The 01001, built in 1925

The 01 in LEGO

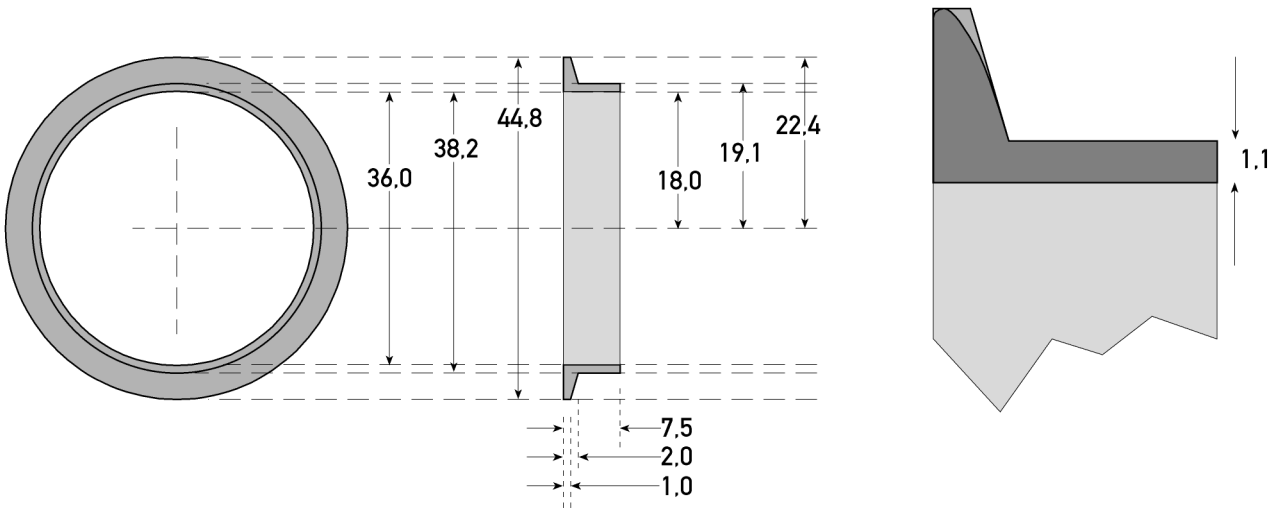
The BR01 was one of the first german **Einheitslokomotiven** (*unified engines*, BR ~ **Baureihe** ~ building series, 0 ~ express passenger). In the 19th century all german countries (like **Bayern**, **Preussen** etc.) had their individual railway structures including a large variety of engines. After world war I, there was the idea to unify the construction principles of future engines to make both manufacturing and maintenance more economic. For example the 01 had, like all engines for fast passenger trains, drivers of 2m diameter. This unification program was never realized in its full ambitious extent. Major reasons were the different demand caused by world war II, and thereafter the **Traktionswechsel** replacement of steam by diesel and electricity. Only few of the many constructions were build in large numbers. As a side effect of the program the **Einheitsloks** have this typical familiar look, that makes them interesting to be built in model. Finally some of the machines spent their last years in service in different european countries, as reparations for the lost war.

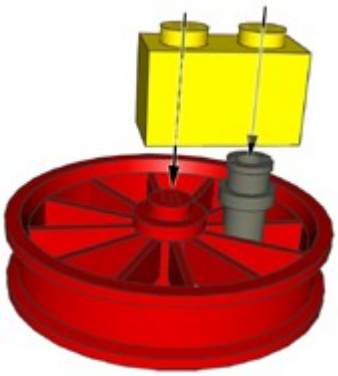
The 01 was found to be the superior design of a 4-6-2 (2'C1) engine in a competition between the 01 and the 02, and so 241 machines were built from 1925 on. The design was modified in several points, e.g. from 1939 on 55 engines had three instead of two cylinders. The fact that it was to heavy for many tracks, lead to the development of the similar 03. Most of the engines survived WW II and were reconstructed differently in both parts of Germany. They were in service until 1973 in western, until 1983 in eastern Germany. Today still a few BR01 are in operation pulling museum trains.

The red 70ies spoke wheels (LDRAW #35) as drivers result roughly in a correct scale. For my first experiments I removed the outer flange of the wheels, which requires some turnery, but I found the inner flange too small to hold the engine on the tracks when going through switches. So I supplied, like others did before, the wheels with appropriate aluminum rings. Probably you need somebody to do this for you, but with the sketch below it's not a big thing. Remember that the profile of the flanges must be rounded to make the wheels go well in curves. Just imagine a flanged driver intersecting a curved rail!

