss (and tube) on the splines of the gearbox shaft.

Alternative solutions

Gear-change lever

As an alternative to a simple gear-change lever made from steel plate or bar, a lever can be made from 20mm box-section steel, with a hole drilled through the bottom to accept a steel tube through which the pivot bolt can pass. To make the lever look even more professional, a bolt can be welded to the top to accept a plastic gear knob.

Gear-change lever support

A more substantial gear-change lever mounting can be made by drilling through the frame tube and welding in a length of thick-walled 8mm tube, through which the lever pivot bolt is passed. A short length of bar welded to frame tube E will provide additional support for the lever.

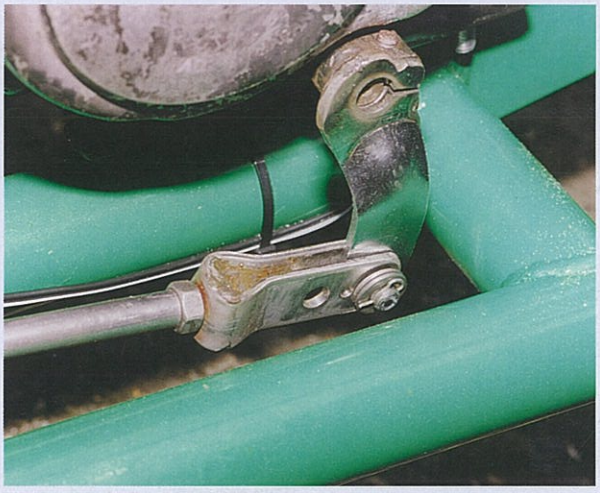
Gear-change linkage

If a Honda 70 engine is used, a simple gear linkage can be made by removing the gear-change pedal from its shaft on the engine/gearbox, then cutting it down using a hacksaw, and flattening it in a vice. The pedal can then be refitted to its shaft in a vertical position, with a hole drilled towards the bottom to accept a 6mm bolt. A gear-change link rod can be made from steel tube with a nut welded to each end, as described for the track rods in Chapter 5. Two end fittings can be made from steel strip, with an 8mm hole drilled through the centre into which an 8mm bolt can be welded. The end fittings should be bent into a U-shape to suit the gear-change lever and the gear-change pedal on the engine/gearbox, and then drilled to suit the bolt or clevis pin to be used to secure them to the lever and pedal. Locknuts can then be screwed onto the end fitting bolts, and the end fittings can be screwed into the ends of the link rod. The end fittings can be screwed in or out of the link rod as required for adjustment, and then connected to the lever and pedal using bolts and Nyloc nuts, or clevis pins and split-pins.

An alternative design of gear-change lever made from box-section steel. (Steve Williams)

A short length of bar welded to the frame will provide additional support for the lever. (Steve Williams)

A simple gear-change linkage arrangement for the Honda 70 engine/gearbox. (Steve Williams)



STARTING

The engine fitted to my Buggy was designed to be started using a kick-start. However, when the engine is fitted to the Buggy, the space in which to operate that kick-start is limited. I've described how I started the Buggy in 'The original Buggy design' at the beginning of Chapter 3.

For shear luxury, if you have sourced a later model motorcycle as a donor, it will probably have an electric start. This does mean that you will have to carry a battery fitted in a suitable position, probably behind the driver's seat. You'll also need to install the necessary wiring and fit a start button which can be easily reached by the driver when seated in the normal position. If you're using an electric start, find an acid-proof battery box – the donor motorcycle will probably have one – which will prevent the possibility of an acid spill injuring the driver or damaging the Buggy if the Buggy is being driven over rough ground or up steep slopes, etc.

Ducks and dives

Lubrication

Lubricate all the control cables with WD40 or a similar lubricant. This is particularly important if your Buggy is used in wet or muddy conditions.

Chapter 9

Finishing and final build

Once you've completed your Buggy and all the components have been fitted, with everything as you want it and all the welding finished, it's unfortunately time to take it all apart again in order to paint it – but I bet you won't be able to resist giving it a try before you do!

Label everything as you take it off, despite the fact that having built your Buggy you will know it very well – it's surprising how quickly you can forget, and how many of the nuts and bolts can be mixed up. Take care when draining and refilling the brake hydraulic system, and also if you need to drain the petrol tank or fuel line. Always use new brake fluid of the correct specification and avoid contact with the Buggy frame or your skin, as it can damage both. Please dispose of old fluid correctly, do not tip it down the drain.

