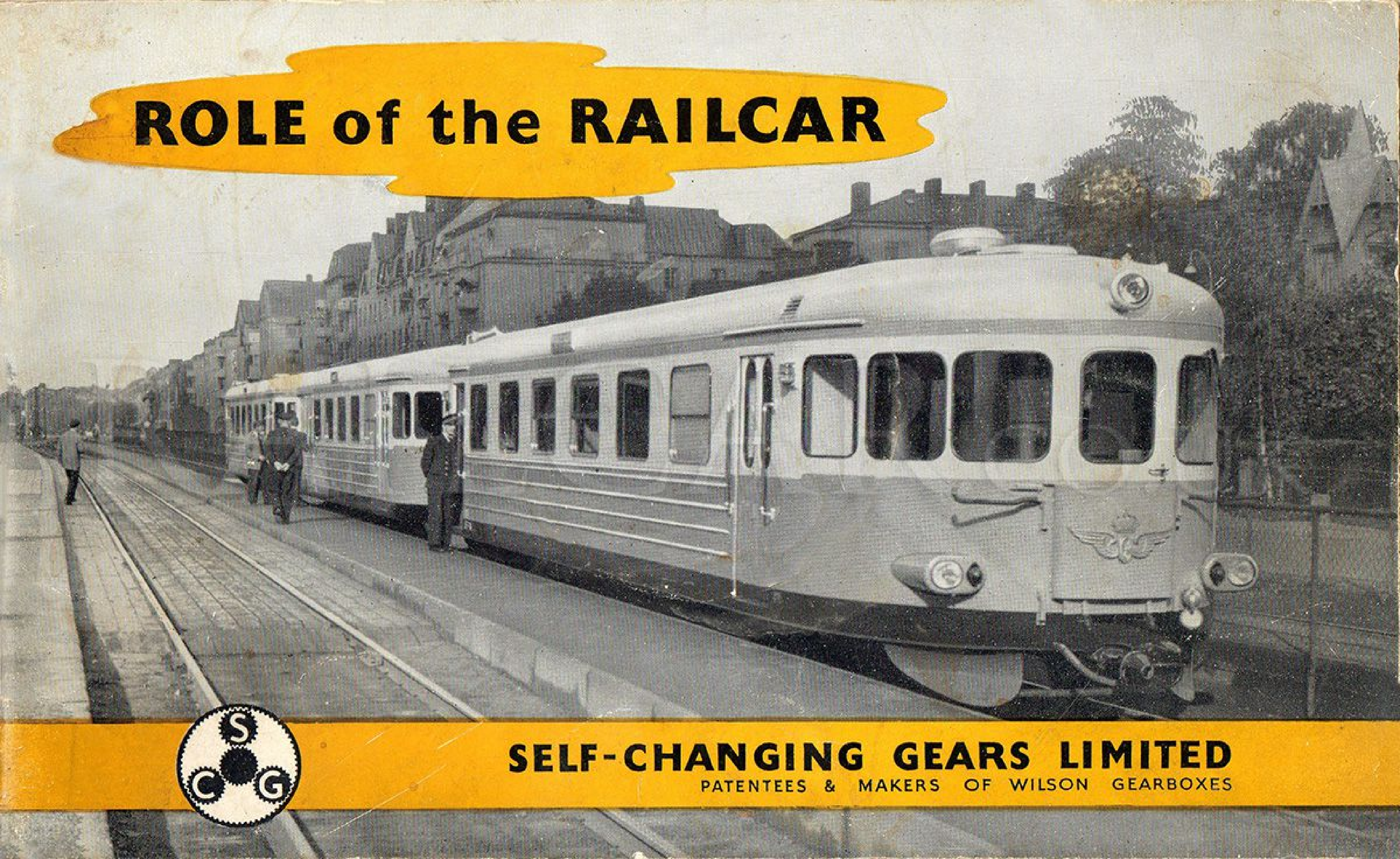
ROLE of the RAILCAR



SELF-CHANGING GEARS LIMITED

PATENTEES & MAKERS OF WILSON GEARBOXES

FOREWORD

This short survey sets out the advantages and scope of railcar operation. Used abroad for many years their use is likely to be greatly expanded in Britain. We, as makers of the Self-Changing Gearboxes used by railcars operating in 12 different countries all over the world, commissioned a well-known and respected railway technical writer, to prepare the text without fear or favour. This informative and comprehensive booklet is the result.

Cover Photograph.

Our cover photograph shows two power cars of 200 h.p. each, coupled with a central trailer. A special electrical coupling enables an unlimited number of cars to be quickly coupled together. Each power car has a Self-Changing Gearbox.