Then I had the idea of driving these wheels by an 70ies train motor. Experiments with a 4,5V motor were successful, but it required more power to pull a heavy engine with wagons. Finally I found a solution (see below) that makes use of the wise design of the old motor. You can run it on 9V with infra-red control. The coal tender has enough space to hold eight rechargeable AA-size NiMh batteries (8 x 1,2V = 9,6V).

Now that there were already so many custom made things, I decided to have moving rods. This required one of the three drivers to be blind (no flange). The blind drivers don't touch the rails, they need to be driven by the rods. Therefore it is necessary, that the left and right connecting rods have an fixed angular displacement of 90° – like the real engine! Unfortunately the short brass axles of the spoke wheels can slip in the bush of the motor. Due to friction in curves – remember that we usually run in a circle, either left or right – the angular displacement becomes 0° or 180° by the time: the mechanism will stick and fail!





One could solve the problem by gluing the brass axles into the bushes that are fixed to the gear (wheels could still be removed by unscrewing the motor). I preferred to fix the angular displacement at the blind drivers by replacing the two short axles by one longer brass axle. I drilled an appropriate hole in a 2x4 brick to support this axle. Additionally I allowed the motorized wheels to slip on the rails by removing the rubber rings I used before.

Now I had to fix technic pins to the spoke wheels. I enlarged (cut) the already existing slits of the pins, so they fit loosely on a spoke. Next I fixed the pins exactly using a temporary LEGO construction mount to the center stud of the wheel as reference. Unfortunately I forgot how it worked exactly, but I remember that it required a fence brick to achieve the correct depth, so the rods won't hang on the center stud when in motion. Once all pins were mount in a one-stud-radius (8mm) as indicated by the yellow brick, I glued this by filling two-component adhesive between the hollow pin and the spoke from behind.

At this point you could take technic liftarms as rods. For three reasons I decided to mill customized rods: (1) it simply looks better (2) the gauge of LEGO rails is always too large and technic liftarms will increase this misproportion (3) it allows to model the Heusinger-Walschaerts-control that looks very funny when in motion. Once again I took advantage of the principle to use the exactness of LEGO parts if you are going to make customized parts. The rods are milled from PE (polyethylene, elastic!). There was no gluing required. Holes of 4.5mm will stick on pins. 4.8mm holes will turn freely. For the small control rods I used white PS (polystyrene) tubes of 3.2mm diameter as axles. With some turnery I made them either stick or turn freely, like a miniature version of technic pins. On the other hand a 3.2mm tube, holds, like the flex tubes, in a hollow stud!

How to repair and modify 70ies train motors

The 70ies train motor was the only one intended to be opened. It had screws! Exchange motors were available. Both the 4.5V and the 12V motors fit into the same gear box, but used different transmission ratios. The 12V version is comparable in power and speed and compatible to the 80ies train motor.

After 40 years in service most of the motors are in bad condition, and it is hard to get good spare parts. Usually the gear itself still works fine. Here you find instructions how to find cheap exchange for the powerful Bühler motors, and how to use the slow transmission ratio to compensate for the large diameter of the spoke wheels used on my BR01.

The modification makes my heavy engine run at an acceptable speed and power even if run at only 9V.

If you want to do the modification for small old train wheels (fast transmission ratio) it is only a little more difficult. CONRAD has a transparent 10mm silicone tube on stock that makes perfect long-life rubber rings for the old red train wheels!

It takes about one hour and requires only little tools but be aware that you might destroy an precious vintage part, harm yourself etc.

So I take no responsibility if you follow my instructions and I ask you not to do it, if you don't have appropriate tools and craftmenship.

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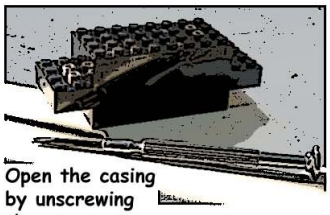
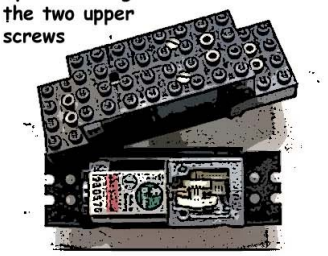
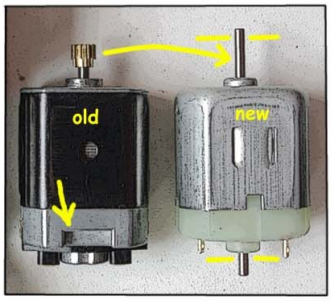


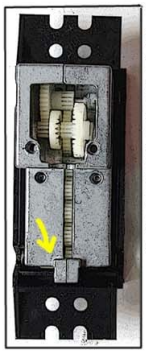
Open the casing by unscrewing the two upper screws



The Bühler 4.5V motor drives the left (smaller) gearwheel. Alternatively the 12V motor drives the right (larger) gearwheel. Due to the design of the gear the 12V engine runs much faster. The idea is now to replace an old 4.5V motor by a new strong 12V motor but to use the lower (4.5V) transmission ratio to make it useful to run with large spoke wheels!

