KENDAT

DTU

Low-Cost Animal Cart Programme

TECHNICAL
37
RELEASE

Twin Wood Plain Bearing Axle for Donkey Carts

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These bearings are designed to fit carts like that shown in Figure 2 but any cart could be modified to take the bearings described in this Technical Release.

The system shown here is for two offset live axles (ie the axles go round). Using two axles allows any wheels to be used and provides plenty of room for the bearings.

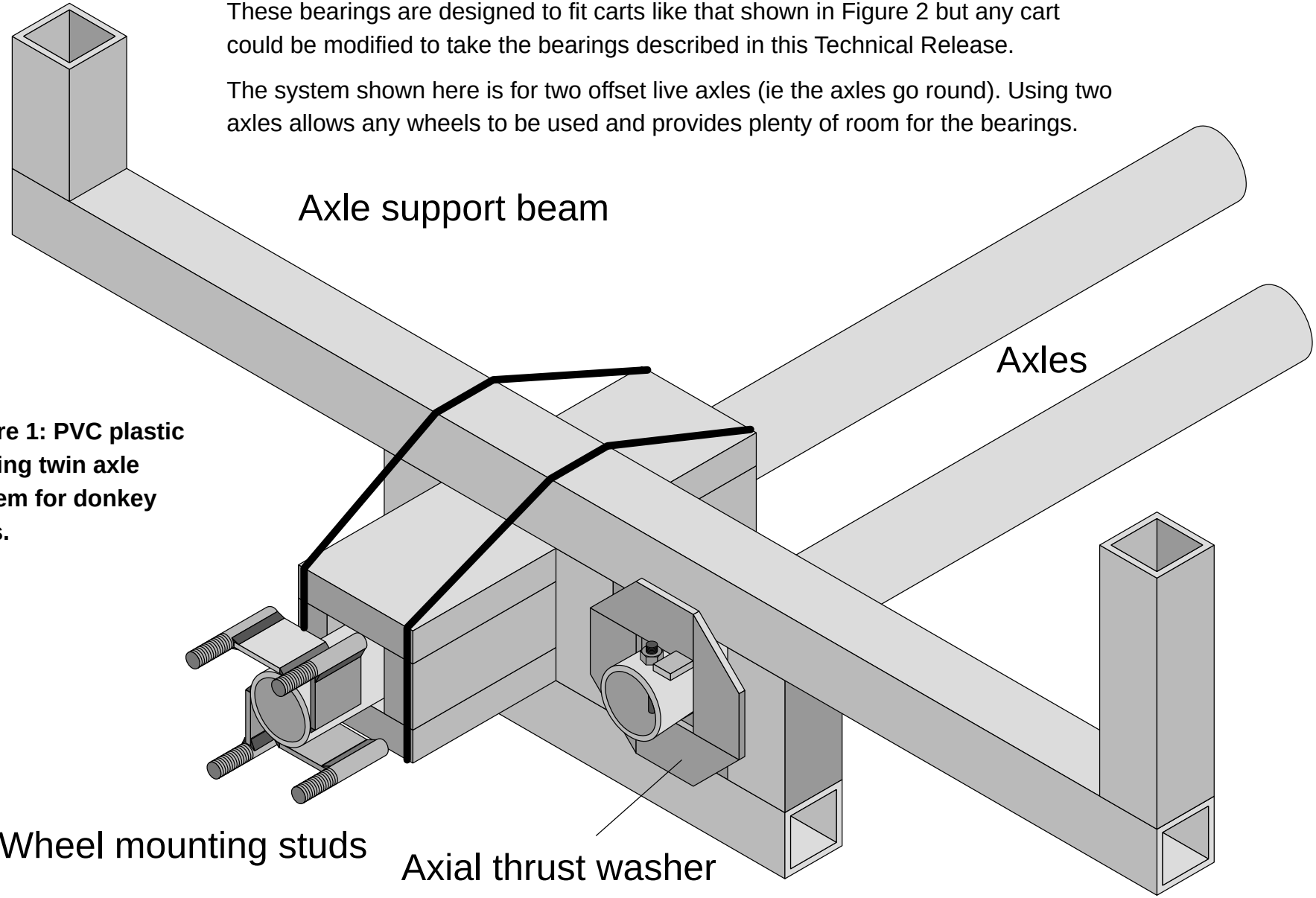

Figure 1: PVC plastic bearing twin axle system for donkey carts.

Wood plain bearing twin axle system for donkey carts.

Introduction

In this booklet we tell you how to make an axle system for a simple donkey cart from round steel tube and wooden planks. The instructions do not cover how to make the cart itself - you will need to read other Technical Releases from us to find out how to make the carts.