PAINTING

Whichever method of finishing you intend to use, it's important that all the components are clean, de-greased and that any rust is removed with a wire brush and abrasive paper.

On my Buggy I had the frame

Fig. 9.1. The completed buggy assembled, but unpainted. (Steve Williams)

Fig. 9.2. A final check to make sure everything is in the right place. It's better to make any changes now rather than to have to do more drilling and welding after your Buggy has been finished. (Steve Williams)

Fig. 9.3. Unfortunately the temptation to give it a go (just to make sure it all works properly) is too great. This driver has let his enthusiasm get the better of him. Where's your crash helmet mate? (Steve Williams)

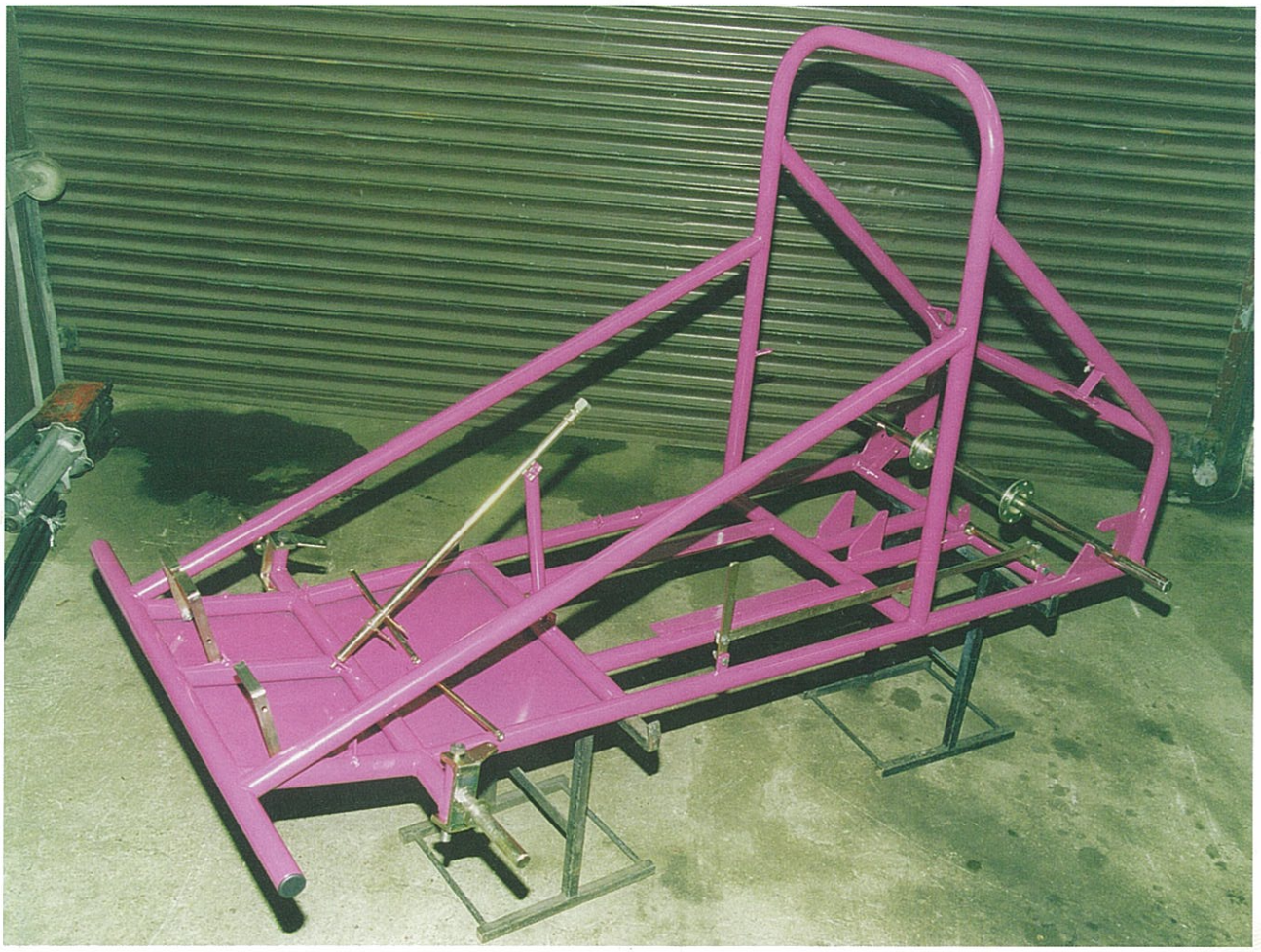


Fig. 9.4. The finished frame looks really smart ready to have everything bolted back into position. This one has been powder coated. (Steve Williams)