Acknowledgments are made to the following companies whose railcars are shown in this booklet ;

A.E.C. Ltd. and British United Traction - Pages 4, 19, 20 and 3rd Cover

Cravens Railway Carriage and Wagon Co. Ltd. - 21

The Drewry Car Co. Ltd. - 2, 5, 8 & 15

Swedish State Railways - Outside Covers, 6, 7 & 13

The Victorian Government Railways and Walker Bros. Ltd., with Messrs. Martin & King - 17

Walker Bros. Ltd. - - - 10 & 23

ROLE of the RAILCAR

A short survey of the advantages and scope of railcar operation

Advantages of high power to weight-moved ratio

The key to successful railway operation as far as motive power is concerned is the provision of high horsepower per ton of moving weight. Its importance can hardly be over-estimated.

Not only does it enable high speeds—up to the maximum that track and curves will permit—to be maintained steadily over undulating profiles, but it allows of very rapid acceleration from standing starts and from speed restrictions, whether these be caused by signal slacks, permanent way repairs, curves or other restrictions.

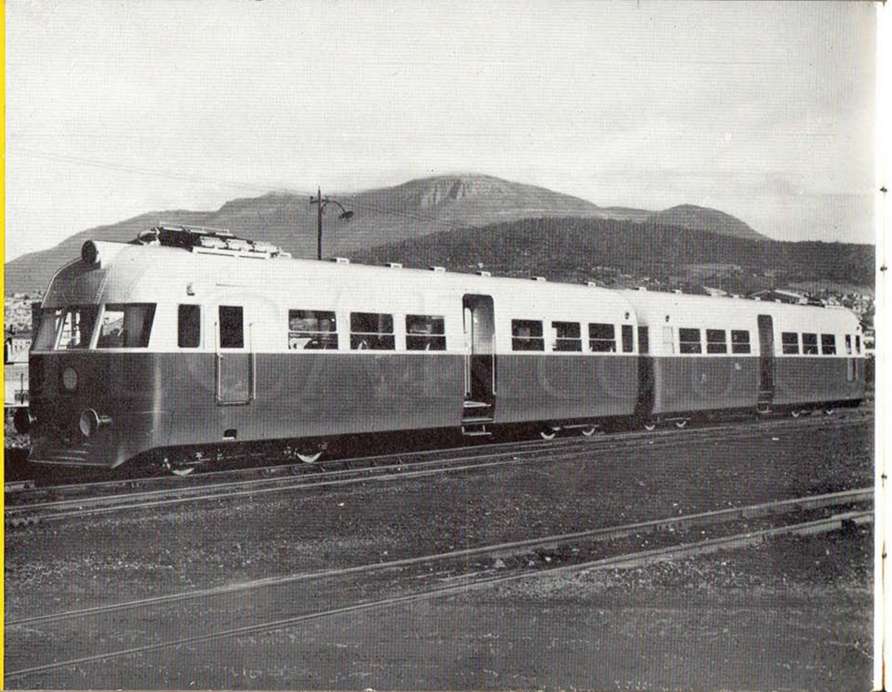
All correct railway operation is based on punctuality, in order to get maximum density of traffic over any given track, and also to gain complete safety of operation. Strict punctuality rules out all possibility of collision. High horsepower per ton of total weight enables schedules to be maintained on the most exacting timings; but, just as important, it enables punctuality to be regained *at the earliest possible moment after any out-of-course delays.*

High horsepower per ton of moving weight can be provided with any form of motive power but not economically. In the vital factor of high horsepower per ton of moving weight a locomotive of any type is inferior to motive power constructed on the principle of each vehicle or fixed set of vehicles with its own motive power; that is the railcar or railcar-train.

In the end, however, performance depends on the adhesion between wheel and rail—the maximum tractive effort which can be transmitted without slipping. What high h.p. per ton does is to enable maximum tractive effort to be maintained up to a higher speed. But the same factor of rail-and-wheel adhesion governs matters in reverse—that is, in deceleration as distinct from acceleration.

Maximum braking force should be almost, but not quite, enough to make the wheels slide. There are two main factors which limit the braking power; first the adhesion between wheels and rail; secondly the friction between the cast iron brake block and the steel tyre.

Both are variable and so make braking a difficult problem if high rates of deceleration are needed in routine working. Yet in this respect, too, the railcar is in advance of locomotives of any type, in that it is much easier and more convenient to install in them the modern



A Drewry twin-car diesel set on the Tasmanian Government Railways. These cars have given unrivalled service in Tasmania for many years. Self-Changing Gearboxes are standard on Drewry railcars.

forms of disc brakes. These reduce the number of variables from two to one, and not only give more efficient braking with much less maintenance, but, just as important, give a far more constant standard of braking, less susceptible to frictional variations, and make calculated braking distances much more in accord with the regular day by day stopping distances.