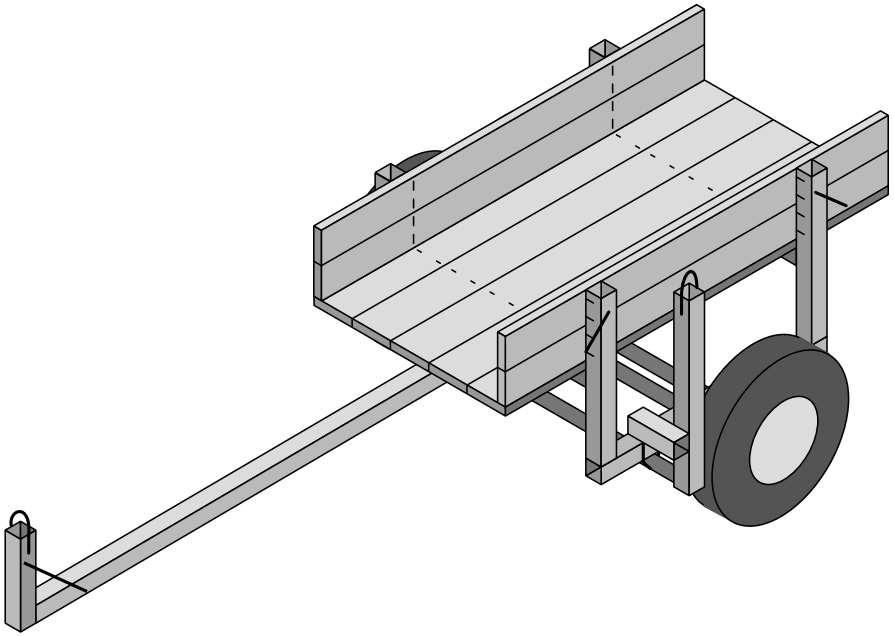

Figure 2: DTU donkey cart fitted with twin axles and PVC bearings.

You should find that you can make the axle system for about £40 including the wheels, tubes and tyres. This cost will depend on the cost of the materials and labour. Once you get organised, two men can probably make and fit one cart with axles in half a day. This is quite a lot faster than it takes to find and a scrap car axle and it will be much cheaper.

In other booklets in this series you can find out how to make other low-cost axle systems and carts.

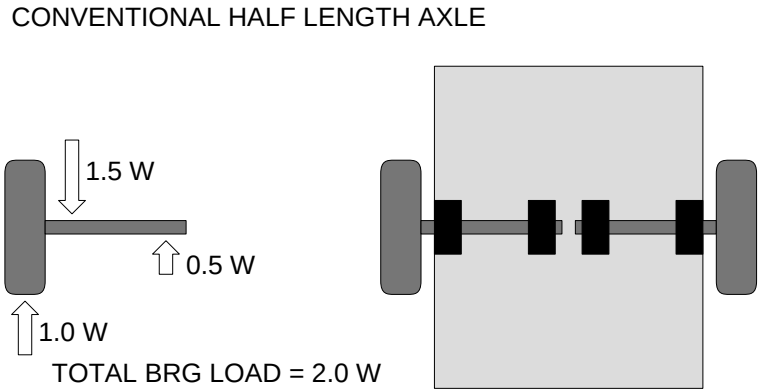

Figure 3: bearing loads in conventional half shaft axle.

Why have twin axles?

There are two types of axle: fixed or stub axle - the wheel hub rotates on the stationary axle; live axle - the axle revolves in stationary bearings.

With the stub axle types the bearings must be inside the wheel. This is easy with expensive ball bearings but more difficult with cheap wooden bearings. You need to make them quite long to stop wheel wobble and so they stick out of the wheel. It is also quite difficult to make without jigs and special tools. If you really want that type we have quite a good system using PVC tube for the bearing. We can send you a Technical Release on how to do it.

Twin axles allow much bigger bearings and do not require such great accuracy in manufacture. Figure 3 shows the bearing loads of the usual way of doing it and Figure 4 shows the DTU method. You will see that bearing loads are 30% lower. Surprisingly there is no extra steel required either because there would have to be some steel to support the middle bearings anyway.

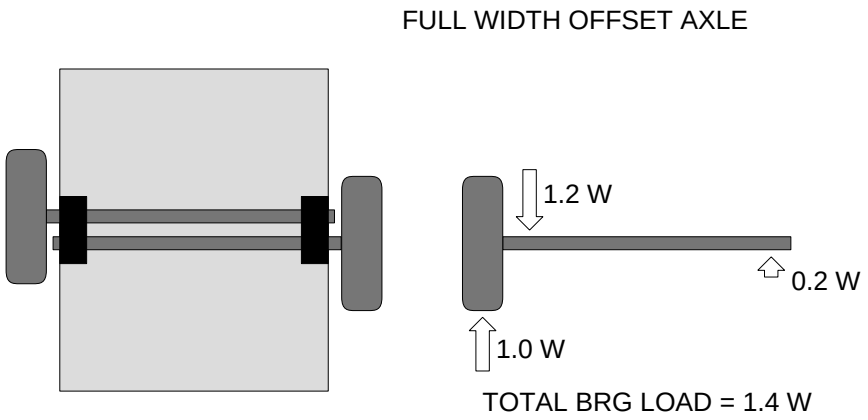

Figure 4: bearing loads in twin offset axles.

Easy to make design.

These axles are designed to be constructed without any special tools and jigs, and without any hard-to-get materials. The only tools which you must have are a simple welder, a hacksaw, and a hammer. You might find that a couple of 4" or a 5" G clamps (or something like it) are useful too. We have deliberately designed the axle so that drilling is not required.

We have tested many of these axles in Kenya and Uganda and we have had only a few failures caused by poor welding or

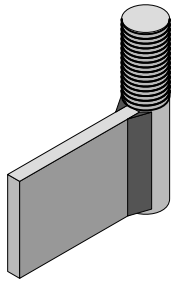

Figure 5: a welded wheel stud and strut fabrication.

incorrect material. We think that they are strong enough, but you can always find someone to break anything. To get a reasonable cost you need to experiment a bit to see how the farmers treat their carts and what they expect them to stand.

It is important to grease the bearings every few weeks.

