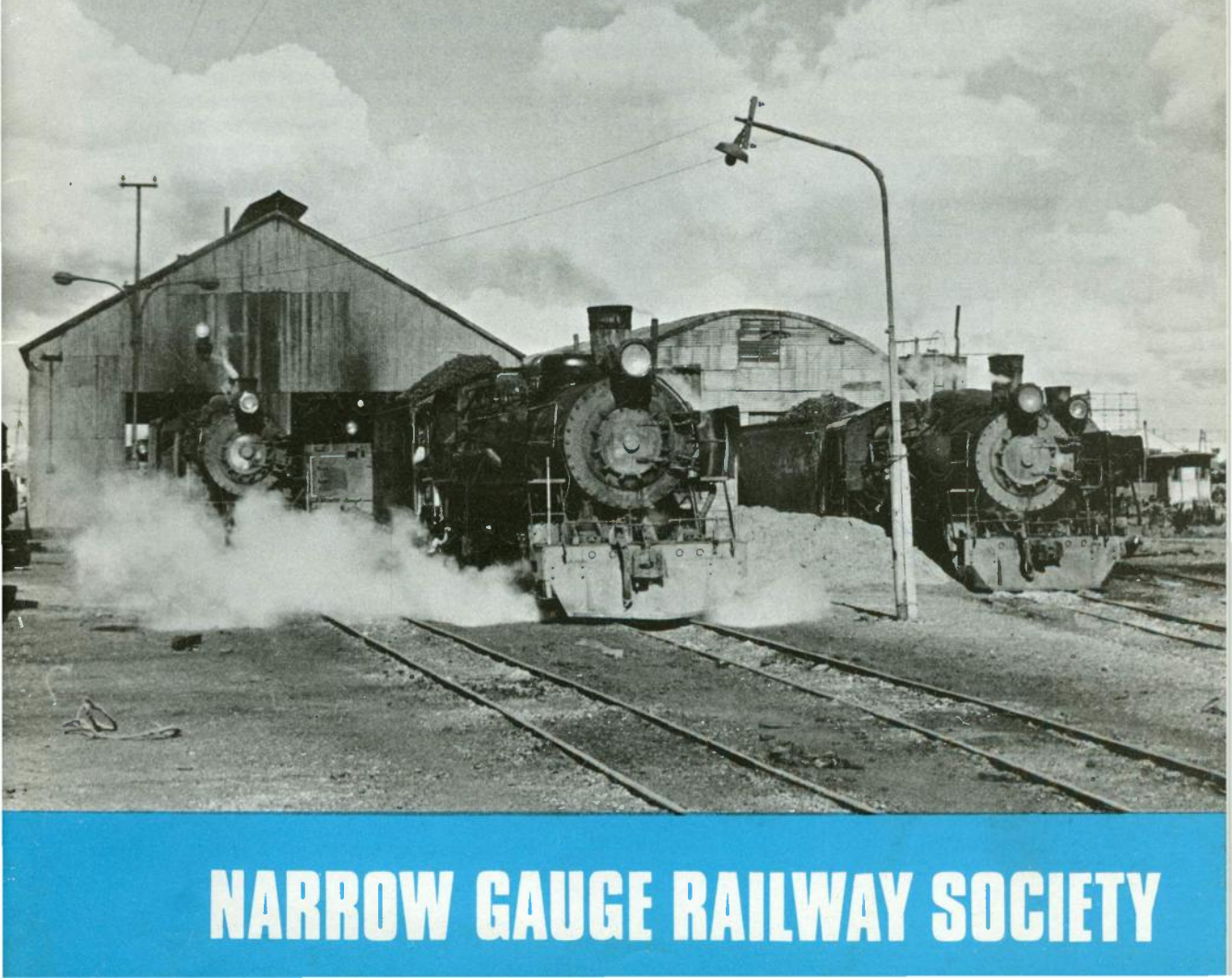
THE NARROW GAUGE

No.82



NARROW GAUGE RAILWAY SOCIETY

NARROW GAUGE RAILWAY SOCIETY

Serving the narrow gauge world since 1951

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The Society was founded in 1951 to encourage interest in all forms of narrow gauge rail transport. Members interests cover every aspect of the construction, operation, history and modelling of narrow gauge railways throughout the world. Society members receive this magazine and Narrow Gauge News, a bi-monthly review of current events on the narrow gauge scene. An extensive library, locomotive records, and modelling information service are available to members. Meetings and visits are arranged by local areas based in Leeds, Leicester, London, Malvern, Stoke-on-Trent and Warrington. Annual subscription £4.50 due 1st April.

THE NARROW GAUGE

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Published quarterly by the Narrow Gauge Railway Society to record the history and development of narrow gauge rail transport. Our intention is to present a balanced, well illustrated publication, and the Editor welcomes original articles, photographs and drawings for consideration. Articles should preferably be written or typed with double spacing on one side of the paper only. The Editor appreciates a stamped addressed envelope if a reply is required. A range of back numbers, and binders for eight issues are available from the address above.

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EDITORIAL

No 82 WINTER 1979

Our intention was to include in this, the last issue of *The Narrow Gauge* for the current year, something for everyone. However "The World's Most Advanced Steam Locomotive" is considerably larger than was originally planned and several short articles have therefore been held over until the Spring issue. We first learned of the Rio Turbio 2-10-2's in 1964 but it was only in 1972 that Ken Mills became the first enthusiast to "discover" the railway and report his findings. Preparing the article was a team effort lasting several months, and we hope that you agree that the space we have devoted to this subject, and the title, are fully justified.

Railway enthusiasts are reputed to be wonderful at reminiscing. Why then do we receive so few articles describing a memorable trip to this railway or that country? To our younger members 1960 is ancient history and I know that many of you were active much earlier. So why not let us share your experiences on the narrow gauge, not only last year, but a decade or more ago.

Cover: Narrow Gauge Super-Power. Four of the world's most advanced steam locomotives line up outside the R.F.I.R.T. depot in Río Gallegos. (K. Mills)

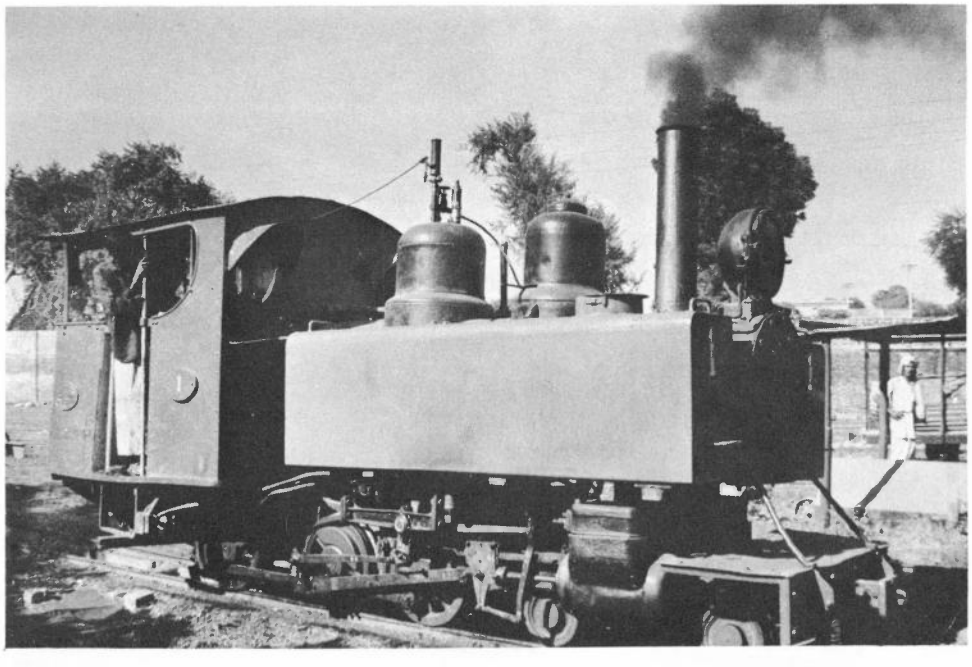
MORE LIGHT ON THE BALDWINS

M.G. Satow, O.B.E.

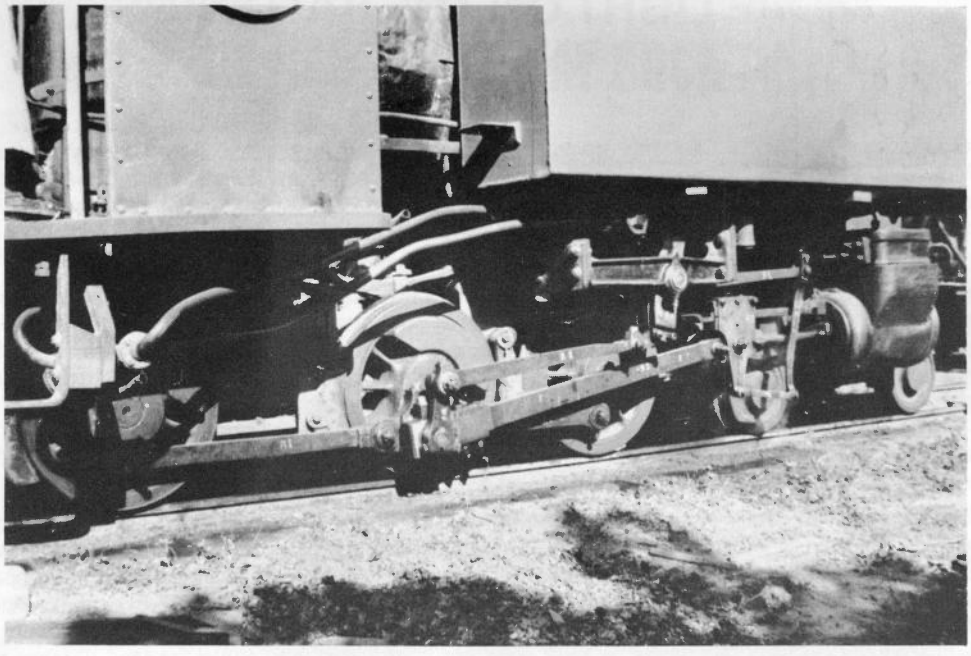
I was very interested in Mr. D. Clayton's article on the former War Department Light Railway Baldwin 4-6-0 tank locomotives in *"The Narrow Gauge"* No. 80, and would like to add a few details. It is fortunate that several of the class survive in regular service in India even today, and in late 1972 I spent some time examining Baldwin 44899 at the Khatauli Sugar Mill in Northern India. These notes and the accompanying photographs are the result.

Mr. Clayton made reference to the lack of available detail of the hinges on the side tank filler hole lids. These were not arranged to lift up, but swivelled sideways on a pivot on the side adjacent to the boiler. A pivot pin was riveted into the lid, which was simply a circular, flat plate, and this pin fitted into a strap riveted to the outside of the filler branch. This pin might have been a little aft of the transverse centre line, but almost certainly survived on the Ashover Light Railway locomotives because the cover photograph and the upper photograph on p.16 show the lids half open and casting a shadow on the filler branch. Khatauli Sugar Mill 1 had been fitted with replacement side tanks of welded construction, but the original filler branches were used again, but fitted 'inside out' so that the strap and pivot pin show quite clearly on photographs.