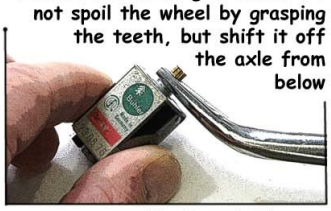
This one is available at CONRAD electronic for €5.





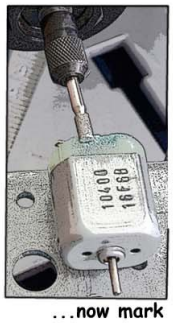
Two make the new motor fit, we need to (1) mill the gap at the bottom that holds the motor on the gear (see left) (2) cut the axles (3) transfer the brass gearwheel and (4) fix the electric contacts.

Remove the brass gearwheel. Do not spoil the wheel by grasping the teeth, but shift it off the axle from below



Next mark the gap to be milled at the printed side (engraving SUN) for correct polarity lateron

Now cut the short axle. Caution it might get hot! Remove heat by fixing some metal to the axle...



Now mill the marked gap. Work like a dentist, step by step, until it fits into the gear...

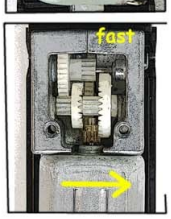
...now mark how much of the long axle needs to be cut...

...and cut it!

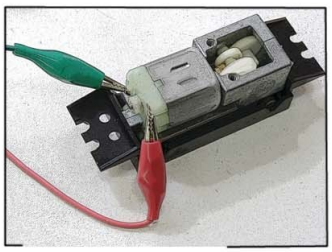
Rounden the end of the axle will make it easier to push the gearwheel on the axle...

It fits perfectly and needs no glue (2mm dia.)

Put the motor in the gear and check the right position of the brass gearwheel.

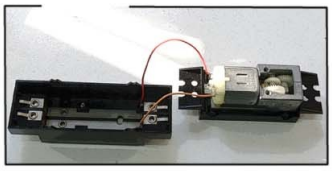


(If you want to run the engine with small train wheels you need to turn the brass wheel around and fix it so it drives the large (right) gearwheel. Therefore you need to file the gear casing so you can fix the motor a little to the right side... lower picture)

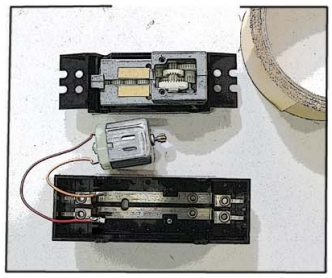


Now you definitely have to test this. If the motor and the gearwheel is positioned correctly you should hear no awful sound. Probably the milled gap is not exact. If the motor fits only loosely you will have to glue it lateron in the position that you found during this test! But first let's do the electric contacts:

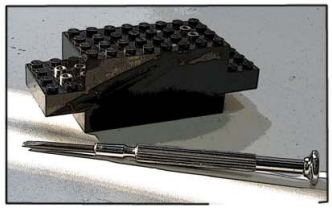
The Bühler motor contacts the tin plates inside the casing directly. We have to solder two small wires between the tin plates and the contacts of the motor.



Now repeat the test and glue the motor to the gear in the tested position. You can try with double-sided adhesive tape, but this is only a preliminary thing.

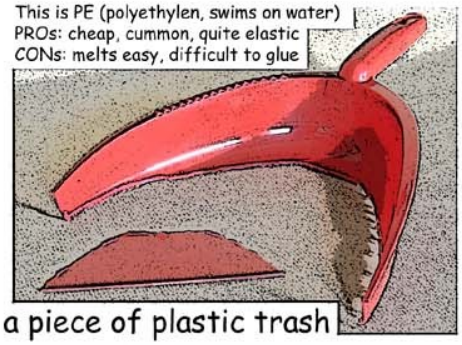


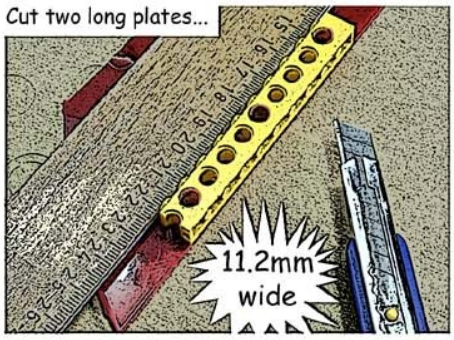
I recommend Cyanacrylate as adhesive. It sticks fast and does not hold too strong, so you will be able to separate if necessary. Be careful not to spill any glue into the lower part of the gear (the little gearwheels that transmit between the front and rear wheels).