Cutting list and costs

Table 1 shows a cutting list for a complete axle - Recent prices of materials in Kenya are shown converted into £UK.

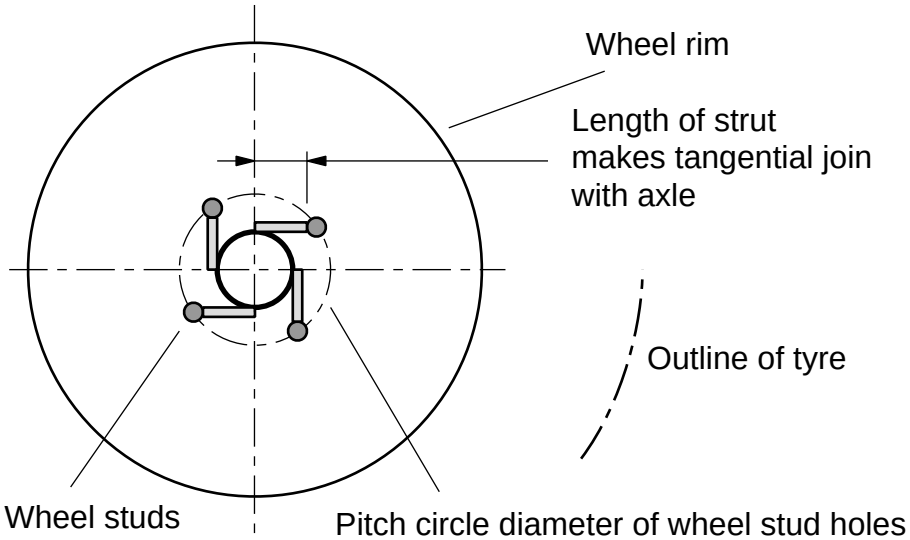

Figure 6: length of wheel strut.

Construction step by step

1) The first job, is to get all the material together and clear a space to work. Ideally you will be able to work on a flat area of concrete.

2) Start by making the wheel stud struts shown in Figure 5. You need to make one of these struts for every stud hole in the wheels you are going to use. Figure 6 shows how to measure the length of the struts. The struts are made from 6×40 flat bar or similar and M12 bolts 50mm or 60mm long. The flat bar should be long enough so that it meets the axle tube tangentially as shown in Figure 6.

TABLE 1: materials for wooden bearing twin axle.

component	material	# lengths reqd [#×mm]	total material for one axle [mm]	cost [UK£]
wheel studs	50×M12 nuts and bolts	10	10	2.60
wheel stud struts	6 × 40 flat bar	10×65	650.00	0.49
axial thrust washers	6 × 40 flat bar	8×90	720.00	0.54
axle cross bolts	75×M12 nuts and bolts	4	4	1.04
axles	1-½" BSP malleable iron pipe	2 × 1500	3000.00	6.00
bearing block restraint loops	R 8 re-bar	8×430	3440.00	0.56
main bearing top + bottom	100×25mm timber	4×300	1200.00	0.20
main bearing sides	50×25mm timber	4×300	1200.00	0.20
small bearing top + bottom	100×25mm timber	4×50	200.00	0.03
small bearing sides	50×25mm timber	4×50	200.00	0.03
wheel rims, tyre + tubes				25.00
			TOTAL	**36.69**

3) Once you have made these struts, screw a nut onto each one until it touches the 40×6 metal. Then put the thread through the hole in the rim and screw another nut onto the thread. Tighten this nut lightly with a spanner. Repeat for all the struts so that they all point the same way round the axle, as in Figure 6, and leave a gap for the axle.

4) Now centre the axle in the rim and get it square using a tape measure, a trysquare and a plank or piece of steel resting on the tyre.

   To do this put the wheel rim on the floor and put the axle in place in the middle. You should put something under the end of the pipe to get it in the right position as shown in Figure 7. Get an assistant to hold the top end of the pipe and tell him to keep very still! Use your tape to measure from the outside of the pipe to the inside of the rim as Figure 7 shows. Measure in one place and then measure the gap opposite. Move the axle pipe over until it is central. Repeat this for the other direction at right angles.

   Now use the trysquare and a piece of wood to get the axle square to the rim as shown in Figure 8. You put the wood on the tyre or rim so that it is flat and you put the trysquare on the wood. You have to move the axle until it is straight with the trysquare and your assistant must hold it without moving. Check it several times - its hard to correct!

5) Once you have it in position, tack weld the ends of the struts to the axle tube as shown in Figure 9. (As Figure 9

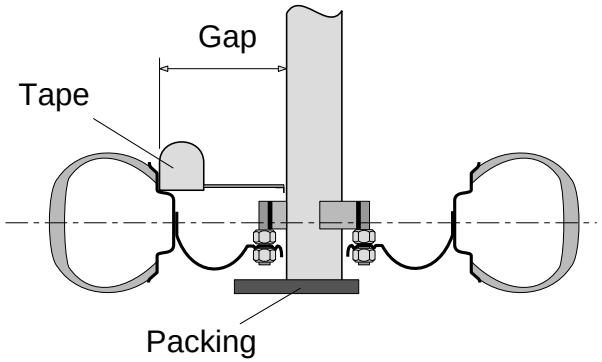

Figure 7: using tape measure to centre axle in wheel.

