THE FIUE-UNIT BROAD GAUGE LONG DISTANCE GANZ TYPE TRAIN OF THE ARGENTINE NATIONAL RAILWAYS

By
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It twice happened before World War II that the Ganz Works (Budapest) concluded business transactions with the Argentine "General San Martin" Railways. The complete mechanical and electrical equipment of six diesel railcars, their bogies and welded chassis together with the ingredienst of the bodies prepared for erecting, as also the necessary technical instructions, were delivered to the railway company in 1935 and this enabled it to erect the bodies and assemble the railcars at its own head workshop at Junin. As a result of the perfect cooperation and the reliability of the equipment manufactured by Ganz, these two remote controlled three unit trains, when making their first trial run, covered the 1063-km distance between Buenos Aires and Mendoza in a non-stop run at an average speed of 101,5 km/h — a veritably unique performance. Encouraged by the splendid results, the Railway in 1938 ordered further 12 fouraxled railcars from the Ganz Works: this time the order was for completely finished cars which were then delivered by the factory already under war conditions in 1939. All of these 18 vehicles are still doing service and giving perfect satisfaction.

It was after such antecedents that, after the end of the war a new order was received for 26 multiple-unit trains; 21 trains out of the total of 26 were to be supplied to the General San Martin Railways. Sixteen of these were four-unit trains intended for short distances, and five were five-unit long-distance trains. We wish to deal with the latter five trains in the following description.

When ordering these trains, the railway company was led by the consideration that, over long distances, normal steam-powered trains composed of the usual railway carriages would fail to attract a "spoilt" travelling public with high requirements because of insufficient speed and a lack of that degree of comfort which would induce the public to dispense with the advantages offered by aerial journeys over the same routes. In order not to lose this profitable class of passengers, the company had to put specially designed train units in service which — on account of their great speed and comfort — would withhold the passengers ready to fall off and would, at the same time, ensure for the railway the required excess of receipts over the sum of the annual charges against the capital account and the costs of service.

Let us now see what the manufacturing works afforded to the Railway in respect to the mechanical equipment of these trains and in that of the devices which were to promote the comfort of passengers.

Main technical data of the trains

Gauge	1 676 mm
Total length over buffers	133 284 mm
Width of body	3 260 mm
Bogie centre pitch	
railcar	18 920 mm
trailer	18 800 mm

Number of wheels	
driven bogies	6 mm
running bogies	4 mm
Wheel base of driven bogies	4 100 mm
Wheel base of running bogies	3 160 mm
Number of seats in saloon ..	184
Number of seats in dining room	56
Lighting voltage	72 V
Air conditioning: cooling and heating combined with ventilation	
Type of engine..........	XII Jvf 170/240
Engine output	2×600 H. P.
Transmission	mechanical

Knorr-Lambertsen, compressed air

Brakes	
Weight, ready for service	285 600 kg
Weight, fully loaded.....	312 400 kg
Maximum axle load	17 000 kg
Maximum travelling speed	120 km/h

General arrangement

The five-unit de luxe train consists of two power cars, one at each end, two intermediary trailers with passenger rooms and a dining car placed in the midst.

The power cars comprise the following compartments: engine room including the driver's stand; a spacious room for heavier luggage; a compartment for hand-luggage; a saloon with 32 seats; lavatory; water closet. The trailers — coupled directly to the railcars — contain a saloon with 60 seats, lavatories, water closets and a hand-luggage compartment. The dining car, placed in the middle of the train, contains a dining room with 56 seats, a kitchen and a compartment for the kitchen personnel.

The driven end of the power cars is streamlined, while the side walls at the coupling ends of all carriages extend past the end walls, so as to prevent air eddies between the units as far as possible. It is likewise with a view to reducing air resistance that the sides extend downwards in so-called skirts. The cars are joined by means of central automatic couplers (system Ganz), closed gangways, and the air- and cable-couplers.

Mechanical equipment

Both power cars have identical tractive and auxiliary equipments. They consist of the following main units:

Engine:

Type	XII Jvf 170/240 (supercharged)
Bore	170 mm
Stroke	240 mm
Arrangement of cylinders	V
Number of cylinders	12
Speed, idling	450 r. p. m.
Speed, gear changing	770 r. p. m.
Speed, max. service	1 150 r. p. m.
Normal output..............	600 h. p.