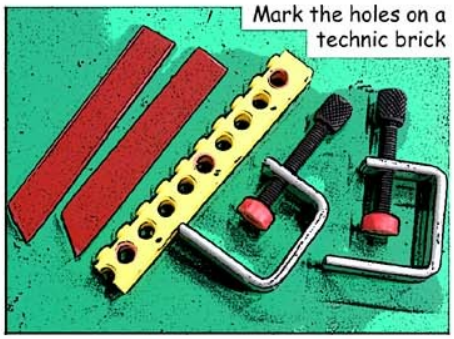


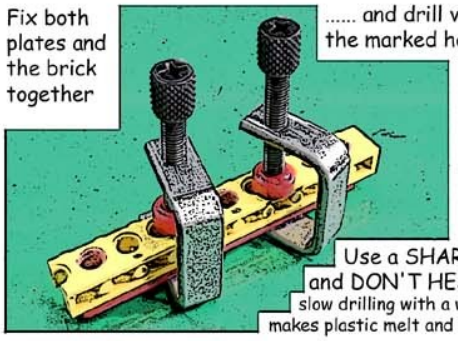
Now close the casing again. If the wires are not too long it should be possible to close the casing without violence. Good luck!

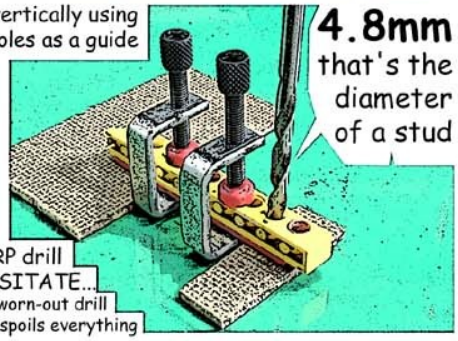
How to mill CUSTOMIZED RODS for BB-wheels.... from a piece of plastic trash