Fig. 9.5. Special metal paints can provide an easy-to-apply, durable finish. Some can be put straight on to metal, even rusty metal once the worst rust has been removed. (Steve Williams)

powder coated at a cost of £25 by a local powder-coating company, although (as you might have guessed) I had no choice of colour. To get a good price the frame went through the coating plant with another batch of components, so that's the colour I got!

A cheaper method of finishing would be to brush paint with a hard-wearing outdoor paint such as Hammerite, or spray with automotive paint which is available in aerosols.

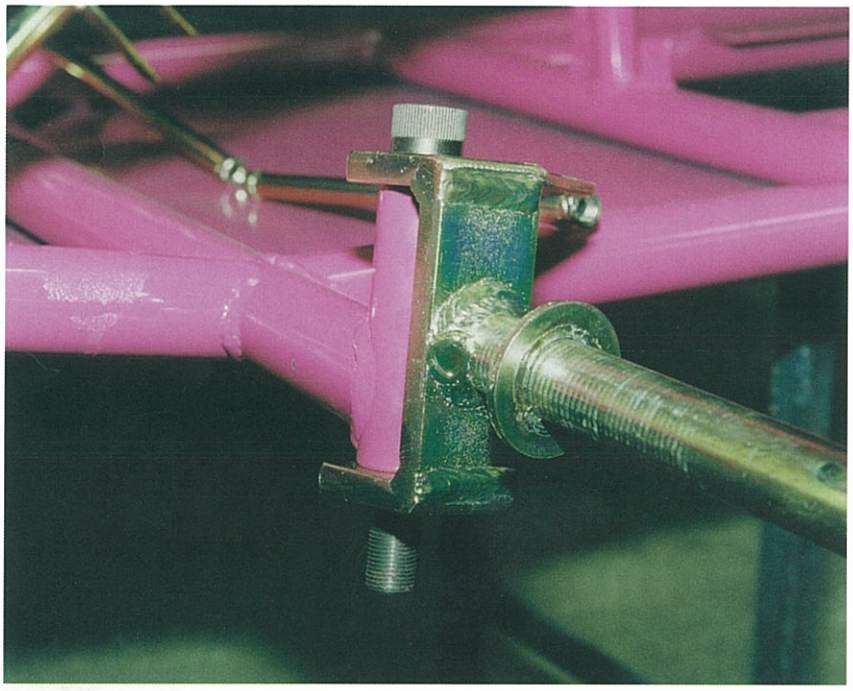
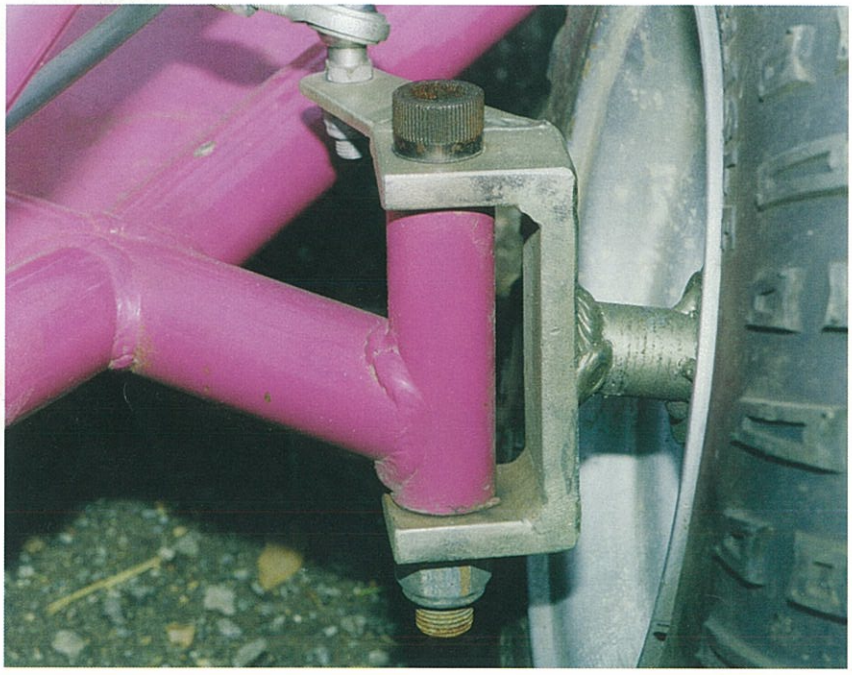


