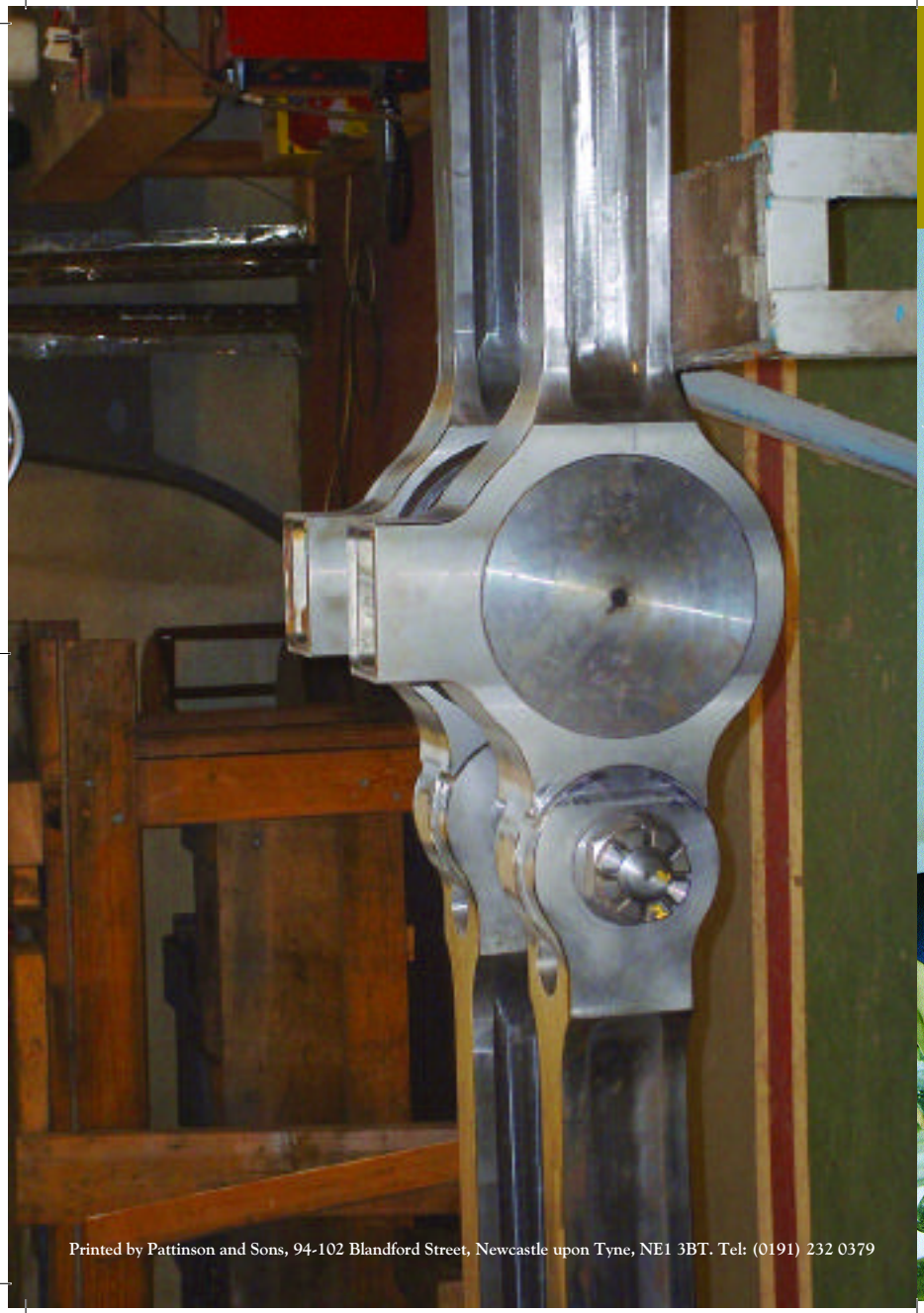

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Top Link

Issue 4
Summer 2002

Framed!

Journal of The A1 Steam Locomotive Trust

CONTACTS

The A1 Steam Locomotive Trust

President
Mrs D. P. Mather

Vice-President
Mr P. N. Townend

Board of Trustees
Mark Allatt (Chairman and Marketing: mark@a1steam.com)
Wreford Voge (Taxation: wreford@a1steam.com)
Barry Wilson (Finance: Barry@a1steam.com)
Andrew Dow (Sponsorship: Andrew@a1steam.com)
Rob Morland (Project Planning: rob@a1steam.com)
Tony Roche (Chief Mechanical Engineer: tony@a1steam.com)

Director of Engineering
David Elliott (davide@a1steam.com)

Company Secretary
David Burgess (davidb@a1steam.com)

Telephone hotline: 01325 460163 e-mail: enquiries@a1steam.com
All correspondence to: The A1 Steam Locomotive Trust
Darlington Locomotive Works
Hopetown Lane
DARLINGTON DL3 6RQ

The website is www.a1steam.com – user name: PATRON; password: PACIFIC

Darlington Locomotive Works

Works Manager
Mike Wood (Mike@a1steam.com)

Pro tem., the Works opens 2nd Saturday in the month at 11 00, 12 30 and 14 00 (You must buy entry to Darlington Railway Museum, next door, first.)

