



The brave new world of steam . . . this is the Class 52 'Kriegslok' which has been rebuilt by Sulzer as a prototype for a new generation of ultra-efficient steam locomotives. No. 52.8055 is seen near Einfahrt Hendschiken on August 1, 1999 with the 'Nostalgie Orient Express'. NICOLE MANSKE.

CLEAN STEAM

An environmental revolution is taking place which could give steam traction a new and greener image – and thereby a new lease of life. CHRIS MILNER flew to Switzerland to get the low-down on 'high-tech steam'.

COAL-fired steam locomotives portray an unfortunate public image. Much-loved though they are for nostalgia reasons, environmentalists view them as dirty, smelly and old-fashioned.

Modifications to improve such engines are of course nothing new, but as cleaner and more efficient diesel and electric traction makes even greater strides, several eminent engineers have strived to increase the efficiency of the steam locomotive.

In Britain, standard gauge heritage railways still operate steam the traditional, labour-intensive way – coal-fired with two crew members. Even though the majority of footplatemen are volunteers, there are still numerous disadvantages for the operator. These include preparation and disposal overheads, fire risks in dry weather, long lead-in times and the problems of finding coal of a suitable quality now that the destruction of the British coal industry is all but complete.

Oil-firing, as practised by several UK narrow gauge lines, is also dirty and inefficient compared with internal combustion and, at the time of writing, only three owners of standard gauge

locomotives have made public their intentions to equip their locos to run on both coal and oil in the future.

But what would happen if steam were to undergo such a radical rethink that it actually overtook diesels and electrics to become 'Clean Steam' – the power form of the 21st century?

In Switzerland, they are working to prove it can. Having already proved that powerful narrow gauge locos can be built to run on light oil (similar to that used for central heating) with the bonus of just one person on the footplate, engineers have now modified a huge German Class 52 'Kriegslok' 2-10-0 to run on the same grade of oil. Already it is showing considerable savings in efficiency, a potentially

longer boiler life and a virtual doubling of its horsepower.

The company undertaking this innovative and radical work is one with a name well-known in British traction circles – Sulzer Winpro – and the man behind it all is Swiss engineer Roger Waller, head of steam development at Sulzer's Winterthur works.

Waller is a disciple of the great Argentinean steam pioneer Livio Dante Porta and is also keen to perpetuate the work of two other eminent exponents of high-tech steam – David Wardale and Philip Girdlestone.

Sulzer now owns the former Swiss Locomotive and Machine Works (SLM), and recently sold part of the site to Adtranz. Sulzer retains the SLM name and under that, has built eight narrow gauge steam locomotives for Swiss and Austrian tourist lines. These use methods and technology which not only make them more efficient, but increases their power output so much that they can compete with diesel or electric locos of similar size.



Left: A close-up of the Brienz-Rothorn Bahn's SLM-built 0-4-2T No. 15 – which uses new steam technology – leaving Brienz station on September 8. It's hard to believe that this loco is just three years old. CHRIS MILNER.

CLEAN STEAM

Right: An amazing shot of 'New Kriegslok' No. 52.8055 undergoing testing of its new motion inside the workshops at Winterthur earlier this year while suspended a few inches from the ground by overhead gantry cranes. Memories of Rugby testing plant come flooding back!
NICOLE MANSKE.

The company is believed to be the only one in the world currently specialising in the design and manufacture of 'modern' steam locos, as opposed to conventional steam engines in China and Britain (the latter qualifying by way of the A1 Pacific and various narrow gauge locos).

Sitting in a modest office in the middle of continental Europe and sipping coffee from a mug depicting GWR 4-4-0 *City of Truro* (having handed me one with LMS 'Jubilee' *Bahamas* on it!), Roger Waller, who was born in Zug (coincidentally the German word for train!) explained the background to his 'new steam' project.

"I've always had an interest in steam, and during student holidays I travelled to Braunschweig to learn more, although at that stage I had no intention to build locos.

"I later trained as a driver on Rhaetian railways before joining SLM in the late 1970s, working on various diesel and electric projects.