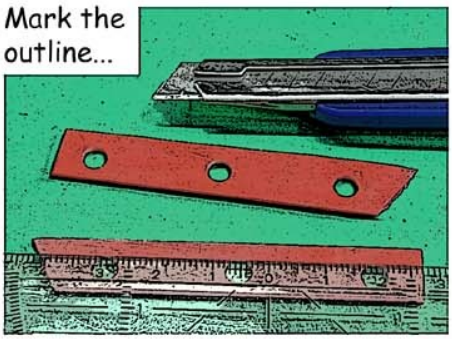


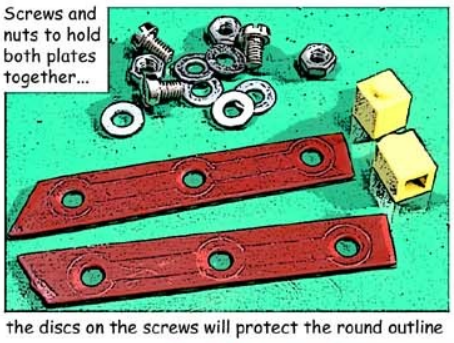


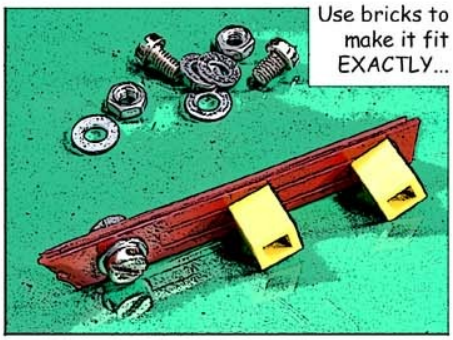


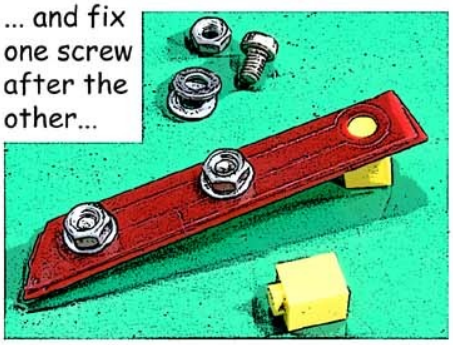


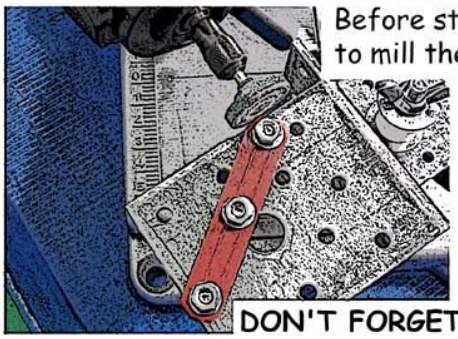


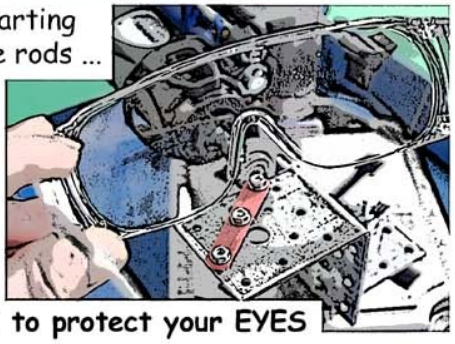


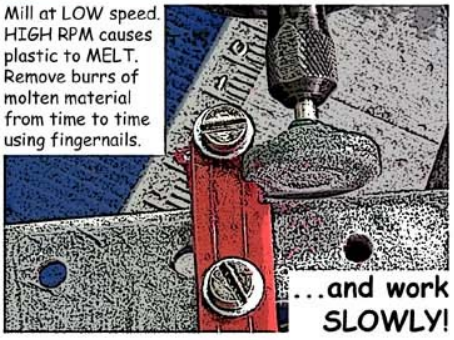


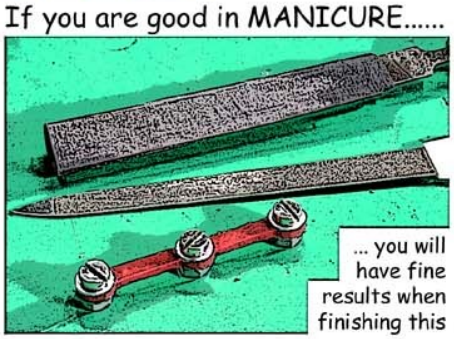


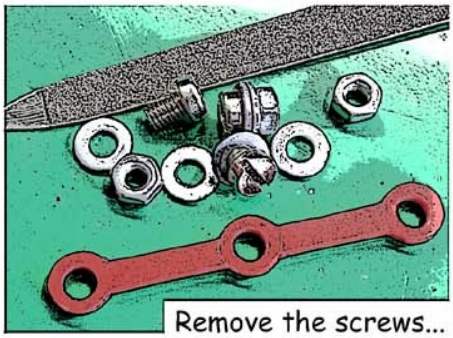


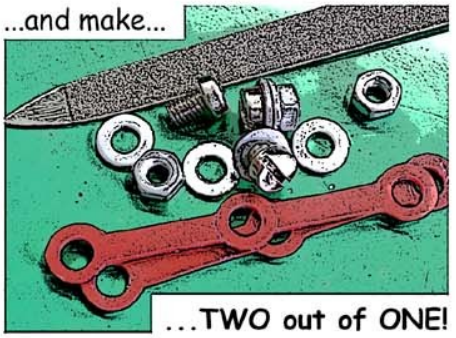


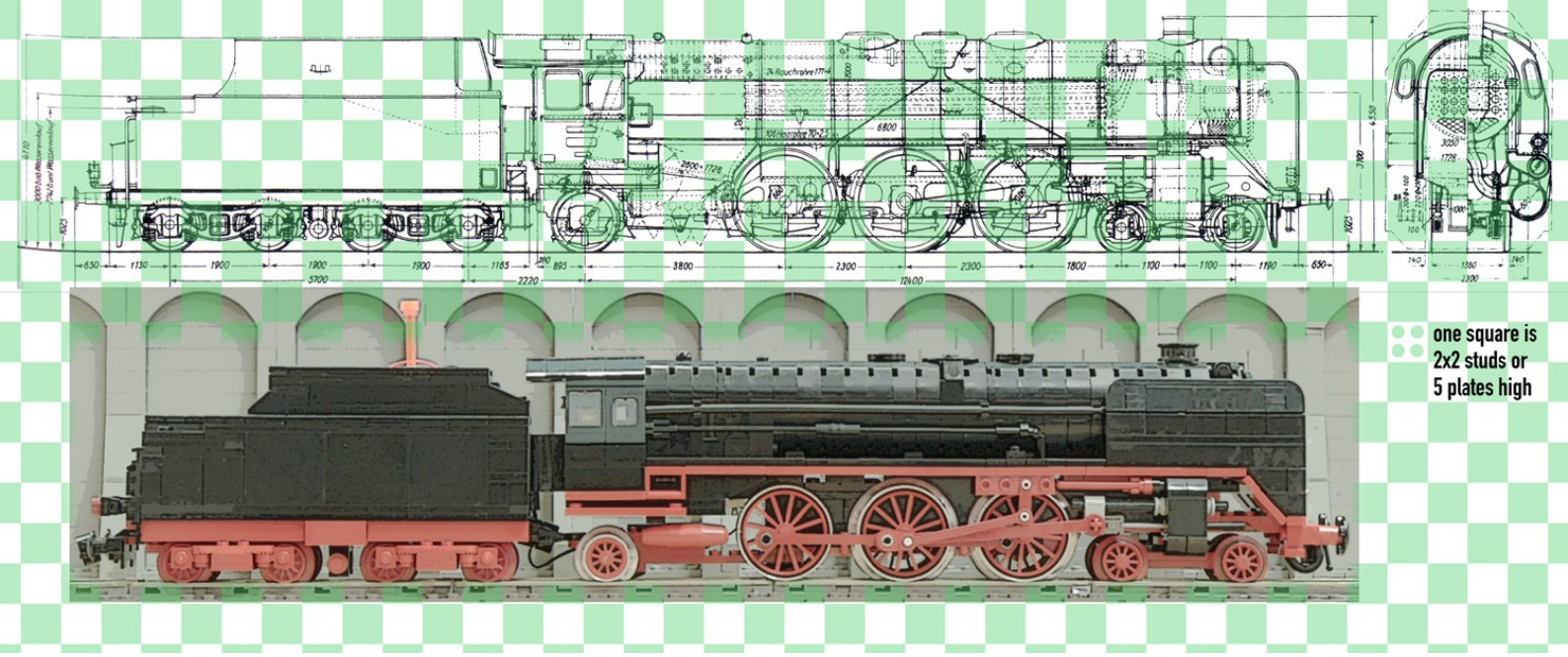








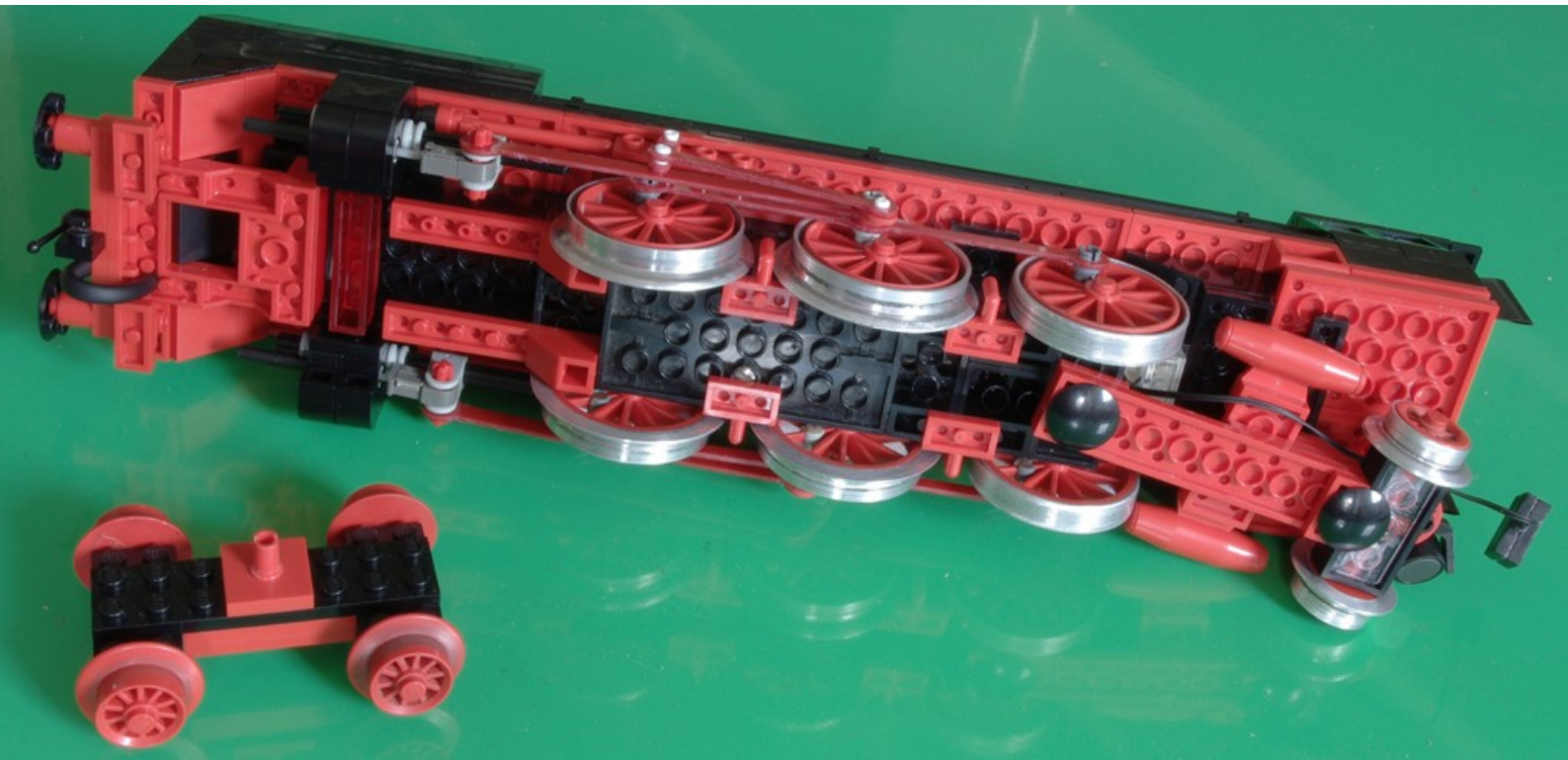


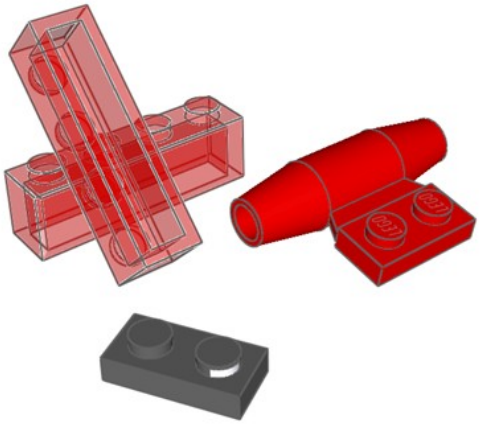


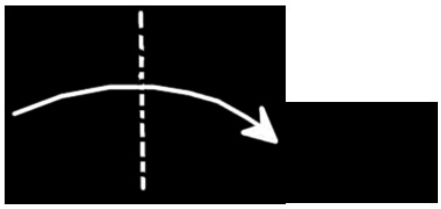
When scaling the 2300mm between adjacent drivers from the original construction sketch to the 48mm (6 studs) of the model, we get a scale of 1:48. This makes a minifig being 190cm tall in reality, the LEGO engine 500mm long (62 studs or almost four straight tracks) compared to the original length of 23940mm. If you use smaller drivers (like large BB-wheels) minifigs will be giants! So I used the above LEGO raster scaled to the original sketch as a rough guide when modelling the engine.

Let's have a look at the frontal profile: 8 studs wide is perfect. However, the gauge of rails **Spurweite** in Germany is 1435mm, makes 3.7 studs. The gauge of LEGO rails is roughly 4.5 studs – an error of more than 20%. This error makes all LEGO engines and wagons look wrong proportioned, and very difficult to build realistic wheel assemblies, especially if you consider the very narrow curve radius. This is also the main reason, why I decided to mill customized rods that are less than 2mm thick.

The narrow curve radius required a lot of experimenting to finish the gear. To maximize the clearance of the four front wheels at the cylinders, these are supported loosely inside a 1x4 brick without centre studs #3066.