COVENANTS

To become a covenantor, or to start an extra covenant, a heritage covenant or a dedicated covenant, contact Alan Dodgson at **enquiries@a1steam.com** or 01325 460163, giving your name/contact details (phone/e-mail/address). Many components can be paid for by dedicated covenant. Items over £1,000 can be sponsored by an individual or a group of people. Other components are also available.

	cylinder cover, right – machining	£600/1 x £10 pm
PS52M	cylinder cover, centre – machining	£600/1 x £10 pm
PS53M	Cartazzi axlebox pattern	£2,400/4 x £10 pm
PS61M	eccentric crank bolt/nut/locking pin – L, R	£60 each
PS350–1	crank pin nut/locking pin – Ltrlg, R trlg	£120 each
PS356–7	cplg rod oilbox cover – Mid/L/R, L/R trlg	£150 each
PS378–81	piston valve spindle crosshead guide (5)	£60 each
PS394–8C	piston valve spindle crosshd guide – mach.	£60 each
PS394–8M	machining of coupled hornblock liners (12)	£150 each
PS399–410	machining of inside motion plate	£600/1 x £10 pm
PS410	coupled cannonbox set castings (2)	£2,100/4 x £7 pm
PS433–4	Cartazzi axlebox casting – L, R	£800 each
PS441–2	Cartazzi axlebox machining – L, R	£1,600/1 x £26 pm
PS443–4	Cartazzi axlebox cover pattern	£500/1 x £9 pm
PS445	Cartazzi axlebox cover casting – L, R	£150 each
PS446–7	Cartazzi axlebox cover machining – L, R	£450/1 x £7.50 pm
PS448–9	Cartazzi a/box backplate & mach. – L, R	£950/1 x £16 pm
PS450–1	cab spectacle glass frame patterns – L, R	£600/1 x £10 pm
PS452–3	cab spec. gl. frame bronze castings – L, R	£300/1 x £5 pm
PS454–5	cab spec gl. frame castings, mach. – L, R	£600/1 x £10 pm
PS456–7	cab spectacle safety glass – L, R	£450/1 x £7.50 pm
PS458–9	cab side windows (complete) – L, R	£600/1 x £10 pm
PS460–1	cab side screen frame pattern – L, R	£300/1/ x £5 pm
PS462	cab side screen frame casting – L, R	£150 each
PS463–4	cab side screen frame mach., hinges – L, R	£450/1 x £7.50 pm
PS465–6	cab side screen safety glazing – L, R	£300/1 x £5 pm

Back cover: The fully-fettled coupling rods seen side by side at the Works in July 2002. *(photo: Barry Wilson)*

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Issue 4: SUMMER 2002

Editor: Gerard M-F Hill

JOURNAL OF THE A1 STEAM LOCOMOTIVE TRUST gerard@A1steam.com

Below: No-one else was there one summer day in 1964 to see wheezy 60121 ***Silurian*** reach its journey's end in the decent obscurity of Platform 16 at York. The loco survived until October 1965. Note the lift (left), linking with the goods subway. ***(photo: Nigel Dyckhoff)***

Cover picture: On 17 July 2002, John Rushworth with air-drill and reamer is working on one of the 2nd coupled-axle hornguide bolt holes. ***(photo: Fastline Photographic Ltd)***

EDITORIAL

I am very conscious that most covenantors aren't able to visit Darlington Works and depend on *Top Link* for news. By the kindness of Fastline Photographic Ltd of York, this issue has several photos specially taken to show some of the gorgeous pieces of metal now being assembled in the Works.

The Renault 5, once the car for the young and fashionable, had one rear axle a bit further back than the other, but then they didn't have David Elliott on the job: the A1's axles are a little bigger, but these lumps of metal have been fitted to within 3 thousandths of an inch or less. Arthur Peppercorn must have wished he had tooling and instruments to do that. 'What price accuracy?'tells how it was done. Our Director of Engineering also has a riveting piece on 'Snap or flush?'

Following on from the Chairman's piece on 'Reorganisation', our new Chief Mechanical Engineer explains who does what on the engineering side. Andrew Dow brings us up to date on progress in our preparations for building the boiler. The budget would not run to a pop-up book, but non-technical readers can turn to 'Know your drain cocks'for all you really need to know about why the A1 uses that great invention by the third most famous Belgian.

I have received several more historic photographs: thank you very much. If you asked for their return, I will send them back as soon as the printers have finished with them. As Nigel Dyckhoff went to such trouble to dig down that far, *Silurian* is on the title page but not as background. The 'History'section is shorter this time, because there was a lot to fit in elsewhere.

The Editor unhappily missed an excellent 'spring day out'on the Mid-Hants. It seems the food was particularly good and there were many 'new'faces among those who find Darlington rather far for a day out. Plans for our Convention in the autumn are in hand, with something special at the Works, and for next year.

This issue was slightly delayed so as to include the accounts in the same mailing. As well as reporting the Convention, the next issue should include more pages of 'History'and a most interesting centrespread. After recent cautious progress measured in thous, *Tornado* should show highly visible developments.

To speed up visible progress, you can volunteer your services in marketing, in the office or in the workshop (see page 13); you can recruit a friend or three as covenantors; and you can take out a dedicated covenant or increase your monthly one (see page 27). Everyone can make a difference, so that the 'impossible'takes only a little longer.

Gerard M-F Hill

BOILER NEWS

WATERCRESS SANDWICHES

On 18 May this year's Spring Day Out was held on the Mid-Hants Railway and 65 covenantors attended. From Alton we travelled in a reserved section of the service train to Alresford, for a buffet lunch served in the newly converted goods shed. During lunch a brief update of progress from Mark Allatt, David Elliott and Rob Morland was followed by a question-and-answer session.

After lunch 6024 (a GW loco, not a GC 4-4-0) took us back to Ropley to view the works and various locomotives being renovated. The dismantled parts of 60019 *Bittern*, especially the frames, showed the extent of the job facing their team, by comparison with *Tornado*'s. After a pleasant hour getting smuts in the eyes and coal dust on the shoes, we took the train back to Alton.

Thanks to the Mid-Hants Railway's hospitality and excellent facilities, this was a great day out as well as a good opportunity for covenantors in the South, some of whom cannot visit Darlington, to meet and keep in touch.

