The German E 19 electric locomotives of 1940 - Forward

When I first viewed models of some of the early German electric locomotives, and indeed of the French 2D2, **I could not understand what was meant by the quill drive**. The quill drive allied with the oft-quoted *"most powerful…"* got me really intrigued. So I just had to research them, and in so doing, I got to appreciate the technology that brought these locomotives to the attention of the model builders. Being a Pennsylvania Railroad fan, I realised that the same drive system was used for their GG1, which is also modelled by Marklin.

Anyway, for this treatise, I would like to review the E19 model built by Marklin in various forms since the 1990s. But first I have some information on the prototypes, which used the standard German Railways AC supply current of 15,000 V at a special frequency of 16 2/3 Hz.

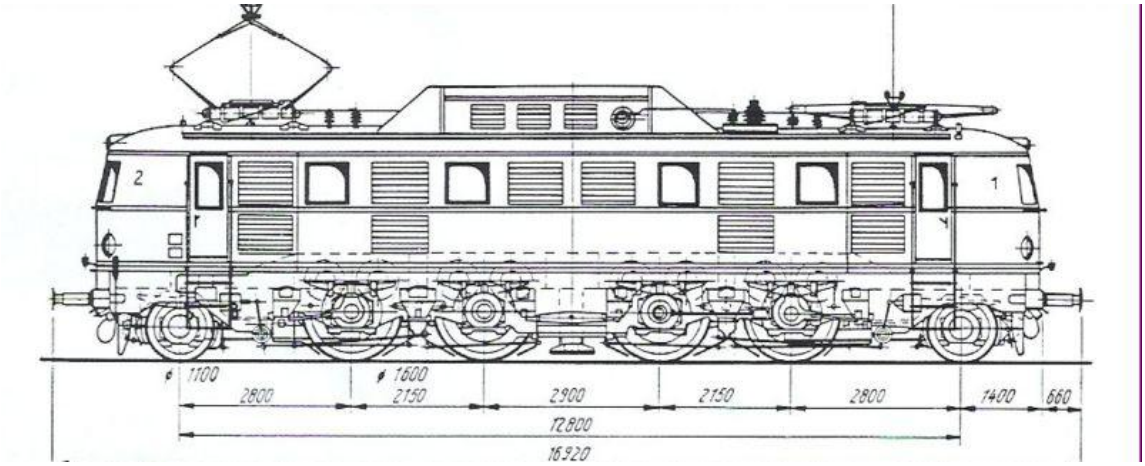
The Four Prototype E19

The E 19 was the last German electric express train locomotive developed before the Second World War, using as a basis the successful E18. The idea was to build suitable motive power for the Münschen - Berlin electrified express trains. The locomotive was specified for a top speed of 180 km / h and a weight of 110.7 tonnes, with the option for an extended top speed of 225 km / h.

The ruling gradient on this stretch of line was the Frankenwald ramp, and the E 19 was designed to handle this task from the beginning. The specifications required the transport of 360 tonnes on the 13 km long ramp between Probstzella and Rothenkirchen without a helper locomotive.

4 locomotives were ordered by the DRG for testing purposes, the first two in 1938 were built by AEG (subclass E 19.0), and were a modernized version of the E 18. From an aesthetic view, the enclosure panels on the E 19.0 were welded instead of riveted. These engines entered service as E19 01 and E19 02.

The second two by Siemens/Henschel (subclass E 19.1) in 1940, (the units modelled by Marklin), were of a more conventional riveted construction, but had a modern dynamic brake (banks of resistors to create back-emf, to waste current, and to dissipate heat from the motors acting as generators, when no electricity is supplied*) housed in a distinctive humped roof structure. This made the E 19.1 strikingly different in appearance to the E 18 and E 19.0.



