Locomotive modeling

(Steam Locomotives)

Ver 4.0 S. Tajima, February 2021

Preface

Ver1.0 of “Locomotive modeling” was edited in 2001 including 15 models by scale (mostly) 1/45. After 17 years, another 16 model locomotives are complete and I thought it was high time to revise, producing Ver2.0.

Ver2.0 is divided into three parts and “Steam Locomotive” is one of the three.

Union Pacific class 4000,
Big Boy (4000).

Scale = 1/50

Year of construction 1941.
Length (locomotive) 22086mm,
Length (locomotive and tender) 35781mm.
Weight (locomotive) 350.4 t, (tender) 157 t.
Maximum tractive effort 61460kg.
Driving wheel diameter 1725mm,
Leading wheel diameter 914mm,
Trailing wheel diameter 1067mm.
Manufacturer ALCO.

This is the very first model of my carrier other than one or two HO modeling before. And I don't remember when I started or finished. I wanted to make this model as live steam, but because of poor design with no experience in live steaming, it didn't work. So, I converted it motor driven with battery (because at that time, both wheels are not insulated each other). After that, I did a big modification to convert it into electronically controllable locomotive like my other models. So, it is almost nonsense to say the time of completion.

When I got the idea to construct, I found a drawing of locomotive in a magazine (or to be exact, the drawing induced me to make) but no drawings about tender. And even having a drawing of the locomotive, I didn't know which driving frame rotates relative to body. I found out by looking at pictures (which was not many), but the construction of tender remained unknown for a long time. And I made the tender by, perhaps, looking at some ALCO's locomotives carefully. And I thought that the diameter of the wheel was 950mm. It later turned out to be 1027mm and I not only replaced the wheels of tender but remade tender chassis as well.

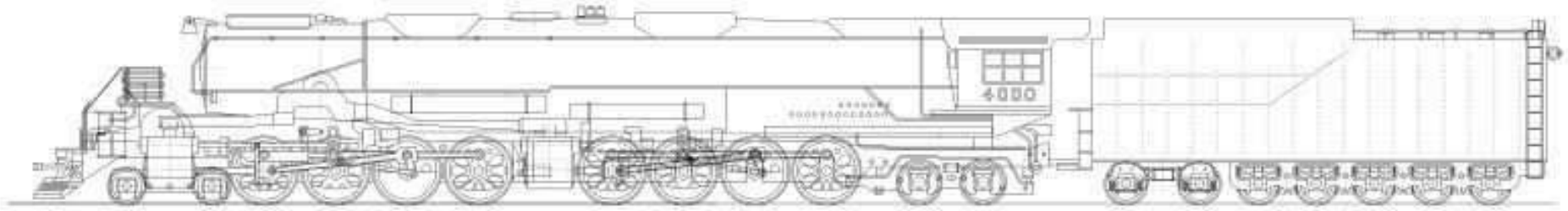
Even then, one thing remained unknown to me - drivers cab has closed environment, that is, there are doors in the back of the cab. That was totally impossible to know by photos. Nobody ever cared about how cab's doors looked like. It remained an enigma until 1997 when I visited Dallas by business. In Dallas, one Big Boy is preserved at museum. And finally I got the information more than 20 (or maybe 30) years after I got the idea to make it.

This is an articulated steam locomotive all right, but not a compound locomotive. That is, the four cylinders are the same size, and steam from the boiler is supplied to them simultaneously.

The front deck looks very formidable, and air compressors are stored inside. The front end design is very characteristic of ALCO locomotives.

The color scheme was totally my original. I didn't like just black painting, and I used gray sprays. But I later knew that some of the Big Boys was painted temporarily with gray which seemed to be not far from this color....

Big Boy is one of the most beautiful locomotives - particularly among big articulated locomotives.



Reference;
Robert A. LeMassena, Robert J. Yanosey. Union Pacific official color photography, Morning Sun Books Inc., 1993.
Kratville The Challenger locomotives, Kratville publications, 1980

Southern Railway, Merchant Navy Class (21C17)

Modeled in 1990, Scale = 1/45.

Wheel arrangement 4-6-2.
Year of construction 1945.
Length between buffers 21228mm, Height 3912mm, Width 2743mm.
Weight 98 t(engine), 47 t (tender).
Driving wheel diameter 1880mm, Leading wheel diameter 940mm, Trailing wheel diameter 1092mm.
Manufactured at Brighton works, SR.

The original has three cylinders. So the model above has third cylinder and the second driving wheel has center crank, both of which are invisible. Perhaps the axel for the second driving wheel was most difficult to make because it had a crank. However, all the wheels don't have spokes – which is exceptional for locomotives in Britain. That was one of the reasons I tried this type. I was not sure that I could make spoked driving wheel with that diameter (about 42mm) .

Driving torque is transmitted from motor to the third driving wheel by gear train. Control circuitry and drivers are housed in the main body and there is not much space left. On the other hand, tender is totally empty.

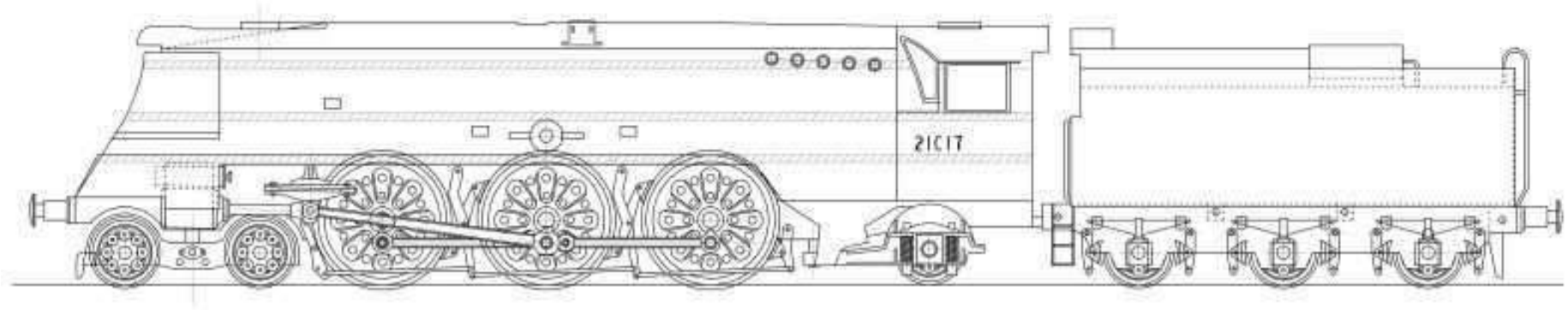
Since chain driven valve gear was introduced (to the original), the driving mechanism look simpler than most of other steam locomotives. This made it considerably easier to model with quite smooth outer casings.