Before continuing, it seems advisable to devote a few lines to the main characteristics and the history of the engines type Ganz—Jendrassik, and this the more so as the engine of the train in question symbolizes the peak and at the same time means the conclusion of a phase of development.

The first four-wheel railcars, built by the Ganz Works in 1926, were provided with petrol engines; this system was maintained until 1929 when the development work of the first Ganz—Jendrassik railcar engine — one based on the Diesel principle — had been completed. This engine can claim to have been the first engine of the Diesel type that in railway service had stood the test.

The main design characteristics of the engine are the following: antechamber ignition ensuring perfect combustion by means of a rational design of the combustion space; insensitivity to blocking up; atomizer with a diameter exceeding 1 mm; fuel injection pump ensuring atomization of diesel oil independently of the engine speed; a decompression device ensuring safe starting in any weather; powerful construction adapted to heavy railway service. Induced by the splendid results obtained from this highly successful type of engine, the factory provided all its subsequent vehicles with Ganz—Jendrassik engines and even replaced the petrol engines of the earlier cars at a later date with the new type. The 120, 160, 220 and 300 h. p. units manufactured until the outbreak of World War II had strait engines and the trial run of the first 450 h. p. V type engine took place already during the war. However, the growing claims concerning increased passanger capacity and higher speed, furthermore the use of power consuming equipments serving the greater comfort of passengers, require such a rapid stepping-up of the output of the diesel engine, the sole source of power of the cars, that — at present — the engine equipped in one bogie has twice the maximum pre-war output.

It is quite obvious that, having to do with vehicles used in railway service where the dimensions of the engines to be incorporated in the power cars are restricted by a host of factors (e. g. gauge, gabarite, prescribed maximum weight and axle load of the rolling stock, required passenger capacity of the railcars), increase of engine output on such a scale, that cannot be achieved by simply enlargening the engines.

Another method to obtain better output is to increase the amount of fuel consumed per unit of time by stepping up the speed. Since, however, the railway required powerfully built and long-lasting engines, together with the highest degree of operational safety, the factory refrained from exploiting the possibility offered by an increase of the speed up to the highest admissible piston speed, for to do so would evidently have meant a certain renunciation of the said principles.

It was after such antecedents that the third method of output-increase, i. e. the raising of the mean pressure on the piston, was chosen. This is achieved by increasing the quantity of fuel per working stroke and the corresponding quantity of air required for the process of combustion. This is performed by a turbocompressor. The latter, rotating together with the gas turbine which utilizes the energy of the exhaust gases, compresses the air of atmospheric pressure before each intake, thus enabling the engine to suck in more air, while the cylinder volume remains unchanged.

This method is very convenient inasmuch as — apart from mounting of the turbocharger — it requires practically no essential change in the design of the engine. It should be remembered that, apart from the actual number of revolutions and the output, it is not so much the mean effective pressure on the piston as rather the forces of inertia of the crank gear which determine the dimensions of the engine : these forces do not increase if the speed remains unchanged, so that the engine parts need not to be strengthened.

We do not propose to describe here the other mechanical equipments of the train, for — essentially — they are hardly different from the well-known other constructions of the Ganz Works. Yet, we must not omit to mention the body steel construction of light weight design because, in their dimensioning, new principles had to be applied.