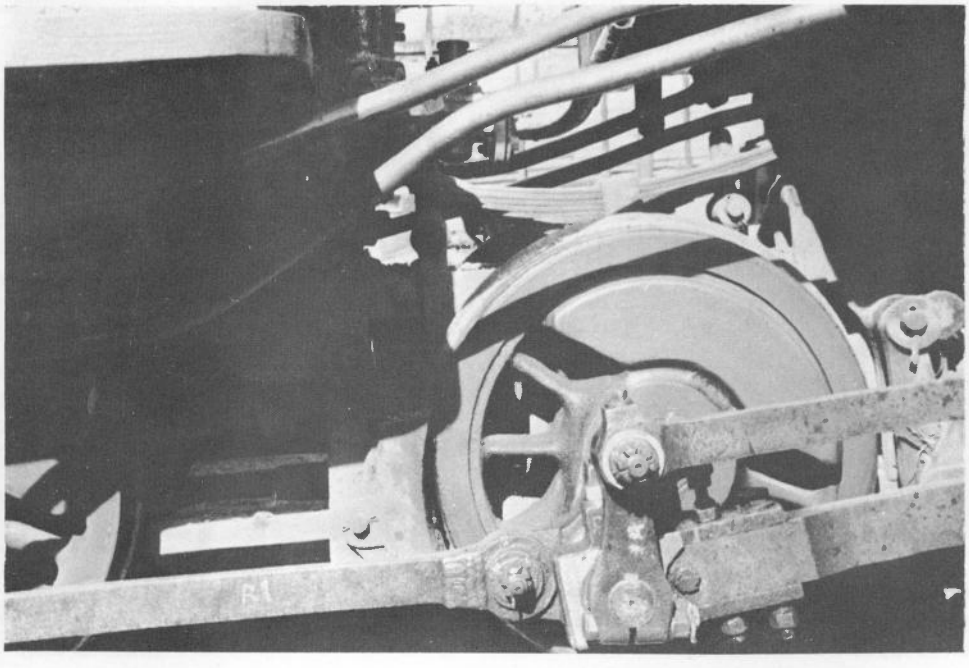
I was also able to obtain details of some of the cab fittings, although naturally there have been some changes in sixty years operation. The water gauge is mounted on the left hand side of the firebox, and carried on stalks from the backhead. The upper stalk is fitted into a right-angle palm flange riveted to the firebox wrapper. Two test cocks are mounted on the right hand side, and blow off into a cast-iron tundish with a drain pipe down through the cab floor. The near side of the tundish is vertical and the far side curved around the firehole door to give an elongated slot on top. The reversing lever quadrant is provided with closely spaced notches to allow 'notching up' almost ad infinitum! The original American injectors on this locomotive had been replaced by Gresham & Craven units, which were readily available in India.

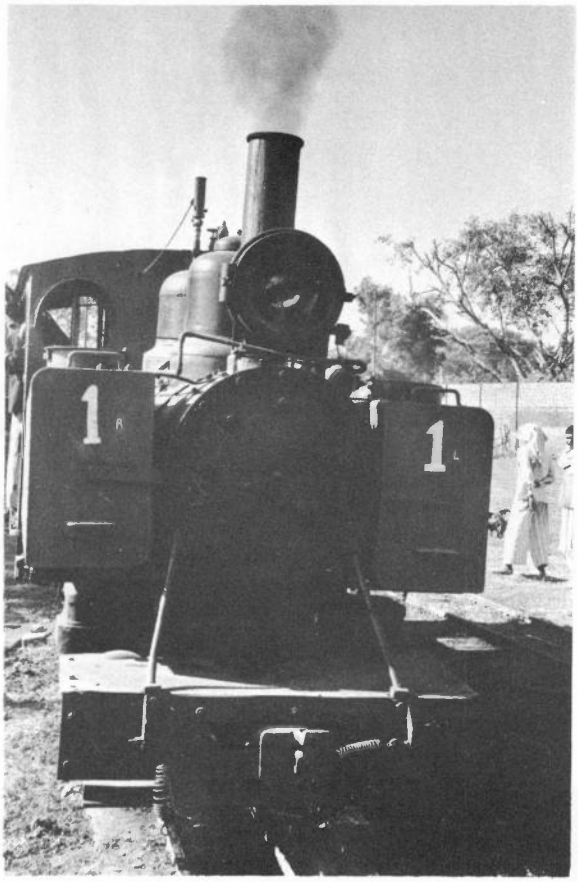


Khatauli Sugar Mill 1 outside the shed in November 1972. It still carries its BLW builders plate 44899/1917, and apart from new safety valves, whistle, electric headlight and welded side tanks appears almost as originally built. *(M.G. Satow)*

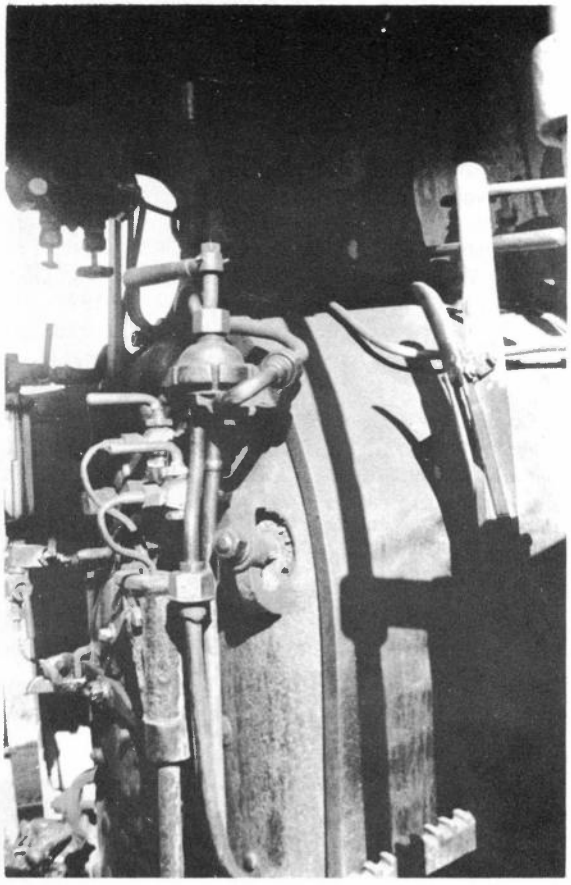


Wheels and motion of 44899, which had been carefully marked prior to a recent overhaul. Note the welded tank with an extra footstep added, and the replacement injector. The detail below clearly shows the transverse adjusting bolt on the inner big-end brass, and the welded coupling-rod eye. The additional brake block is just visible on the right behind the original brake-block. *(M.G. Satow)*





Although the replacement tanks are almost identical in shape to the originals, that on the left is mounted several inches higher than normal, giving the loco an odd appearance in this view.
(M.G. Satow)



The cab of 44899, showing the test cocks and tundish, reversing lever and quadrant, washout doors and steam brake valve (centre foreground). The water gauge is not too clear in the left background, and the black mass in the top left is the sight-feed lubricator. *(M.G. Satow)*

The Baldwins were originally provided with steam brakes operating blocks on the trailing side of each coupled wheel, but an interesting improvisation had been carried out on 44899. An additional brake block, bearing on the leading side of the driving wheels, was squeezed into the limited space behind the leading wheels and hung from the front brake hanger but behind the front brake block. Just how, when or why this had been done I was unable to discover.

During the same trip I also visited the Dehri-Rohtas Light Railway, where the Rohtas Industries Baldwin (44728/1917) lay derelict. This had been robbed of several parts, and the valve chest was without its cast-iron cover and sheet-steel enclosure. The valve chest is of an unusual 'sandwich' construction, with the valve housed in a thick casting complete with stuffing gland, and provided with a separate cover. Studs let into the cylinder casting pass through the valve chest and cover, and are secured by nuts and washers. This detail is usually hidden by the outer cover.

Most of the details discussed will, I hope, be clear from the photographs which might also be of assistance to the modellers within the Society.

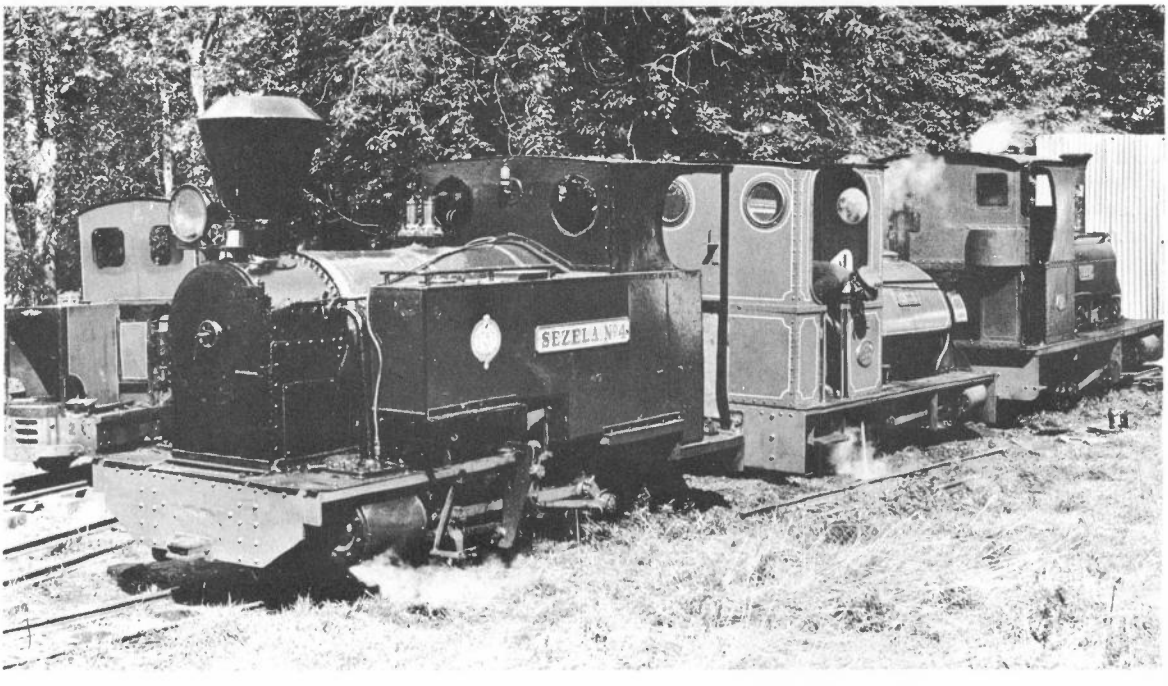
THE WONDERFUL WORLD OF WHEELS

This, the first major event organised by The Transport Trust, was held at Knebworth House, Stevenage on the 2nd and 3rd September 1978. Although there have previously been other events on the Knebworth West Park & Wintergreen Railway—a 'Stately Steam-Up' in 1972 and a 'Narrow Gauge Steam Rally' in 1976—'The Wonderful World of Wheels' added veteran cars, commercial vehicles and cycles to complete the transport scene.

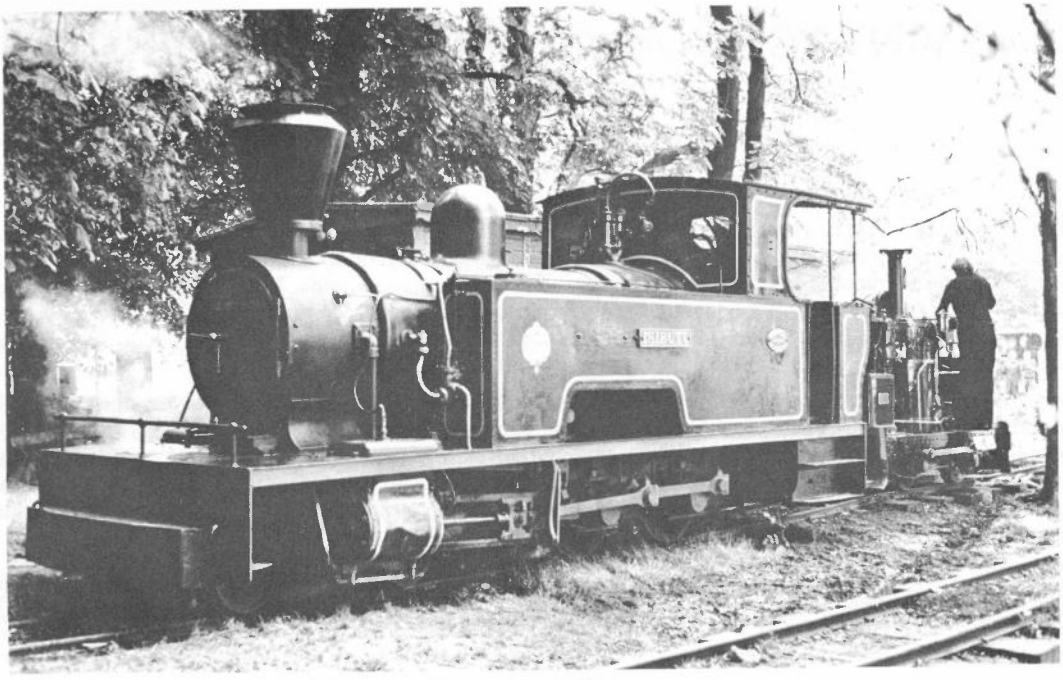
Both days were blessed with perfect weather and brilliant sunshine, and opened on the railway with a parade of locomotives at 12.30. Then, from about 14.00, the locomotives of Pleasurerail and several visiting machines worked on the railway. All are featured in the accompanying illustrations, kindly provided by D.T. Rowe.