1947 - Schematic: Eisenbahn Journal –

The dynamic brake enabled braking distances as short as possible, thus increasing the permissible maximum speed. With an hourly output of 4,000 kW (E19.0) and 4080 kW (e 19.1), these locomotives were in 1938 the most powerful production locomotives in the world, exceeding even Pennsy's GG1. They entered service in 1940 as E19 11 and E19 12.

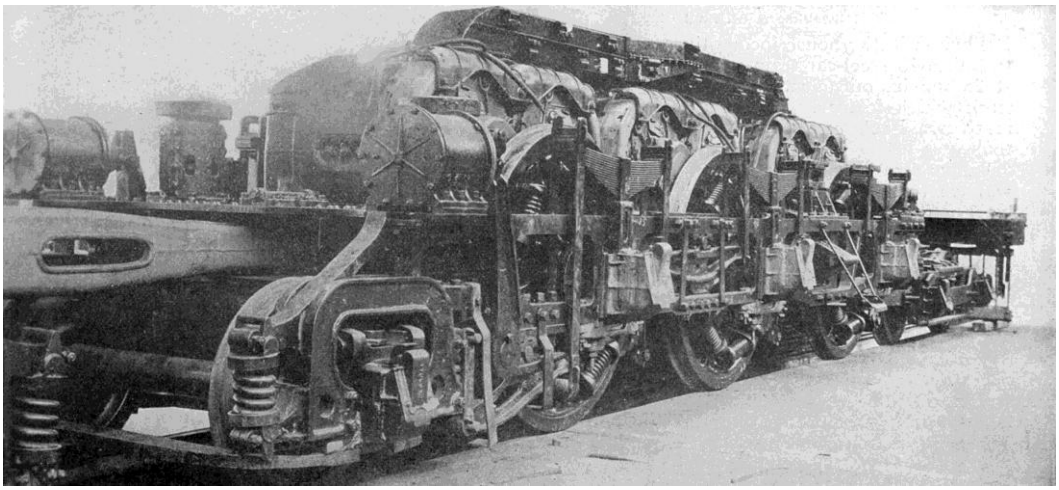
The electrification program for the Münschen - Berlin long distance connection was largely halted by the war in 1939, so the locomotives were used elsewhere. I have great respect for Marklin's research capability, and I quote from the model user manual.

"The locos offered by AEG differed scarcely from the class E 18. The E 1911 and E 1912 from Henschel.SSW in 1940 were by comparison, equipped with a higher roof dome. E 1911 and E 1912 were delivered with four double motors and single axle drive which were subsequently replaced by the DB with individual motors.

As a consequence of the war, the planned use of the locomotives between Berlin and Munich never took place. They were used instead on express trains primarily in Bavaria. The DB overhauled them and employed them on D-zug express service.

E19 11 was scrapped and E 1912 is preserved at the Nurnberg Transportation Museum."

Some Technical Information



The E19.1 were a 6 axle locomotive, designated 1D1. One axle each at front and rear were for carrying or guiding wheels, like the leading truck or bogie on a steam engine. There were 4 driving axles in a fixed frame, each with wheels 1,6 meters in diameter. To follow on from Marklins description I will expand on their *"E 1911 and E 1912 were delivered with four double motors and single axle drive…".* The motors were mounted in pairs over each of the driven axles. Each motor was geared to what is called a "quill" drive. Imagine the Quill drive as a coronet with a diameter less than the driving wheel, with a geared ring engaged directly with the shaft gear of the electric motor. This coronet rotates about the driving axle, with 6 protrusions at the outer extremity, engaged with 6 wheel cups (sockets) on the inside of the driving wheel. These wheel cups are held by springs or rubber buffers between the wheel spokes or segments, to allow "give" or flexibility. (See the springs inside the wheel circumference, in the photo above. This is not the E19 – used for illustrative purposes only).