Fig. 9.6. We had parts that were likely to get chipped and damaged cadmium plated. (Steve Williams)

Fig. 9.7. Make sure that the self-locking nuts on the steering pivot bolts are correctly tightened, and lubricate the bolt threads. (Steve Williams)



It may be possible to take your completed frame and other parts to you local vehicle body shop for them to spray. Again, you may find it cheaper if they spray your frame with what is left in the spray gun at the end of another job.

You may find that items such as the pedals, rear axle and front stub axles, etc, get chipped and damaged if painted. You may prefer to get them zinc, cadmium or chrome plated. While this will add to the cost, it is likely to provide a more durable finish. On my Buggy I had these parts cadmium plated, and they certainly looked very good, creating a contrast with the painted frame.

Once your frame has been completed and painted, you'll find that the front and rear chassis tubes have open ends, which should be sealed against water and dirt entry using rubber or plastic bungs. This is important to guard against the risk of corrosion.

FINAL BUILD

As you finally put your finished Buggy back together again, make sure that all the bolts that need to be tight are, and check that items such as the rear axle, front axle assemblies, pedals, gear change and steering are all free to move as required. Grease all the pivot points and moving parts, and it's advisable to apply a small amount of general grease to all screw threads to help prevent them from rusting and seizing up.

When assembling the front hub carriers to the frame, it's important to make sure that the self-locking nuts on the steering pivot bolts are correctly tightened. If the nuts are too tight, the hub carriers will not be able to pivot and you'll have no steering, and if the bolts are too loose, there will be excessive play in the steering. Use copper grease or anti-seize compound to lubricate the bolt threads, and always renew

Fig. 9.8. The completed Buggy, ready to go! (Steve Williams)

the Nyloc nuts once they've been removed.

Remember to bleed the brake hydraulic system to remove the air before you use the Buggy (see Chapter 8), and also reconnect the gear-change mechanism, checking that it works correctly and that all gears can be selected. Adjust the gear-change linkage if necessary – see Chapter 8.

Finally, make sure that the chain is correctly tensioned, and reconnect the control cables, adjusting them until you're happy with the operation of all the controls. Lubricate the control pivots and the cables.

Chapter 10

Using your Buggy

So, now you've finished all the hard work involved in building your Buggy, you'll want to rush out and try it! But, before you do, there are a few things to bear in mind. Remember that your Buggy is not designed for use on the road, and indeed it would be illegal to do so – this means that you need to find somewhere safe to use your Buggy, ideally somewhere where you will not annoy other people! This Chapter provides advice on how to use your Buggy safely, and how to make sure that it stays in tip-top condition to provide you with many hours of fun.

FINDING SOMEWHERE TO USE YOUR BUGGY

Neither the author nor the publishers intend this Buggy to be used on a public highway. It does not comply with the Vehicle Construction and Use regulations in the UK. The Buggy is intended for off-road use on private property only.

First of all, you need to find somewhere to use your Buggy. The most important thing to remember here is that you must ask for and receive the landowner's permission before using your Buggy on any land which you don't own yourself. The chances are that if you explain exactly what you want to do, and

Fig. 10.1 Your Buggy should provide you with hours of fun, but always wear a helmet and suitable protective clothing. (Steve Williams)

show the person concerned your Buggy (perhaps even let them have a go behind the wheel), you'll find a sympathetic local landowner who will allow you to use your Buggy on his or her land. Remember that the Buggy, and especially its steering system, are designed to be used off-road, and if it's used on tarmac, tyre wear will be heavy, and you may find that the steering appears rather sluggish.