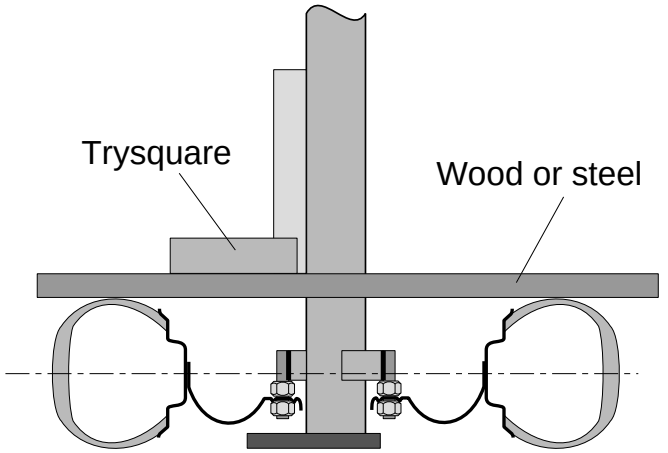

Figure 8: using trysquare to get axle square to wheel.

shows, you can use wooden wedges to hold the axle in place in the rim.) Then weld the struts on properly. Do as much welding as you can without taking the axle out of the wheel because the metal changes size as it heats and cools and it may move out of place.

6) Next make the bearing blocks from 100×25mm timber and 50×25mm timber to the lengths in the cutting list.

7) Cut six 105mm pieces of square tubing for the bearing boxes. Mark the centre of the axle support beam of the cart and put marks on the beam 25mm and 125mm either side of this. You need to weld the 105mm pieces on to the beams as shown in Figure 10.

8) Fit the bearing blocks and fix them in place with loops of 8 to 12mm round bar as shown in Figure 1 and Figure 11.

9) Make four axial thrust washers from 40×6 or 40×3 or similar flat bar like those shown in Figure 12. You must remember to weld on a tag made of a 20mm length of bar to each ring as shown in the drawings. This makes the washers go round with the axle and stops wear in the wrong places.

10) Insert an axle into its large bearing but not its small bearing

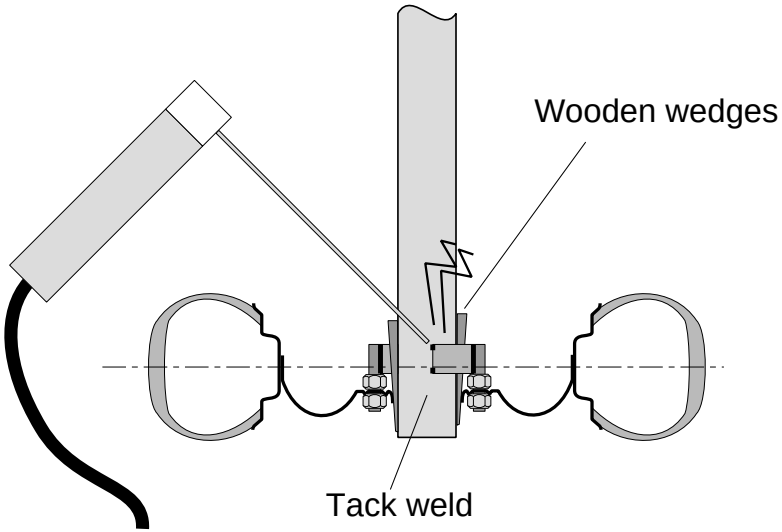

Figure 9: tyre, wheel and axle tube during tack welding stud support struts

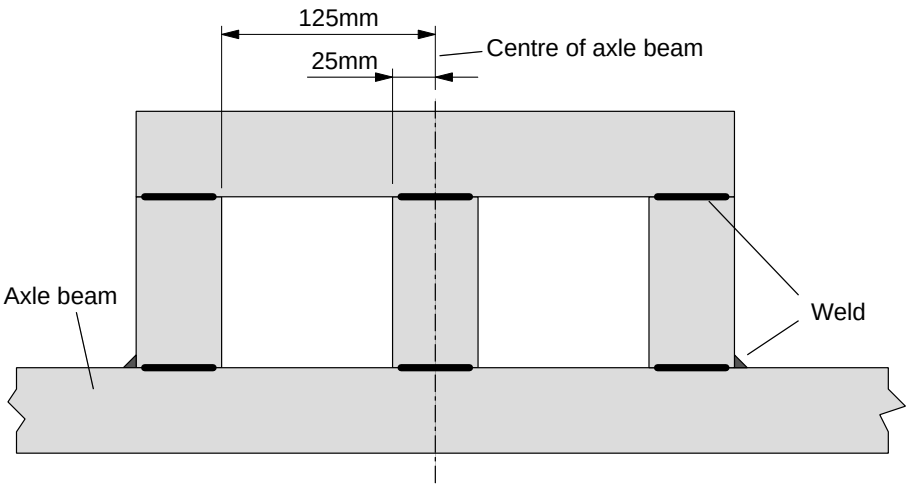

Figure 10: position of bearing support blocks.

and tn put on one of the axial bearing washers with the tag away from the small bearing. Then push the axle all the way through until there is a 20 mm gap between the wheel stud struts and the bearing blocks. Put the second axial ring on to the axle. You should now have an axial washer either side of the small bearing as shown in Figure 13.

11) Now mark the position of the cross bolt holes. Remember that the nuts will have to be turned so do not make the holes too close to the washers - centre about 15mm away is fine. Use the welder to blow the holes.

12) Remove axles from the bearing, apply lots of grease and refit the axles, washers and cross bolts.