The Trust and their sponsor H.R. Owen Ltd. deserve the success that crowned this venture, which may perhaps become an annual event.

PIXIE, brought by the Rev. E.R. Boston from the Cadeby Light Railway, on a train at Knebworth.



SEZELA No. 4, owned by Pleasurerail, with TRIASSIC and LILLA owned by J.B. Latham, being steamed outside the shed.



ISIBUTU, the 4-4-0T from Tongaat sugar estate, under the trees with CHALONER, the visiting De Winton from the Leighton Buzzard Narrow Gauge Railway

Hunslet No. 1 (on left) and PETER PAN on another of its 1978 outings, at the junction leading to the loop around the park

VINTAGE ROUMANIAN ELECTRICS

Pascal Pontremoli

Narrow gauge passenger railways worked by electric locomotives are common throughout Europe, but industrial railways of the same type are comparatively rare. When the locomotives are vintage steeple-cab electrics then such railways are of special interest.

The Fabrica de Hirtie Busteni is a major paper factory located at Busteni, a little north of the Roumanian capital of Bucharest. It was established about 1890, and a few years later a 700mm gauge railway was laid from the factory to the lower terminal of the Sciel aerial cableway in the Bucegi mountains. Timber felled in the mountains was carried first by the cableway, then loaded onto the railway for transport to the factory. The line was worked by steam locomotives, the first being a Krauss 0-4-0 side tank (2862/1894). In 1901 a 0-6-0 side tank (Krauss 4590) was delivered, and finally a further similar machine in 1914 (Krauss 6767).

In and around the factory the steam locomotives obviously presented a potential fire hazard, and the tracks were electrified on the overhead wire system supplied with direct current at 220 volts. Two BoBo electric locomotives built by Allgemeine Elektricitats-Gesellschaft, Berlin (AEG 531/1907 and AEG 1524/1913) work these lines. A further small four wheel electric locomotive is kept in reserve, and according to the factory management this was originally an electrically powered bogie wagon also built by AEG, though it now carries no clue as to either the builder or building date.

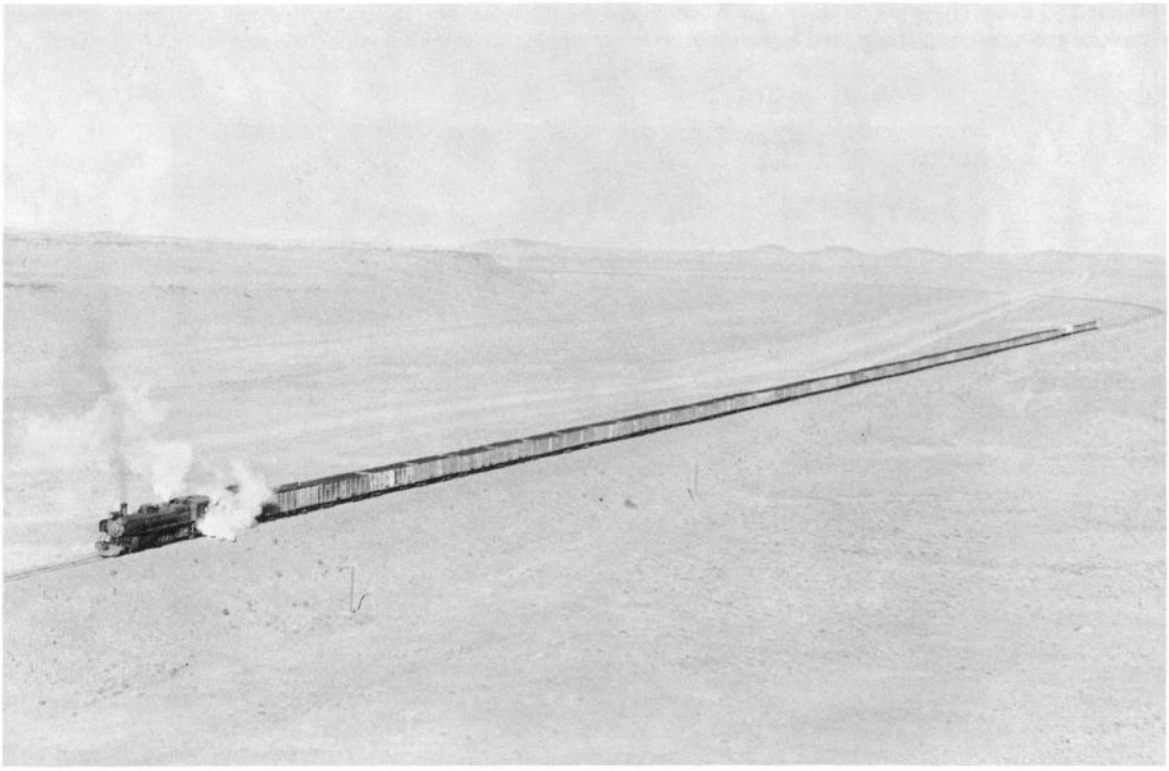
During 1930/35 the steam locomotives were taken out of service, and from then on the electrics were the exclusive power on the line. The section to the aerial cableway closed in 1968/69 and the transport of timber by rail ceased. The factory however is still operational and has expanded over the years to occupy sites on both sides on the main Bucharest—Ploeşti—Braşov road. The 700mm gauge is still used extensively for internal transport, and several times a day traffic on the main road is held up while a vintage steeple cab electric locomotive makes its way from one side of the factory to the other.

Traffic is held up at Busteni while this vintage AEG electric loco hauls a wagon load of paper across the main road one day in August 1977. *(Pascal Pontremoli)*

THE WORLD'S MOST ADVANCED STEAM LOCOMOTIVE

M. Swift & R. Wilkinson

Large scale mineral development gave birth to railways, and for more than 150 years wherever man has excavated the earth track laying gangs have usually followed close behind. In many countries these railways were laid to a narrow gauge, especially during the great mining boom in the last thirty years of the Victorian era. A second boom in mining occurred after the second World War, when many new lines were laid in Africa, South America and Australia to transport metal ores and coal to the sea for shipment. However, by that time the traditional railway concept had changed considerably, and this new generation of railways was laid out with high productivity as the goal. Massive earth moving equipment enabled the terrain to be altered to suit the track, and often led to the adoption of 4ft 8½in gauge even in countries where metre or 3ft 6in gauge was normal. Heavy section rail and deep ballasting permitted very high wagon axle loads, and the advent of mass-produced diesel locomotives capable of working in multiple allowed one man to move loaded trains of a size previously unknown outside North America. Then the adoption of sophisticated control systems enabled the maximum number of trains to be worked over a single track, while radio telephone removed the impression of "heading into the unknown" once endemic to many railways in distant lands. However, in the remote wilderness of southern Patagonia one line was built which was totally different–a traditional light railway laid to 750 mm gauge and 255 km (160 miles) long, but capable of moving well over a million tons of coal a year, with steam locomotives!



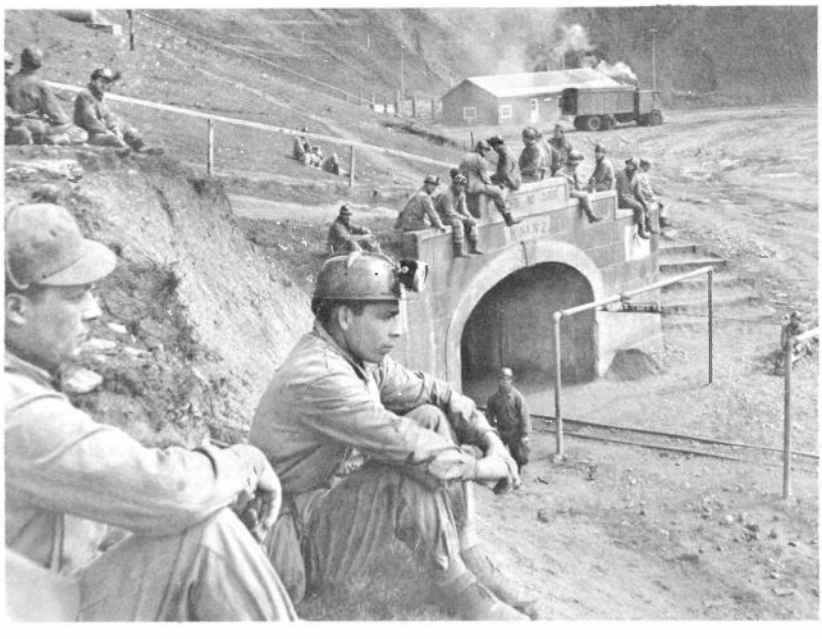
A train of empty coal wagons destined for Río Turbio is almost lost in the barren landscape west of Río Gallegos. *(B. Roberts)*

The Rio Turbio coalfield was located more than eighty years ago, but the principal coal consumers in Argentina were 3000 km (1875 miles) distant in the vicinity of Buenos Aires. It is therefore hardly surprising that this find was not seriously developed until the early 1940's when coal was not readily obtainable from South Wales and other foriegn sources. Río Turbio is close to the Chilean border, and only about 32 km (20 miles) from the west coast. However, there was little alternative but to carry the coal eastwards, and the original intention was to build a railway north and north-east to the port of Santa Cruz. A later survey pointed to a shorter route to Río Gallegos, the provincial capital, although there were no shipping facilities there at that time. A fleet of Sentinel steam lorries was imported to transport the coal until the railway could be built, but they burnt almost as much as they could carry on the long journey, and were soon replaced by diesel lorries. However, their operation in such conditions was an interesting last chapter in the history of the Sentinel steam lorry.

Construction of the railway started in 1950, using track recovered from the 750 mm gauge lines of the Ferrocarril Nacional Patagonica from Puerto Madryn to Alto de las Planas and Rawson, in Chubut province to the north. Eight Henschel 2-8-2 locomotives and a quantity of rolling stock also arrived from the same source. Work proceeded rapidly and the line was essentially finished within nine months, although the onset of winter delayed final completion until September 1951.

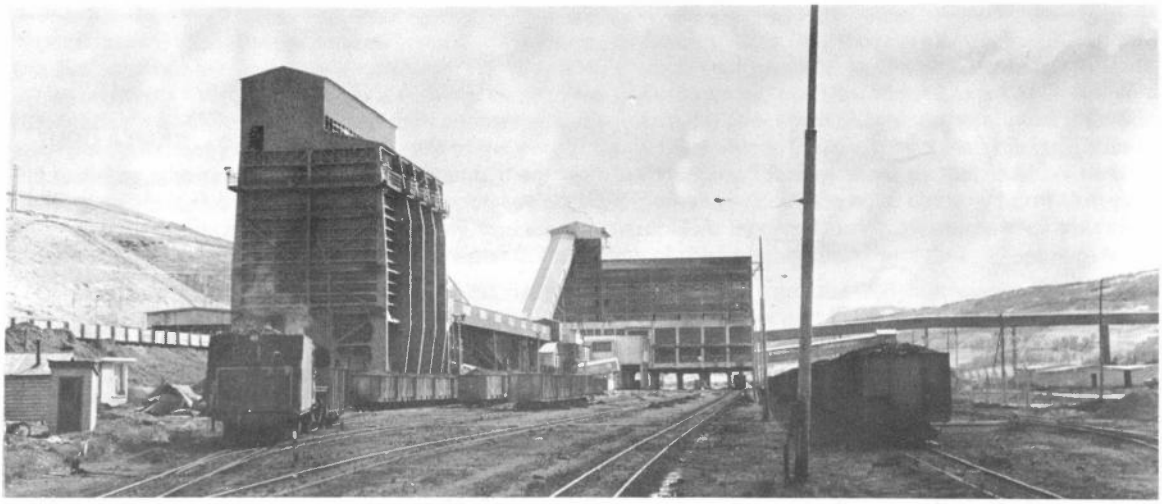
The line runs through one of the most inhospitable landscapes anywhere on earth. There is very little rain, and vegitation is limited to coarse grasses, with only a few stunted trees in the vicinity of the mines. In winter the temperature falls to -20°C, and for a major part of the year high winds sweep across the land, sometimes reaching 160 kph (100 mph), and raising clouds of dust from the arid ground. In these conditions it is easy to understand why the population averages less than one person to each square mile.