"Then, during a holiday to South Africa in 1981, I got to know David Wardale, the man who had his own ideas about modifying steam locos and who was behind the dramatic and extensive modification of South African Railways' 25NC class 4-8-4 *The Red Devil*.

He was such an influence on me that when I returned to SLM, I decided I wanted to help him further – so I quit my job to work as his assistant for two years between 1982 and 1984."

It was during Waller's time in South Africa that he saw a copy of a report comparing the costs of steam, diesel and electric traction on the Kimberley-De Aar line, which showed that 25NC locos were far more cost-efficient at that time than 7E electric or 34 class diesels.

"Taking into consideration the capital costs of the electrification equipment, its maintenance and the cost of diesel fuel, coal was cheap and in plentiful supply. To this day I remain unconvinced about the advantages of modernisation on such a scale and at such a pace."

Waller firmly believes that steam in most countries of the world was dismissed too prematurely, aided by what he calls "creative



Right: Inside the main erection shop at Winterthur, where so many Swiss steam and electric locomotives have been built, is the tender for No. 52.8055 viewed from the cab end showing the oil and water capacity gauges. At the rear is the former SLM works shunter.
CHRIS MILNER.



accounting" – Britain being a prime example, particularly in the aftermath of the Beeching report.

"There was no good reason why so many locomotives needed to be scrapped, and with such haste", he says. "Many had seen only a few years service."

Returning to Winterthur after his spell in South Africa, Waller was convinced more than ever that there was a future for steam using modern technology which had not yet been fully exploited. He therefore began to assess

the advantages and disadvantages to see if the shortcomings could be eliminated, or at least reduced.

He had identified that the disadvantages of 'old' steam were its staffing costs, high maintenance costs, low efficiency, pollution, preparation and disposal times and the problems associated with rivetted boilers.

After some theory and experimentation in the late 1980s, his breakthrough finally came at the beginning of the 1990s when he received a private letter complaining about creeping 'dieselisation' of the Brienz-Rothorn Bahn (BRB), the highest steam-operated line in Switzerland. In the letter was a suggestion that the railway be encouraged to build a new steam loco.

At that time, Winterthur Works was still owned by SLM and Waller's response was also in a private capacity – but with the approval of an SLM director. It led to an official request from the BRB to build a new loco. Now all Waller had to do was convince SLM this was a sensible commercial step to take!

As can be imagined, this would require enormous persuasive powers and hard-headed arguments, but he managed to convince the company to undertake a marketing survey to see if there were any more potential customers. Remarkably, a major one was found with the decision of Austrian Federal Railways (ÖBB) to place an order – and so, almost overnight, the credibility of high-tech steam soared.

Waller's proposal was to build a



On September 7, 52.8055 was undergoing attention to its horn guides and other components at Winterthur. Despite the apparent intensity of the repairs with all wheels out, Roger Waller was confident that the loco would be back in one piece by October. CHRIS MILNER.



The BRB's prototype 'new' steam loco No. 12 makes no exhaust as it storms up the 1-in-4 on the outskirts of Brienz towards the mountains in this typical Swiss landscape. CHRIS MILNER.

conventional-looking steam locomotive, running on light oil, which would out-perform existing diesel locos of equivalent size and gauge and whose trains would require only a driver and a guard.

In order to save on the cost of a fireman and eliminate one of the most inefficient and frustrating aspects of conventional steam locomotive ownership, he also intended to fit a water pre-heater to keep the loco in a virtual state of readiness.

The BRB's loco cost 1.8 million Swiss francs (around £775,000) and although SLM had built a few new boilers in 1986, this was the first steam loco it had built in its entirety since 1952!

Designated type H2/3, it featured a fully-insulated lightweight all-welded boiler, with modified draughting and streamlined steam passages, which was far more thermally efficient than those of the coal-fired locos.

In addition, the use of light oil meant that pollution would be minimised. This has been confirmed by subsequent tests which have shown that carbon monoxide and nitrous oxide emitted by the new steam loco are considerably less than a diesel of the same vintage. Additional operational benefits were the elimination of fire risk due to lack of sparks (indeed, there was virtually no exhaust at all if the combustion mixture was right) and the fact that there was no smokebox or ashpan to clean.