BOILER

Readers may have seen elsewhere that the trust has been contacted by Interlok, the Polish company which runs the locomotive works at Pila, and indeed a member of the board has been to Poland to see them. This was a fact-finding mission: it doesn't mean we have decided to build the boiler abroad. We intend if at all possible to build *Tornado* entirely in Britain, but in view of the complexity of the regulations and lack of capability among British manufacturers we

Covenantors on our Spring Day Out at Ropley locomotive shed, getting a really close look at BR 9F 2-10-0 92212 (?) and LMS 2MT 2-6-2T 41312. Note the sunshine, part of our carefully laid plans, of course. *(photo: Rob Morland)*

cannot afford to ignore any serious approach by a suitable organisation.

FRAMES & MOTION

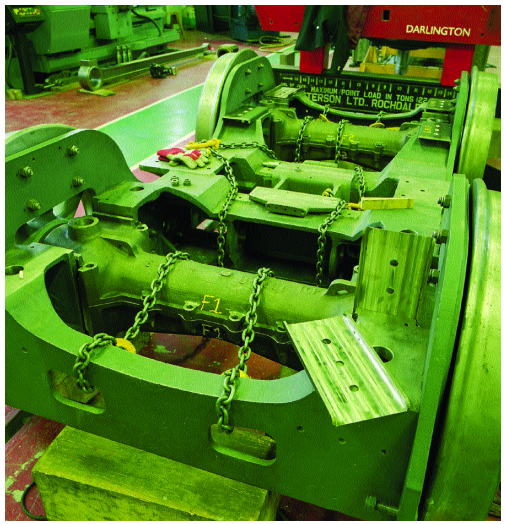
Three months have been spent on painstaking fitting of axle and cannonboxes to the frames, and adjustment of roller bearings. With David Elliott having returned to the 'Big Railway' on a short-term contract, Ian Howitt's team have been stepped up from 2 to 3 days per week on site at Darlington.

A lot of work has gone into preparing and successfully fitting the axleboxes: see the separate item below, 'What price accuracy?'

To set the distance between axles, the bushes had first to be machined – by Nigel Facer at Ian Howitt's workshop – and then pressed in at Darlington with a hired 50-ton press. The oil holes were drilled through and the oil grooves cut with a cold chisel by Nigel. Front and back rods were assembled, using the knuckle pins made by Ufone. Barry Wetherell continues fettling the rods with abrasive flap wheels.

Cartazzi wheelset

The Cartazzi wheelset – axleboxes, hornblocks and fittings – is complete and will be fitted to the locomotive in the near future.



Bogie

The bogie hornstays have been made by Ian Howitt and are ready for fitting. The manganese-steel hornblock liners (between which the axleboxes slide) have been machined and one is seen here on 17 July 2002, resting on the front of the bogie, before being attached to the horn guides. The liners were to be fitted as soon as the work on the coupled-axle liners was finished. The bogie should soon be complete.

(photo: Fastline Photographic Ltd)

Cab

The new cab sides have been delivered and re-assembly is under way.

For rivets, see 'Snap or flush' on p. 20!

SUPPORT COACH

In 1993 the trust agreed with Ian Storey to acquire jointly a support coach, Mk 1 BSK no. 35457; by a further agreement, the coach was maintained in use behind Ian's locomotive, LMS 5MT 44767, until we needed it. Our half-share cost us £1,750 and has now been sold to Ian for that sum, as required under the terms of the agreement.

It is likely that the coach would be of limited use to the trust because recent changes in the regulations mean that within a few years no Mk 1 coaches will be allowed on the main line. We shall look for a newer, replacement support coach when the need for one becomes imminent.

CERTIFICATION

Our Vehicle Acceptance Body (VAB) made a further visit on 28 May to inspect the locomotive and to approve a number of still-outstanding design changes and corrected non-conformances. We were also introduced to Bob Bramson from The Engineering Link, who will be our new point of contact when the Heritage Engineering VAB team retire in July.

DARLINGTON LOCO.WORKS

For the contract placed on Ian Howitt for truing up the hornblocks, he bought a Bridgeport milling machine to be used as the basis of the on-site machining kit. As part of this contract, the machine was to be re-assembled, installed at Darlington and commissioned. This has now been done and it has speeded up fitting of the hornblock liners by enabling the liners to be skimmed on site. The machine appears to be in good condition and is capable of producing accurate results.

A buyer has come forward for the CNC lathe, which – with the reversion to outside subcontract labour for work on the locomotive – has now been declared surplus to requirements.

The volunteers have continued with the structural floor over the office building. They are in the process of making and fitting handrails. When finished, the bulk of the patterns will be stored above the office, liberating much-needed floor space for further work on the locomotive and the establishment of a formal quarantine area. This will be a holding area for components awaiting inspection and approval, or for components which have failed inspection and are awaiting corrective action.

A good second-hand battery has been acquired for the fork-lift truck, which is in use again *(see next page)*.

Lifting jacks

The jacks are in the process of having some minor wiring changes and replacement of the temporary brake covers (plastic buckets!) by fitted steel covers. This has been required by the insurance inspector.

The other major requirement is to re-certify the jacks at their proof load. As originally renovated and used for the trial fit two years ago, they were given a temporary insurance certificate on the basis that no-one would work under the engine when it is in the up position.

Another requirement is to make a dedicated lifting beam for the rear of the locomotive to enable adequate clearance for rolling the wheels in. A design has been prepared for this and it is intended to contract Taylors of Leeds to check the stressing of the beam, make it and then test-load it and the existing lifting beams on the jacks to renew the insurance certification.