Reduced axle loading and weight distribution

In one further railway fundamental the railcar is a striking improvement over locomotive traction, though its full effect can be felt only if a whole branch line, or division, or area, is worked wholly or largely by railcars or their brother, the power van. Locomotives in general form only 5 to 6 per cent. of the total wheeled stock of a railway. Yet apart from a bare handful of mineral railways their use dictates that the permanent way and all the underline bridges and structures must be twice as strong as needed by the other 94 or 95 per cent. of wheeled stock, because of their axle load and weight concentration. Taken as a traffic machine, therefore, the locomotive can scarcely be called an efficient or paying proposition. On the other hand, railcars and multi-car trains have axle loads scarcely exceeding those of normal loaded wagons, and the distribution—in regard to bridge loading—is as good as that of a passenger carriage.

These fundamentals covered, the many particular advantages of a railcar or railcar-train may be considered. In the first place, however, the criterion of high horse-power per ton means that in theory the railcar or the multi-car train should always be operated solo or in multiple-unit, otherwise the advantage of the high h.p. per ton is thrown away and the railcar becomes really a locomotive hauling trailers, and so not capable of schedules and speeds as fast as those of a solo car. But there are ameliorations compared with locomotive traction, in that the weight of the railcar itself is devoted in a large part to revenue earning whilst still acting as a tractor, and so even with one trailer or two the h.p. per ton of total weight may be higher than with a locomotive hauling a train.

Existing railway methods of dealing with heavy and bulky transport may not always allow of great use of solo railcars or trains, unless most of the passenger transport can be turned over to such means. But such vehicles have very definite uses.

Multi-car trains for fast, long distance service

Multi-car trains are the most economical, most speedy and most comfortable form of long-distance express service. Such trains as the pre-war Flying Hamburger and Flying Cologner, with start-to-stop speeds of 80-82 m.p.h. over long distances, were operated by twin-car and triple-car trains of fixed formation. So are the Dortmund-Paris and Dortmund-Basle services of today;

This diesel train is the non-stop "Enterprise" running 112 miles in 2¼ hours from Belfast to Dublin. The power cars incorporate A.E.C. engines and Self-Changing Gearboxes.

Another example of the application of our transmission for multiple unit operation. This illustration shows one of 35 twin car articulated sets supplied by the Drewry Car Company Limited to the New Zealand Government Railways. Each twin car set is fitted with two Self-Changing Gears five speed and reverse gearboxes each driving the outer bogies through coupled axles for which we also supplied the spiral bevel final drives. The control system is arranged for multiple unit operation so that three twin car sets may be coupled together thus forming a six car train.