This is the angle to show this locomotive's distinctive style. Smoke deflector is almost a part of body and I wonder if it worked well.

Significance of the British locomotives is that no headlights are equipped. They must have driven by watching signals at night. (Wasn't that scary ?)

The original color was malachite green, but that color was not available, and I had to content with some similar color. This colorful paint scheme was also one of the British traditions (at least in the prime days of steam traction).

Tender has three wheels supported by sheet springs with single solid chassis and no equalizers are utilized – this is the common British practice. It is a wonder that they have run by very high speed daily with this mechanism. Tracks must have been terribly well maintained.



Center driving wheel before nickel plating.
Crank for the third cylinder is clearly seen. Non spoked driving wheel is rather rare in British locomotives.
Also, the other wheels are without spoke and this is a significant point of this locomotive.

Sister class called “Battle of Britain” and “West Country” had almost identical design, but lighter to cope with wider area of railway system.

The driving wheels were made by two pieces. Lathed brass wheel was bored with oval holes and then thin brass circular sheet was soldered to which another holes were bored.

Circular plate of “SOUTHERN” gives a very nice accent to otherwise black smoke box door. The plate was made by etched brass which was polished and covered by transparent paint – but now losing it’s color.

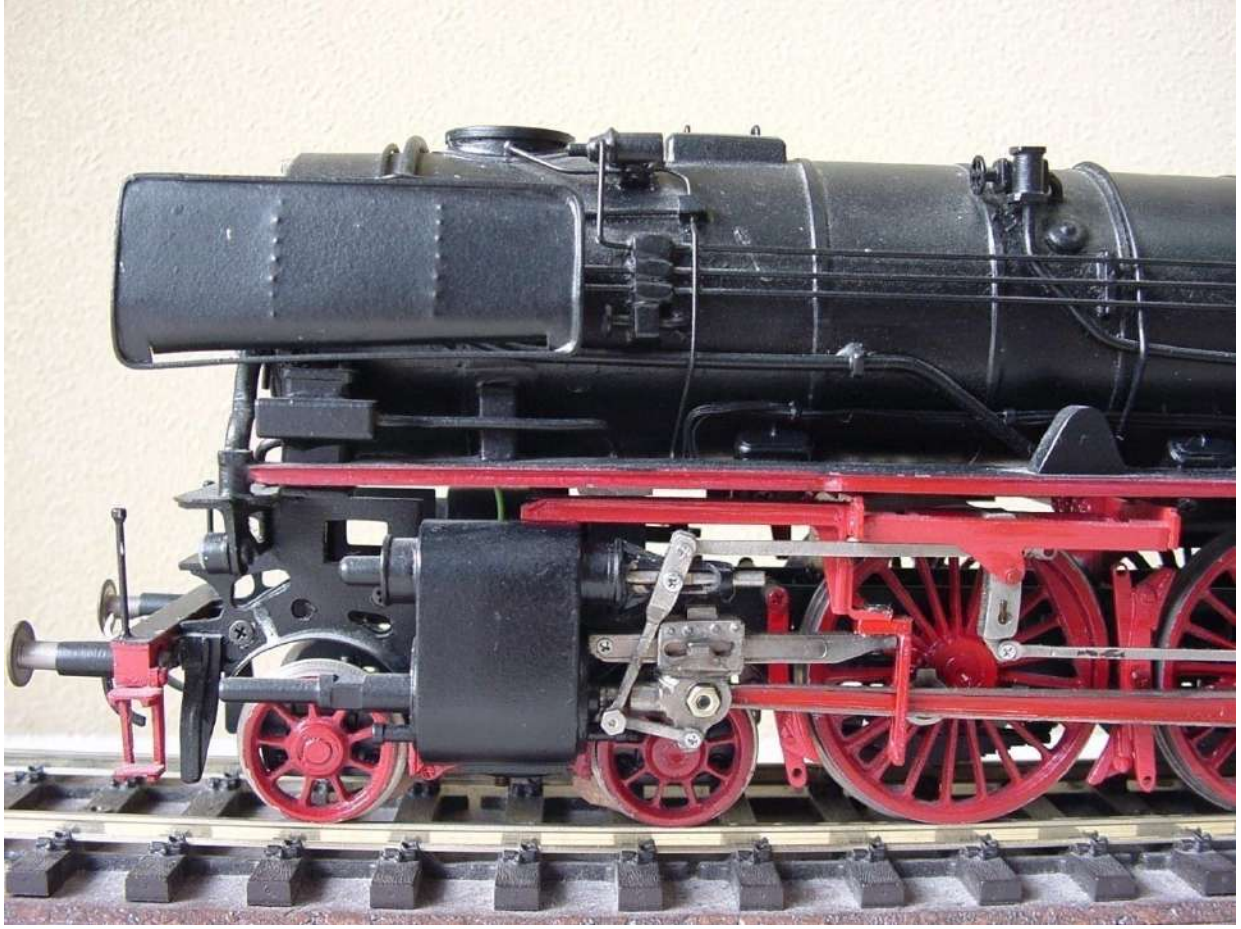
References;
Sean Day-Lewis, BULLEID Last Giant of Steam, George Allen and Unwin, London 1968.
Stanley Creer, Brian Morrison, The Power of the BULLEID PACIFICS, Oxford Publishing Co., 1983.

Baureihe 01, DB (01220). Modeled in 1994, Scale = 1/45.

Originally built in 1926, the boiler was replaced to new one in 1957 which altered original style.
The model shows the days after boiler replacement.
Mechanical Data;

Overall length between buffers 23940mm
Height 4250mm
Maximum speed 130Km/h
Weight 108.9t (without tender)
Driving wheel diameter 2000mm
Leading wheel diameter 1000mm
Trailing wheel diameter 1250mm
Tender wheel diameter 1000mm