To proof-test the jacks it is necessary to load them up to 25% over the normal working load. As our jacks work in pairs, 40 tons of test weights are required. Taylors have these, so the full jack set will shortly be sent to them to do the certification. This certification should last for at least five years.

The Works fork-lift truck is seen lowering a pallet with the Cartazzi axleboxes, unloaded on their return from North View Engineering after machining. *(photo: Barry Wilson)*

FRAMES

When I was taking A-level engineering at school, I clearly remember my teacher stressing that the cost of manufacturing in engineering tends to rise exponentially with the required degree of accuracy. This has changed somewhat with the advent of highly accurate CNC machines, but it still firmly applies to hand fitting.

I have read that the roller-bearing A1s cost 20% more to build than the plain-bearing version and sometimes I have wondered why: the cost of the cannon-boxes and roller bearings would not account for this increase. Now I understand. To date, the hornblock-liner fitting work on 60163 has taken in the order of 320 man/hours and cost over £2,000 in machining and grinding.

The use of roller bearings means we need to be even more

In the green corner, Nigel Facer, RN (retired); in the blue corner, Ian Howitt of that ilk. *(photo: Barry Wilson)*

precise in aligning the axle centres with the coupling-rod bush centres and getting them parallel to each other. Plain bearings start with a clearance to the journals of up to 0.020″ to enable the oil film to form properly as the axle rotates. If there is a slight misalignment of the axles, the soft white-metal bearings will wear asymmetrically until the engine is 'comfortable'. This is part of the essential running-in process.

By contrast, *Tornado*'s roller bearings have a radial float in the order of 0.002″ to 0.003″ and are not expected to wear to any appreciable extent. Suppose the adjacent axles are set, say, 0.015″ further apart than the centres of the coupling rods. The softest part of the finished assembly, the white-metal lining of the rod bushes, will rapidly wear asymmetrically until the holes are sufficiently oval to compensate. The result is likely to be failure of the rod-bush lubrication film, causing early failure of the bearings. Thus we need to work to an order of magnitude of greater accuracy than for the plain-bearing version.

Grinding: the hard way

The coupled-axle cannonboxes are all now located in their final positions in the hornblocks, generally following the optimized positions recommended from the Severn Valley optical alignment survey results. In theory, it should have been a process of machining the backs of the hornblock liners to the thicknesses indicated by the Severn Valley recommendations. In practice, it was not that simple.

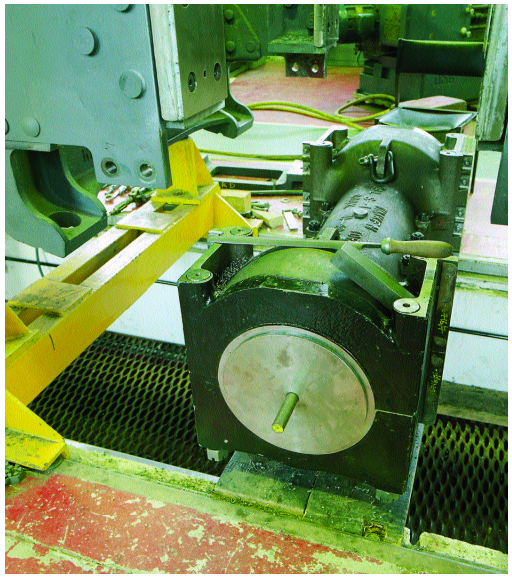
It was found to be difficult to keep the liners a constant thickness when they were machined. Each liner comprises a shallow, channel-shaped back plate which hugs the hornblock face, with face and side wear-plates (from 11–14% manganese steel) welded on.

It would seem there is a differential stress between the manganese-steel plates and the back plate; the result is that, as one face is machined and gets thinner, it causes the whole assembly to bend – like the bimetal strips used in thermostats.

To overcome this it was decided to grind the manganese-steel faces rather than machine them. Grinding imposes a much lower tugging force on the work piece than milling. A fixture was made from mild steel to which the liner was securely bolted using its own bolt holes. This held it flat. The fixture was then held down on the magnetic bed of the grinder and the manganese-steel face was ground to provide the required overall thickness.

As the liner was held down evenly all over, the tendency to bend was resisted. Where the liner was not thick enough to fill the gap, it was ground to a thickness that enabled standard shim material to make up the gap.

Cannonbox fit



Precision engineering, in the form of one of the cannonboxes ready for a trial fit, waiting to be jacked up between the horns of the middle coupled axle. The managnese-steel liners can be seen, bolted to the hornblocks. What looks like a wheel trim is the dummy centre, from which protrudes the inch-diameter rod used for centreing. The hornstay is secured to brackets at either side; one is seen on the left of the picture.

(photo: Fastline Photographic Ltd)

All square

The cannonbox for the middle coupled axle was the first to be fitted, and the required clearance in the hornblocks of between 0.004″ and 0.012″ was achieved. Checks were made to the fronts of the cylinders to ensure that the cannonbox was square to the frames as defined by the optical alignment measurements. It took several trial fits to achieve this, with small adjustments of the shims. Each trial fit involved refitting the hornstays – not a trivial task when they weigh over a hundredweight each and need to be jacked into place as they are a slight interference fit.

To set the axle centres accurately, Ian Howitt made some dummy centres, which are a gentle push fit into the ends of the cannonboxes and axleboxes. Each dummy centre has an accurately bored central 1″-diameter hole, so a round bar can be threaded through each cannonbox (the axleboxes on the crank axle). A large internal micrometer, specially calibrated for the purpose, is used to measure between the protruding 1″ bars.

At first, we found discrepancies in the measurements if the micrometer was stored in the tool cupboard. We ascribed this to the cupboard being cooler or warmer than the frames, so the assembled micrometer is now stored resting on the footplate. Measurements are now consistent regardless of time of day.