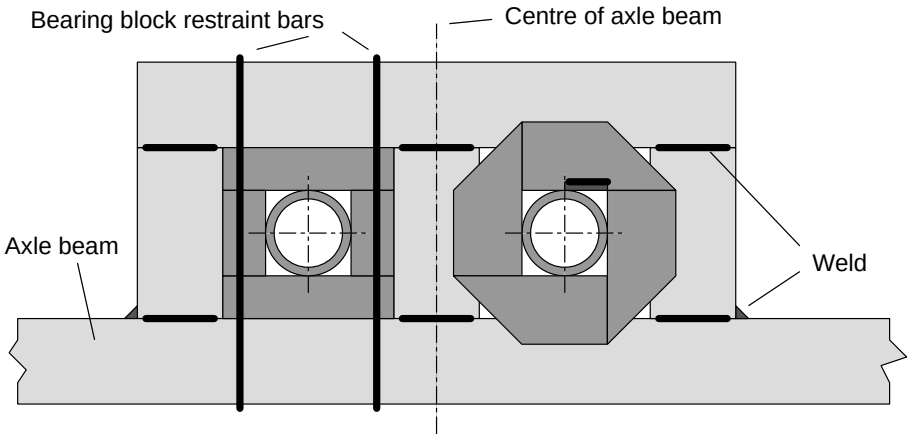

Figure 11: axial bearing washer.

13) Cut the excess axle off about 40mm from the washer. To mark a line around the pipe to cut it square, wrap a strong piece of paper or thin card around the pipe, get the edge in line and use the edge to guide the felt tip pen or scriber as you mark the line.

14) You've finished it!

Other DTU cart developments

The DTU has been working on new designs of wheels, hubs and bearings to bring down their costs and make things more locally manufacturable. It has designs for twin axles with wooden bearings and twin axles with scrap or new ball bearings which do not need any machining. And it has two systems of fixed axle: one with PVC bearings and another

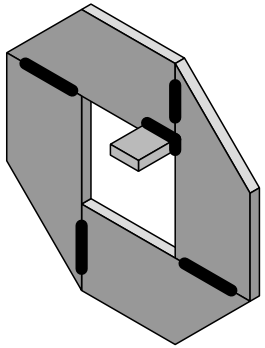

Figure 12: axial bearing washer.

using needle roller bearings which you make yourself. Again for these needle roller bearings no machining is necessary.

Other hub designs using, for example aluminium castings, have been in production in Nigeria and we are trying to reduce or eliminate the machining in these. Also wheel designs in steel sheet, cast aluminium and timber are under development.

The DTU has also been working on a range of cart body types for use with both donkeys and oxen. It has designs for wooden and steel framed types. The wooden types are cheaper in material terms, but the steel framed ones are easier to make because the joints are more straightforward - nevertheless you can make either type of cart in only a few hours, if you are reasonably set up with tools and materials.

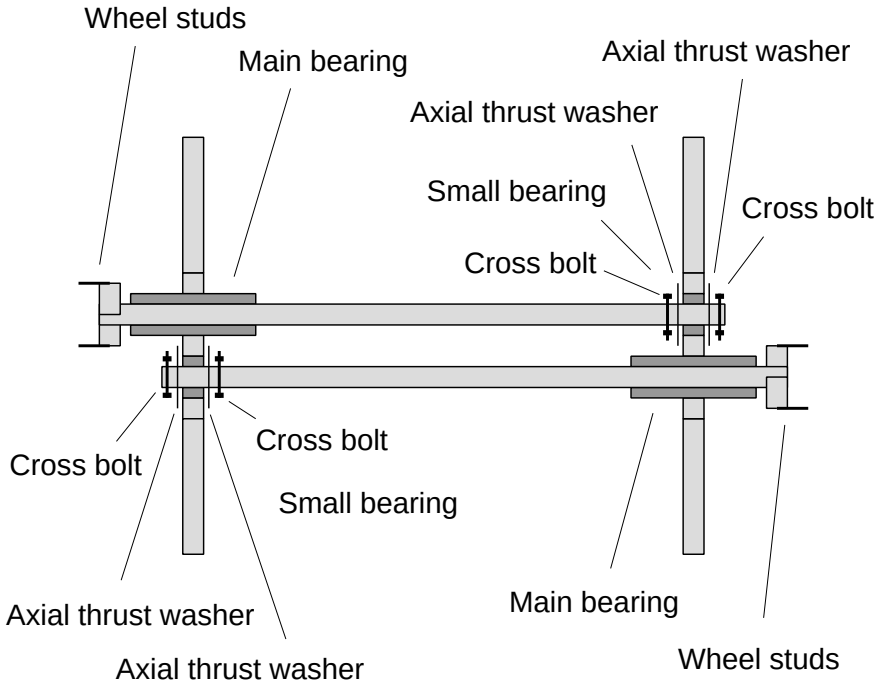

Figure 13: axle and bearing arrangement.

Drawings

You will find four drawings on the next pages, the first two give a general section view of the axle. The third gives a view of the components of the axle itself and the fourth a drawing of the thrust washer.