In order to make the luxuriously equipped passenger rooms of the train still more attractive, the Railway desired that the vehicles should be built as observation cars and that, to this end, the windows should be placed very close to each other with possibly the narrowest pillars between them. We know that, as a rule, it is the pillars between the windows which form the connection and ensure the coaction between the lower and upper head girders i. e. the underframe, and the roof. As these pillars in the given case had to be particularly narrow, specially careful and tensometrically controlled calculations were needed to make sure that they would be suitable for the said task. Therefore, the designers adopted the principle that the shear stresses between the upper and lower girders should be borne by the broader windowless fields at both ends of the cars and that, consequently, the slender pillars between the windows should just form a simple connection between the said girders. While, thus, they play no important part in bearing the shear stresses they still have to endure those deformations which arise from the sliding of the upper and lower zones caused by the elastic strains of the said windowless car end walls. The greatest bending moments arise, of course, at the joints where the connecting pillars are attached to the two girders. Preliminary computations and test measurings having shown that inadmissible stresses would arise at these points of the pillars, the designers, in order to solve the problem, had to resort to a method hitherto quite unusual in railcar manufacture. The method consisted, essentially, in the application of the principle of the so-called prestress. Since of the two constituting elements of the pillar, i. e. the inner pillar and the outer casing sheet, it was the latter deformation which would have given rise to that stress which the said calculations showed to be inadmissible, weights amounting to 50 per cent of its own operating load were suspended on the car body prior to welding the outer casing sheets onto the inner pillars. In this way the bending stress arising at the edges of the casing sheets became equal to that arising in the inner pillars. Tenso-metric measurings made to control preliminary calculations confirmed these results. The structure built after the said precautionary measures is giving in actual service full satisfaction.

Air-conditioning is the most important of the equipments provided for the comfort of passengers. Long journeys of many hours under inappropriate conditions induce a feeling of fatigue. It is only natural that the most efficient method of railway propaganda is to offer the public such comfort as is suited for reducing the fatigues of travel to a minimum or, still better, to turn the journey into a veritable recreation. Air-conditioning occupies a prominent place among the new and up-to-date equipments serving this purpose.

Almost from the time the Ganz factory embarked upon building of railway vehicles powered by combustion engines, did it also engage in the designing and the manufacture of air-conditioning devices. It took, thus, an active part in bringing the technique of air-conditioning to its present high level, and — storing up rich experience through the successive phases of development and utilizing each new experience — was able to elaborate a special type of its own. It is this air-conditioning equipment, type Ganz, with which the train under review was provided.

What is actually, the purpose of equipments of this kind? It is, briefly, to develop in the inside of the railway carriages a separate "micro climate" which is more or less independent of the outside atmosphere, a climate the atmospheric conditions of which — such as the composition of air, the temperature, humidity and circulation — are determined and produced by the designing engineer in accordance with the physiologist's scientific and experimental results.

It will be seen that the solution of the problem imposes two tasks :

1. To enable the railway carriage to bear its own microclimate, its interior has to be isolated from the outside atmosphere as completely as possible ;

2. such mechanical and calorical operations have to be performed as will ensure the production and maintenance of the above-defined atmospheric conditions.

ad 1. To achieve the first task, i. e. to make the inner space of the carriages independent of the outside atmosphere, it is necessary to carefully insulate the elements which constitute the boundary between the inner space of the carriages and the outside world, and to carefully bar off those apertures which form connections between outside and inside atmosphere.

With this end in view, the structure of the walls and the floor of the cars is composed of three layers : the outer steel sheeting, the inside panelling which has to satisfy both aesthetic and hygienic requirements, and between the two the insulating layer. The usual thickness of the steel sheets constituting the sheeting of the walls is 2 mm, that of the roof 1,5 mm : the entire sheeting is welded to and forms with the skeleton of the car body a jointed structure. The skeleton consists of easy pressed elements. The whole outer surface is coated with an aluminium-like paint so as to reflect sunrays as far as possible.

In order to prevent thermal conductivity the internal panels are nowhere allowed to components come in direct contact with the of the frame : to prevent such contact, elements are inserted between them which consist either of wood or other bad heat-conductors. The inner panel, i. e. the walls, ceiling and floor inside the cars, consists of carefully processed plywood coated with high-quality top veneer, the pleasant optical and tactile properties of which contribute to making the stay in the cars agreeable. Tight fitting and a possibly projectionless jointing of surface-portions and wooden sheets are carefully attended to.

The heat insulation of walls and roof is achieved by means of a suitably thick insulating layer which adheres to the outer sheeting. Besides insulation, this layer serves the purposes of preventing the condensation of vapour on the sheets of the sheeting and the efficient absorption of sounds and noises. Sprayed Limpet Asbestos, of which the heat- and sound-absorbing properties are well-known, was used by the manufacturers as insulating material.

However careful the insulation of the inner surfaces of the cars is, the creation and maintenance of the said independent "microclimate" would be rendered perfectly impossible were the passengers allowed to open and close the windows at their discretion, as they are wont to do in the usual railway carriages. By doing so they would let any amount of so-called false air, i. e. air that destroys the effects of air-conditioning, into the circulation as provided by the conditioning apparatus, and this would disturb the entire system even in those compartments where no window has been opened.