Rio Turbio mines are operated by Yacimientos Carboniferos Fiscales (YCF), the State Coalfields Board, and the 'Dorotea' and 'A' seams are worked from adits driven into the hillside. Coal is conveyed to a main haulage adit, loaded into 4 tonne capacity mine cars on the 750 mm gauge underground rail system, and hauled to the surface by AEG electric trolley locomotives. On the surface tipplers discharge the coal into a 4000 tonne storage bunker from where it is fed to the washery, then conveyed to loading chutes spanning four narrow gauge tracks. About 0.85 million tons are produced each year and although relatively low grade, this coal is suitable for power stations and steel production, and is therefore an important factor in the industrial development of Argentina.



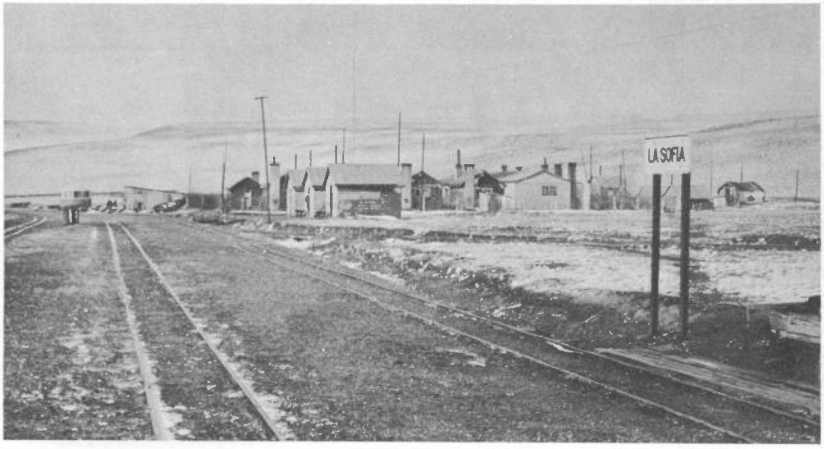
A group of Chilean miners outside the adit to Mina No 2, which carries the date 1952. In the background is one of the Sentinel steam lorries, still in use when this picture was taken in the early 1950's. (N. Dudley collection)

YCF also operate the railway to Río Gallegos, entitled the Red Ferrocarril Industrial de Río Turbio (RFIRT). The track commences at Mina 1 and 2, where the wagon repair shops are now situated, and passes along a wide, swampy valley to Mina 3 and 4, the No 2 Washery and loading point at Bacigalupo some 2 km to the east. A fan of long sidings here serve the loading chutes and receive equipment and stores brought in by rail. After leaving the mine and the town of Río Turbio (km 255) the route turns south to La Dorotea (km 252), where a corrugated iron shed covering three tracks, a few sidings and a turning wye serve as the locomotive depot. Continuing south and south-east, the line reaches El Turbio (km 229) and Glencross (km 186) before turning east towards the coast. The remainder of the route is largely across a featureless plain with low hills in the distance on either side. Earthworks are minimal and the only substantial civil engineering feature is a bridge about 70 m long over the Río Rubens at km 182. Loops are provided at each station and at km 167, but these stations merely serve

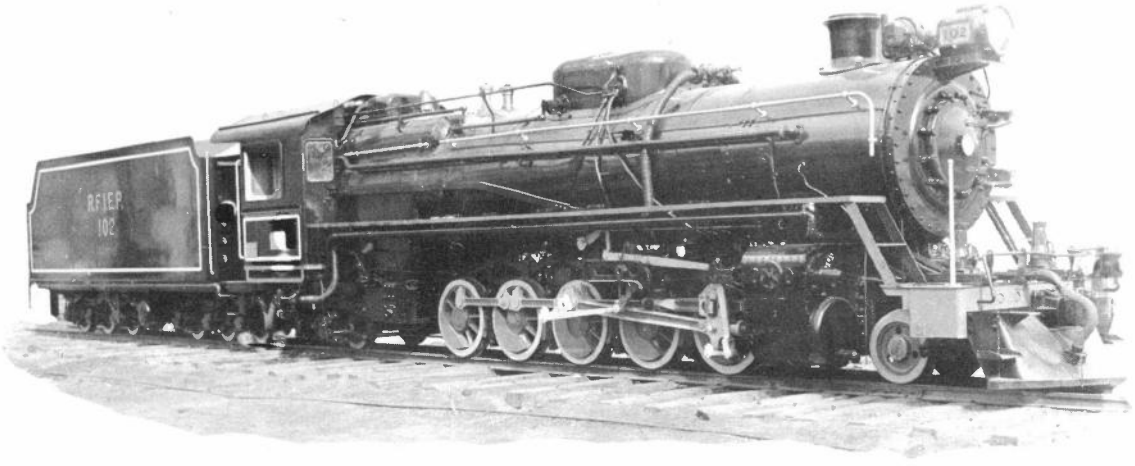


Bacigalupo yard in March 1972. Coal from the mine cars on the left is stored in the large bunker behind the locomotive, then conveyed to the washery in the background. The four loading tracks are in the centre, and a train is being made up on the right. (K. Mills)

One of the Henschel 2-8-2's hurries the local train past the marshalling yard at Rio Turbio on 29 October 1965. A train of mine cars stands on the higher level in the background. (N. Dudley)



This cluster of huts at La Sofia marks the major intermediate station on the line. (N. Dudley)



102 (Mitsubishi 844/1956) stands on the temporary track outside Mihara Machinery Works before being prepared for shipment to Argentina. The letters R.F.I.E.P. on the tender are a bit of a mystery. *(Mitsubishi Heavy Industries Ltd)*

camps for the track maintenance gangs, or at best a tiny village. The principal station is La Sofia (km 136) where trains normally cross, take water and exchange crews, but there are others at Bella Vista (km 108), Las Buitreras (km 66) and Palermo Aike (km 34). Three derelict Henschel 2-8-2 locomotives and many of the wagons used during construction were still stored at the latter station in 1972.

Río Gallegos is now a substantial town with a population exceeding 16000. The railway terminates beside the river where corrugated iron sheds serve as the locomotive depot and workshops. Loaded coal wagons are propelled into one of two rotary tipplers which discharge the coal into conveyors for loading aboard ship or stockpiling.

The track was originally laid with 17.5 kg/m (35 lb/yd) rails on timber sleepers in earth ballast, restricting the permissible axle load to 7.5 tonnes. In recent years virtually all this light rail has been replaced by 24/25 kg/m (48/50 lb/yd) rail recovered from other systems. Gradients on the line are easy, only 0.3% (1 in 333) against loaded trains, and 0.7% (1 in 143) against empty trains.

The eight Henschel 2-8-2 locomotives that were first transferred to the line had been built in 1922, and weighed about 49 tonnes in working trim. Although these worked coal traffic for the first few years they were inadequate to achieve the full potential of the mine, and in 1954 YCF placed a contract for the design and construction of ten new 2-10-2 locomotives. At that time there were few manufacturers anywhere in the world that were capable of undertaking such a task, and the contract was awarded to Mitsubishi Heavy Industries Ltd, Mihara Machinery Works at Hiroshima, Japan. The design was based on the very successful metre gauge E class 2-10-2 of the Ferrocarril Nacional General Belgrano, the first examples of which were built by Baldwin in 1921. Others were turned out by Henschel in 1929 and Skoda in 1949 to bring the total number in the class to sixty.

There were many constraints upon the designers: the narrow gauge and limited axle load, the high power output required and the low grade of fuel—a friable, dirty coal with 14-18% ash and a calorific value of 21 000-23 000 kJ/kg (9 000-10 000 BThU/lb). Designs were completed in 1955 for a handsome, well-proportioned machine which not only proved itself in service, but was also capable of substantial further development by L.D. Porta a few years later. In the spring of 1956 the first locomotive was completed, tested and shipped to Argentina on March 20th. The last was shipped on June 5th. They carried Mitsubishi works numbers 843-852 and running numbers 101-110.

A heavy bar frame extending from the front of the cylinders to the front of the firebox carried the coupled wheels and formed the basis of the locomotive. The side frames were 60 mm (2 $^{3}/_{8}$in) thick and set only 460 mm (18in) apart. At the leading end a massive steel casting fitted between the side frames to form the smokebox

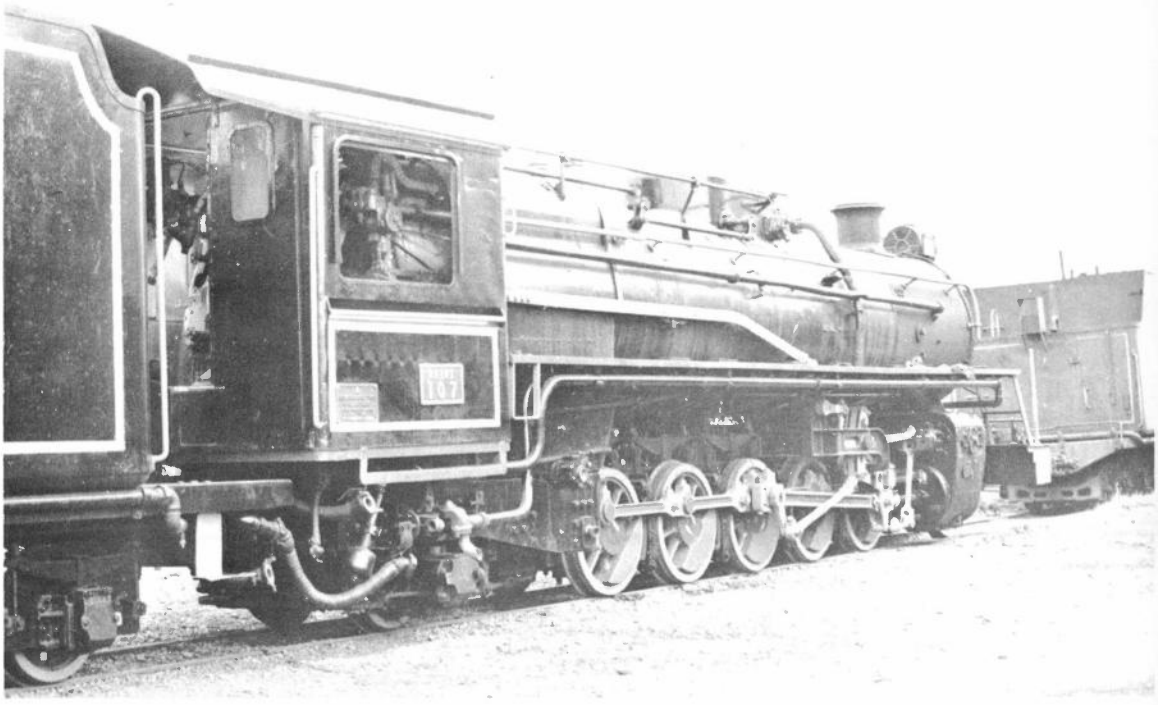
107, one of the first batch of locomotives, in store following an overhaul in the Rio Gallegos workshops. The steel pilot had not been fitted. In the background are the ship loading conveyors. *(B. Roberts)*

saddle, and extended forward to carry the leading pony truck and cast steel pilot beam. At the trailing end another large casting extended across the front of the firebox and connected the inside bar frames to short rear plate frames on either side of the firebox. The drag box casting joined the rear frames beneath the cab, supported the firebox and carried the draw-bar to the tender. To prevent flexing on the light track, substantial cross stays were fitted between the frames.

The boiler barrel was partly welded and partly riveted, coned towards the firebox and fitted with a Belpaire inner firebox incorporating a combustion chamber. An elongated casing covered the steam dome and sand container mounted on the boiler. The smokebox housed an 18 element superheater, conventional blast pipe and was surmounted by a neat, cast chimney. Electric head and tail lights were fitted, powered by a steam generator carried in front of the chimney.

A cylinder and steam chest was bolted to either side of the frame in line with the smokebox saddle. Large diameter, inside admission piston valves admitted steam to the cylinders, and were actuated by Walschearts motion. Plain bushes were fitted in the big end and coupling rod bearings, but, to combat the dusty conditions, special covers and dust seals were fitted. The driving wheel tyres were flangeless, but those on the coupled wheels were flanged in the normal way because the line curvature is not particularly severe. To provide the flexibility needed to negotiate the light, uneven track all springing was fully compensated. Steam cylinders actuated brake blocks on the coupled and tender wheels, but a vacuum system was provided to operate the train brakes.