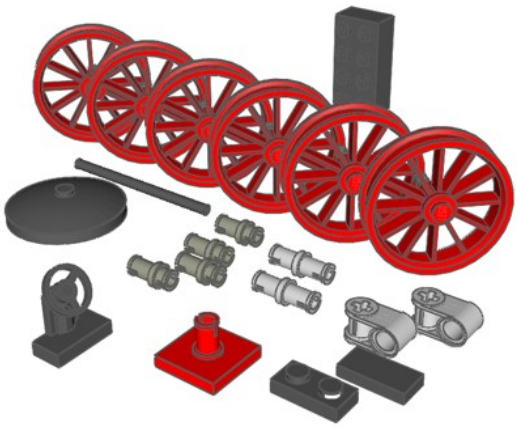


The aft wheel pair is linked to the main gear just below the blind wheels. This way the link (with the -non-realistic- mount red jet engines) has just enough clearance in curves and the aft axle is only little crooked to the rails. The link also supports the magnet coupling to the coal tender and the power supply cable. As LEGO cables are quite stiff, I soldered a thin cable to an Electric Plate 1x2 with Contacts #4755. This way the tender can be uncoupled very quickly.

The plugs that close the holes of the jet engines are made from broken pieces out of my trash box. It requires a little turnery but they can be made from all parts that have hollow studs.

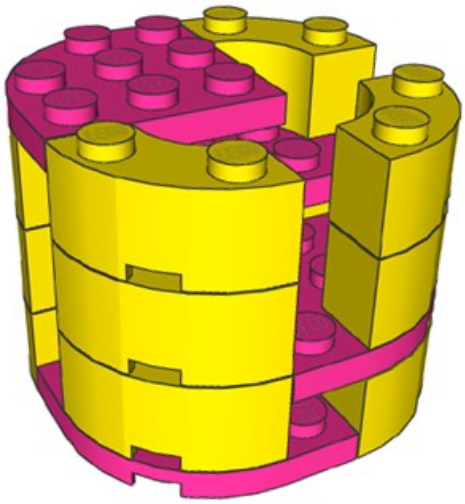
It is difficult to close the 2-stud gap between the locomotive and its tender. Both vehicles move extremly relative to each other when entering or leaving curves. The real engine has small doors and ladders for access to the control cabin. I found a cheap five-minute solution to fake the doors by using black plastic sticker foil. I folded the foil in half on the adhesive side. The overlapping rectangle sticks at the inside of the cabin. When entering the curve the *soft* door touches the tender for a millisecond and flips back thereafter.

All these measures make the engine run at 0.35m/s when pulling two long passenger wagons on an average track (2/5 curves 3/5 straight) at 9V. That's about half the speed of the original (120km/h). Almost all of the weight of the locomotive is carried by the motorized drivers. As a result of this it lurches a little from side to side in the rhythm of the moving rods, which - by the way - make a lot of noise..... heart-beat! Isn't that what fascinates us about steamers? Dirty, heavy, powerful, noisy, visible, self-explanatory mechanics!



One might have the impression I have great fun in destroying parts instead of using them. On the left you see the few parts I modified besides the motor. I combined the pins with the spoke wheels, and drilled a 2x4 brick for the blind wheel axle. I cut the middle part of the #6536 axle joiners to improve the functionality of the pistons. I drilled a 3.2mm hole in the centre stud of the 4x4 dish, and fixed the little steering wheel there with a short piece of flex hose. The remaining stand of the steering wheel I used elsewhere. I had to file the pin of the red 2x2 tile a little to make it move more freely. And I soldered this customized electric brick with wire. Finally I cut two short pieces of rubber hose.

Non-LEGO-parts are the exchange motor, the aluminum rings, a brass axle of 3mm diameter, some cable, black sticker foil for the doors, white sticker foil for the ring-like markings on the buffers, the ten rods, some polystyrene-tubes of 3.2mm and 4.8mm diameter (for *double-studs*, that hold the red #2432 handle upside down).



The 5-wide boiler is made from 81 #3063 macaronis. If you don't want to spoil the almost-round profile, you need to fix it with overlapping #30357 round corner plates. I had to build it almost massive and it finally required only nine corner plates to stabilize it. Although this is basic bricking, it can be very challenging because old macaronis don't hold well, if at all, and filling the gaps between the round parts in a both stable and economic way is a labyrinthian task. Finally the engine weighs 1050g including batteries. When applying the 1:48 scale raised to the third power this is only 116tons compared to the 170tons of the original 01.

LEGO trains started in the 60ies with battery power and presently it looks like it will end with battery power. The first remote control for trains were sets 138, 139 and 139A from 1969!

I personally don't understand, why the most important LEGO principle – modularity – had been mistreaten so often in the past train programs. By the way – modularity was also the main principle of the **Einheitslokomotiven**... and they didn't really manage it either!

So I am waiting for suitable remote control for motors and switches, and at least another curve radius.

ulimy