Work on the prototype, which became No. 12, began at Winterthur in 1990 and was completed and commissioned in July 1992, coinciding with the BRB's centenary year. Like all previous locos, it carries an SLM works plate.

So pleased was the railway with its acquisition that it later increased the order to three. It already operated seven SLM-built 0-4-2Ts on the Abt rack system – including five which were more than 100 years old – and although its passenger figures were rising, the new arrivals allowed some of its older locos to be retired. One, No. 4, now

stands plinthed between the BRB station and the lake at Brienz.

The line itself is 7.6km (4.7 miles) long, of 800mm gauge and twists and turns as it climbs 1,678 metres from the Brienzersee (lake) at 566 metres above sea level to the summit station at 2,244 metres (7,360ft) above sea level. The ruling gradient is 1-in-4.

Another key design feature incorporated by Waller was that of weight reduction. The BRB insisted that the maximum weight of the two-coach train and loco should be 23 tons. With the coaches weighing seven tons together, this meant that the loco had to weigh a maximum of just 16 tons.

Some of the weight-saving measures adopted included the use of an all-welded boiler instead of a rivetted one, and the deployment of a light steel, again welded, in place of the usual heavy cast-iron cylinders.

In the firebox, there was a particularly innovative departure from tradition, the normal brick arch being replaced by a heat-resistant stainless steel screen. The cab and water tanks are also of all-welded construction.

As Roger Waller points out: "Much of this technology was not possible until recently as the materials simply did not exist."

The heavily-insulated boiler is another key design feature, for after a day's work, much of the heat is retained and the next morning there is often 70psi on the clock, meaning that a working pressure of 225-250psi can be attained in just 15-20 minutes.

Thanks to modern telecommunications, it is even possible to have a stone-cold loco operational in next to no time too – for the pre-heater can be switched on from the driver's home so that by the time he arrives at the shed, the loco is already in steam!

Further weight savings were made below the running plate. The complex motion of these rack locomotives is built from new types of steel and the wheels are, of course, roller-bearing fitted.

The only area Roger has still not been able to resolve concerns boiler washouts; the locos still have to be taken out of service for a day every three to four weeks for such a task.

So how is such a one-man machine driven? From the right-hand position, the driver works the loco with one hand on the regulator and the other on the oil feed valve. Other controls immediately to hand include a brake valve, drain cocks and the injector feed controls. Behind the driver is an additional set of controls used only during the descent. What is particularly noticeable is the uncluttered appearance of the cab; there is no



Left: The cabs of SLM's new narrow gauge steam locos are clean and tidy without the clutter of piping normally found in loco cabs. The driver has his right hand on the regulator and his left is on the oil control valve. SLM.

“ Much of this ‘new steam’ technology was not possible until recently as the materials simply did not exist ”

CLEAN STEAM

Right: In comparison to the picture on the previous page, the Brienz-Rothorn Bahn's 1933-built No. 6 emits acrid sulphurous smoke as it leaves Brienz station on September 8. CHRIS MILNER.

labyrinth of pipes and gauges.

Figures produced by Waller show that the BRB's 1890s steam locos can propel one coach of 48 passengers and a crew of three up the mountain (For this he gives a productivity index of 100). Two newer SLM steam locos built in the 1930s with larger boilers can propel two coaches holding 80 passengers, for which they have an index of 167.

Of the line's four diesels, one can manage a single coach with a capacity of 48 (index of 150), while the three newer locos can take two coaches for a productivity index of 350).

But, astonishingly, prototype steam loco No. 12 was found to easily manage two coaches with 120 passengers... resulting in a productivity index of no less than 375. It thus became the most productive combination on the railway.

For the remainder of 1992, No. 12 covered 1,040 miles (1,675 km), but the following year this had almost trebled to 2,865 miles and rose further in 1994 to 3,500 miles. By then the two production locos - Nos. 14 and 15 - had joined it. (The BRB omitted No. 13 because of the usual superstition connected with that number!).

Mention was made earlier of the ÖBB. Alongside the construction of No. 12 in 1992, SLM also built two other similar prototypes with interchangeable parts - one for ÖBB for use on the Schafbergbahn and the other for the Montreux-Glion-Rochers de Nay line (MGN) in the east of Switzerland.