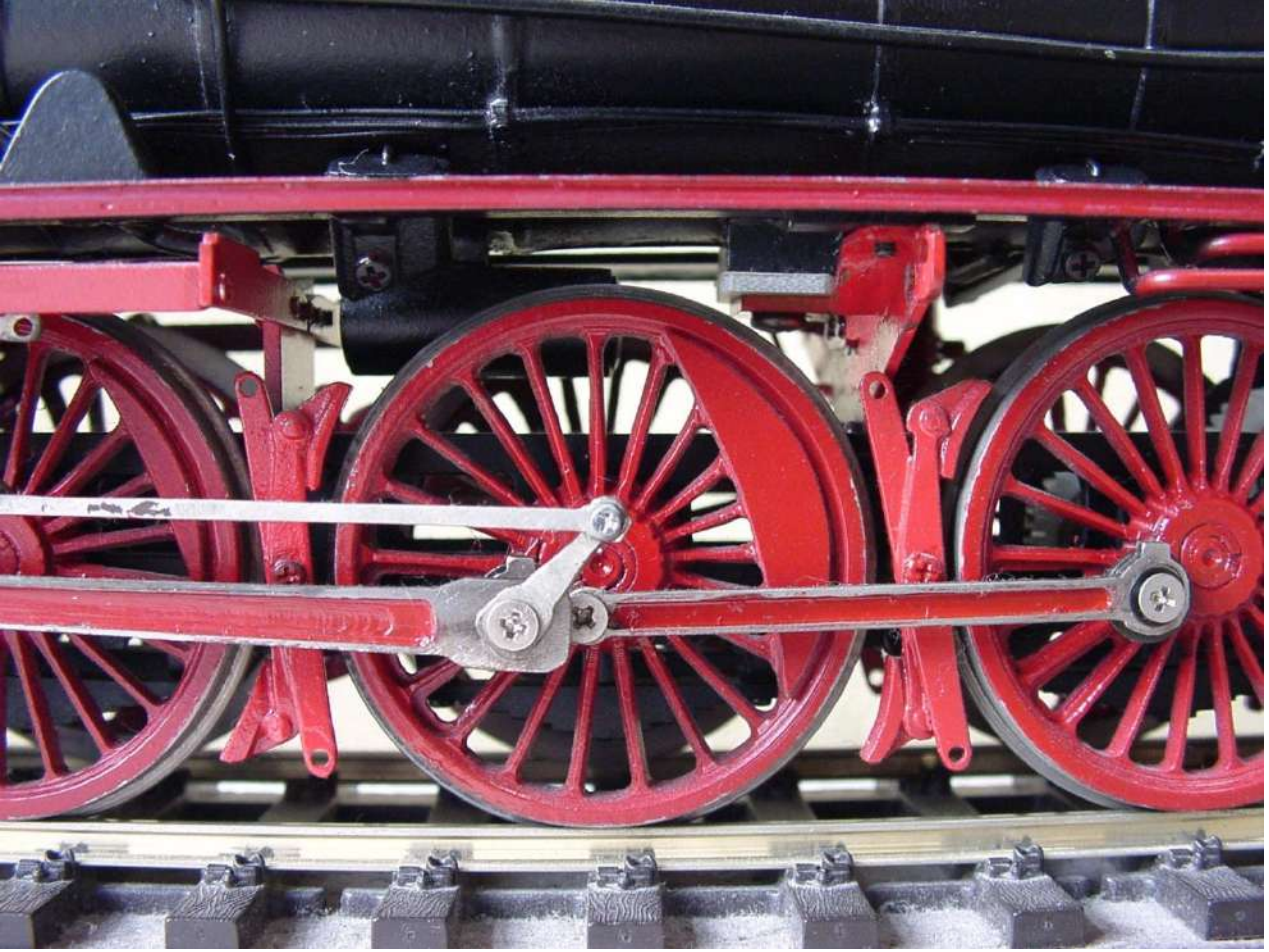
Manufacturer ; Henschel (01220)



Close up of valve gear and driving wheel.

Most attractive features of this locomotives are big driving wheels with thin spokes, almost fragile looking bar frames through which one can see the other side, massive boiler with almost invisible short chimney and Minden style smoke deflectors.

This locomotive is one of the most complicated models I have ever built. Making spoked wheels are always challenging, but the driving wheel has some enforcement ribs around the spokes near crank pin as observable above. And that part was most challenging to make. All the wheels are insulated with one another so that power and control signals are fed via two rails. Driving wheels are fixed to the axis with 90 degree displacement in phase, insulated side is fixed to the axis permanently and non-insulated side is adjusted when building. Bar frame was modeled as close to the original as possible with dummy sheet springs, but the trailing wheel is mounted on movable frame as opposed to the original. Otherwise, it was impossible to manoeuvre steep curves of r=2000mm.

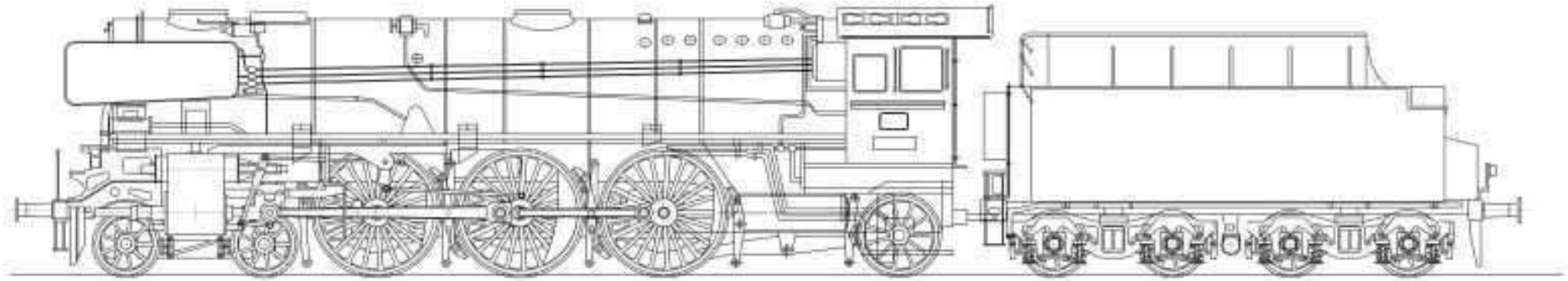


Air tank is observable inside the second driving wheel.
The brakes are just dummies.

I tried to model bar frame and thin spokes of the driving wheels both of which show the well calculated original design. It is a wonder that even fragile looking frames and wheels are supporting such a massive locomotive.

In this model, third driving wheel is motor driven and driving force to first and second wheels is transmitted via connecting rods. White gears which transmit torque from the driving motor are partially observable in the picture above. I feared that the rotation of the first driving wheel might not be smooth because the plays of the connecting rods would cause phase inaccuracy from the third driving wheel. But it worked successfully after some mechanical adjustment.

All rods are made of brass and nickel plated, but as observable above, slight peeling out has already occurred. Boiler and body are made of 0.3mm brass sheets. Frames are made of 1.5mm brass and painted black before assembly.



Drawing and the real model.

The diameter of the driving wheel is 44.4mm and there is very limited space for breaks, particularly the breaks sandwich the wheel. The boiler of 01 220 was replaced and the model is the one with new boiler.

Another thing notable when making this model was the introduction of CAD for making drawings. I thought it was almost impossible to draw the spoked driving wheels by hand, I bought a 486 PC with Win3.1. Win3.1 froze so often that I had to save data in every 30 minutes or less, but even then, the power of CAD was very helpful.