Similar dummy centres were made for the coupling rods, which were set up on trestles with the front and back rods assembled with the knuckle pins. Bars through the dummy centres were used to enable the distances between the centres of the rod bushes to be checked. It was reassuring to find the variations well within the ±0.005″ allowed on the drawing. Three were within 0.002″ and the fourth was 0.003″.

The Bridgeport NC milling machine in use in the Works ***(photo: Barry Wilson)***

Axle spacing

These results enabled us to set distances between the axle centres to the nominal dimensions. To fit the rear axle, the front liners were ground to the calculated thickness, fitted with shims as appropriate and the cannonbox lifted into the datum position (with the axle centre level with the datum marks on the frame). We inserted wooden wedges between the rear faces of the cannonbox and the hornblock to push the cannonbox hard up against the front liners.

Having ascertained that the middle coupled-axle cannonbox was in the datum position, the distance between the 1″ bars was checked.

Several adjustments were made, inserting shims or removing small amounts of material, until the axle centres were about 0.003″ less than nominal. The hornstays were then replaced and the gap between the hornblocks and the rear faces of the cannonbox was measured.

After that, the liners were ground to 0.006″ less than the gap, in order to have a finished clearance of 0.006″ for the cannonbox in the hornblocks. With further adjustment, this was achieved.

Final measurements indicated the distance between centres was accurate to within 0.003″ and the axles were parallel to within 0.002″ with boxes in their nominal positions.

The same was done with the front axleboxes, with the 1″ bar serving to keep the two axleboxes in line with each other.

The next process was to set the side clearance on the cannon and axleboxes (to allow the locomotive to traverse tight curves). Each cannonbox and front axlebox was meant to have $^{3}/_{16}$″ sideplay.

The inside manganese-steel plates were machined to give the required play and to ensure that, at their extreme travel, both side liners on each cannonbox make contact at the same time.

The final setting of sideplay on the leading axleboxes will be done when the axleboxes are on the axle to ensure that both axleboxes hit their side liners at the same time.

The final process is to replace the 24 temporary bolts holding the liners on, using fitted bolts. This involves reaming the liner and hornblock holes and turning the previously-made bolts down to be a driven fit in the holes. This was under way at the time of writing in early July.

Thinking of volunteering?

Steam Dreams let our volunteers travel on their trains to tell passengers about the A1 and recruit new covenantors. Contact Alan Dodgson if you can help.

From time to time we need one or two people with experience as engineering draughtsmen. Nothing complex, just things like adding small technical detail to meet today's specs and standards, or retitling. Contact Tony Roche.

The Works needs someone local to ensure utility bills are checked and paid, safety-critical equipment (e.g., slings, lifting gear and portable electrical appliances) is inspected and checked at the right times, COSHH regulations are adhered to and routine health and safety issues addressed. Contact David Elliott.

Among the many vital roles performed by the trustees, few are more vital than washing the tea mugs. ***(photo: Barry Wilson)***

TWO
BIG
PICTURES

In the Works, 17 July 2002

Above: In the foreground is an axlebox for the crank axle, with dummy centre fitted for alignment. In this view, looking west, Ian Howitt is reaming one of the holes for the fitted bolts securing the horn guides. *Left:* The coupling rods assembled on stands beside the driving wheels, so the distances between crankpin centres could be measured accurately. *(photos: Fastline Photographic Ltd)*

CHAIRMAN'S COLUMN

Thanks to Fastline Photographic Ltd, this issue of *Top Link* is literally covered with recent photographs of progress on *Tornado.* As you can see, our engineering team are burning the midnight oil over the summer months to ensure that we reach our intended targets for our Annual Convention in October.

In the last edition of *Top Link,* I was delighted to be able to announce the appointment of Tony Roche as our Chief Mechanical Engineer. In this issue Tony shows that he has already taken up the reins of office with a brief article on some of the principles that the engineering team are following and a list of its members, many of whom are new.

Although the trustees recognise that many covenantors wish (or have no choice but) to remain armchair supporters of the trust, we need many more people willing to step forward as volunteers to fulfil roles that we have identified within the management, marketing and engineering teams. 'How you can help'on page 13 details some of the roles that we need people for, the nature of the job and the skills required. I would like to express my thanks to all of you who have answered my call for additional volunteers and encourage those who haven't to do so.

Above all, what the project needs at the moment is – as usual – more money. Elsewhere in this edition of *Top Link,* Andrew Dow's article covers some of the issues that we are facing in identifying and commissioning a supplier for the boiler. The photographs of the frames, wheels and motion tell their own story. However, in spite of this progress, we still have a funding gap of about £750,000 **if** we are to complete *Tornado* by 2005.

There are several ways you can help to complete *Tornado* more quickly:

1. Consider increasing the size of your contribution.
2. Take out a Dedicated Covenant. These buy the component of your choice, and can cost as little as £5 extra per month. You can fund already completed parts or almost any of the items still needed. A list of just some of the available components is on page 27.
3. Recruit a friend. They might also join you in sponsoring a Dedicated Covenant.

Any of these will make a real difference. The more covenantors we have, the sooner *Tornado* hauls its first train.

I'd like to take this opportunity of thanking you all for your continued support of the project and I look forward to seeing as many of you as possible at our Annual Convention on Saturday 5 October in Darlington.

Mark Allatt

FINANCIAL

New auditors

Following completion of the audit of accounts for the year ended 31 March 2002, KPMG in Newcastle expressed a wish to resign as the auditors of our companies, The A1 Steam Locomotive Trust and The Locomotive Construction Company.

KPMG were appointed auditors when Touche Ross resigned several years ago. The reason was the same in each case: the audits were really undertaken only because a senior member of their staff was involved with the A1 project. Mark Allatt was employed by KPMG and when Mark moved on, the auditors did not wish to continue with our annual audits.