DATA

A comparison of Total Train Weight

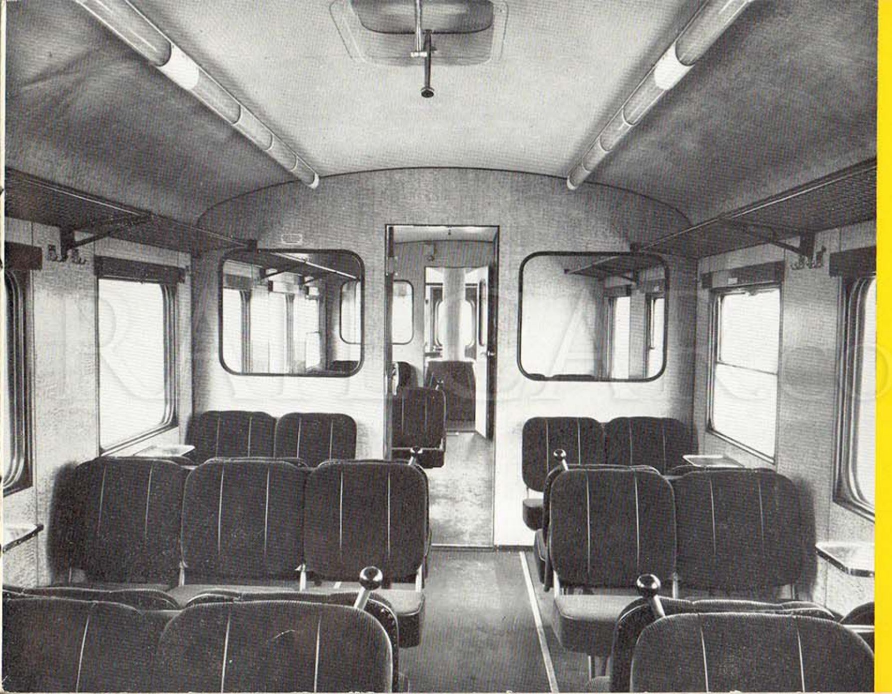
For carrying 190-200 passengers

	Approx. Horse Power per ton.	Total Train Weight in tons.
Four Car Diesel Train	$7\frac{1}{2}$-8	160
Diesel Locomotive	$6\frac{3}{4}$	306-310
Electric Locomotive	$6\frac{1}{2}$	310-315
Steam Train (Silver Jubilee)	5	384

A comparison of Axle Loading and Weight Distribution

	A.	B.	C.	D.
Four Car Diesel Train	15	2.75	0.5	0.46
Diesel Locomotive	19	3.6	1.6	1.27
Electric Locomotive	20-21 plus about 1 ton dead weight	3.8	2.35	1.7
Steam Train (Silver Jubilee)	22 plus about $1\frac{1}{4}$ tons per wheel hammer blow	4.55	—	2.35

A. Axle load in tons.
B. Tons per foot of fixed wheelbase.
C. Tons per foot of total wheelbase.
D. Tons per foot run of engine and tender over buffers.



This modern interior amply supports the point made on page 9, when dealing with passenger comfort.

Diesel railcars in New Zealand, face varying climatic conditions and arduous routes. For over ten years they have been giving valuable service to New Zealand Railways, resulting in new orders for which Self-Changing Gears gearbox reverse units and final drives were specially designed.

the Dublin-Belfast "Enterprise", and the Hamburg-Copenhagen express. All these, it may be noted, are international trains crossing frontiers, and are dealt with more quickly and easily by customs officials than are long steam trains, with benefit to the passengers through shorter stops.

Long-distance express internal services can also be handled by multi-car trains, or railcars coupled in multiple-unit, such as the old Paris-Lyons service (317 miles) in France; Buenos Aires-Mendoza (800 miles) in Argentina; Hamburg-Basle (570 miles) in Germany; Madrid-Coruna (525 miles) in Spain; and the now numerous services from Dublin to such towns as Cork (165 miles), Sligo (134 miles) and Limerick (123 miles) in Eire.

More than one set can be coupled in multiple-unit when traffic necessitates; but one of the present main uses of multi-car trains in multiple-unit is to give service to different areas, all sets starting out in one train (up to a maximum of 12 cars in Holland), and then being divided at important junctions, one set going in one direction, a second set in another, and so on. In the reverse direction the fixed formation sets, of anything from one to five cars, come together at the junctions. Regular examples of this form of working are to be found in Eire, the Netherlands, France, Germany, Spain, Italy, Argentina, Ceylon and Australia. (See centre pages).

These are the cream of the passenger traffic. But how does the railcar meet the needs of the milk and the skimmed milk—the services with high operating costs and the services with low traffic, and the services which must dovetail in with steam trains? To cater successfully for traffic, there must first be a demand, actual or potential. Then the service given must be frequent, fast, punctual, comfortable and safe. Finally the price must be reasonable for the quality of service offered, even when the quality is of the highest.

The bright airy interior of a railcar with modern seats, up-to-date lighting and controlled ventilation brings the passenger into a good humour even before the wheels begin to turn, brings more of them to the railway from the roads, even without increased speeds or lower fares.

The reasons for lower operating costs

The railcars, however, must be net revenue earners for the railways, either by reduced working costs or by attracting more gross revenue, or by a combination of both. Many years of experience have proved the railcar, for equal traffic capacity, to have much lower operating costs which are achieved mainly under the following headings:

Greater availability and greater possible mileage in any given period.

Lower maintenance costs per unit of distance run.

This small railcar used on Irish country routes pulls a trailer and parcel van. The cars are mounted from track level.

Lower fuel costs, due to low specific consumption, less weight, and no stand-by consumption.

Lower wages bill through reduction in the necessary train crew.

Reduction in stand-by losses.

Ready for service in short time.

Smokeless and sparkless operation, leading to a reduction in cleaning costs and deterioration, and to practical elimination of lineside fires.

The relative degree of saving under each heading varies with each application. In South Africa, for example, locomotive coal costs only 11s. 6d. a ton on the tender, so it is also impossible for any kind of diesel vehicle to show an appreciable saving in fuel cost, for diesel fuel oil is £9 15s. 0d. a ton. This price ratio of 17 to 1 is not found anywhere else. In Australia, for example, it is about $4\frac{1}{2}$ to 1, but only $2\frac{3}{4}$ to 1 on the basis of the heat value of the two fuels. In Brazil the two ratios are $2\frac{1}{2}$ and $1\frac{1}{2}$ to 1. So in these two countries, which are quite average, the diesel railcar can easily show a substantial direct fuel saving.