Three headlights are all dummy and will not light up. Thus, the control of this model is limited to speed and direction.

Reference;
M.Weisbrod, W.Petznick. Baureihe 01. Transpress Verlags. 1993.

AD60 Class New South Wales Government Railways (6039) Modeled in 1998, Scale = 1/45.

Wheel arrangement 4-8-4 + 4-8-4
Year into service 1952 ~
Driving wheel diameter 1397mm, Leading wheel diameter 914mm, Trailing wheel diameter 914mm.
Overall length 33121mm , Weight 264.2 t.
Tractive effort 264922N.
Manufacturer Beyer Peacock.

Among many type of steam locomotives, Garratt locomotive is one of the most distinctive motive power. Continents utilized this type are almost limited to Africa and Australia. Most of the African gauge is 1067mm, there is a problem of scale when modeling for 0 gauge. And information is very much limited. Some pictorial books are available for African steams, but it is almost hopeless to find necessary dimensions let alone the drawings. So, the remained candidates were found in Australia, and Internet was at hand. I got in touch with New South Wales Rail Transport museum, and bought a very nice book by Internet.

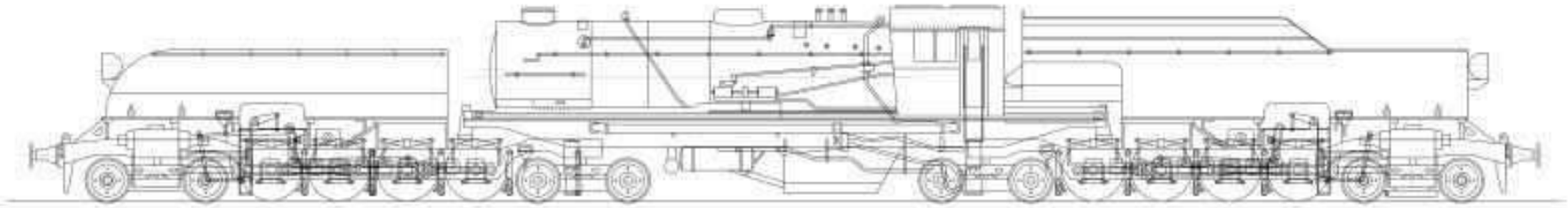
AD60 – articulated D60 – may be one of the biggest Garratt locomotives, and I feared a bit of the manoeuvrability of my rails with steep curves, but it worked all right.

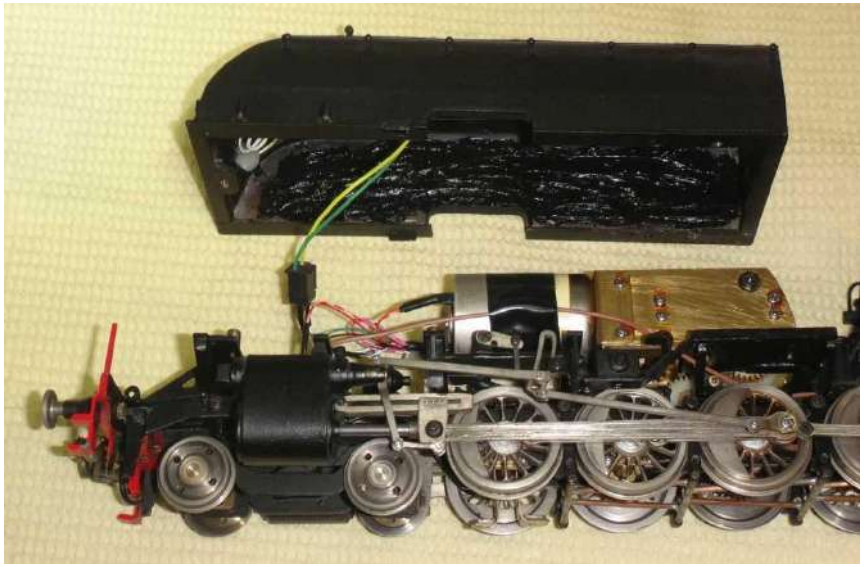
Some says Garratt locomotives are ugly – very unusual, that is true. But thinking about the balance of big articulated locomotives, I think Garratt is the best. Two engines can bear almost the same weight, – the difficulty of Big Boys were that the front engine gets slippery - center of gravity moves inside when running on curves and ample space for boilers is available which enables to use fat efficient boilers.

I don't understand why Americans never used this type on their rails – which were not always kept in best conditions. As the fact that African rails were the largest users of this type tells, this type of locomotive can manoeuvre worse conditioned tracks. And faster express locomotives can be constructed more easily compared with Mallet type articulation. French made Algerian Garratt locomotive must have been a sight to see.

Beautiful running mechanism. Four spoked driving wheels and Walschaerts valve gear gives a very nice view – what a pity that the running wheels were not spoked (but that made me easier to make).

Purposes of the components attached to various locations of the locomotive can be sometimes guessed and sometimes not. Although not observable clearly, powered valve gear reversers are equipped to both engines – it is not practical at all to control valve gears mechanically from cabs which moves relative to engines at curves. And there is a cutting off of water tank facing to the smoke box. This is because the smoke box door won't open without it – I realized while I was making drawings.





Motors are installed within water tank/coal bunker at both ends.

Inside the body, black RTV is applied to damp tin like sound caused by the brass made body. Without it, the locomotive tends to make cheap toy like sound.

Green and yellow wires are to illuminate the head light. Thus, this machine has light ON/OFF control as compared with 01 220.

Motors and driving gears are housed in water tank and coal tenders. Electronic control equipment and DC/DC converter are housed in the boiler. Manoeuvrability turned out to be not bad. Not only simple curves above, but S curves combined with other track can be worked without trouble. It is very nice to see two sets of driving mechanism works simultaneously.

One thing I could never understand until today is the two poles equipped on the water tank. What are they for ?