Whilst this arrangement did result in lower audit charges, it also meant the work got lower priority. We had to fit into their timescale and we found this invariably meant that the audits were not completed until the following December.

After some thought the board decided to seek a local firm to undertake our audits and we were pleased to reach an arrangement for this work with BKR Haines Watt. Their offices are only five minutes away from Darlington Locomotive Works and many of their staff are from a now-closed KPMG office.

Their practice is substantial, with over forty offices across Britain, affiliated through BKR International to over a hundred countries. The firm specialises in offering a wide range of services to privately-owned or family-owned companies.

The good news is that audits should be completed somewhat earlier than in previous years and we have reason to hope that the audited accounts will be ready for circulation to covenantors with the next issue of *Top Link*. If anyone with access to the internet would like to know more about BKR Haines Watt, their website can be found at www.hwca.com.

Barry Wilson
Finance Director

Make a note in your diary!

The A1 Steam Locomotive Trust

Annual Convention

Saturday 5 October 2002

Darlington Locomotive Works

See you there!

ENGINEERING QUALITY

On my first visit to Darlington, my over-riding impression – and it gave me great delight – was the physical progress made in the construction of *Tornado*. What I could see taking shape is a wonderful reminder of the magic and majesty of steam locomotives. The achievement of converting basic metal into useful components is one of the great satisfactions that are a privilege of the engineer and craftsman.

Throughout the railway age, taking any locomotive onto the rail network has always required both practical engineering excellence and documents, the aim being to produce, and prove that you have produced, a traction machine that is fit for its purpose and capable of safe operation. British and European legislation have made both paper and practical requirements ever more demanding to meet.

1948 and now

The quality of anything built under Arthur Peppercorn was respected because of the wealth of engineering talent and the LNER facilities he commanded. Now we must demonstrate from our records that quality standards and procedures have been followed – and can be audited by the sceptical – throughout construction. Typically the areas that must be recorded are design, specification, procurement, manufacture, material definition, finished acceptance and lifetime maintenance.

All this brings its fair share of paperwork, but it isn't paper for the sake of it. On the contrary, it is vital. We must be dedicated to applying designated systems and process requirements, or *Tornado* will not gain a licence to operate main-line.

The production team

The engineering organisation needs to reflect the particular experience and skills to implement procedures and documentation. Whilst there has been plenty of activity in these areas, the pace needs to be raised and I am delighted to report that appropriate new volunteers have come forward to support the expertise of the current production team. The enhanced team will be

David Elliott	Director of Engineering
Alan Lusby	Quality Systems and Manual
Graham Nicholas	Railway Inspection Liaison
John Barr	Inward Inspection
Bernie Brooks	Document Controller

We will of course maintain regular dialogue with representatives of the railway Vehicle Acceptance Body, now The Engineering Link, to ensure that we gain quality acceptance and approval at each step in the construction process.

Tony Roche

MORE NEWS ON THE BOILER

Now we know what we want, the rest should be easy: our requirements were outlined on pp. 18–19 of *Top Link* 3. We can now go to a boiler manufacturer and place an order. After all, there are plenty of them, and one of them will want to build our boiler for us. There are railway workshops and firms that make parts and overhaul boilers for preserved railways. There is industry: oil, gas, chemical, nuclear. They use boilers. We have plenty of choice and we can get on with it.

Well, no. Everything in the last paragraph is wrong. We are *not* able to go out and buy a boiler. A steam locomotive boiler is a very specialised piece of equipment, quite unlike a fixed, industrial steam generator. The railway workshops and manufacturers that used to make boilers no longer exist, or know less of this than we do. All we have are a few small, specialist repair firms, although some have recently built non-taper boilers for small locomotives.

Industrial boiler manufacturers understand the general principles that apply to pressure vessels, but not boilers that rush around the countryside at 75 mph. They are not going to learn new skills to build one large – but, to them, non-standard – boiler with no guarantee of further business, and we can't force them to.

In any case, we want more than manufacture: we need redesign services since (as outlined in *Top Link* 3) we need drawings based very closely on Diagram 118, but with welded construction, new materials, and lower dome and safety valves. This work has to be done in a way that will satisfy all the current regulatory bodies, Railway Safety Ltd, HMRI and Railtrack, as well as our insurers.

The A1 boiler is 30 ft long, weighs 28 tons and works at 250 lbs/sq. in. It is big by any standards other than American; if it failed it could throw itself a long way and kill people. All concerned are therefore looking for very high standards.

The first boiler of its kind

No boiler like this has been built in Britain in the working life of almost anyone still at work. No boiler like this has *ever* been built to meet the requirements of the EU Pressure Equipment Directive. This brings into focus the inescapable fact that people who overhaul boilers do not have the knowledge needed to construct a new one, and even those who have built small, brand-new boilers will probably not be equipped to tackle this job. We need expertise of, today, a very rare kind.

This project is extraordinarily bold, and the search for experience and skills has proved complex and prolonged, but it will succeed. We intend to have competitive procurement and as soon as we have more news, you will find it here.

Andrew Dow

SNAP OR FLUSH?

From time to time people ask "Will the tender be welded or riveted?" The answer is not straightforward. Ostensibly, all 49 Peppercorn A1s were built to the same design, but tenders built to Doncaster's interpretation of the drawings looked very different from Darlington's. Up to 1941, almost all high-sided 8-wheel tenders were put together with countersunk (flush) rivets, so tender sides looked smooth.

When new tenders were built for the Thompson Pacifics, round-headed (more correctly, snap-head) rivets were used as an economy measure, as this saved the chore of countersinking all the holes. This practice continued for the Peppercorn A2s and then the Doncaster-built A1s. However, the 23 A1s built at Darlington reverted to countersunk riveting for both tenders and cabs. The drawings specify the diameter of the rivets but not the head shape, so either style is legitimate.