It is perhaps surprising that no mechanical lubricator was fitted, but the cylinders were supplied with oil from sight feeds, and spring loaded pads supplemented by gravity feeds were fitted to the axleboxes. Large capacity



The driver's side of 107, showing the injector beneath the cab, outside regulator and sanding rods, and vacuum pipe under the edge of the running board. Flexible hoses between the locomotive and tender are not connected in this picture. (B. Roberts)

reservoirs were provided to permit operation for long periods without attention.

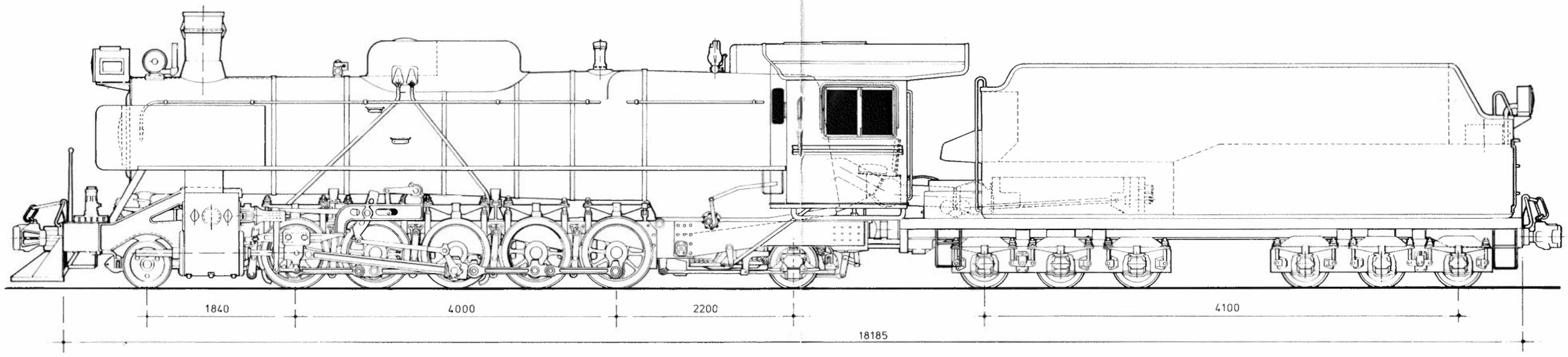
The locomotive crew had a comfortable, fully enclosed cab fitted with sliding rear doors, sliding side windows and large padded seats in the American style. The driver occupied the right hand seat and the fireman the left hand, where the controls for the mechanical stoker were located. So far as we are aware no other 750 mm gauge locomotive was every fitted with a mechanical stoker, but on these machines it was essential. The stoker screw was driven by a two-cylinder steam engine mounted in the tender, and delivered coal onto a firing plate just below the butterfly firedoor. Steam jets were installed to blow the coal onto the firebed, but in practice the draught is sufficient to carry it forward. The tender tank and coal bunker were of welded construction, mounted on a fabricated steel frame, and carried on two six-wheel bogies.

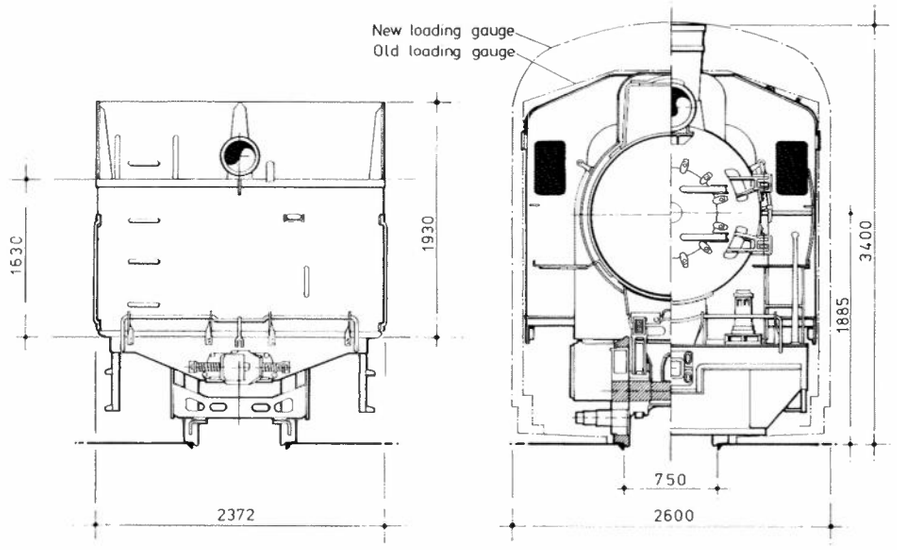
Each locomotive was painted black with the wheel centres, side rods, pilot beams and running plate painted red. Handrails and grab irons were white, and the tender side, tender rear and cab side lined out in white edged with blue. The running number and initials appeared on a circular plate fixed to the smokebox door, a rectangular plate on the cab side, and in gold letters on the tender. In recent years there have been some alterations to this livery, as can be seen from the illustration.

There is some uncertainty about the date that the locomotives entered service. One source suggests that six went into traffic in 1961/62, the remainder in 1964, but it seems more likely that they were introduced progressively as they arrived from Japan. In traffic they proved capable of developing 522 kW (700 hp) and were adequate to handle the trains for a time. However, Ing. L. D. Porta, who had been working on improvements to steam locomotives in Argentina since 1947, became involved with these 2-10-2's, and the results were astounding.

RED FERROCARRIL INDUSTRIAL DE RIO TURBIO 2-10-2 LOCOMOTIVE (SECOND SERIES)

Specially drawn for The Narrow Gauge No 82 by Roy C. Link





Leading dimensions:	*First series 101-110*		*Second series 111-120*	
Cylinders: dia × stroke	420 × 440 mm	16½ in × 17 3/8 in	420 × 440 mm	16½ in × 17 3/8 in
Coupled wheel diameter	850 mm	2ft 9½ in	850 mm	2ft 9½ in
Carrying wheel diameter	570 mm	1ft 10½ in	570 mm	1ft 10½ in
Boiler pressure	14 kg/sq cm	199 psi	16 kg/sq cm	228 psi
Boiler mean diameter	1321 mm	4ft 4in	1321 mm	4ft 4in
Tubes: —number	108	108	88	88
—dia × length	51 × 4200 mm	2in × 13ft 9 3/8 in	51 × 4200 mm	2in × 13ft 9 3/8 in
Flues: —number	18	18	18	18
—dia × length	133 × 4200 mm	5¼ × 13ft 9 3/8 in	133 × 4200 mm	5¼ × 13ft 9 3/8 in
Grate area	2.43 sq m	26 sq ft	2.43 sq m	26 sq ft
Heating surface: —firebox	10.2 sq m	110 sq ft	10.2 sq m	110 sq ft
—tubes and flues	93.7 sq m	1007 sq ft	81.7 sq m	878 sq ft
—total evaporative	103.9 sq m	1117 sq ft	91.9 sq m	988 sq ft
—superheater	30.3 sq m	326 sq ft	30.3 sq m	326 sq ft
—total	134.2 sq m	1443 sq ft	122.2 sq m	1314 sq ft
Locomotive weight: —empty	43.0 tonnes	42 tons 6cwt	43.0 tonnes	42 tons 6 cwt
—in working order	48.5 tonnes	47 tons 14cwt	48.5 tonnes	47 tons 14cwt
—adhesive	38.0 tonnes	37tons 8cwt	38.0 tonnes	37tons 8cwt
Tractive effort at 85% boiler pressure	10 870 kg	23 960 lb	12 420 kg	27 370 lb
Tender capacity: —coal	12.0 tonnes	11 tons 16cwt	12 tonnes	11 tons 16cwt
—water	10.5 cu m	2300 gallons	10.5 cu m	2300 gallons
Tender weight: —empty	15.5 tonnes	15tons 5cwt	15.5 tonnes	15tons 5cwt
—full	38.0 tonnes	37tons 8cwt	38.0 tonnes	37tons 8cwt
Total weight of locomotive and tender in working order	86.5 tonnes	85tons 2cwt	86.5 tonnes	85tons 2cwt

Notes:

Precise details of the pipework were not available, and the following were therefore omitted from the drawing, but are shown on photographs:

Vacuum pipe along right hand running board, and hoses on pilot beam and tender buffer beam.

Injectors under cab at each side, with delivery pipes under running board to clack valves on boiler top in front of dome cover.

Exhaust steam pipes from smokebox along running boards to ashpan on each side.

Flexible water pipes from tender to injectors.

The conventional steam locomotive has an overall efficiency of about 5-7%, is dirty and needs constant attention. Combustion air is usually drawn through the ashpan and grate, and mixed with a small amount of secondary air from the fire door. When coal is burnt waste products may remain on the grate restricting air flow, causing the fire to cool and form clinker. When the demand for steam exceeds the rated output boiler efficiency falls off rapidly, and the blast carries unburnt fuel through the tubes to be exhausted as black smoke.

Several important modifications, most of which had already been proved on other Argentinian locomotives by L.D. Porta, J. Vittone and J. M. Martinez, were made to three of the 2-10-2's over a period. The locomotives concerned were 104 DON BOSCO, 108 ANDRE CHAPELON and 110 SANTA CRUZ. A gas producer combusion system was introduced into the firebox to reduce clinker formation and prevent the loss of unburnt fuel. The primary air supply to the ashpan was restricted, and exhaust steam admitted through jets beneath the grate to reduce the temperature of the firebed. A greatly increased amount of secondary air was induced into the firebox through twelve special tubes, four positioned on either side and four towards the rear of the crown sheet. An extended brick arch increased the flow path of gas produced in the firebed, and ensured thorough mixing and complete combustion before it reached the boiler tubes. In service the original boilers did not achieve a sufficiently high degree of superheat, so the number of tubes was reduced to increase the proportion of gases passing through the superheater flues.

Admission and exhaust diffusers were fitted to the piston valves to smooth the flow of steam into and out of the cylinders. Multiple narrow rings finished to fine tolerances were installed in the valves and pistons, drip feed lubrication to the valves, and tailrods and improved packings provided for the pistons to reduce wear and steam leakage. Magnesia insulation blocks were fitted to the cylinders and valve chests to minimise heat loss. Finally, a "Kylpor" exhaust system replaced the original blast pipe and chimney, reducing back pressure in the cylinders, increasing the smokebox vacuum and, by imparting a swirling action to the exhaust gases, preventing

117, one of the second batch of locomotives built in 1963, stands here at Río Gallegos and shows many of the modifications applied by Sr Porta. The chimney shape is much less attractive, and this loco has lost the top section. The piston tail rod cover is visible, and the blank covers on the steam chest and air relief valve flange. The lagged pipe below the running

settlement of char in the smokebox. The Kylpor system, as its name suggests, is a derivative of the Kylchap (Kyläla-Chapelon) blast pipe which exhausts flue gases in two stages. Passage of the exhaust steam through the first stage entrains gases from the tubes in the lower half of the boiler, whilst the second stage induces the greater volume from the superheater flues.

A second batch of ten 2-10-2's was ordered from Mitsubishi in 1962, incorporating all the modifications described above, and also fitted with German pattern smoke deflectors. To avoid regular stops to take water connections were provided to allow water to be drawn from a tank car behind the locomotive. All ten were shipped to Argentina on 27th December 1963, carrying works numbers 1135-1144 and running numbers 111-120. They were placed in service during 1964-65.