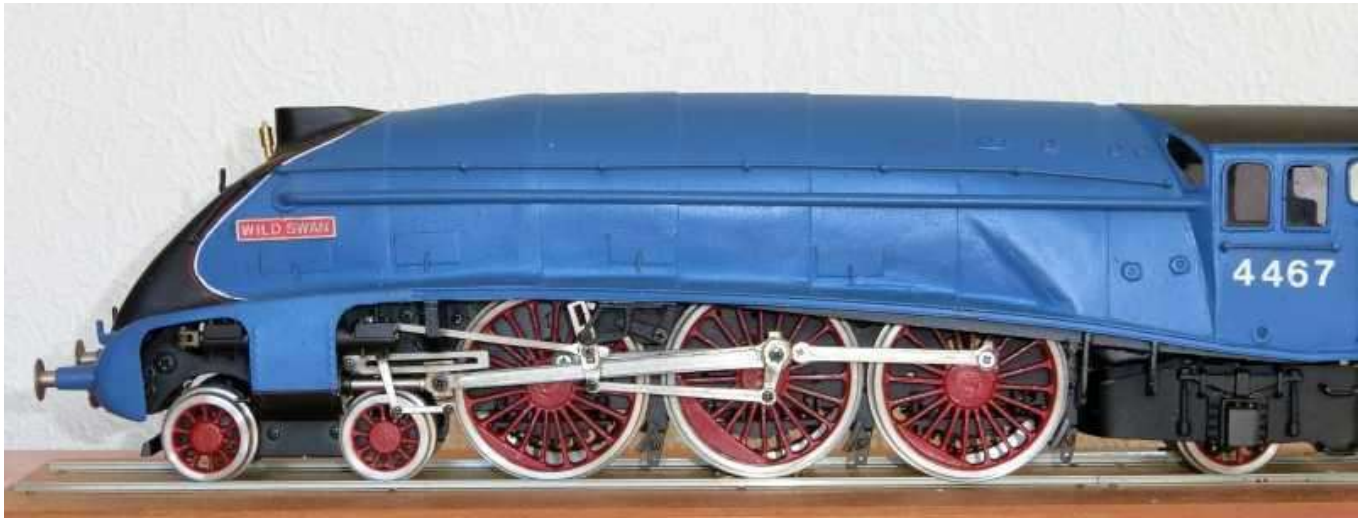
Reference ;

K.T.Groves, H.J.Wright, M.Morahan, The 60 class, The New South Wales Rail Transport Museum, 1994.

Class A4 LNER Wild Swan

Modeled in 2001, Scale = 1/45

Axle arrangement 2C1.
Year of construction 1938.
Length over buffers 21650mm.
Width 2743mm.
Total weight 167 t.
Tractive effort 16,086kg.
Driving wheel diameter 2032mm.
Maximum speed 140km/h.
Manufacturer Doncaster works.



This is one of the best known steam locomotives not only in Britain but throughout the world (for enthusiasts at least), particularly her sister locomotive “Mallard” holds world speed record of 203.4km/h, although German Class 05 also claims similar speed. However, the beauty of this model may be found in her stream lined body which is unique designed by Sir Nigel Gresley.
The locomotive was a product of heated competition between the then LNER and LMS. It was designed for express passenger locomotive to serve between London(King’s cross) and Edinburgh thus equipped by 2032mm driving wheels with three cylinder driving gears, and notably by a “corridor tender” which has a narrow passage to the hauled trains for driving staff change during it’s run,

In modeling, the main focus lies how the body line is represented with formidable three pair of driving wheels. When the original locomotive appeared, the driving wheels and front of the cylinder was covered by a casing so that a straight line is emphasized in level with that of the tender. But it was later removed for better maintenance, revealing her real beauty.

The actual structure of the model is far from the original, not only because the model is driven by electric motors, but also the three cylinder structure is completely omitted (see BR class 18 for comparison). Yet the model has some contrivance to cope with relatively steep curvature of rail that is common in models. The trailing wheel actually has independent frame from the main one so that the wheel has wider freedom of lateral displacement (same as in the case of DB 01 220).

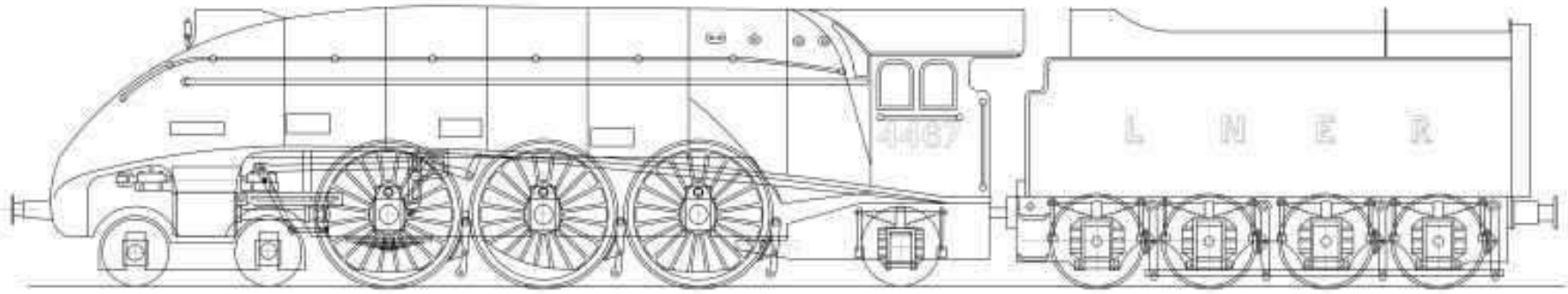
One of the difficulties in modeling is the painting. Unfortunately, I am not talented in painting and I always rely on commercially available spray paint and handiwork when necessary. Thus, the lines separating black and blue livery was drawn manually.

The silhouette of the body is the result of soldering pieces of brass plates. It looks more or less all right.

At the time of modeling, not much information was available in the internet let alone the moving pictures with (three cylinder) sound at speed.

The references attached are all acquired after having completed the model which provided information to satisfy my curiosities.

The corridor tender looked like this. A door at the end of the tender and a small circular window for lighting and knuckle/hook coupler. One of the structures still puzzling me is the four wheel tender with rigid frame and leaf springs rather than bodies with leaf and coil springs. How can it stably operate over 150km/h ? (Not to mention over 200km/h.)



Tender of the class A4. The four wheels are attached to a single frame with no equalizers at all. I read somewhere that the springs are very carefully adjusted for smooth running, but it is a wonder that this almost crude looking tender could work over 200km/h.

The wheel is complete and nickel plated. Later, this is to be painted in red and will become a main component of the A4 pacific as shown here.

References ;

Derek Penney, LNER Pacifics, Ian Allan 1997.

Gavin Morrison, Gresly A4s, Ian Allan, 2001.

Brian Hollingthworth, The great book of Trains, Salamander books 1987.

du Bousquet, Grand Ceinture

Modeled in 2009, Scale = 1/45

This locomotive is generally referred to “du Bousquet” locomotive after the inventor Gaston du Bousquet of Nord railways. As seen above, it is a four cylinder compound locomotive, connecting two engines back to back. The structure looks rather unusual, but they were not uncommon particularly in France and were found in China as well.