These two also enjoyed unparalleled success and resulted in orders for three production series locos for ÖBB. These were built alongside BRB Nos. 14 and 15 in 1995 and 1996.

Comparison figures for No. 12 against a 1930s-built coal-fired loco have revealed some staggering results - a 36 per cent increase in power, 82 per cent increase in power-to-weight ratio, a reduction in fuel consumption per trip



of 41 per cent, and a 56 per cent increase in speed up the mountain. Analysis also showed that around 12.5 per cent of heat was transferred into kinetic energy at the axle, almost double that of the 1930s locos.

Figures kept by Waller for the BRB show that the three new locos now account for 42 per cent of all mileage on the line and rack up annual average mileages of just under 2,800 miles each.

"With just one man on the footplate, aren't there safety implications", I asked Roger. "Not at all," he replied. "It is not proven that having two people on the footplate is safer and in any event, the locos are fitted with a deadman's pedal, plus rollback and over-speed detectors, both of which are electronically-controlled and which will apply the brakes. It is very safe."

To find out how the operators of the new locomotives have found them, I visited the BRB and met Pia Meier, the line's marketing manager. "Considering these are the first steam locomotives the line has bought for 60 years, we are very pleased with them," she said. "After some initial teething problems, all three are now in daily use."

"They are much more powerful, very cost-effective to operate and are liked by the crews as they are clean and efficient.

"For the older locos, we have to import coal from Germany's Rhur region which costs 500 Swiss francs (£210) per ton. Each round trip uses coal worth £72 plus the wages of the three crew. In contrast, we pay 33 cents (14p) for a litre of oil for the new locos which have a consumption of around 150-160 litres of fuel on a round trip. This equates to around £22 plus the wage costs. Hauling one coach with a coal-fired loco, and two with the oil-burner, the economics are understandable", she added. Currently, a return ticket to the summit by steam costs £28, so a full train with 'new' steam grosses £3,350 for a fairly minimal outlay in fuel and staff costs." Impressive profit potential!

Ms Meier added that the railway has ambitions to increase its annual passenger figures from 165,000 to 190,000 and eventually 200,000, but that thanks to the new engines, it doesn't need to order any more locos for this, just coaches. The increase is quite feasible as the railway's centenary year produced a record 250,000 passengers.

To discover how these space age machines perform from an enthusiast's point of view, I took a ride behind No. 12 with two coaches. It certainly seemed an accomplished performer, digging in hard when the going got tough, although the exhaust note is much softer and

LEADING PERSONALITIES IN THE MODERN DEVELOPMENT OF THE STEAM LOCO

LIVIO Dante Porta has without doubt made the most significant contribution to developing an ultra-efficient steam locomotive in the past 40 years or so.

Born in 1922 in Argentina, he was a student of the great SNCF loco engineer André Chapelon and at the age of 26 performed his first modifications to a steam loco.

Porta became renowned for the gas producer combustion system (GPCS), a simple change that provided improvements in boiler efficiency, with reduced smoke.

Later developments by Porta included revised design and construction methods, and the use of state-of-the-art materials. Among his most significant developments have been Kylpor and Lempor exhaust systems.

In the late-1950s, Porta took a position as general manager with the Argentinian Rio Turbio Railway, where he successfully undertook modifications of the engines to improve their efficiency, power, and availability. A move to become head of the thermodynamics at the Instituto Nacional de Tecnológica Industrial, Buenos Aires, allowed him to devote more time to the next generation of steam locos.

Now in his 70s, Dr Porta's opinions and views are still sought worldwide. For Britain's pioneering A1 project, he produced a 150-page

proposal for efficiency and performance improvements linked to the maintenance of a traditional appearance. Some proposals have been included, but other more radical changes have been resisted.

Porta's most recent work was in Cuba on the 1919-built Alco-built 2-8-0 No. 1816. Rebuilt under his supervision, No. 1816 (featured last month) has GPCS to allow it to run on 'bagasse' (sugar cane waste), improved draughting, a feedwater heater and higher boiler pressure.