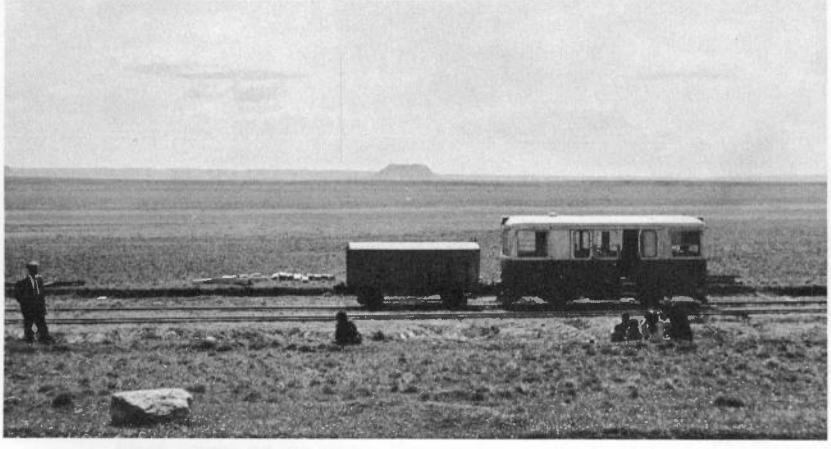
Tests were carried out to prove the effectiveness of the modified design. and the results were spectacular. The maximum sustained power at the drawbar was increased from 522 kW (700 hp) to 895 kW (1200 hp). The boiler efficiency reached 78-80% for long periods at high steaming rates, and steam losses were reduced considerably, enabling the locomotives to return an overall efficiency of 11-12%, nearly double the figure normally attained with modern steam power! Late in 1965 a series of trial runs were made with a train of 75 wagons, but about two years later a monster train of 127 wagons totalling 3000 tons was taken on test by one 2-10-2, although some banking assistance was provided on adverse gradients. This is quite an incredible load on 750 mm gauge and certainly forcefully demonstrated the potential of a large, modern steam locomotive.

The final modification carried out on one of the second batch of 2-10-2's (possibly 113, now named PABLO NIEVA) is the cyclonic gas producer combustion system. This introduces secondary air tangentially into the firebox to create a swirling action and reduce still further the carryover of unburnt char. It is possible that further development of this variation has been undertaken in the last few years.

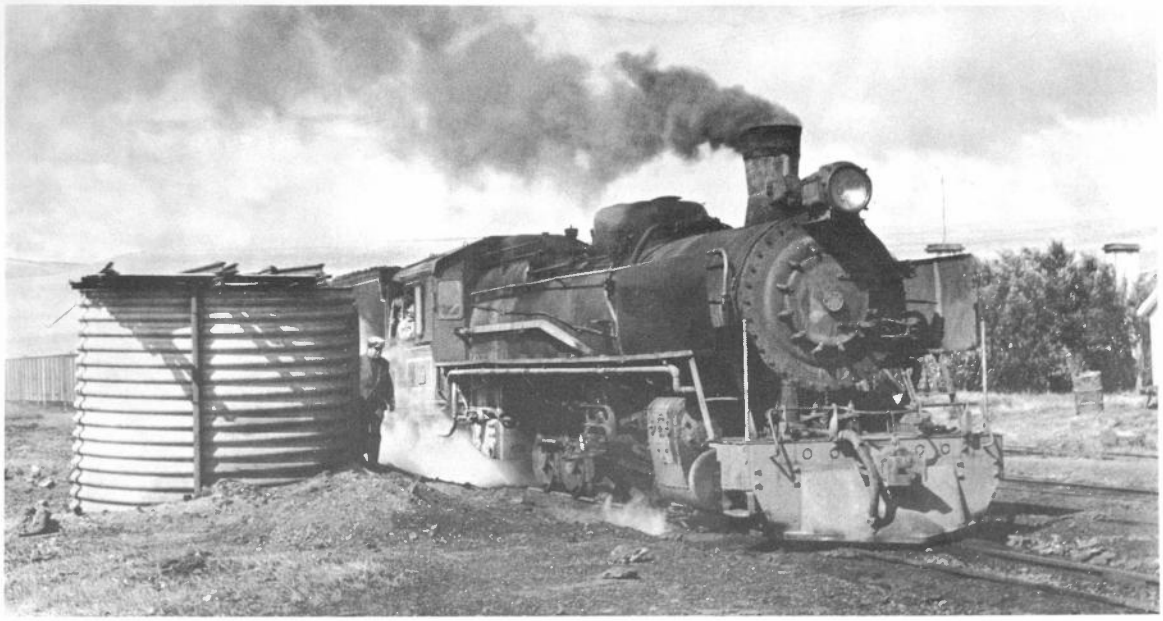
plate carries exhaust steam to the ashpan jets. On the tender the cylinder heads of the stoker engine can just be seen above the front steps, and just to the left of the vacuum hose is the valve to connect with a water tank car. *(K. Mills)*

L.D. Porta climbs on board 113 before leaving with the 75 wagon test train in November 1965. The corrugated iron sheet fixed to the smoke deflector protects the smokebox vacuum and steam chest pressure gauges fitted for the tests. *(N. Dudley)*

Autovia AV2 stopped on the line with carburettor trouble in September 1965. *(N. Dudley)*



A large railcar and trailer wait to pass the coal train at Glencross in November 1965. *(N. Dudley)*



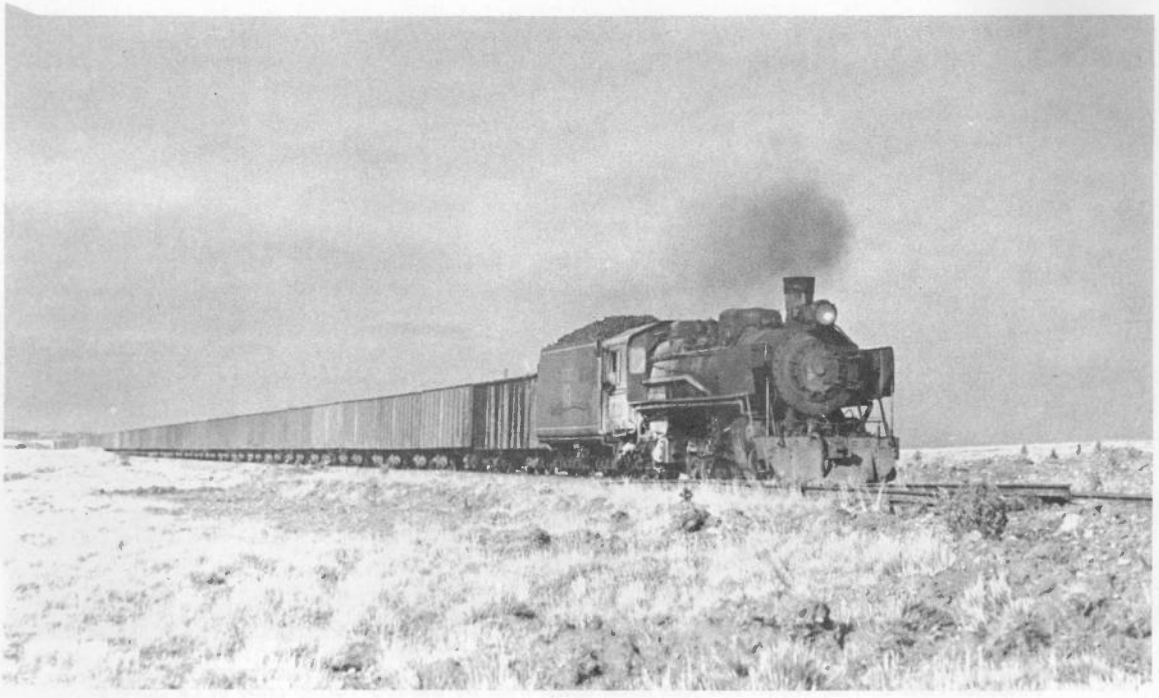
Another view of 113, which has just been taken over by the Río Turbio crew at La Sofia in March 1972. *(K. Mills)*

In their present form these locomotives are capable of continuous operation for long periods with a minimum of attention. The firebox design virtually eliminates tube cleaning, and the Kylpor exhaust system effectively prevents settlement of char in the smokebox. Cooling the firebed dramatically increases the intervals between fire cleaning to 40-50 hours, and because a drop grate and self-emptying ashpan are fitted this is not an objectionable task. The boiler water is treated, and large blow-down valves are fitted to clear scale from around the firebox. Boilers are washed out every 5000 km (3200 miles). To maintain efficiency, and avoid the possibility of a failure on the line, preventive maintenance schedules based on SNCF practice are adopted. All wearing parts are checked at fixed intervals and either repaired or replaced if the wear exceeds specified limits. Locomotives are overhauled at Río Gallegos workshops every 60 000 km (37 500 miles), but the boilers are never separated from the frames, a further aid to steam-tightness.

With such impressive results it is perhaps surprising that the work of Sr Porta, and the success of the Río Turbio 2-10-2's has not been publicised more widely. But until the last few years the only reference, in this country at least, was a brief note in *Railway Gazette* in 1964. Despite a large and enthusiastic audience at a meeting of the Institution of Locomotive Engineers in Manchester on 7th March 1969, when Sr Porta presented a paper describing his work this was not, so far as we know, reported outside of the Institution.

Coal is carried in modern, steel, bogie open wagons weighing about 7.75 tonnes empty, and of 16-18 tonnes capacity. The bogies are fitted with plain axlebox bearings, and a large proportion of the total fleet has vacuum brakes. Automatic centre couplers are fitted to each end, with release levers extended to the side of the wagon. The stock has been gradually increased over the years, and now totals about 325. In addition to the coal wagons there are about 50 other bogie vehicles of various types, predominantly box-cars and tank-cars for stores and oil required at the mine.

No passenger services are now operated, although we believe that a workmens train was run between El Turbio and the mine up to the middle 1960's, by there are still a small number of wooden, end balcony coaches which are sometimes added to the coal trains. Most staff transport is by light railcar, or 'Autovia', of which about five are in service. A novel vehicle, still in use in 1965, was a modified trolley with detachable ramps allowing a Jeep to be driven onto it and locked in position with the rear axle jacked up. The offside rear wheel was then fitted with a special pulley which drove, through a leather belt, a similar pulley fixed to the trolley axle. The progress of this unusual conversion is reported to have been somewhat erratic at times!



113 in full cry across the Patagonian grasslands about 6 km west of Río Gallegos on a train to the mine in March 1972. *(K. Mills)*

A kilometre of empty wagons separate 113 from the creaking, wooden bogie coach at the rear of this train heading for Río Turbio . *(K. Mills)*

With only through workings of block trains, the railway is ideal to operate. Two locomotives are normally in steam at Rio Turbio, one working stores and materials trains or shunting the wagon works at Mina No.2. The second locomotive shunts the loading sidings, and makes up trains at Bacigalupo for the run to the coast. These trains are normally made up to sixty loaded wagons, totalling around 1500 tonnes. The first thirty wagons in each train are vacuum braked, and a wagon specially painted in red and white stripes is added to the rear end to enable the locomotive crew to verify that the train is complete.

Until the late 1960's one loaded train a day was adequate to deal with the output from the mine, but in more recent years two trains have usually been operated, leaving either end of the line at about 09.00 and 19.00, and taking 9-10 hours for the journey—an average speed of 25-28 kph (15.6-17.5 mph). There are no signals on the line, and control is by written train crossing orders. Points at the loops and stations are controlled from local hand levers. One locomotive works right through with its train, and to avoid frequent stops for water is coupled to a bogie water tank wagon. The eastbound and westbound trains normally cross, take water and exchange crews at La Sofia. On arrival at Río Gallegos a further locomotive takes over to shunt the train to the unloading sidings, where it is split up and individual wagons are propelled through one of two rotary tipplers, discharged and the coal either loaded aboard shop or conveyed to stockpiles. The later, more powerful locomotives normally work the through trains, and the earlier design carry out shunting duties. However, the present stock of twenty 2-10-2's is more than adequate for a service which requires no more than eight locomotives in steam each day.

To fuel Argentina's industrial development, and particularly to supply new power stations, additional coal supplies are essential. In recent years Powell Duffryn Technical Services Ltd and the National Coal Board have advised YCF on the development of the mine and transport facilities, with the ultimate objective of raising annual production to 3 million tonnes. To handle this traffic the railway must be upgraded and the installation of heavier rail was the first step towards raising the permissible axle load to 14 tonnes. A fleet of 300 new bogie wagons, of 12 tonnes tare and 40 tonnes capacity, is proposed, with roller bearing axleboxes and air brakes to permit much higher speeds. The existing harbour at Río Gallegos can only handle 7000 tonne ships, and the 12m (40ft) tidal range makes it far from ideal. A new harbour 24 km (15 miles) further downstream is therefore envisaged, capable to loading 30000 tonne ships, and the railway would be extended there, bypassing Río Gallegos.