There are many examples where diesel railcars in local and branch-line traffic have shown a fuel consumption only one-twelfth in weight the coal consumption of the steam trains they replaced. Quite commonly diesel fuel is four times the price per ton of locomotive coal, so that a usual saving in fuel charge is of the order of 66 per cent.

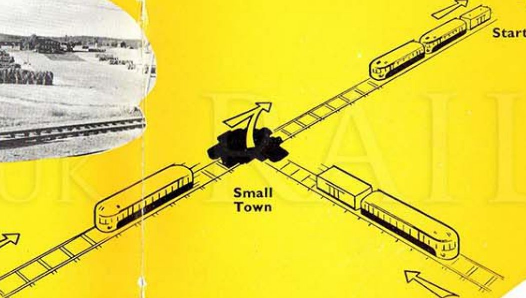
The greater availability and greater possible mileage are inherent to the diesel railcar. First of all such vehicles do not need so much servicing as steam motive power. They do not need to be stopped for water every 100 or 150 miles, and they can carry quite enough fuel for about 24 hours work and perhaps even more. Many cars up-country, for instance, can be re-fuelled economically only at one place, and therefore carry enough for two days' running. Also, their preparation time is very short, for they have no need of steam which must be raised slowly to avoid damage to the boilers.

Further, their maintenance and repair, though based on the same principles of replacement and renewal as applied to steam locomotives, are not at all the same in regard to work done. There is no boiler wash-out day keeping the unit out of traffic one day in every eight to fourteen.

Moreover, all the parts needing attention are small, and most of them can be handled by one man, so that labour time is cut down and fewer large special appliances such as heavy cranes and turntables are needed.

The Versatility of the Railcar

The railcar is perhaps the most flexible of all railway motive power units. It can run solo, or in multiple-unit with three or four power cars; it can operate with a control trailer as a duo-directional unit ; it can haul one or more trailers ; it can be designed as an all-passenger car, as an all-freight car, or as an intermediate combination of the two ; it can be built as an adhesion car or as a rack-railway car ; it can have one, two, three or four axles driven ; it can heat its own interior and have equipment to heat trailers . . . . . .



Arrows indicate return journey

Start One driver Railcars coupled.	Car A 180 h.p. Express	Car B 150 h.p. Slow	Trailer
Arrive Small town and divide.	Car A 180 h.p. Express. Proceeds Fast with Original Driver	Car B 150 h.p. Slow Stopping Car, with Second Driver	Trailer
Arrive Destination.	Car A 180 h.p. Express	Car B 150 h.p. Slow. Leaves Trailer	
Return to Small Town and couple up again.		Car B 150 h.p. Slow, drops second driver	
Finish with original driver.	Car A	Car B	

Greater mileage of the railcar derives from the less time spent in servicing, maintenance and repairs; from the higher speeds possible over many sections of line, which, with greater accelerative and decelerative powers, make for quicker schedules; and finally from the quicker turn-round time at terminals, the railcar or multi-car train here being the equal of the multiple-unit electric train.

When any line or district is worked largely by diesel power there is a distinct saving in the painting and maintenance costs of overhead bridgework, station buildings and lineside erections because of the lack of soot, water and exhaust steam. There is a similar saving in the maintenance of the vehicles themselves, particularly in the roof and side panels; the exterior needs less cleaning, and the interior is not damaged as in steam by the constant ingress of smoke and cinders. Moreover, eating on the train becomes a more pleasurable and hygienic diversion for the same reason.

Economy extends not only to the superstructure but also to the substructure. The permanent way suffers less wear and tear, its maintenance becomes less expensive and easier and its safety becomes greater. Also, it suffers less from particular factors brought in the wake of steam locomotive operation, for example, continuous blow-down, which has been shown to increase permanent-way maintenance charges measurably.

In many railcar expenditure sheets a substantial item is that for interest and depreciation. The capital cost of a railcar usually is not low; and its high potential mileage and availability, and its low running costs, are rightly expected to offset that largely. But it has been the practice even to the present day to assume the railcar will have a short life, so heavy book charges are written against it to cover this. Yet the same maintenance and renewal methods which give the steam locomotive a life of 40, 50 or 60 years are practised with railcars, and a life of less than 25 years, or 4 per cent. depreciation, is hardly in accordance with the facts. Recent official calculations in Germany, where railcar traction began in 1924, allow a life of 35 years for diesel railcars of normal type, and 15 years for the light diesel railbuses, the first of which has been running only since 1950. Even such an authority as the Interstate Commerce Commission, used to the quick writing-off of American business methods, allows a life of at least 25 years for railcars; and railcars in different parts of the world, for example, Sweden, Switzerland and Canada are known to have had a life of that span often without regular replacement and renewal of parts.