Acknowledgements

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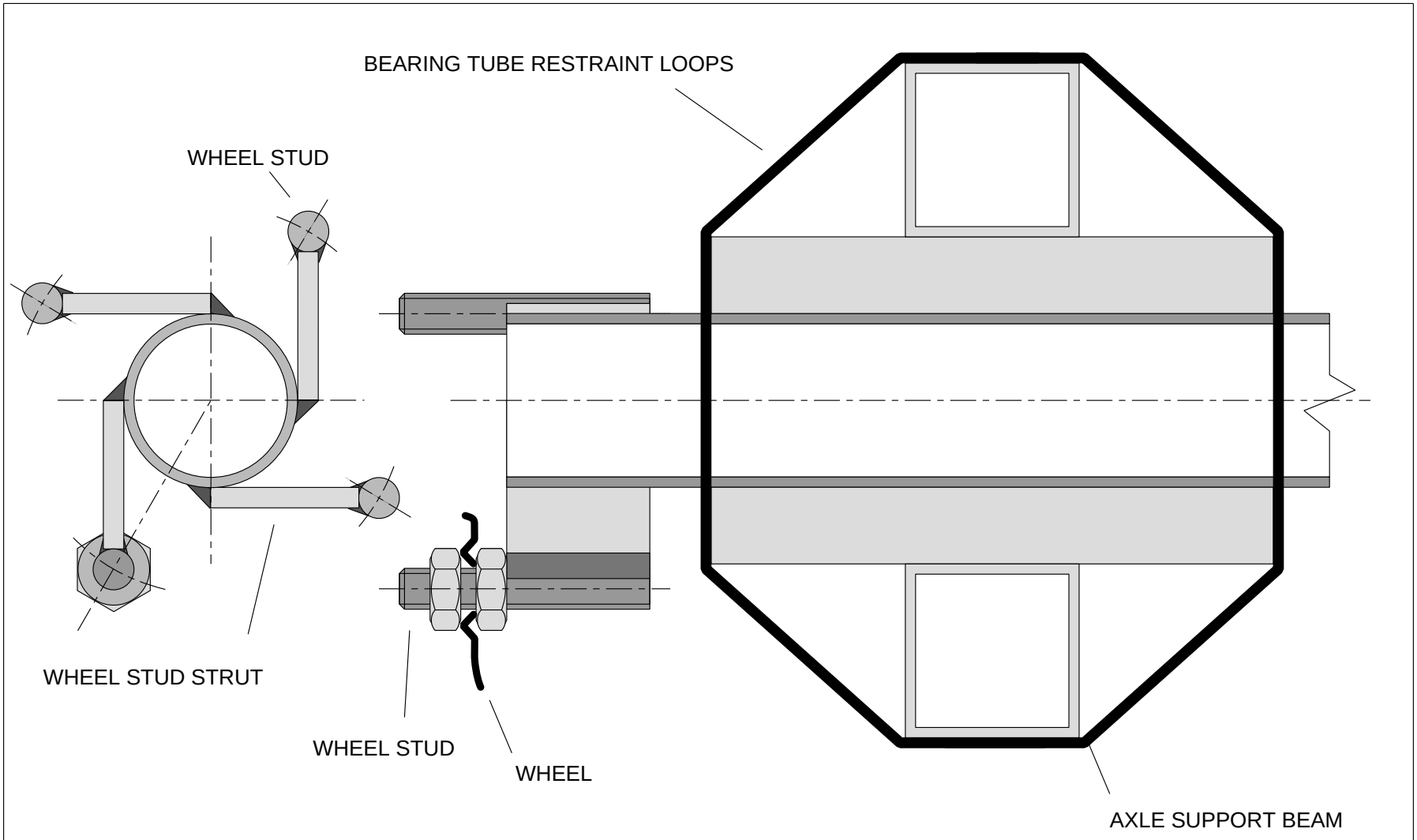