It goes without saying that wherever you use your Buggy, you must treat the land with respect, and if you're on a farm, or in open countryside, you should follow the country code.

Motor vehicles off-road

The Countryside and Rights of Way act 2000 makes it clear that driving any motor vehicle, including motor bikes, quad bikes and scrambler bikes (and, therefore a Buggy), on footpaths, bridleways, restricted byways or off-road is an offence, unless the driver has lawful authority.

The Country Code

- Enjoy the countryside and respect its life and work.
- Guard against all risk of fire.
- Fasten all gates.
- Keep your dogs under control.
- Keep to public paths across farmland.
- Use gates and stiles to cross fences, hedges and walls.
- Leave livestock, crops and machinery alone.
- Take your litter home.
- Help to keep all water clean.
- Protect wildlife, plants and trees.
- Take special care on country roads.
- Make no unnecessary noise.

INSURANCE

There is no legal requirement for the Buggy to be insured, but it would be worth checking with your insurance broker to see if you're covered on your existing household or motor policy for any 3rd party claims against you for injury or damage. If not, they will probably be able to arrange cover for you.

SAFETY WHEN USING THE BUGGY

When using the Buggy, safety must always be the first consideration. Be sensible, and always wear a crash helmet and suitable protective clothing. Above all, use common sense.

Helmet and clothing

A crash helmet should be worn at all times, and a suitable one can be purchased from a motorcycle accessory shop. Buy the best you can afford.

At all times wear adequate protective clothing, such as a one-piece overall. Never wear loose or trailing clothing, such as a scarf, which could get caught up in the wheels or drivetrain.

Seat

Make sure that your seat is securely fitted to the frame, whether it's a proper go-kart seat or whether you have used a plastic stacking-chair seat.

Seat belts

Whilst seat belts are not a legal requirement for an off-road Buggy, you may decide that it makes sense to fit them. I haven't used them because I feel that it's safer not to.

If you want to fit seat belts, consult an engineer about mountings etc, and use the appropriate bolts, washers, brackets and fixings. It's vital to make sure that the seat belt mountings are strong enough to cope with the loads they might have to handle – bear in mind that in cars, the seat belt mountings are bolted to special steel reinforcing plates. Always follow the manufacturer's advice when fitting seat belts.

Filling the Buggy with fuel

Do not smoke anywhere near an area where petrol is stored. Do not fill the Buggy's fuel tank when the engine it hot, and always stop the engine before filling with fuel.

Driving the Buggy

Although the Buggy is designed to be used off-road, bear in mind that it has no suspension, and it's not therefore suitable for use on rocky or boulder-strewn terrain. The ideal ground on which to use the Buggy is an open field with short grass, or a reasonably flat track. If you decide to drive the Buggy through long grass or vegetation, be prepared for any nasty surprises which may be hidden from view, such as large stones or tree-stumps.

When driving the Buggy up a steep incline, use low revs – this will reduce any risk of the Buggy tipping over backwards.

If you think that the Buggy is going to tip over, keep your hands on the steering wheel. As an additional safety feature, netting could be fitted to the Buggy frame to keep the driver's limbs and head within the frame – this will help to guard against injury if the Buggy tips over.

When using the brakes, remember that if you're driving off-

Fig. 10.2. If you're driving through long grass, beware of any nasty surprises which may be hidden from view. (Steve Williams)

road on grass, particularly wet grass, or mud, it will be very easy to lock-up the back wheels – the trick is to apply the brakes gently. This shouldn't prove to be a problem, in fact it will probably add to the fun, unless you're travelling towards something solid at the time!

Moving a Buggy which is stuck

The Buggy is quite light and can be picked up by two fit adults. In the unlikely event of the Buggy becoming stuck in mud, it can be lifted clear, but if resorting to towing, ensure that the tow rope is attached to a substantial part of the frame.

MAINTENANCE

To keep you Buggy in tip-top condition, and to make sure that it's safe, regular maintenance checks should be carried out both before and after use.

Before using the Buggy

- Check for fuel leaks.
- Check that the wheels are securely fastened.
- Check that the brake, accelerator and clutch cables are securely connected and that the linkages work.
- Check that the steering pivot pins are tightened correctly, and check the operation of the steering.
- Check the condition of the chain.
- Check the engine/gearbox oil level.
- Check the tyre pressures (where applicable).