In South Africa, considerable work has been done by David Wardale based on Porta's principles. Working for South African Railways from 1974, Wardale believed SAR was making a mistake in scrapping its steam fleet, and made suggestions of improvements, but with little effect on the management. He was, however, allowed to convert 19D 4-8-2 No. 2644 to run as a GPCS loco, resulting in increased power and economy.

Wardale also set about creating the one of SAR's most modern locomotives, 25NC 4-8-4 No. 3450 'The Red Devil'. With assistance from SLM's Roger Waller, No. 3450 was fitted with the GPCS system, enlarged superheater, a double Lempor exhaust and a feedwater heater, resulting in a 38 per cent reduction in fuel costs compared to unmodified 25NCs, with

drawbar horsepower readings in excess of 4,000hp.

When Wardale left South Africa, he spent time at Datong in China working to modify a QJ 2-10-2. Despite equipping No. 8001 with GPCS, plans by Wardale for other improvements - triple Lempor exhaust, roller bearings, valve improvements and increased superheat - were never carried out.

In the past decade, the principles of Porta are still being followed by a number of engineers. The Ffestiniog Railway's Hunslet 2-4-0STT Linda was at one time fitted with a GPCS system and Lempor exhaust by Phil Girdlestone.

Girdlestone also worked with Hugh Phillips Engineering to modernise several 2-8-2s in the Sudan, before he moved to the Alfred County Railway in South Africa, where Wardale's ideas were applied to a couple of NGG16 'Garratts'.

Nigel Day and Shaun McMahon have been involved in fitting Lempor exhausts to two Welshpool & Llanfair locos, and more recently Day has been involved in the oil-burning project of Snowdon Mountain Railway's No. 4 Snowdon.

Meanwhile, in Britain, revised Caprotti cams and improved draughting are just two of the improvements being fitted to BR Class 8 Pacific No. 71000 Duke of Gloucester during its rebuild at the East Lancashire Railway.

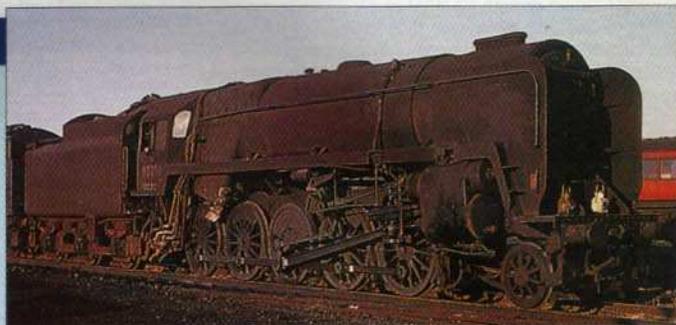
Considering these are the first steam locomotives the line has bought for 60 years, we are very pleased with them. After some initial teething problems, all three are now in daily use.

PAST BR STEAM EXPERIMENTS

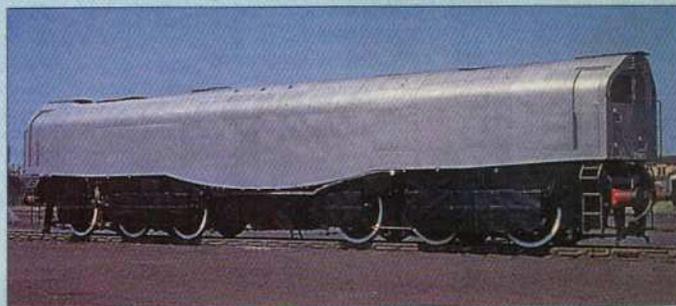
AS late as the 1950s and 1960s, new locomotives being built under British Railways were the subject of experiments in a bid to improve efficiency. A batch of ten BR Standard 9F 2-10-0s, Nos 92020-9, were fitted with Franco-Crosti boilers which had water pre-heaters. The idea behind the design was that hot gases, after passing through the main boiler flues, were drawn backwards through the tubes of the pre-heater, heating the water before it entered the main boiler. Several similar pre-heating experiments had been tried over the preceding 50 years. The conventional chimney was only used for lighting-up purposes. The lack of any real benefit prompted BR to consult André Chapelon before they were converted back to conventional operation. Here, No. 92028 emits a plume of black smoke from the chimney half-way down the right-hand side of the boiler as it shunts coal wagons at Finedon Road, Wellingborough, in July 1959. KEN FAIREY/COLOUR-RAIL.