The railcar is perhaps the most flexible of all railway motive power units and in passenger service it can do everything the steam locomotive can do except haul long, heavy trains at comparatively low speed with the potential unpunctuality or extreme slowness of schedule which must always accompany low h.p. per ton.

The Nyasaland Railways have recently put into service Drewry railcars as illustrated here. These are fitted with Self-Changing Gears four speed and reverse gearboxes and spiral bevel axle mounted final drive units.

The versatility and variety of railcar operations in various parts of the world

Main Line Operation in Ireland

Few better examples of railcar flexibility are to be found than on the lines of the Great Northern Railway Board (Ireland), where 20 A.E.C. railcars with two engines and two Self-Changing Gearboxes each are in traffic. Normally they operate in pairs with a trailer between in fast and semi-fast main-line work; but some are allocated to suburban and branch traffic, and the formation is varied according to traffic, and sometimes is made up of a railcar and a control trailer.

The well-known "Enterprise" express running non-stop in $2\frac{1}{4}$ hours between Dublin and Belfast, 112 miles, has been operated now since the autumn of 1950 by these triple-car sets; and the six-days-a-week fast 2.15 a.m. newspaper train from Dublin to Belfast is another regular working. Several other main-line trains with four stops in the 112 miles are also diesel workings. Introduced between June 1950 and April 1951, many of the cars have exceeded 300,000 miles in the first four to four-and-a-half years of service in several cases without major overhaul. On the main-line services the fuel consumption over the whole period has averaged 5 to 6 m.p.g., though on the "Enterprise" non-stop runs it is 6 to $6\frac{1}{4}$ m.p.g.

In similar fashion, the 60 railcars, also with two of the same power-transmission groups, on Coras Iompair Eireann are used for fast daily return services between Dublin and such towns as Cork, Waterford and Sligo; and also for suburban services on the Bray lines and stopping trains down to Wexford. On occasion, four of these cars handling six trailers of ordinary stock have been used along the main line on a 50 m.p.h. schedule for 86 miles.

General Purpose Operation in Australia

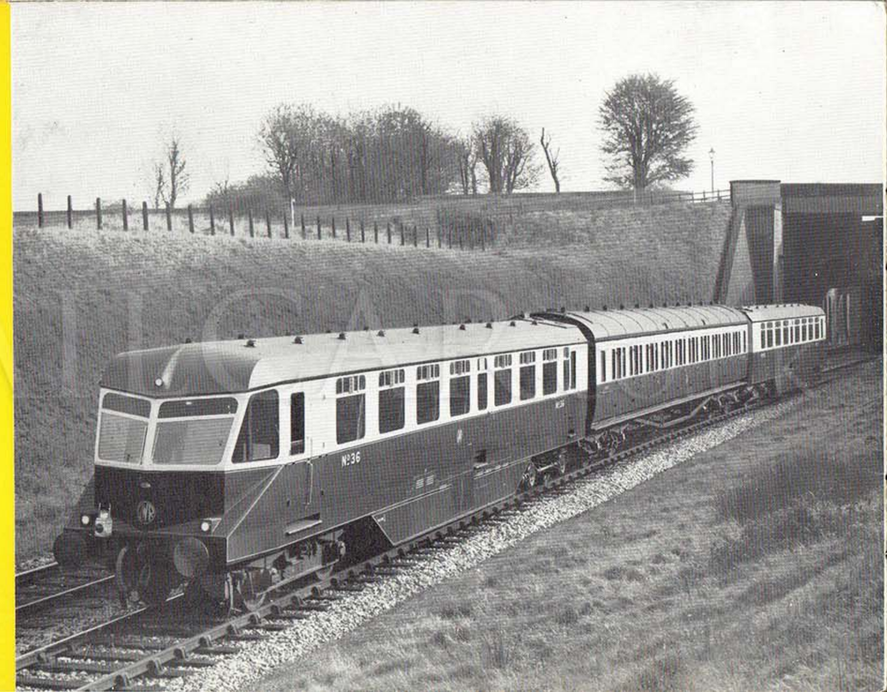
General-purpose operation over 5ft. 3in. gauge tracks, often in indifferent condition, has been the work of the railcars on the Victorian Railways since 1947. The fleet includes a dozen single-unit cars of 100 b.h.p., 16 single-unit cars of 150 b.h.p., and a dozen triple-car sets with a central power bogie carrying two engines totalling 280 b.h.p.