After using the Buggy

- Clean the Buggy, paying particular attention to all the moving parts, such as the bearings, rear axle, control cables, chain, etc.
- Check the tightness of all fastenings.
- Where applicable, check the front wheel retaining split-pins and their washers for wear and damage.
- Lubricate the chain.
- Lubricate the steering pivot pins.

Finally, take care and have fun using your Buggy.

A happy customer – Derek Manders's granddaughter Charlotte tries out her new Buggy, . . .

. . . followed by Derek himself. (Steve Williams)

It looks as if this driver means business! (Steve Williams)

This is one of the buggies that took part in the inaugural University Air Squadron (UAS) Buggy Challenge at Abingdon in the summer of 2003. (James Coleman)

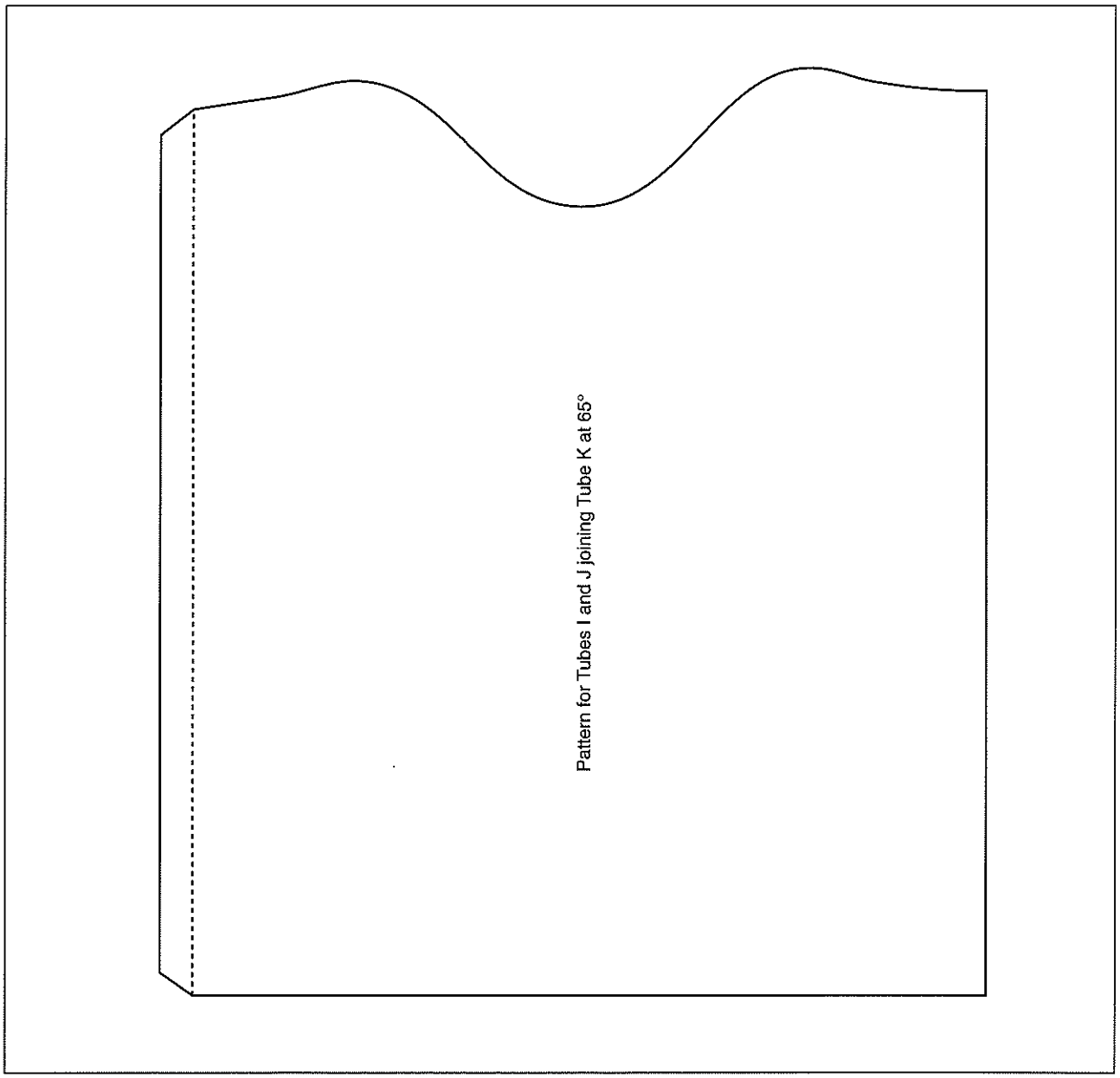
Another variation on the theme, also seen at Abingdon. Note the additional safety features – the extra roll-hoop on the front chassis tube and the plastic netting across the sides of the frame. (James Coleman)