Even the 2-10-2's will be unable to haul the 5000 tonne trains anticipated in the future, and the advantages of alternative motive power have therefore been considered. Electrification is difficult to justify for only a few trains a day, diesels require expensive imported fuel, and both were therefore rejected in favour of new steam locomotives. The first design considered was a 2-10-10-2 Mallett, but this has since been developed into a 2-12-12-0 Mallett estimated to weigh 180 tonnes without tender, capable of producing 2982 kW (4000 hp), and hauling trains at speeds up to 74 kph (46 mph). With track improvement, easing of gradients and new rolling stock, trains of 10000 tonnes are considered to be possible.

This design naturally incorporates Ing Porta's advanced ideas, including a feed-water heater, economiser, air heater, cyclonic gas-producer firebox, ash conveyor system, and double Kylpor exhaust. The boiler, firebox and cab only extend over the trailing group of coupled sheels, so a 27 cubic metre (6000 gallon) water ballast tank is positioned above the leading engine unit.

The RFIRT is an impressive example of an efficient narrow gauge railway constructed at minimal cost, largely on a self-help basis, and operated under difficult conditions in a remote corner of the world. Its present steam locomotives are the most technically advanced examples of the steam age, now rapidly drawing to a close elsewhere, but perhaps themselves about to be replaced by new technology which will ensure at least one pocket of narrow gauge steam freight operation into the 1980's and beyond.

Because the RFIRT and its locomotives are so little-known we have had to rely on many sources during the preparation of this article. Special thanks must be given to Norman Dudley for providing a considerable amount of background information and photographs. Ken Mills, co-author of *World of South American Steam* (Roy Christian & Ken Mills 1974), kindly allowed us to refer to the detailed description of his trip over the line in 1972, and supplied many of the illustrations. Basil Roberts also provided a large number of photographs. Locomotive drawings, photographs and specifications were generously given by R Kashima, Chief of the Rolling Stock Section, Mitsubishi Heavy Industries Ltd, Mihara Machinery Works to the N.G.R.S. in 1964, and have been paricularly useful in the preparation of the arrangement drawing, undertaken by Roy C. Link. Reference has also been made to *Railway Gazette* (30 March 1964), *Japan Railfan Magazine* No 2 (1964), *Continental Railway Journal* No 15 (1973); No 17 (1974), No 21 (1975), No 31 (1977) and No 34 (1978). The following articles: "Coal Mining in Argentina" *Colliery Guardian* (April 1969), "British Mining Consultancy" by Dr M J Barber, *Colliery Guardian* (August 1977), "Things Left Undone" by N Dudley, *The Mining Engineer* (November 1977) provided much of the mining history, and "Steam Locomotive Development in Argentina" by L D Porta, a paper presented to the Manchester Section of the Institution of Locomotive Engineers on 7th March 1969, *J. Inst. Loco Engrs.* Vol 59, (1969) was a major source of technical information.

SCOTTISH PEAT MOSS RAILWAYS

A. Neale

Other than mining, peat harvesting is probably the only industry in Britain where narrow gauge railways have an assured future, since the soft, boggy surface virtually precludes the use of alternative wheeled transport. Several systems still operate in this country, and indeed many of these are expanding rather than contracting—a welcome change these days. Those in Scotland are mainly located in three distinct areas. The largest group is situated in the central lowlands between Glasgow in the west and Falkirk in the east, a small group lies in the north-east of the Grampian Region, and the third group is just north of Carlisle, though most of these are in England rather than Scotland. In addition, there are isolated systems near Cowdenbeath in Fife, and at Douglas Water near Lanark. This article is largely based on visits to a number of these railways in August 1978.

It is convenient to begin our survey near Glasgow, where the tiny system now operated by Hewden (Contracts) Ltd is situated inconspicuously beside the A80 road at Moodiesburn. Krikken Bros. began to work this moss in 1939 using primitive hand barrows. As the workings expanded a horse and sled was introduced, then a light tractor and trailer until 2ft gauge track was laid. This was originally worked by hand until a 20/28h.p Motor Rail diesel was purchased from Whatlings Ltd, a Glasgow contractor who had used it on a hydro-electric scheme in the Highlands. It still remains in regular service despite the arrival of a similar loco from Peat Development Co Ltd, Douglas Water about 1969. This served solely as a source of spares and has never been used here. Most of the wagons are Hudson skip frames with crude, slatted wooden bodies, but one has an unusual body built from scaffold poles and chicken wire! The operation was sold to the present owner in September 1977, but Mr Krikken stayed on as manager. He would like to obtain another locomotive if he could find one at a reasonable price.

On the high ground bordering the A71 south-east of Wishaw is a small moss which was worked by the Benhar Moss Litter Co. Because it did not appear on maps it apparently escaped discovery, but it was worked by horses for most of its existance and never owned any locomotives. The company was taken over by Scottish Agricultural Industries Ltd about 1969, and a tractor brought in to work the railway. Rubble and hardcore were laid on either side of the formation, and the tractor straddled the 2ft gauge track, towing slat-sided wooden wagons between the workings and the mill. Operations ceased in April or May 1978, the track was lifted and the mill burned down. The remaining wagons were also burned on site about July, leaving only the old stable and tractor shed, and the trackbed out onto the moor to indicate where the railway once ran.

South of Falkirk is an expanse of bleak moorland dotted with abandoned collieries and railways, where the industrial archeologist could spend many fascinating days. There are also four peat railways, the two smallest being alongside the minor road from Longriggend to Caldercruix. On the east side Lanarkshire Moss Litter Co Ltd work an extensive area which was first developed before 1914. The 2ft gauge railway was originally operated with horses until the present manager introduced the first petrol locomotive, a type R Lister (3795/1931), which is said to have been obtained from a brickworks at Robroyston, near Glasgow in 1946-47. This lay in pieces at the works for some years until it was taken to an engineering works at Cupar, Fife, about 1947 for rebuilding, but this has yet to be completed. A second similar Lister (5114/1933) was purchased from Falkirk Corporation about 1949 after being used by the Corporation on the construction of the "Rest & Be Thankful Road", or possibly at their brickworks. A quantity of skip frames and rail arrived with this locomotive. There have been other locomotives here, but this Lister is now the sole motive power. Over the years its JAP petrol engine has been replaced by a Lister LD2 diesel, and a full length awning similar to the maker's standard design fitted. Now painted orange and green, it carries the name DRUMBOW EXPRESS after a local village. The wagons here are now mostly Hudson frames with wooden bodies, though there are still a few old wooden wagons in service. The moss was taken over by the Caledonian Peat Products Ltd in July 1978 but continues to trade under its old name for the present. Both companies are subsidiaries of Hamlyn & Co Ltd.

Across the road is the tiny system originally owned by A Guerts & Sons, but now also part of the Hamlyn empire. The track is lightly laid, even by peat railway standards, and has been disused for some time. The solitary locomotive is a small 11/13 h.p. Ruston diesel lying dismantled in its shed at the end of the line. A row of wooden wagons occupies the siding entering the mill, and the entire operation appears unlikely to be revived.

A few miles to the north are two other operations. Richardson's Moss Litter Co Ltd have a small railway on Fannyside Moss which is laid to the unusual 2ft 6in gauge. It is worked by a modern Lister Blackstone loco built in 1968, and slatted wooden wagons which appear to have been constructed locally using wheels and axles by William Jones and another supplier. The spare loco, a Motor Rail, has been at the firm's Longtown works for about two years awaiting repair.

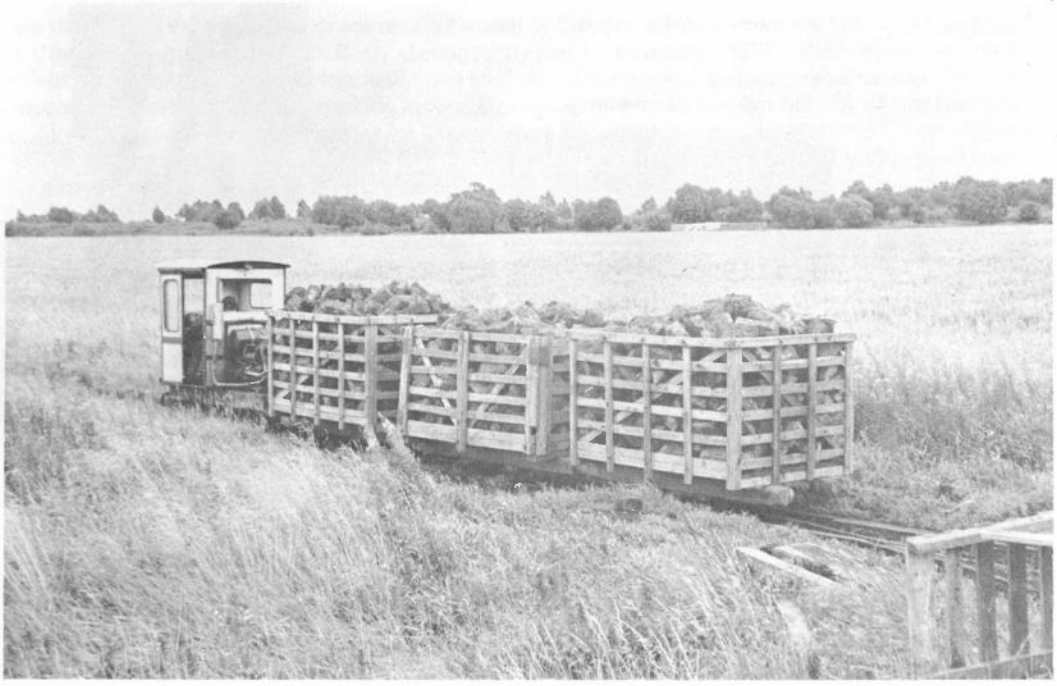
Lanarkshire Moss Litter Co Ltd: DRUMBOW EXPRESS outside the machinery shed at Longriggend.

A Guerts & Sons: The disused track leading to the mill and loco shed.

Caledonian Peat Products Ltd: A train of modern steel wagons on the approach to the mill at Gardrum Moss

Caledonian Peat Products system on Gardrum Moss, south of Falkirk, makes an interesting contrast with the usual light 2ft gauge track and wooden wagons. This track is laid to 3ft gauge with about 30 lb/yd rail on wooden sleepers, and the peat is harvested by modern machinery, milled on the moss and loaded into modern steel bodied wagons built by Allens of Tipton. Ruston 48DL locomotives are employed to haul the trains to an electrically operated tipping stage behind the works. The first Ruston, together with the track and wagons, arrived in 1962 from the North of Scotland Hydroelectric Board, Olgrinbeg Power Station at Altnabreac in Caithness, where it had been used on a peat development project. A second locomotive also arrived from the same source; a Fordson tractor mounted on a skip frame which had been built by a firm in Glasgow. Its 'Heath Robinson' appearance contrasted sharply with the modern equipment, and after a period of disuse it was cut up for scrap in 1969. In more recent years two other 48DL locomotives have arrived, but both required conversion to 3ft gauge. The first was a 2ft gauge class 48DLU from Bush of Alfreton, previously at British Gypsum, Fauld. The second was of metre gauge, originally DOWIE at the Crich Quarries of Clay Cross Co, and later used by G Dew & Co Ltd, the Oldham contractor, on a sewer construction scheme in South Wales which featured in *The Narrow Gauge* No. 53. Last summer only the Fauld loco was in service, the others having failed, one with a broken crankshaft and the other with a defective fuel pump. There is a well equipped repair shop here, which also overhauls 2ft gauge locomotives from Moss Morran works near Cowdenbeath.

North of Falkirk, Richardson's Moss Litter Co Ltd have a 2ft gauge system from a mill beside the road, across fields to Letham Moss hidden behind a belt of trees. The layout and rolling stock are conventional enough, but the three locomotives are certainly unconventional. A Lister Blacksone dating from 1962 has merely been rebuilt with a non-standard engine, but an early Motor Rail, already extensively rebuilt, languishes in the shed awaiting the aquisition of another suitable eingine. However, the real *piéce de résistance* is the working locomotive. Originally one of a pair of wartime 20DL Rustons from British Aluminium Co Ltd, Burntisland, they were obtained from Thomas Muir's scrapyard at Thornton Junction, together with a Hunslet which was soon disposed of as it was too heavy for work on the moss. One of the Rustons is currently at Longtown works awaiting a new engine, but the other was rebuilt at Letham Moss Works. The original Ruston engine and bodywork were removed, and the frame modified to receive a BMC 2-2 diesel engine and truck radiator. Unfortunately the crankshaft of this engine rotated in the opposite direction to that of the Ruston, and the fitter first installed a helicopter drive unit between the engine and gearbox to reverse the rotation. This proved unsuitable, so the entire engine was therefore turned round to bring the crankshaft out to the front, and the engine was also offset to one side of the frame. A layshaft was carried in bearings on the left hand side of the frame, with V-belts and pulleys connecting the engine and layshaft at the front, and the layshaft and gearbox at the back. This novel reconstruction proved satisfactory, and was completed by the addition of a new cab, drive guard and spring buffers to produce a useful, if unusual locomotive.