The locomotive has significant riding stability, especially at speed, because the whole mass of motor(s), gears, axle, and wheels are sprung as one unit within the frame. In the picture below, you can make out the sprung vertical horn-block above the wheel journal. The picture was taken by M K Roxton. It is a 1:5 scale model of the motor mounting and final spring cup drive of the E18 in the DB Museum, Koblenz. The model is mounted over a mirror, so you can see the underside of the single electric motor, axle housing, and wheels. The major difference in the E19 was the use of twin motors.

The Quill drive system allows a degree of radial motion and possibly a small amount of axial motion to smooth the drive from the motor, and isolate it from mechanical shock as well. Quill drives were used by many electric locomotives in France, Italy, and in the United States, particularly those of the Pennsylvania Railroad—their long-lasting GG1 design being perhaps the best known.

The full name of the consortium who built the two locomotives of the E19.1 series was Siemens-Schuckert (SSW)/Henschel. Here are some more technical details.

SSW equipped the machines with twin engines to each axle, of the type WBDM265, which also provided a panel type finish to the floor of the machine. This allowed more space within the body for the electrical equipment, which included large transformers to reduce the transmitted current to that suitable for use by the motors. The series connection of the twin engines allowed a higher voltage at lower currents, which saved weight compared to the E 19.0 pair. Furthermore, the bus-bars, the low-voltage windings, and the windings of the built-in transformer were made of aluminum in order to save copper for the war effort. (The aluminium components were replaced with copper by DB after the war, to increase reliability).

Due to the use of twin engines, the brake linkage of the E 19.1 pair is on the outside of the wheel frame, so detail differs from that on the E 18 and E 19.0. The rheostatic braking resistors are housed in the hump-like roof structure above the main transformer. The hump had ventilator grills, and could be additionally cooled by directing the air stream through pneumatically operated flaps at the front of the structure. The driving motor voltage of E 19.1 was regulated very sensitively with 57 stages, compared to 39 stages in the E 19.0.

1967 - Photo Dieter Kempf / da: Die Elektrolokomotive bei der DB - K. Hierl/A. Ritz - Ed. Franckhs – 1967

In preliminary tests, the E19 proved themselves capable of reaching 200 km / h and more, and the maximum power developed (5,700 kW to 162 km / h) was the highest until the arrival of the E 03 in the 60s. In 1940 the four E 19s were assigned to Nuremberg for travel on the line to Saafeld, in turn with the E 18, on the first stage of the electrified line to Berlin. They were permitted to travel 180 km/ h. At this speed, they were capable of hauling 800 tonnes on the level.

After 1945

All four survived the war, in their original express red colour, with only the E 19 12 proving functional in 1945. They were assigned to the DB and storage in Nuremberg. Here is a photo of E 19 12 with only one pantograph, in the destroyed Munich Central Station in winter 1947/48.

1947 - Photo: Eisenbahn Journal –

By 1950 they were in service on the routes to Monaco, Regensburg and Ludwigsstadt. About this time too, the skirting under the buffers was removed, altering their appearance. In 1952 the red livery on the E 19 12 was replaced by cobalt blue (later extended to 19 and 01 and 02), while the 19 11 was known to be wearing the classic DB green in February 1953.

In the 50s the deployment of these locomotives was less challenging, having more regular tasks with daily distances of 900 km. and monthly 28,000 km.

Quoting again from the Marklin user manual, *".....four double motors and single axle drive which were subsequently replaced by the DB with individual motors."* There has been speculation elsewhere, that somehow DB modified the gear ratios at the same time, but there has been no evidence in technical or maintenance reports, that support this assertion. Of course it is quite likely that the driving characteristics of the new motors differed from the original twin sets.

1953 - Photo: Collezione van Kempen / da: Die Elektrolokomotive bei der DB - K. Hierl/A. Ritz - Ed. Franckhs -

*During dynamic braking, the traction motors, which are now acting as generators, are connected to braking grids of large resistors which limit the current flow and dissipate the converted energy as heat in the resistors instead of the motor. Brake intensity can be controlled by varying the excitation of the traction motor field and the resistance of the resistor grid. A direct current system can slow the train to about 5 mph (8 km/h); an alternating current system can slow the train to nearly a full stop.