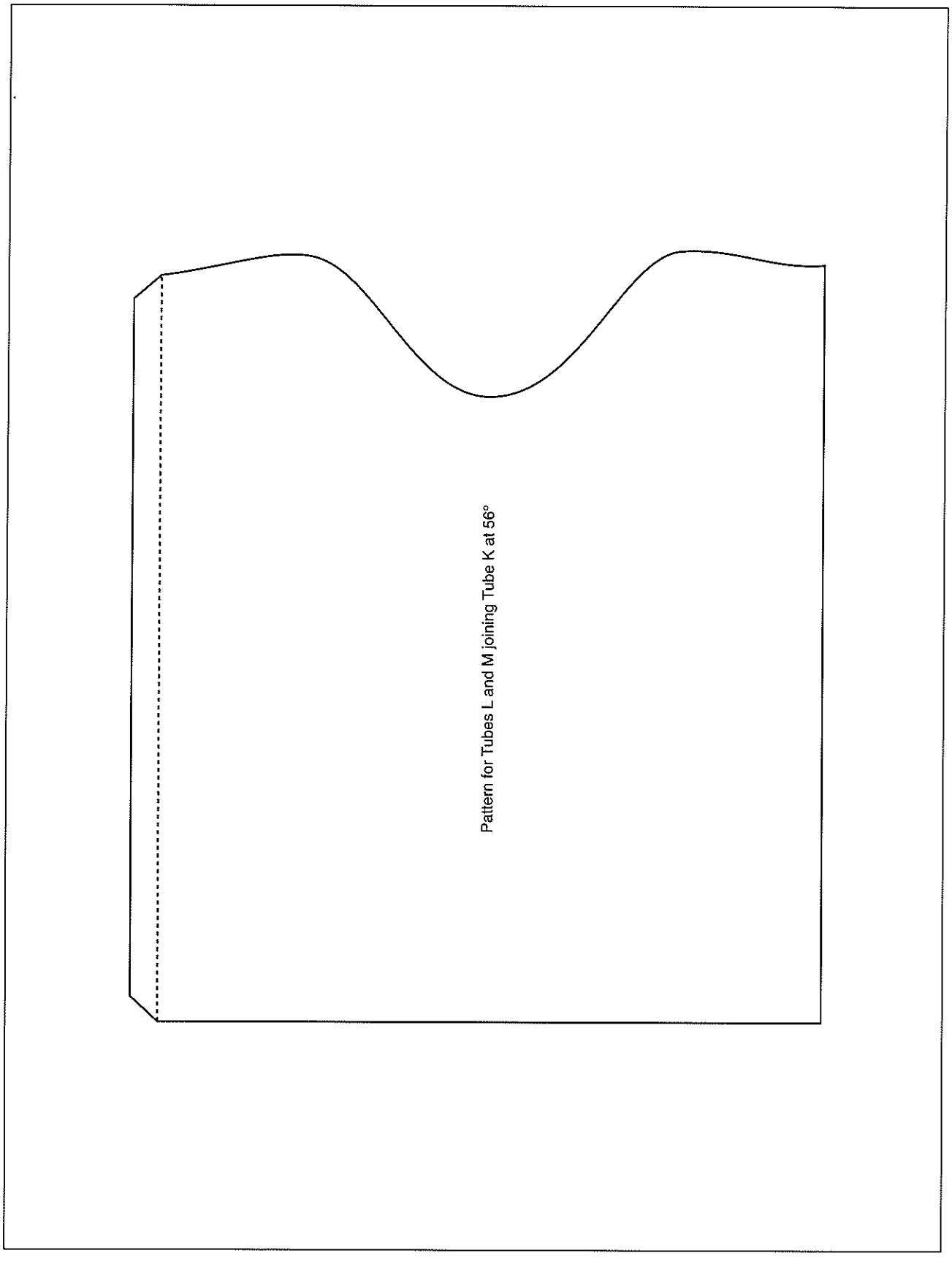
This Buggy is built from square-section tube, and sports side-impact protection bars between the front and rear wheels. These bars were fitted to all the Buggies in the UAS Buggy Challenge – a wise precaution when sharing the track with other competitors. (James Coleman)