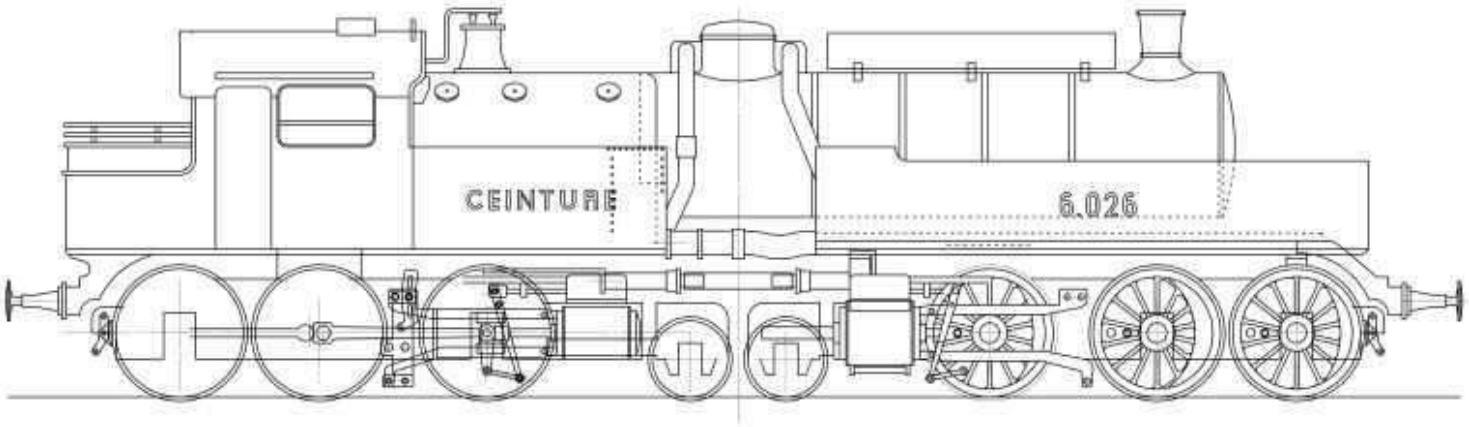
Also, the information of this locomotive is easy to find on the Internet, drawings inclusive.

Year of construction 1909-13.
Weight 102t.
Manufacturer Societe des Batignolles, Cockerill works.

Length over buffers 16750mm.
Driving wheel diameter 1460mm.

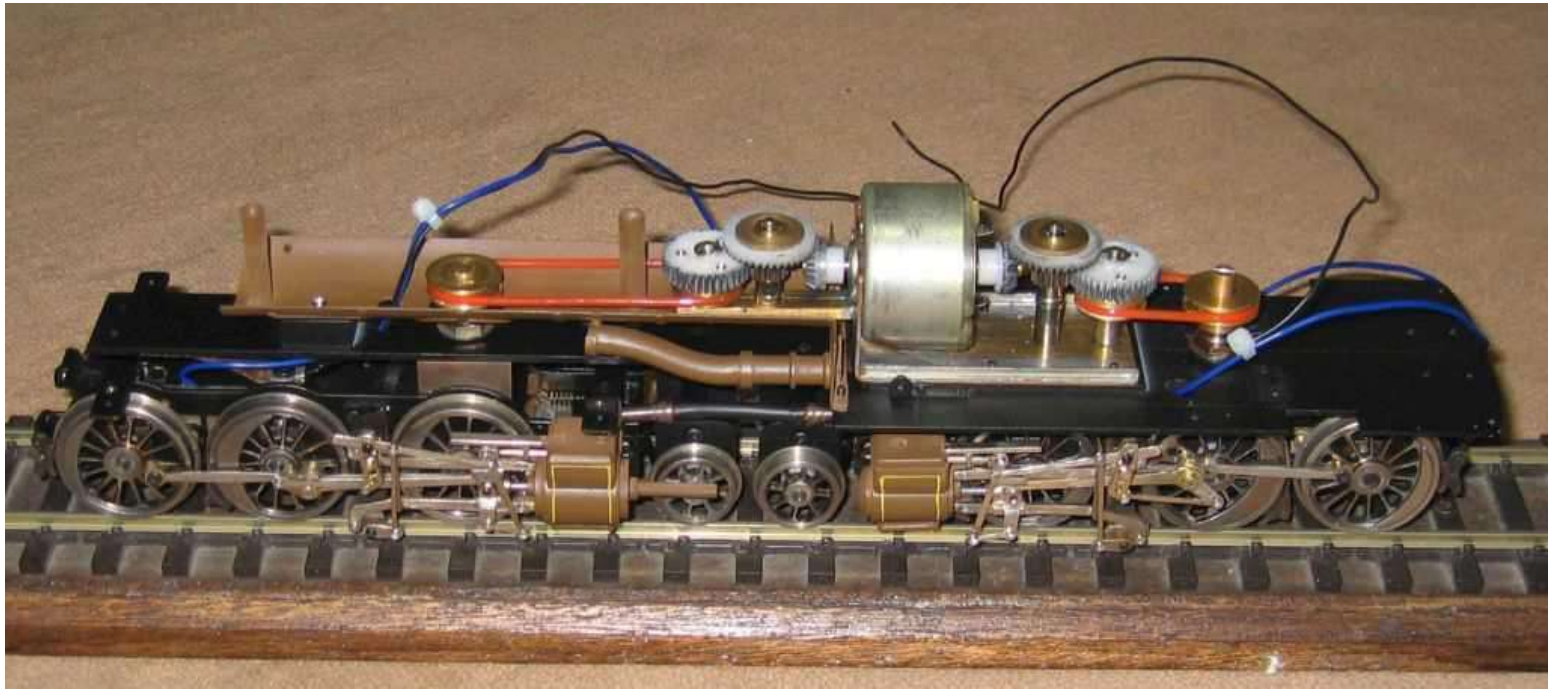
"Ceinture" refers to the Grande Ceinture which was an outer circle line of Paris operated on goods and passenger service. The operator Syndicate de Ceintures was dissolved in 1935 and the locomotives were transferred to Nord railways. The style of operation required a machine that could travel in both directions, having enough tractive effort.

This type of locomotive are classified by an "articulated" locomotive like Garratt or Bigboy, but the difference is that the two bogies supporting one body - hence the locomotive cannot be huge in size. In structure, it shares the same idea of modern electric locomotives.



Driving wheels under making. Lathed brass disk is first attached with counter weight. Then, scribed and holes are bored for grinding spokes out.

Right picture shows just before nickel plating. TWELVE driving wheels are made this way plus four leading/trailing wheels.



Looking into this type as a model, the most difficult point may have been how to drive both bogies. Since two bogies are articulated, power transmission from outside of the bogie is difficult, and the space related to the bogie is very limited preventing installation of power source on the bogie - this is a steam locomotive and shape of boiler, small cab inevitably present high hurdle.