Introduced before the big main-line locomotives, as one of the first stages of "Operation Phoenix", undertaken to bring the Victorian Railways back into the front rank, these set the fashion for diesel traction in Victoria, and paved the way for the big extension inaugurated in 1952.

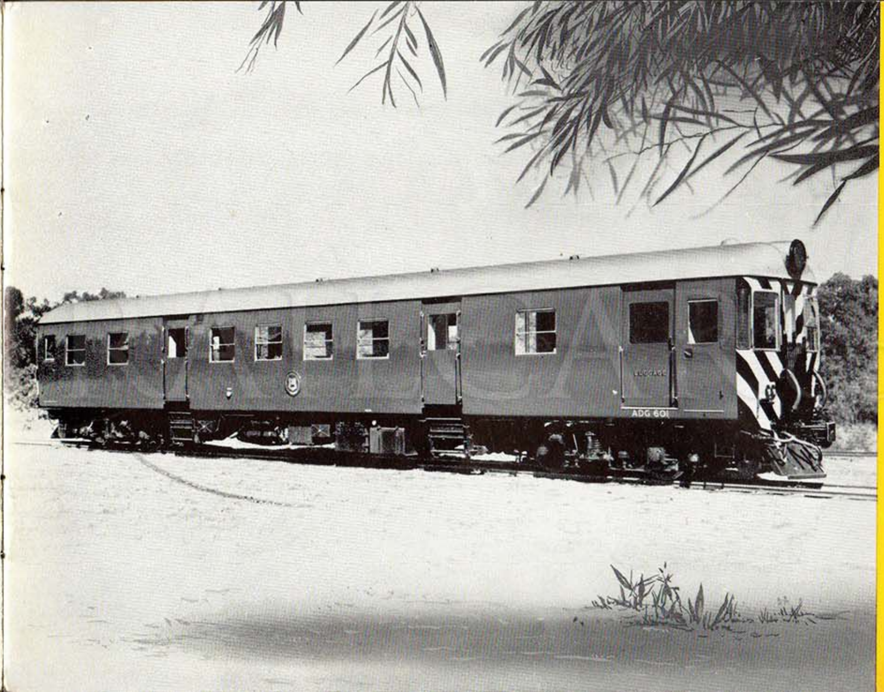
Articulated railcars in service on the Victorian Government Railways are of the central power bogie type. Two Self-Changing Gearboxes are built into the bogie and these operate simultaneously.

A further view of the rail-cars shown on the cover which are now operating in large numbers on the Swedish State Railways.

Diesel-car train at Greystones station, Co. Wicklow, Eire, one of a number which are replacing uneconomical steam trains on Coras Iompair Eireann. Gradually the majority of the steam trains are to be superseded.



An inter-urban pioneer. This triple-car set equipped with Self-Changing Gears was introduced in 1934 by the Great Western Railway between Birmingham and Cardiff and proved an immediate success.



The accelerated service given by these Craven rail-cars cut steam train times by 12 per cent. The striped front is used by Western Australian Government Railways to make them easily seen at level crossings and in congested areas.

Up-Country Running in South America

Few up-country lines have more appalling conditions than those running inland from the small Pacific ports in the northern half of Peru. Close to the Equator, the terrain is arid, and in some cases rain falls only once in five or six years. Yet on three lines running up to 65 miles inland, a battery of 16 railcars has been showing outstanding service for years, and all the cars of the most modern construction have Self-Changing Gearboxes. They work consistently in temperatures up to 100/110 deg. F., in sandstorms, up grades of 1 in 27 to 1 in 30, round numerous curves of 325 to 375 ft. radius, and with track ballasted—if at all—with sand. Eight cars on three of these railways have been recorded to maintain individual annual mileages of about 66,000; and the records show that over a year's working there is one failure only every 176,000 miles plus one delay every 120,000 miles or so, a failure being classed as an interruption exceeding 30 min. or the loss of a service, and a delay being a loss of more than 10 min. and under 30 min.

Suburban Traffic Demands

Railcar traction for suburban services is favoured round large cities in Eire, Northern Ireland, Germany, Italy, Egypt, Victoria, South Australia and Argentina to name only a handful of countries.

Particularly successful long-term results are to be found on the system of the Great Northern Railway Board in Ireland, where four triple-car sets with centre power bogies are allocated to suburban work out of Belfast as far as Lisburn, and from Dublin to Howth with certain workings as far as Donabate.