Right: With flush-sided streamlined casing more akin to an aircraft than a locomotive, Bulleid's ill-fated 'Leader' gets attention outside Eastleigh Works in 1949. By early 1953, national papers were headlining the scandal that despite more than £500,000 being spent on the locomotive, a not inconsiderable sum just after the war, it was a design disaster that had been left to rust in sidings. COLOUR-RAIL.



Above: BR 9F No. 92250, last in the series, was also an experimental loco, being fitted with a Giesl ejector designed by the Austrian Dr Adolf Giesl-Gieslingen, in an attempt to increase the boiler's steaming capacity without increased back pressure. The blastpipe inside the smokebox was formed of a series of nozzles. Built in 1958 at Crewe, No. 92250 – pictured at Oxley in January 1966 – underwent extensive testing at the Rugby test plant attended by Dr Giesl, but like the Crosti, the end results were disappointing and inconclusive. Success with the Giesl ejector was finally found after being fitted to 'Battle of Britain' class No. 34064 *Fighter Command*. Several 'Austerity' 0-6-0STs were also fitted with ejectors, and in preservation *City of Wells* and BR Standard Class 2 No. 78022 have run with the devices. Photo: K. COOPER/COLOUR-RAIL.



But if the narrow gauge locos represented Waller's breakthrough, then his *piece de resistance* came in the form of the rebuild and modernisation of the German 'Kriegslok' 2-10-0.

Owned by the Eisenbahnfreunde Zollernbahn (EFZ), former Deutsche Bundesbahn Class 52 No. 52.8055 was extensively rebuilt by the Sulzer Winpro workshops at Winterthur, making use of the same techniques and principles used for the eight rack locos.

The intention was to use it on the 'Nostalgie Orient Express', a luxury train operating in Switzerland and Germany, owned by the Reiseburg Mittelthurgau and unconnected with the existing VSOE operation, although the coaches used are from the 'Rheingold Express' and other famous European trains.

"Working with the Class 52 was different, because any conversion is bound to be a compromise," said Waller. Some three-quarters of the loco's components were renewed in the rebuild, with the redundant parts being made available as spares for other class members, but Roger says he has "not destroyed anything of significant historical importance, even though more than 200 other examples of the class have survived".

Many of his modifications to No. 52.8055 were based on the principles of Dr Porta, probably the best-known expert in steam loco modification.

Dr Porta (see panel), is a consultant to SLM and was involved in the design of the Kriegslok's Lempor exhaust. He was also present in Winterthur when the 'tuning' of the

loco took place.

Inside the firebox, a new burner system with a 'swirl' effect has been developed by Waller, and as with the narrow gauge locos, the boiler and cylinders have been heavily insulated to retain heat.

Waller firmly feels that heavy insulation of the boiler and cylinders, allied with the more frequent use possible with his engines, means that the highly-destructive expansion and contraction effect on the boilers can be reduced, thereby prolonging their life and removing one of steam traction's greatest weaknesses.

To carry the oil and give the loco an increased range, a tank unit from a redundant road petrol tanker has been fitted on top of the tender. While this may not be aesthetically pleasing, it does allow the capacity to be increased to 9,000 litres (1,980 gallons), in turn allowing the water capacity to be increased to 33,000 litres (7,250 gallons).

While in the works, the Class 52 was given new axles, axleboxes, roller-bearings, crankpins, pistons, valves and a lightweight motion. There were concerns about a possible failure of the motion on the main line, so before leaving the works, the loco was lifted off the rails and suspended from overhead cranes with transverse cross-beams underneath. It was then 'run' at speed with strain gauges attached to the motion to check all was well. Only when Waller and his team were satisfied was the loco allowed out on the main line.

Finished in March this year and outshopped in blue livery with a broad yellow band along the running plate and tender to match its rake of coaches, it underwent a

series of test trains with wagons and coaches around the Winterthur area in March and April before undertaking its first passenger runs at Easter.