People ask about welding: there is a common misconception that smooth-sided tenders were welded. In fact, only one 8-wheel tender was of welded construction, the one built for P2 2001 *Cock o'the North*. All the rest were given their smooth ex-works appearance by grinding the countersunk rivet heads flush with the plates and applying filler where necessary.

What are we going to do for 60163's tender(s)? Unless a truly remarkable

Snaphead rivets: 60122, Doncaster shed, 29 April 1962. *(photo: G. W. Morrison)*

Countersunk rivets: 60147 inside York shed on 12 October 1963. *(photo: G. W. Morrison)*

sponsorship deal appears, the tender(s) for *Tornado* will be welded. We did have serious discussions with Avesta about the sponsored construction of tender tanks from stainless steel, but the parlous state of the steel industry put paid to this proposal. We will probably go for a mild-steel tank, partly redesigned for welded construction and greater water capacity. This opens up new sponsorship possibilities as it could be made in any of hundreds of UK fabrication yards.

We may consider a complete 'design and build'project – to include frames, wheels and brakes – with a rolling-stock builder. If we were to follow the original design exactly, it would restrict us to a few steam-locomotive specialists with the appropriate riveting capacity – and little chance of sponsorship. Drilling the holes would increase costs by at least half.

When we were still hoping to build *Tornado* at Doncaster, our research found that two methods were used in the steam restoration business: sticking on dummy rivet heads using epoxy adhesive, or machining rivet heads with stub shanks (like short rivets) set in holes in the plates and then individually welded on from inside.

Adhesives work well in structures that suffer no significant mechanical or thermal shock. For a tender tank, mechanical shocks are minor, but the thermal shock is real. Imagine we are steaming along on a bright sunny day: the tender is gradually emptying as its dark paint absorbs heat from the sun. Above the waterline it gets quite warm (say 70–80 degrees F). Then we fill the tender with water from underground at, say, 40 degrees F, and the tank suddenly contracts –

faster than the dummy rivet heads. Eventually, after many cycles, the adhesive gives up and the head falls off, with even worse implications for safety than for looks.

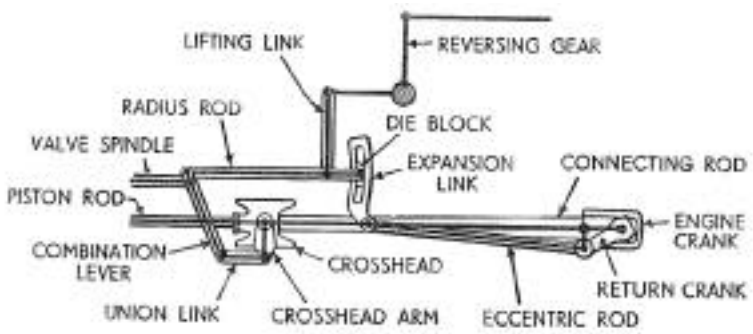
The other option, welding on dummy rivets, is only marginally quicker than riveting the tender together; worse, it introduces potential weld faults that would cause corrosion and ultimately leakage. We calculate the tenders had some 1,050 visible rivets on each side and about 350 on the back – a total of 2,450 rivets to be represented. In view of this, the idea of dummy rivets has been abandoned.

With enforced reconstruction of the cab, we are taking the opportunity to use countersunk rivets for reassembly so that the cab looks at one with the tender. The cab construction does not lend itself to welding, owing to the large unsupported areas of the sides. In any case we may need to partly dismantle the cab when the engine is being repaired. This is easier with rivets.

Historical precedent for the flush tender is strong and, given the continuing assistance from the council and people of Darlington, it is nice to incorporate the one feature that differentiated Darlington- and Doncaster-built A1s. The snap-rivet effect can still be seen on A2 60532 *Blue Peter*, a Doncaster-built loco.

David Elliott

KNOW YOUR DRAIN COCKS



Typical Walschaerts outside valvegear. *(*© George Dow, ***British Steam Horses***, 1950*)*

To boldly go where no editor has split an infinitive before: that is my mission. In response to an overwhelming number of requests (two), I aim to explain this time a few things you always wanted to know about Walschaerts valvegear but never liked to ask. Even this modest aim has its risks, rather like explaining cricket to a South American – long before you get to 'silly mid-on' their eyes glaze over.

The diagram *(opposite)* makes it all perfectly simple, of course. At the top is the bridle rod, by which the driver controls his steed. Using the reversing lever and/or wheel in the cab, he pushes on the bridle rod, the reversing gear pivots, and the lifting link lowers the die block, sliding it down the curved expansion link.

With the die block at its lowest, the engine is (in this typical arrangement) in full forward gear – but stationary. If the driver now opens the regulator, steam enters the cylinder and pushes the piston, the connecting rod starts to turn the crank on the driving wheel, and the locomotive should begin to move. If the driver had moved the reversing gear the other way, lifting the die block from mid-gear to the top of the expansion link, the engine would set off in backward gear.

Tornado has piston valves of 10″ diameter, set above its cylinders. As the wheels turn, the valvegear makes each valve shuttle back and forth, covering and uncovering the inlet and exhaust ports. In full forward gear, the inflow of steam is not cut off until the piston has travelled for 75% of its stroke; hence those loud staccato chuffs when starting. Once the engine is on the move, certainly within a few hundred yards, the driver will use the reverser to lift the die block a little, and so 'notch-up' or shorten the cut-off.

Shortening the cut-off is very much like changing gear in a car: speed is maintained, energy input and mechanical stress are reduced. However, a steam engine has continuously variable gearing with an infinite number of positions. The driver admits steam to the cylinders for only part of the piston stroke – just long enough to give the power required, rather than letting in steam uselessly, only for it to be exhausted up the chimney at little below boiler pressure.