Marklin Models of E 19

I believe the earliest model produced by Marklin was 3769, in the original DRG wine red express engine colour. This was in 1994.

The two most recent models, the 37691 and the 39190, are described here.
These models have the same body casting, and detail additions such as steps, handrails, and roof-top cabling. While the body is in die-cast metal, the added on detail is flexible plastic.

The wheels sets, motor and electronics are all contained on a main chassis cast in metal, with the upper body retained by a single screw which is accessed from underneath the chassis. In the same location, there is a switch to obtain current from the overhead pantograph(s) if desired. The models will run in either of 3 modes, Marklin analogue, Delta or digital. A Delta model 34691 was also available at time of production of 37691.

The clear plastic side windows of the engine are molded in such a way, that interior detail relating to the transformer or switching gear is modelled and visible. Some of the cab detail is visible at both ends, with the front windows finely modelled. 3 headlights are lit at each end, from one small bulb (replacement Part# 61 0080).

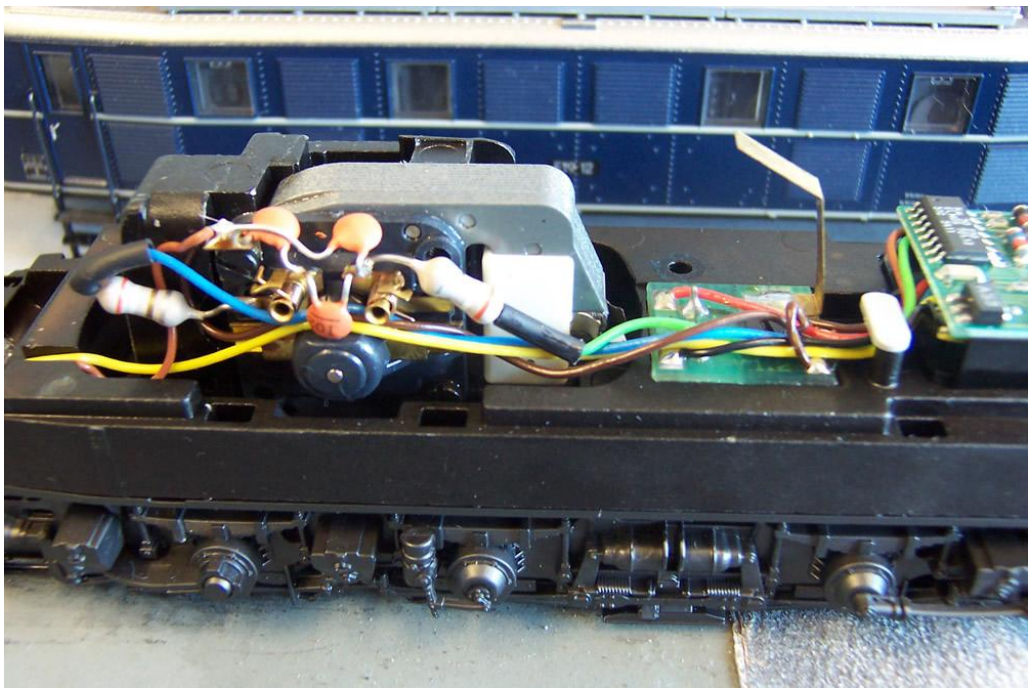
The real engine has 4 driven axles in a fixed frame, with a leading single axle pony truck at both ends, giving the wheel notation 1Do1. In the Marklin model, each set of 2 driven axles is mounted in a wheeled metal frame which swivels like a bogie, to negotiate model curves. The driving wheel spokes show the detail of the quill drive cups inside the outer rim, each retained by 2 large springs.