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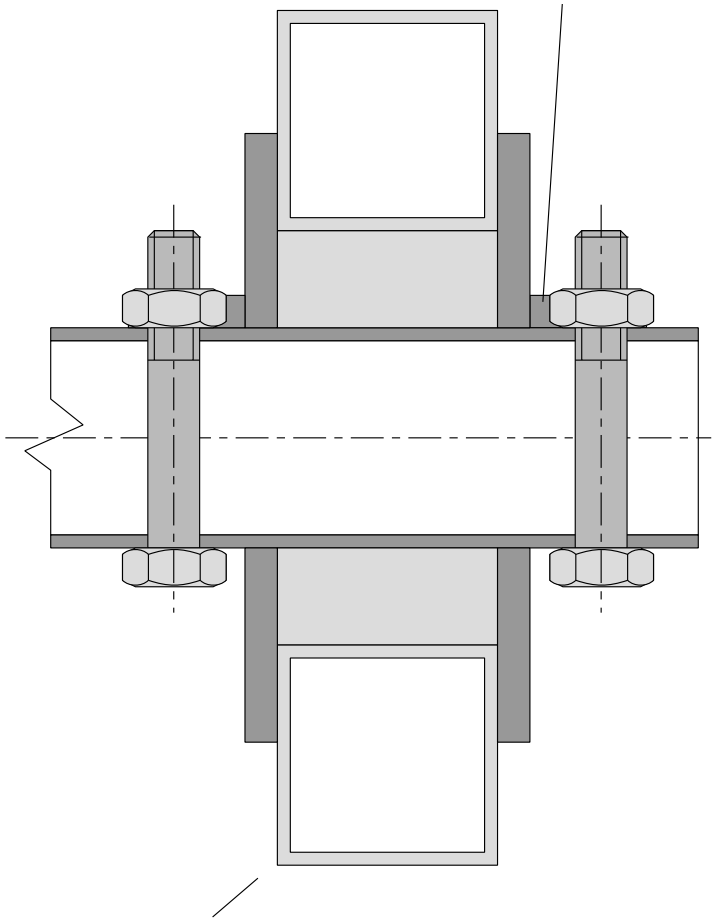
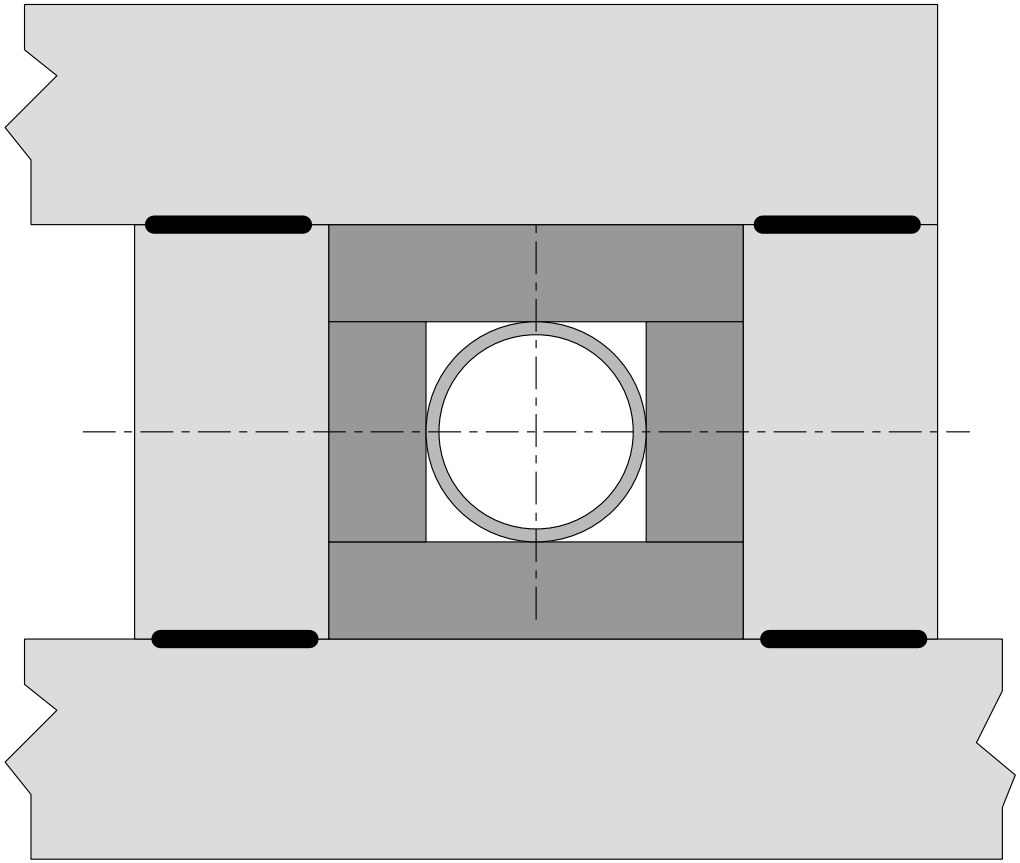
AXIAL RESTRAINT WASHER TAG



AXLE SUPPORT BEAM



END VIEW - THRUST WASHER AND BOLT REMOVED

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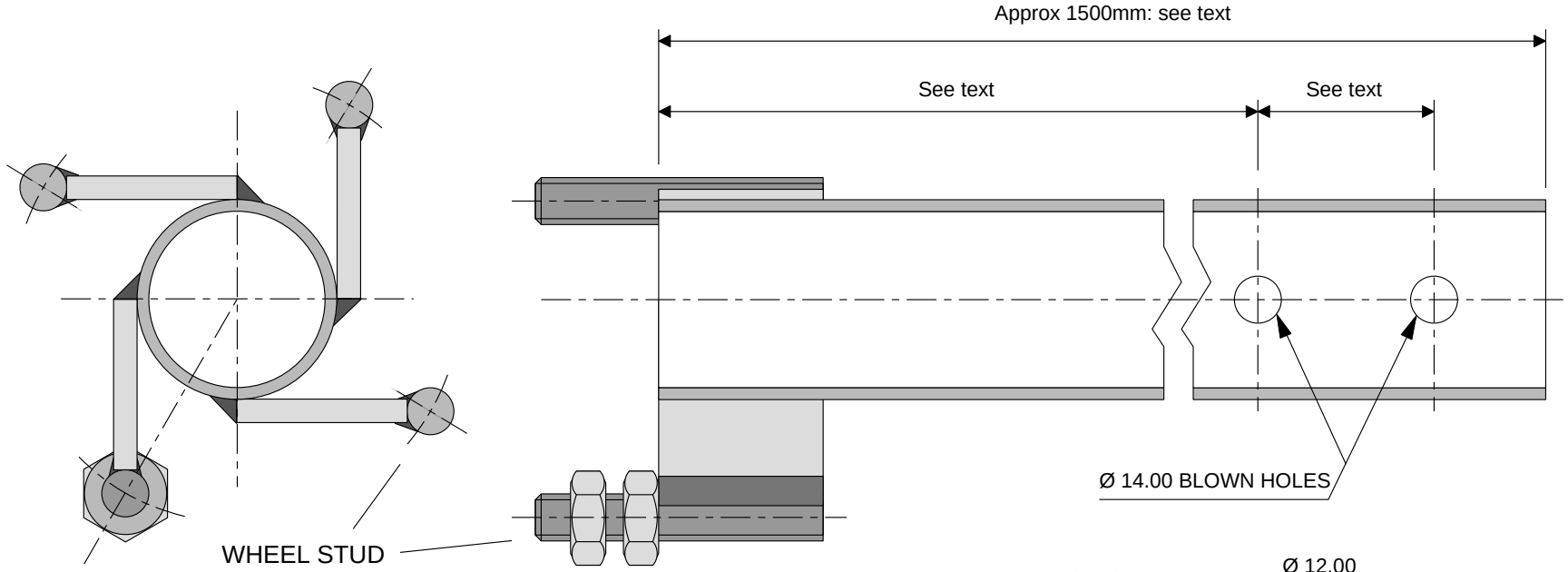
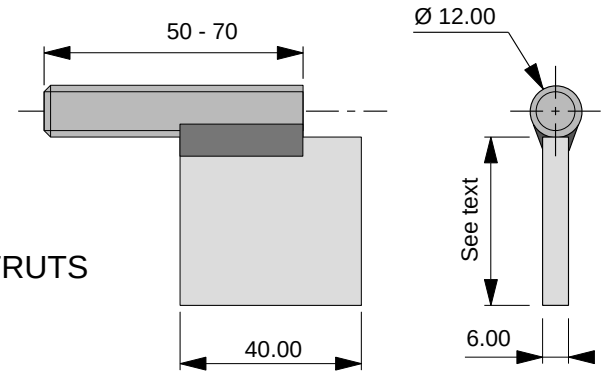