On the crankpin is mounted the return crank: this drives the eccentric rod, making the expansion link rock back and forth, using the die block as its pivot. As the die block is lifted towards mid-gear, it reduces valve travel; the ports are open for less time, and the points of cut-off and release move. At speed on level track, a typical short cut-off would admit steam for only 20% of the valve travel.

Eccentric cranks produce a reciprocating motion that is roughly sinusoidal. This causes the valves to open and close gradually. Ideally, steam engine valves should have an action nearer to a square wave: first fully closed, and then

KNOW YOUR DRAIN COCKS

almost immediately fully open. The clever part of Walschaerts gear is the combination lever, which combines the motion from the eccentric crank (which is at about 90˚ to the piston crank) with that of the pistons. As a result the valves dwell for longer at the end of their stroke (ports fully open), then rapidly accelerate to cover the ports, so there is a free flow of steam through the valves at short cut-offs.

That is why at no. 3 in the Ten Famous Belgians list, behind Hercule Poirot and Adolphe Saxe, must come Egide Walschaerts (1820–1901). He invented his valvegear in 1856 but it came into widespread use only after his death. Unlike Stephenson's gear (invented by an employee, William Howe), it needed only one eccentric rod and, if you placed the cylinders outside, all the gear was fitted outside the driving wheels. Crews found it quicker, easier and cleaner to check and oil. These things came to matter in the age of decreasing profits and increasing staff turnover. On top of that, it uses steam more efficiently.

THE SAFETY VALVE

On the matter of pictures, the Editor has just received a second consignment of photographs from Phil Champion, who was Editor of The Pioneer. Thank you, Phil. Apparently they had fallen down the back of a chest of drawers and have just come to light again. This explains why Gerry Riley's contribution on the derailment at Lincoln had never reached me.

I was also delighted to receive the following letter with two pictures:

Ramsnest Common, Surrey

Dear Mr Hill,

Reading 'What's in a name' eventually stirred some memory cells. After some searching I found in my archives these postcards of 60117 and 60120. I hope that they may be of interest and the trust is welcome to retain them and use them.

Yours sincerely,

P. G. Costello

Peter Costello is very modest about his gift. These are unused colour postcards of paintings by Alan Anderson, such as were widely on sale outside newsagents until colour photographs became the norm for postcards in the later 1950s. The Editor is very grateful; one of these colour cards will be The Big Picture in Top Link *soon.*

THE SAFETY VALVE

The Editor welcomes letters or e-mails from covenantors, especially if they are succinct and polite, but reserves the right to edit for length and content.

Boat of Garten, Inverness-shire

Dear Mr Hill,

I read the latest issue of *Top Link* with considerable interest. The new boiler regulations and their impact on heritage boilers have long been a particular interest of mine, and remain so, though I am now supposed to be completely retired. I have wondered how *Tornado*'s builders were going to cope.

In my experience, there are fewer and fewer people around with much experience or knowledge of loco boilers. I think many of the civil servants dealing with the matter keep shunting it from one 'too difficult' tray to another!

The Mechanicals did take a lead with a committee (on which I sat) on the boiler problem, though it was mainly interested in the problems of manufacturers. At one meeting, I asked about bringing engines back from outside the EU: the DTI rep just said we should have to put a new boiler on!

I was delighted to learn you have recruited Tony Roche as CME. I was very pleased to have a long chat with him at Waverley at the unveiling of the Gresley plaque last summer. Perhaps he may be able to help on boiler problems.

A. J. W. Garraway

Kirkintilloch, near Glasgow

Dear Editor,

I'm sure I was only one of many readers deeply disappointed to read the article on boilers in issue 3 of *Top Link*, with the feeling this was a softening-up exercise to get us to accept that 60163's boiler will not be built in Britain.

If the largest part of *Tornado* is not built here, a lot of the rationale, to recreate part of the British railway scene fifty years ago, is lost. This would be only a step away from buying an Indian or Chinese loco.

Tornado will be just the first of many British locomotives requiring a large new boiler. Even if no more new locos are built, existing ones will need new boilers sooner or later, if they are to stay in use.

I would like to think that a British manufacturer can be found and/or persuaded to build boilers for *Tornado* and subsequent customers. I do not believe there is no British firm capable of doing this work to the required standard.

Angus Dougall

Ed: We would all like to think that, but we haven't yet found a British firm willing and able to build our boiler. As I appreciate that the last issue may not have answered all Mr Dougall's questions, I have asked Andrew Dow to explain a little further why building the A1 boiler is so tricky. *See page 19.*

Bill Bratton sent this pleasing picture of 60129 *Guy Mannering* in the morning sun on 11 October 1961, already coaled and watered, turning at Haymarket shed (64B) after arriving at Edinburgh Waverley with an overnight sleeper from Kings Cross. That pipe behind the driver is using the locomotive vacuum-brake system to power the turntable. Can anyone supply the wording of the sign on the pipe? It begins 'Notice: All engines must . . .'. The smokebox door seems to have been drawing air around the lower rim, perhaps because of distortion of the door but more probably because the asbestos rope seal had failed, apparently a common problem. Although somewhat grimy, 60129 (from Heaton shed on Tyneside) seems steamtight and in good order, but in the background is one of the new diesels: a Brush Type 2? *(photo: W. M. Bratton)*

60123 down the bank at Lincoln

Further to the photographs and commentary sent from New Zealand by Stephen Williams, the Editor received a letter from Alan Garraway, whose father was in charge of the righting of 60123. Alan has promised some further photographs and the Editor is also still hoping to hear from Gerry Riley on the subject.