The model is driven through flat gears by a motor integrally mounted in one set of the bogie-like frames, with two driving axles. Each of the 4 driving wheels has a rubber traction tire. The digital control electronics are at the opposite end of the chassis to the motor, under which are the set of 4 driverless wheels. The side frames of the locomotive (with brake rigging, axle bearings, and pneumatic controllers) are relief molded in flexible plastic.

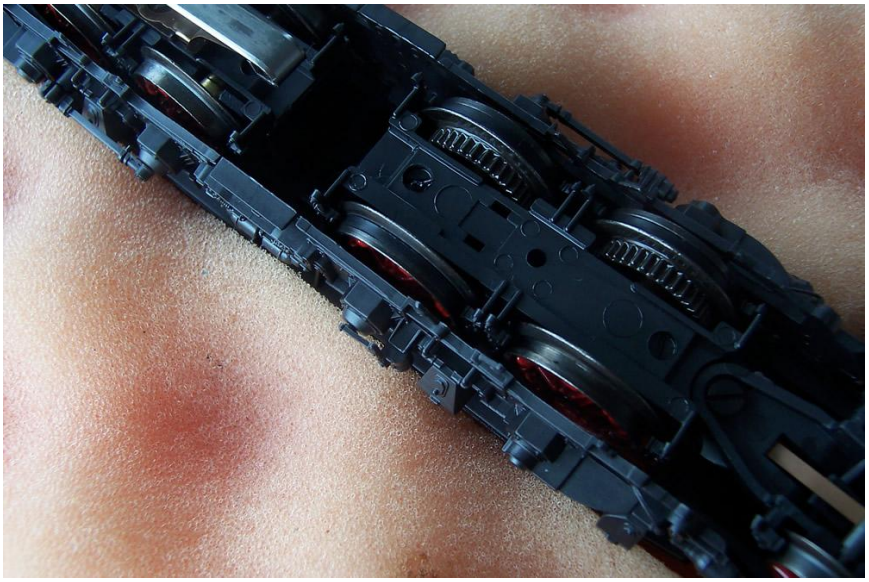
Here is a photo of the flat gear drive train. Unlike some of my other Marklin models that have a similar gear train, both of these models are really quiet. It is recommended to lightly lubricate (one drop) on each of the axles and the gear set, after 40 hours of operation.

37691 produced in 1997 – E 19.12.

The 37691 model (E 19 12) is painted in the cobalt blue, which was applied in the early 1950s. It has a large flat commutator motor with replaceable brushes Part #60 1460 (see photo below). The model drives very smoothly, with small steps on the Central Station controller. The electronics board includes two screw pots. With the first you can adjust the acceleration and braking delay timing, and with the second, set the maximum speed. One set of DIP switches can be used to reset the operation for analogue or Delta, or to reset the address for digital operation, When delivered new it is set to Address 19 for digital operation, and the function of lights on or off can be controlled (adheres to direction of travel).