In this case, a motor that has a shaft to both side drives vertical driving shafts which also act as the pivot of the bogies. Therefore, second driving wheel is driven for one bogie, and first (or third) driving wheel is activated for the other. Because of this structure, the point of pivots are different from original locomotive, but this is a compromise.

Another challenge was to house electric circuitry in very limited space.

References

http://www.douglas-self.com/MUSEUM/LOCOLOCO/bousquet/bousquet.htm
https://fr.wikipedia.org/wiki/Gaston_du_Bousquet
and many others.

BR class 18 (Bayerische S 3/6)

Modeled in 2012, Scale = 1/45

This locomotive is one of the masterpieces of German design. Originally designed for Bayerische Staatsbahn as express passenger locomotive and has several variants, the number 451 belongs to a class that has 2000mm driving wheel, and in modeling, this should be preferable.

The class is a four cylinder compound, meaning that there are two more (smaller) cylinders inside the frame. In case of modeling, it will be very challenging to build four cylinder machine - driving wheel shall have cranks, limited space inside the frame and so on. However, if one tries to produce this model, these points above are imperative, particularly, the frame (called bar frame) has a nice visibility to the inside. (Reason that I didn't make class A4 as three cylinder locomotive was that it has plate frame through which nothing can be seen.)

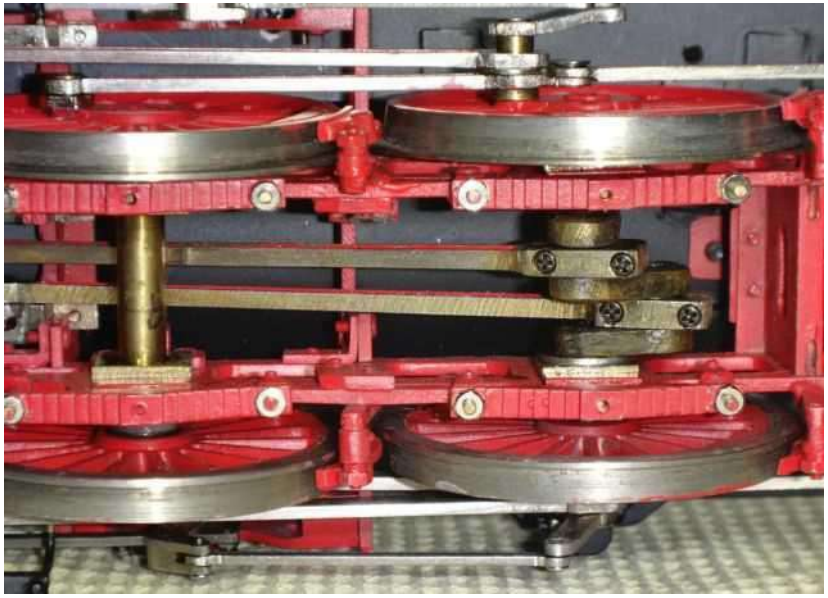
And as anticipated, it turned out to be a most complex locomotive I have ever constructed.

Year of construction 1912.
Weight 83.5t (without tender).
Maximum speed 120km/h.
Manufacturer J.A.Maffei.

Length over buffers 21221mm..
Driving wheel diameter 2000mm.
Output 1300kW.

The looks and style surely justify the machine called “one of the most beautiful locomotives”.
Big elegant driving wheels as well as see through frames matches with a boiler not too big and stylish chimney. The size of the deflector is just as it should be.

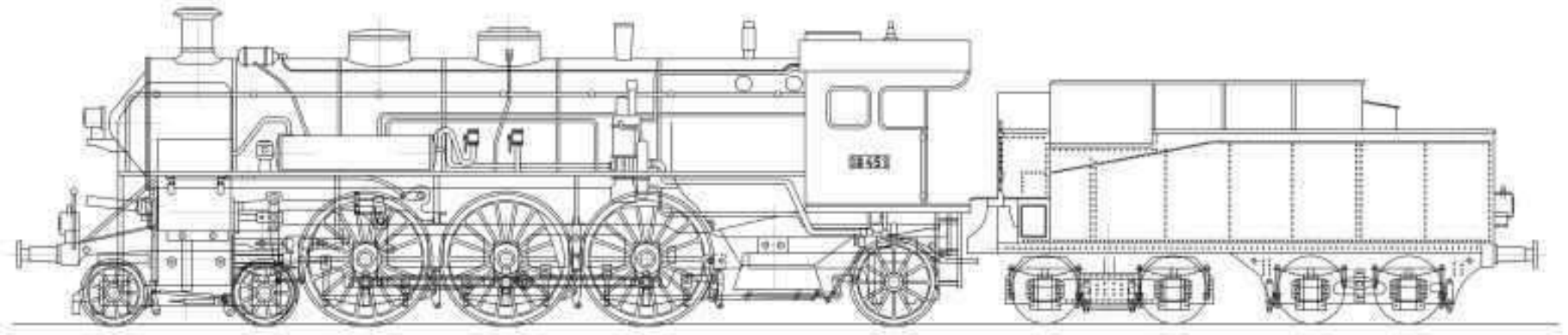
Steps hanging in front of the deflector is actually longer for the real locomotive, but in this model it was cut short to provide space to the leading wheels.