Waller had gathered test data relating to the Class 52's performance before the rebuilding for subsequent comparison, and not only did the tests and live running prove the viability of his theories beyond doubt, but the Swiss railway authorities agreed to an increase in the loco's maximum permitted speed from 70 to 100km/h.

The most significant change, however, was the increase in power output, which, says Waller, has almost doubled – from 1,600 to 3,000hp.

The revitalised No. 52.8055 has now run more than 10,000km (6,200 miles) and in late August was returned to Winterthur workshops for further work.

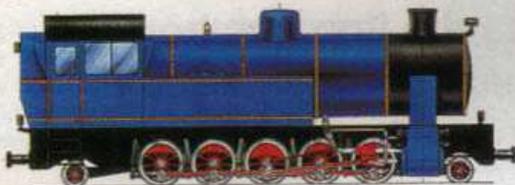
The only serious concern Roger has is the discovery of cracks in the horn guides, although it should be pointed out that these were not replaced as part of the rebuild. The wheels and motion were out during *The Railway Magazine's* visit to Winterthur and the loco is due back on the Swiss main line by October.

"Such cracks are a trade-off you have to accept when partly rebuilding locos, and re-using parts, rather than constructing new ones", explained Waller.

The big question is: could his theory and practice be used to good effect on British heritage railways?

It could, but Waller feels that heavy insulation of the boilers of British locos, especially tapered ones, would seriously affect their aesthetic appearance and he would

CLEAN STEAM



The Roger Waller design for SLM of a thermally efficient oil-burning metre-gauge 2-10-2T. This would be suitable for the German narrow gauge lines such as the Harzquerbahn, but has yet to attract sufficient interest to move to the production of a prototype.

especially tapered ones, would seriously affect their aesthetic appearance and he would therefore recommend all-new construction rather than the rebuilding of old favourites.

"Traditional heritage line such as the Severn Valley and Mid-Hants are better to carry on as they are," he comments. "But what they might find an advantage, on cost grounds, would be the consideration of oil-burning.

"However, for pure tourist lines, such as the Snowdon Mountain Railway, I can see a very big advantage of using the new technology throughout."

So what next? The encouraging thing is that Sulzer Winpro has agreed to continue the steam technology work begun by SLM, and the company has been rewarded for its faith by scooping a prestigious contract to convert four Lake Geneva paddle steamers from diesel to steam. There is an interesting touch of irony where these are concerned, for 40 years ago Sulzer supplied the now life-expired diesel engines to replace the paddle steamers' original boilers!

"This is one area where steam has gone full circle," said Roger with a satisfied smile. "I call it revapourisation."

In a separate workshop at Winterthur, the first of the four giant boilers is being erected, next to which is the paddle gearbox. As with the new steam locos, the new boilers will use oil and be very efficient. Because of the huge size of the boilers, the ships are having to be rebuilt around them, the first being likely to appear in 2001.

Back on the railway front, Waller has in the workshops an ex-SNCF 2-8-2, No. 141R1207, for a conventional overhaul, and a German main line loco, 2-6-2 Class 23 No. 23.058, owned by the Swiss 'Eurovapeur' group.

The man who owns 141R1207 also owns the ex-Bressingham Steam Museum classmate No. 141R73 – which is likely to be fitted with a gas producer system – while a third, No. 141R1332, could end up as a fully oil-fired modification with even more extensive work than on 52.8055, so Waller is optimistic about the future.

He has also produced designs for a medium-sized 2-10-2T, codenamed G5/7, with which he is hoping to interest some of the German narrow gauge steam lines such as the Harz, but so far no firm orders have materialised. Given the parlous state of some of these lines, they are unlikely to do so for the time being.

A tentative order for four 0-8-2T rack locos for the Nilgiri Mountain Railway in India is also being pursued, and there have even been enquiries about gas-fired locos for Russia.

Clearly, exciting developments such as these, coupled with a growing worldwide interest in 'clean steam', could indeed provide an environmentally-friendly future for one of man's most trustworthy inventions as it enters its third century.

After all, our readers predicted in the 1997 centenary souvenir issue of *The RM* a world 100 years hence in which ultra-efficient nuclear-powered steam turbine – and even 'steam-electric' – trains are the accepted way to travel!

RM