AXLE: 2 OFF REQD.



WHEEL STRUTS

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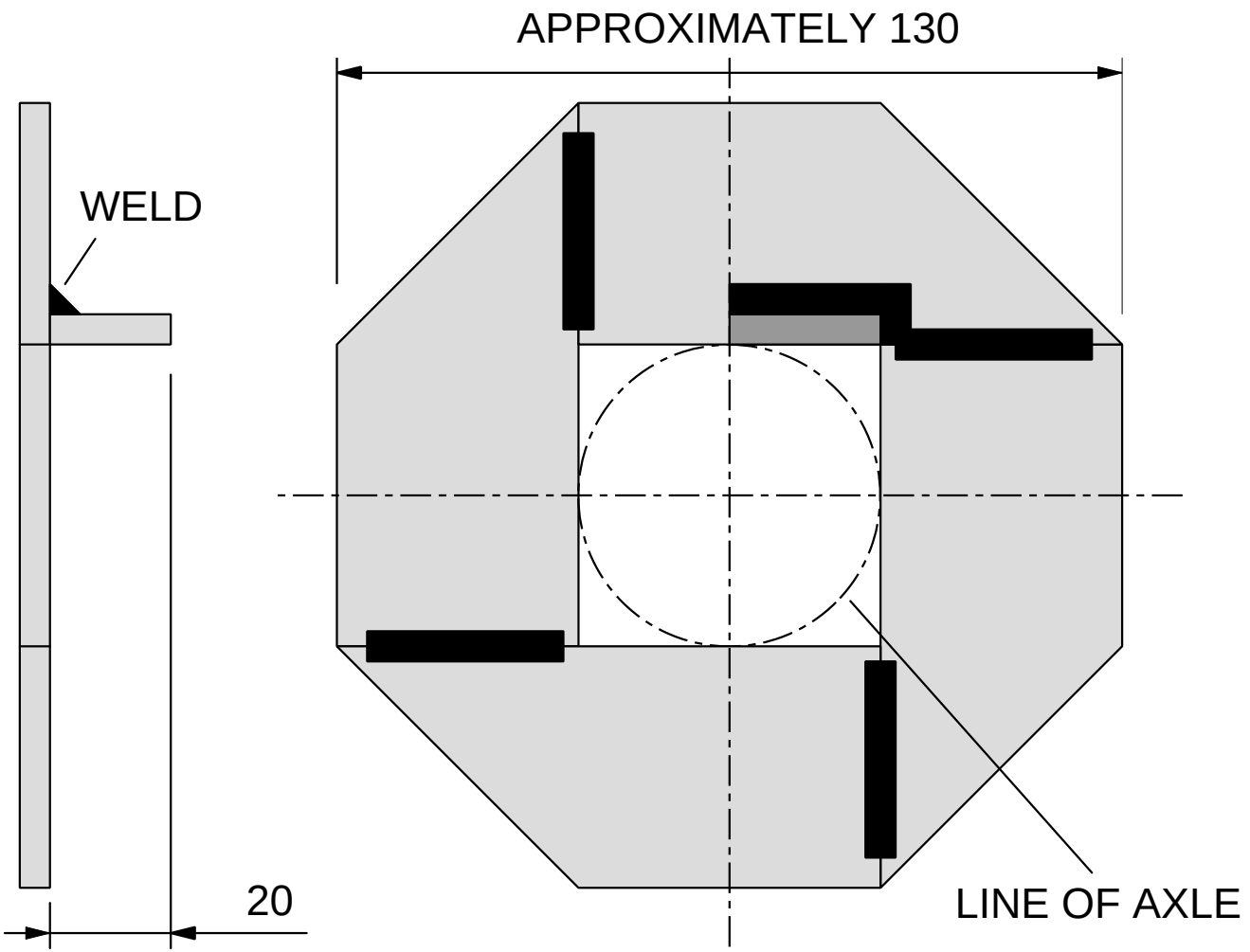

AXIAL THRUST WASHER: 4 REQD

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