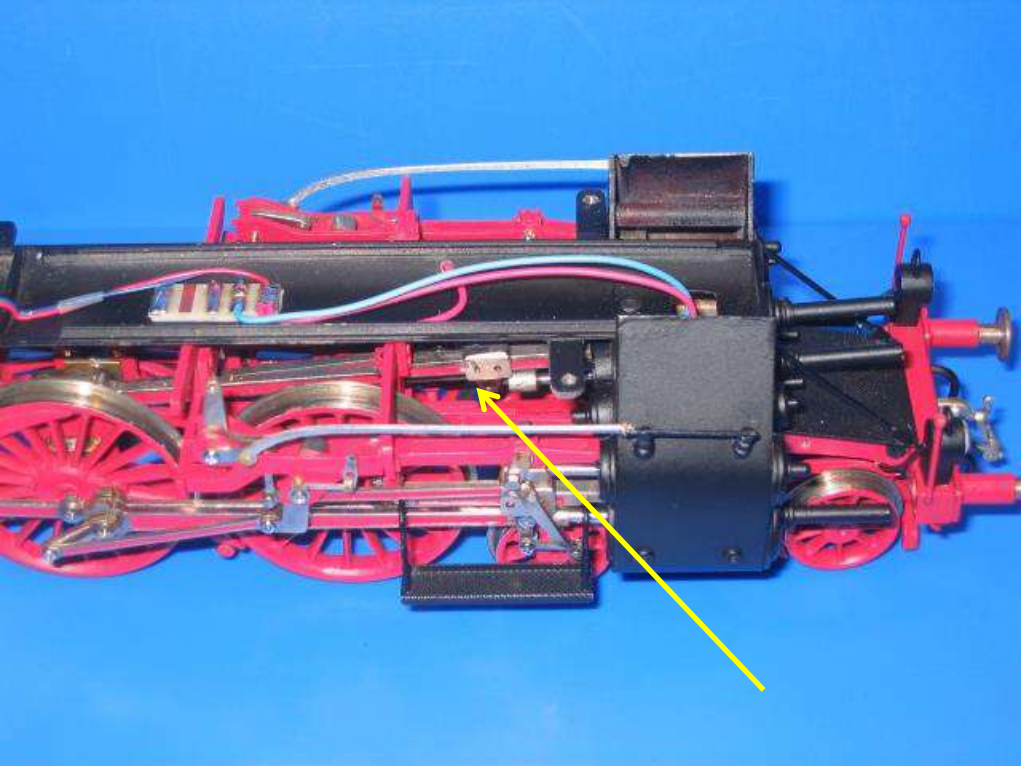


Inside the frame, two main rods are observable. Since these rods are installed after crank shaft is complete, the big ends are closed by another parts fastened with screws.

Sheet springs are all dummies, just to improve the looks when observed from outside through the driving wheel spokes.

Observe that the tender is equipped with rather older type of wheels arrangement. Front wheels form a bogie, whereas the rear wheels are attached to the tender chassis directly. This is a practice adopted to 2-B class steam locomotives.





Above shows internal slider for rod (actually, there are two sliders, but only one can be seen here).
Since the four main rods all drive center driving wheel, the driving wheel has a cranked axis. Obviously, this is difficult to make, but was able to manage happily, no longer remembering exactly how.

Since the model is actually an electric locomotive, a motor drives the third driving wheel via timing belt, and power to other wheels are transmitted via rods only. (No gears can be possibly installed to the second - cranked - driving nor the first driving wheels.)

References

Steffen Ludecke Die Baureihe 18 4-6, EK-verlag, 1994

Siegfried Fischer Dampflokomotiven bei der DB, Frankh'sche Verlagshandlung 1983

http://www.bitte-einsteigen.de/images/Fuhrpark/Dampf/M_37183/Bayerische-S-3-6-wikipedia.pdf

CFA Class BT1,

Modeled in 2017, Scale = 1/45

Designed for PLM's Algerian lines (Algiers - Oran- Constantine) for express passenger service. It started operation in 1936. However, because of the war, their lives were very sadly short.

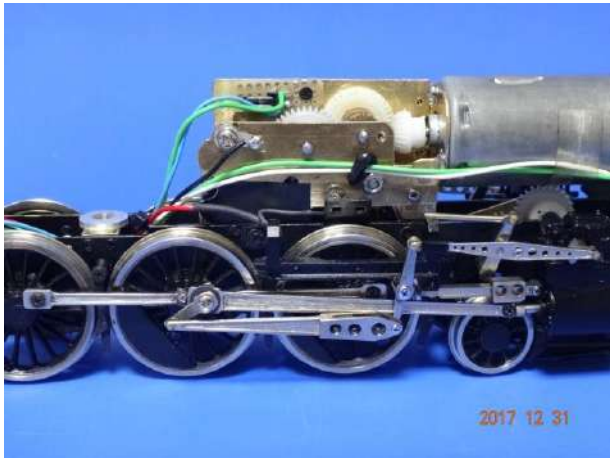
Garratt locomotives are mainly found in Africa, but they are mostly on narrow gauge (1067mm) and inevitably for mixed services, this may be the only standard gauge express Garratt. (AD60 of NSWR is also a standard gauge Garratt).

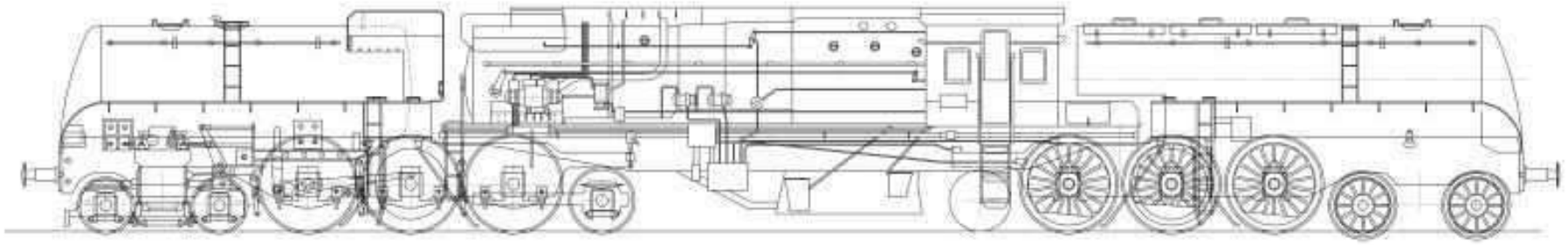
Year of construction 1935.
Weight 216t
Maximum speed 110km/h.
Manufacturer Society Franco-Belge.

Length over buffers 29432mm
Driving wheel diameter 1800mm.
Output 3000HP

Both ends are stream lined and can operate to both direction. The above picture shows coal/water storage first, but the looks are identical in both ends.

In the model, the Cossart valve gear rotates via internal gear train because two rods are impractical to rotate small diameter massless crank. Two motors are installed in each engine and power is transmitted to center driving wheel .





This is the coal bunker side (although, it also contains water). The black flexible cover between the cab and coal bunker is made of coaxial brass. On top of the bunker are the doors for coal loading, and this kind of sealed coal bunker is a quite rare practice. I never found this approach for any other steam locomotives.

Also, this is not a compound locomotive; Garratt with compounding should be very unlikely because of the length between two cylinders.

One of the most interesting features of this locomotive is the Cossart valve gear. Second driving wheel drives a rod (thick rod with three holes) and eventually rotates a mechanism to control in/out of steam to the cylinders. Although the same valve gear is found on 1-D-1 tank locomotive of Nord railways, the details are difficult to know. However, very interestingly, there is a patent document (US2064293) by L.R.C.Cossart in 1932 on the Internet by which I was able to understand some part of the mechanism.

Although the Cossart valve gear claims good characteristics, it seems nice amount of power is required to drive the valve mechanism if that thick rod is necessary - was it efficient ?

References

http://www.dieselpunks.org/profiles/blogs/sunday-streamline-67-algerian-garratts
https://commons.wikimedia.org/wiki/File:CFA_231%2B132_BT_1.jpg
Brian Hollingthworth, The great book of Trains, Salamander books 1987.