All of these have the Self-Changing Gearbox. Introduced in 1938, the F. and G. trains had each run about 950,000 miles by the end of 1954, despite the end-to-end runs of only $7\frac{1}{2}$ to $8\frac{1}{2}$ miles on which they have spent most of their lives. Including interest and depreciation, these cars have shown year-after-year an all-in working cost only 45 per cent. that of steam trains doing the same work.

Freight Haulage

The operation of freight railcars, sometimes called power vans, is undertaken usually to try and eliminate steam traction from certain lines or divisions, normal railcars undertaking the passenger traffic and power vans the freight and parcels service, often with several trailers. On other systems, usually the larger ones, power vans are introduced to provide specialised freight workings in selected districts, usually light parcels and perishable goods.

Two of a batch of six railcars for the Paita-Piura coast line Peru. These railcars run inland working in appalling conditions and all the more modern cars have Self-Changing Gearboxes. The frontal grill forms a protection against attacks by Condors and other large birds.

Social Lines

In numerous countries are to be found lightly-trafficked lines which were built in the full knowledge that they would never pay, and that their primary purpose was to assist the population, usually sparse, to have better living conditions. The railway, generally a government-owned system, undertook to bear the annual financial loss from national considerations. Though train services on such lines may be based on social considerations, the business aspect cannot be overlooked entirely, and there would be no sense in bearing year after year the heavy loss from steam traction when a more modern means of transport, the diesel railcar, is available to cut the operating cost substantially while maintaining, or even enhancing, the train service.

In fact, the use of diesel railcars has made possible to a remarkable extent the co-ordination of the many social, operating, traffic, staff and financial aspects on such lines, and nowhere more so than in the northern and north-western parts of Sweden. For 20 years now the Swedish State Railways have been building up a fleet of light railbuses and railcars to serve these social lines and other secondary non-electrified routes, and they consider these vehicles to be the best answer to road competition. They have now over 400 railcars and railbuses covering more than 16,000,000 miles a year. Maintenance and servicing cost of a railcar plus trailer is only 35 per cent. that of a steam train, and relative crew wages costs are of about the same order. All the new steel bogie railcars of 180/200 b.h.p. have the Self-Changing Gearbox, which helps to bring the low maintenance cost, and also the low initial cost, for a railcar and trailer together cost less than a new steam locomotive.

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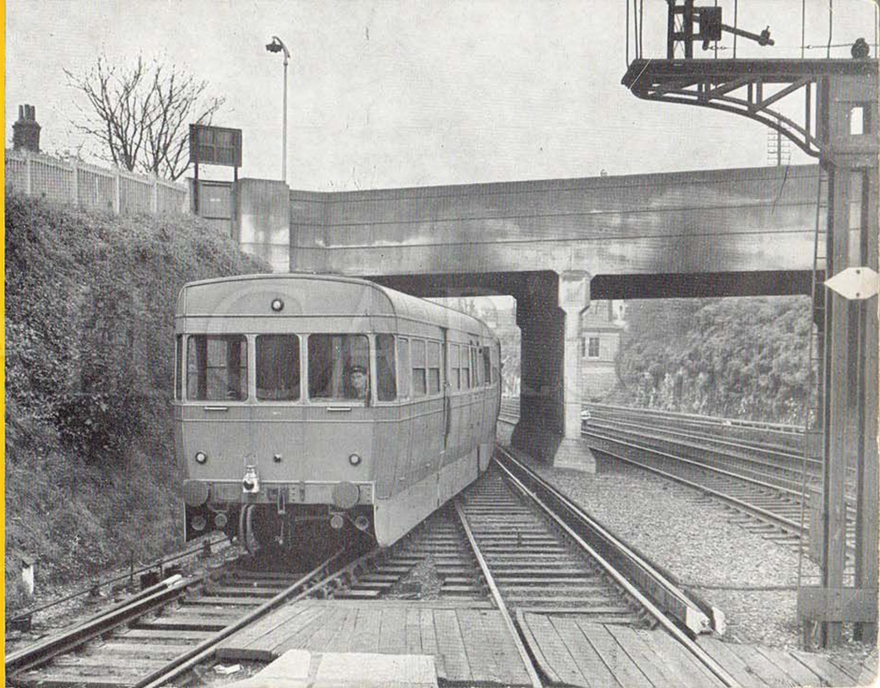
This prototype light railcar set is seen here on branch-line tests in Kent, England. It created a big impression on regular travellers and is the "shape of things to come" in view of the more widespread adoption of railcars by British Railways.



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