To insure the efficient heat insulation of the windows they are composed of three layers : the outer one is a fixed, non-movable glass pane, the inner one is another glass pane that can be opened for the purposes of cleaning, and — between the two — there is a Venetian blind which can be moved up and down by means of a turnable handle and can be adjusted so as to always give the greatest protection from sunrays.

ad 2. The second task in the creation of a microclimate is to endow the inner atmosphere with the required properties : this is the real "raison d'être" of the air-conditioning apparatus.

The purpose to be achieved being to make the journey in the railcars as comfortable for the passengers as possible, the air-conditioning apparatus has to cool the cars in summer, heat them in winter, and provide the necessary ventilation all the year round. In order to be able to meet these requirements, the equipment consists of four main parts :

a) Ventilating device
b) Cooling device
c) Heating device
d) Regulator.

Three kinds of energy, namely mechanical, thermal and electrical, are necessary to operate these devices. The central source of all power is the diesel engine located with in the power bogie. With a view to minimizing efficiency losses, the inevitable concomitants of energy transformation, we must try to utilize all thermal and mechanical energy obtainable directly from the engine, at their source, and to restrict the use of electric power transmission, which involves a double loss of efficiency and takes up much room, to the inevitable minimum.

It is on account of these considerations that the air-conditioning equipment of the train under review consists not of five separate but of two units only, which, placed on the two power cars carrying the diesel engines, provide cooling, heating and ventilation each to its own car and, jointly, to the intermediary trailers.

Seeing that both heating and cooling are effected by the medium of air through the central heaters and refrigerators mounted on the two power cars, it was necessary to provide for the circulation and renewal of air by means of a system of ventilating air ducts running through the entire length of the train, and by a system of ventilators inserted in the said ducts.

The central radiator receives the necessary heating output from the cooling water of the adjacent diesel engine through an impelling pump, a short piping and a regularting valve.

Cooling is effected by a cooling aggregate mechanically driven by the diesel engine: its units — mounted in a common frame — are resiliently suspended on the underframe of the power cars. F12 freon gas is used as a refrigerating medium: apart from its excellent caloric properties, this gas is superior to other similar materials, inasmuch as it is perfectly odourless and has no irritating or harmful effect on the human organism. It is neither inflammable nor explosive.

The regulator keeps the atmosphere of the passenger compartments automatically at a constant pleasant temperature and within the required limits of humidity. Thermostats are used for this purpose which, working in concert with the corresponding relays and valves, set — according to the outside temperature — either the refrigerating or the heating apparatus going and, after having started cooling or heating, keeps the inner temperature at the desired level.

Excess atmospheric humidity is condensed on and driven off the discs of the evaporator through which the air is made to pass. Should the relative humidity of the atmosphere in the passenger rooms still exceed 65 per cent, a hygrostat — mounted in the draft tube — will cool the air off to a considerably lower degree and cause it to be reheated (i. e. dried) in the radiator, so that in a given case — simultaneously with the already working refrigerator — also the heating apparatus is automatically started by the hygrostat.

The trains of the type described in this article were delivered to the General San Martin Railways more than five years ago and have never given cause for complaints. The outstanding quality of service given by them was splendidly attested for by the International Railway Exhibition arranged in connection with the IXth Panamerican Railway Congress which was opened in Buenos Aires on September 7, 1957. The "pièce de résistance" of the exhibition was a five-unit airconditioned Ganz train which had already run many hundred thousands of kilometres on the "Condor Line". The visitors (the Dutch minister and the delegate of the U. S. A. among others) spoke of the beautiful workmanship of the train in terms of the highest praise. As regards service results, both Eng. Bernardini, technical manager of the Supply Department of the Argentine State Railways (formerly technical head of the Ferrocarriles General Belgrano) and Eng. Vallejos, director of the exhibition, while demonstrating the train, found flattering words of praise and expressed their opinion that the railcar trains of the Ganz type had considerably promoted the passenger traffic of the Argentine railways and, through them, had even assisted in the spreading of civilization.