Richardson's Moss Litter Co Ltd: A train being propelled from Lethams Moss to the works.

Richardson's Moss Litter Co. Ltd: The rebuilt Ruston is scarcely recognisable as a 20DL model. The perforated guard on the footplate covers the layshaft.

Caledonian Peat Products Ltd: The new mill and tipping shed at Moss Morran.

Caledonian Peat Products Ltd: Motor Rail 7512/1938, rebuilt with a Lister LD2 engine, near the mill.

Across the Firth of Forth, in Fife, is the second works of Caledonian Peat Products Ltd, on Moss Morran just outside Cowdenbeath. The mill was badly damaged by fire in November 1977, which destroyed three Lister locomotives. A completely new mill has now been erected on the original site, and receives peat from the moss in traditional wooden wagons. The working locomotive is one of a small number built by Motor Rail with single cylinder Ailsa Craig engines. It lay derelict for several years but was recently rebuilt with a Lister engine driving through a chain onto the original gearbox and flywheel. The spare locomotive, an 11/13 h.p. Ruston which originated from the picturesque slate quarries on the top of Honister Pass in the Lake District, has also been rebuilt. The original engine was removed and sold, the radiator and fuel tanks discarded, and the frame then fitted with a replacement engine. The remains of two Listers lie beside the works, but the third went to T. Muir for scrap very soon after the fire.

The moors east of New Pitsligo once supported three peat carrying railways, but only one now survives in operation. This area can be bleak even in summer but the peat supports brilliant purple heather to add colour to the normally drab surroundings. George Watson & Sons harvest peat from a wide area of Middlemuir, and bring it to the works over an extensive 2ft gauge railway system. Two relatively modern Lister Blackstone diesels are in use, but an interesting Orenstein & Koppel petrol loco built in 1929 also survives off the track. The wagons are solidly constructed with timber frames and unusual flared bodies which seem peculiar to this area. The peat is not milled, but sold in blocks and either tipped directly into road vehicles or stock-piled.

Unfortunately the adjacent 2ft gauge system of the Northern Peat & Moss Litter Co Ltd closed recently in favour of mechanical handling equipment. The older Lister was sold with some track and wagons to the new Alford Valley Railway, and has since been overhauled and rebuilt with an enclosed body. G. Watson also purchased some track and wagons, and other equipment went to a local fish meal factory where it was intended to lay a short internal railway worked by hand. The more recent Lister still awaited a buyer in August.

George Watson & Sons: Lister Blackstone 54781/1965 propels loaded wagons past the tipping dock at Middlemuir works.

The loco frame and a wagon almost submerged in heather on the derelict 2ft 8in gauge system near New Pitsligo

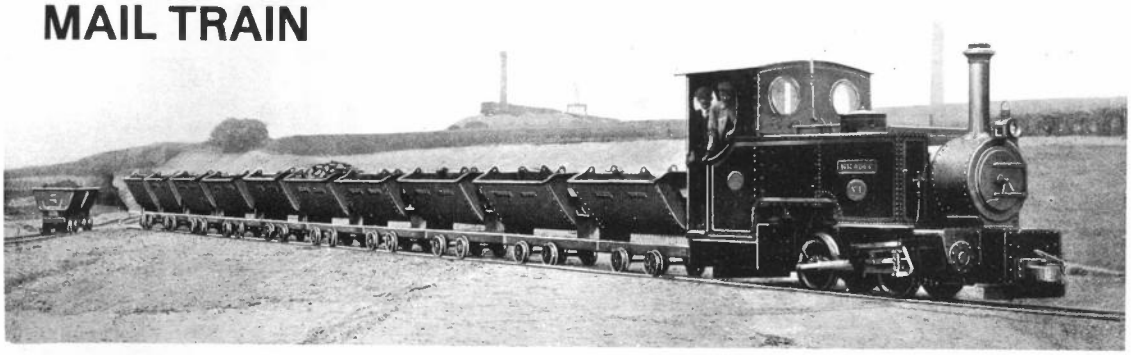
But of greatest interest is the third system, situated alongside the road from New Pitsligo to Strichen. It is 2ft 8in gauge, now completely derelict and covered by heather. It was last worked by Percy Finnie in the early 1960's, although it was obviously laid many years ago. Much of the rail is a squat, heavy flat-bottom section which might have come from the LNER Cruden Bay Tramway. A dozen wooden wagons are scattered over the track, and are unusual in having lifting eyes at each corner and a drop door underneath. Until about 1955 the wagons were loaded on the moss, then towed by a cable attached to a lorry running along the adjacent road. When they reached the roadside loading dock they were pushed onto a portable turntable and placed on a short track beneath a wooden hand crane. Chains were attached to each corner and the loaded wagon was lifted bodily off the track, suspended over a waiting lorry, and the blocks of peat transferred through the bottom door. A former WDLR 20 h.p. Motor Rail petrol locomotive arrived here about 1955 from Northern Peat & Moss Litter Co Ltd. who had reputedly purchased this and the Orenstein & Koppel now at G Watson from a plant sale in Glasgow. The frame and axles were cut in two, the frame widened by inserting steel channels and the axles fitted with tubular steel sleeves to convert the loco to 2ft 8in gauge. A 3 h.p. Petters petrol engine replaced the original Dorman engine. When the line ceased operation this locomotive remained on site and gradually parts disappeared over the years. The surviving frame and gearbox was obtained by member Ian Jolley, and moved south to provide a source of spare parts for his other locos. Even so the wagons and track are still there as a reminder of the former industrial activity in this remote spot.

The systems described illustrate many of the problems associated with operating a narrow gauge industrial railway at the present time. Whilst the purist may despise the peculiar locomotive rebuilds, this solution is essential to maintain equipment in service after manufacturers have either gone out of business or lost interest in providing spare parts for their older products. At the same time the wholesale closure of narrow gauge railways in other industries, coupled with the demand from pleasure railways and enthusiasts makes it increasingly difficult for the peat industry to obtain the additional locomotives, rolling stock and track required to maintain and expand their rail operations. This situation will, presumably, only get worse in the future.

It has not been possible in this brief review to give comprehensive details of all the locomotives owned by each operation. Interested readers are therefore referred to *Industrial Locomotives of Scotland* (Industrial Railway Society 1976), and the reports which have appeared in *Narrow Gauge News*. Better still, go and see them for yourself.

In conclusion I would like to record my grateful thanks to the management and staffs of the systems described for granting facilities, and fellow members Ian Jolley and Mike Swift for information, assistance and photographs.

MAIL TRAIN



THE DARJEELING-HIMALAYAN RAILWAY GARRATT

I have studied the drawing in NG 79 and can now add some further points. But first I should clarify my comment on page 12 that the total resistance of a standard coach was about 500 lb. This should have read **total rolling and gravitational resistance,** apart from flange friction which obviously doubled the total resistance on sharp curves.

The drawing reveals one serious design fault and two further deficiencies which explain most of its erratic performance. The spherical pivot on the leading unit was intended to accommodate sudden reversals of superelevation, but it also allowed the unit to pitch. When pulling hard this unit would proceed in a fair imitation of a kangaroo, explaining the severe vibration and rapid wear in service. A more suitable design would have been either a conventional pivot free to roll in the lateral plane only, or a pivot rigid in the vertical plane combined with more flexible springing on the outer axles to accommodate vertical movement. The latter is the better alternative, but might have presented difficulties on the extreme alignment of the DHR.

Weight transfer due to gradient would also affect performance. On a 1 in 30 water would first be taken be taken from the front tank and 300 galls. equals 10% of the adhesive weight on the leading unit. As the water in the boiler would also move to the rear the front unit would often be 1-1½ tons light, making it even more susceptible to slipping.

The blast pipe and chimney were inadequate. Applying Swindon formulae, quite valid for a machine of this size, the blast nozzle should have been 4.2in diameter instead of 3¼in, and the chimney choke 12in diameter instead of 10½in. The smokebox was also rather small, and would probably have been improved by a 50% increase in length. The method of combining the exhausts was almost bizarre. The correct method would have been to mount the telescopic unit horizontally and then turn the exhaust up into a normal breeches pipe, but this would only have been possible if the bogie pivot was altered as suggested. Despite suggestions to the contrary, the boiler design appears quite adequate. True, the tubes were short, but were made $1^{5}/_{8}$in instead of the normal 1¾in diameter. In any case tubes with similar proportions have been successful on many narrow gauge locomotives.

The absence of a brick arch in the large firebox is surprising. An arch would have prevented the blast pulling holes in the fire and kept the bottom row of tubes clear when the locomotive was working hard.

The sanding gear was inadequate. Steam sanding should have been applied, and preferably to both sides of the driving axle to resist slipping while eliminating stress put on the motion by sanding the coupled wheels only.

Even if these deficiencies had been corrected it is doubtful whether the locomotive would have been a success. The DHR had, with the B class, reached the economical length of train for a single locomotive, and the drawbacks of the Garratt in this situation are so obvious that one wonders why it was ordered in the first place. Was the order placed by the DHR, or was it "sold" to them by Beyer-Peacock or a consulting engineer? The statement that "the ordinary locomotive was ill-adapted to work the DHR with safety" in the original description suggests that it was written by someone unfamiliar with the line, which was—and still is—worked in perfect safety by "ordinary" locomotives.

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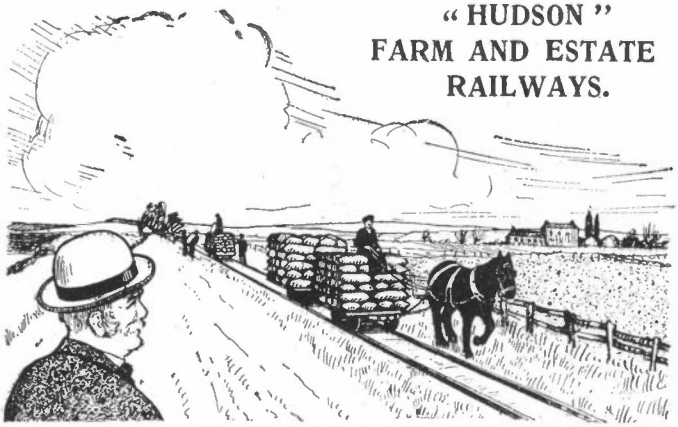

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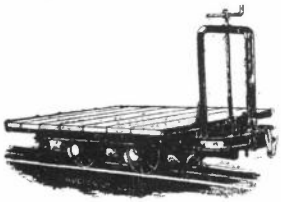

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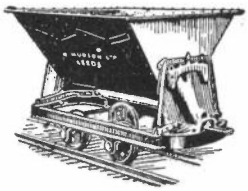

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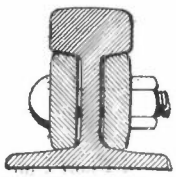

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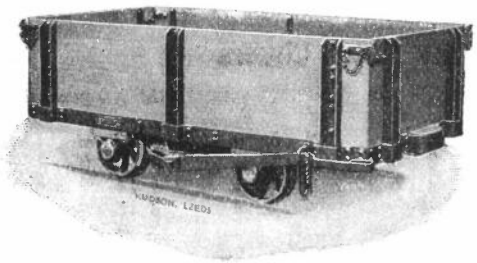

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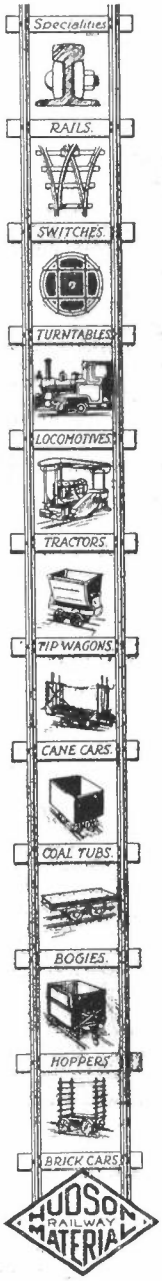

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