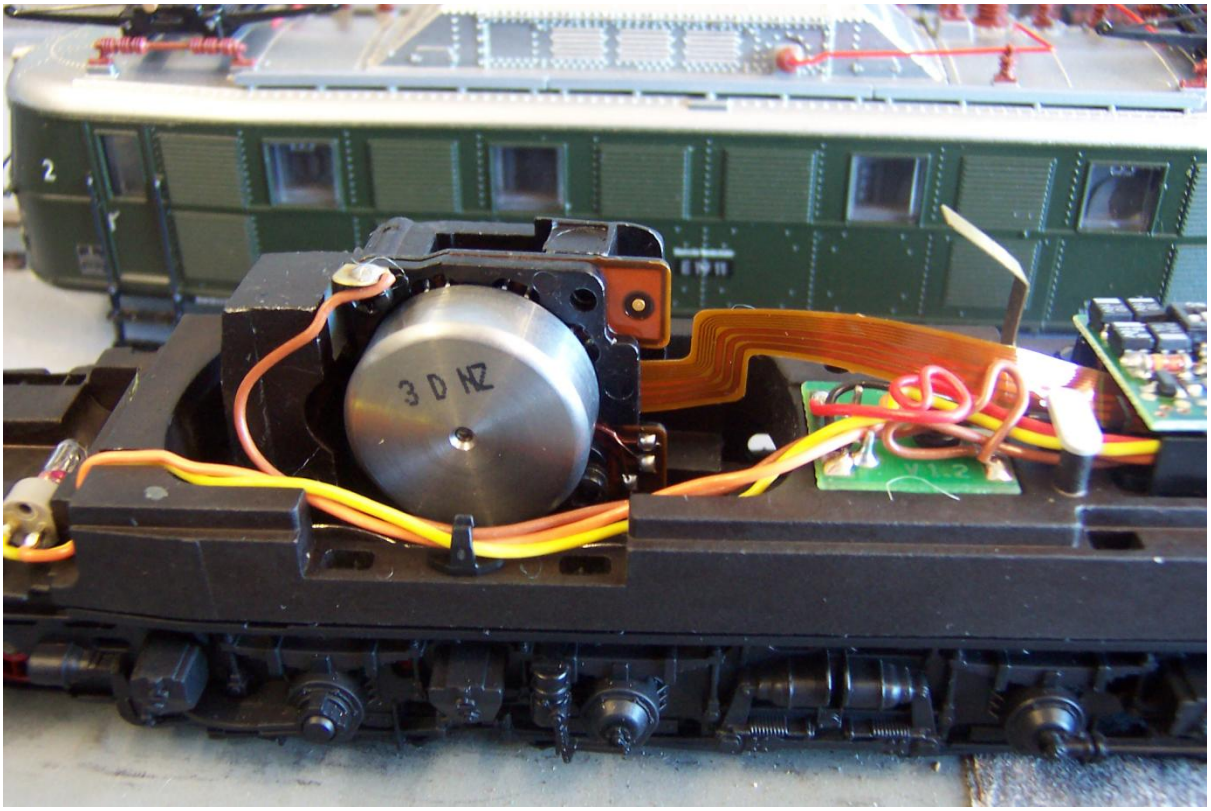


Motor bogie for 37691 with geared wheels and traction tires. Both ground and current are picked up on the other bogie.



39190 produced in 2002-2004 – E 19.11.

The 39190 model (E 19 11) is painted in the green typical of German coaching stock of the 1950s. This model was produced with what is called a C sine motor. This appears to my eye to be a flat can motor, and the Marklin user manual describes it as “brushless, needs no servicing”, but on which the gear shafts can be lubricated. (See photo below). I guess it has a degree of software control from the electronics. The electronics board on this locomotive, automatically recognizes your mode of operation, whether analogue, Delta or digital. As delivered, the digital address is set to 19 at the factory. The model drives very smoothly, with small steps on the Central Station controller. On the electronics board, DIP switches can be used to reset the address for digital operation, and there are two screw pots. With the first you can adjust the acceleration and braking delay timing, and with the second, set the maximum speed. From the digital controller you can control the function of headlights on or off (adhere to direction of travel), and also turn off any acceleration/deceleration range that has been set (to allow for switching).



Parts Available for 37691 and 39190

replacement motor brushes (37691 only) Part #60 1460

small bulb (Part# 61 0080 for digital, or 61 0040 for analogue or Delta mode)

lubricating oil Part# 7149

pickup shoe Part# 7164

pantograph Part# 649 820

traction tire Part# 7152

Photo below shows E19 12 leaving the electric engine stable for its next turn of duty.

Acknowledgments

I have borrowed from a beautiful article about the E18/E19 in Italian, on marklinfan.com

Youtube video from the DB Museum at Koblenz of the E18 drive, by M K Roxton

Some information on dynamic braking came from Wikipedia.com

Possible source for more information would be the Railway Journal Special Edition IV / 92 (in German).