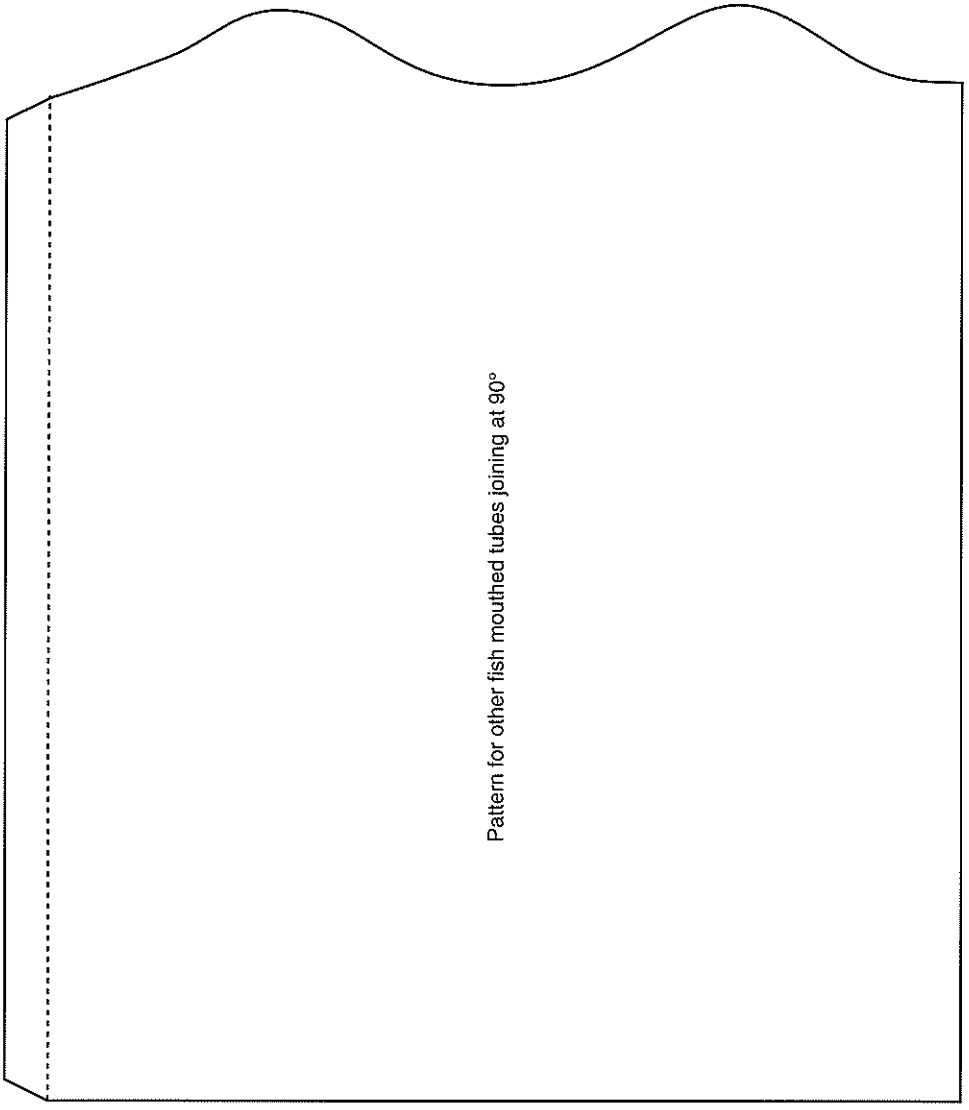
Appendix 1

Templates for fish-mouthing tubes

The following templates can be used as patterns for fish-mouthing tubes using 'The toilet roll trick' described in Chapter 4.




Pattern for Tubes L and M joining Tube K at 56°


Pattern for other fish mouthed tubes joining at 90°

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