5 Chassis Construction

5.1 Introduction to Chassis Design

5.1.1. General principles of a working chassis
Unless it is intended that it spends its life in a showcase, a successful model locomotive must not only look right but must also work reliably. Good design and construction of the chassis is an essential factor in obtaining smooth running free from derailments.

The chassis is defined as the frame with the driving wheels and axles mounted in it. Bogie and pony trucks also form part of the chassis, which in prototype practice is called a running frame. In models of steam locomotives it usually incorporates the cylinders and motion.

There are many alternative designs ranging from simple soldered assemblies, in which the axles are rigidly mounted, to more complex designs, nearer to prototype practice, which incorporate springing, compensation or equalisation. If well designed and made, the more complex types of suspension give better roadholding, and improved electrical track contact, but a locomotive with an accurately aligned and free running rigid chassis will perform far better than one with a more complex arrangement but deficient in design or construction. Whichever type of suspension is used, bogie and pony trucks must be sprung from the main frame, preferably with side control. The spring should support the overhanging weight of the locomotive to give reasonably equal loading on the driving axles.

If a simple rigid chassis is to give entirely satisfactory service it is essential that the axles are accurately located relative to each other. Errors in this respect are a prime cause of trouble irrespective of the type of suspension. Intermediate axles must be given adequate vertical and axial play. A slight degree of vertical slackness for other axles is also recommended.

The builder must decide which type best suits his particular preferences and constructional skill. It is again stressed that a poorly designed or made complex chassis can be far more troublesome than an accurate simple one.

The basic requirements of a chassis are as follows:-

Rigid Type (Figure 1a)

1. The outer axles must be parallel in all planes and intermediate ones must be parallel in the horizontal plane with play in the vertical plane, (see 2 below). All axles must turn freely in their bearings, a degree of slackness (0.05mm clearance) being preferable to a precision fit in the journals.

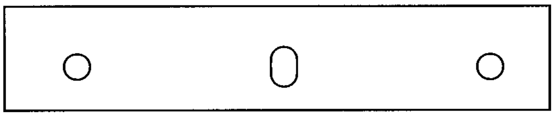


Figure. 1a - ***Rigid frame***

2. In other than four wheel chassis some vertical movement must be permitted in intermediate axles in order to avoid derailments on peaks in the track, which are bound to exist on even the best layouts. Fortunately axle load is not a problem on Gauge O so this can be obtained by + and -1mm vertical elongation of the bearing. The coupling rods of "steam" locomotives are usually sufficiently flexible to accommodate this without the need for intermediate joints.
3. In other than four wheel chassis some lateral freedom must be given to intermediate axles to allow curves of the radii usually encountered on model railways to be negotiated.

Note: Although 2 and 3 above refer to intermediate axles it may be more convenient to allow freedom in the outer axles if there are more than three axles in the chassis or if an intermediate axle is driven.

Sprung Type
This differs from the rigid type in that the axles are not positively located in the vertical plane although the requirements regarding parallelism in the horizontal plane, and the provision of adequate side play remain. The design of the springs, axleboxes and bearings must be such that:-

1. The locomotive is level and at the correct height when standing on level and true track. The simplest way of ensuring this, from here on referred to as semi-sprung, is to allow the axleboxes to rest against stops under this con dition, in which case the springs can only move the axles downwards. (Figure 1b) A small amount of clearance is useful on intermediate axles. (see rigid type 2 above)
   It is more difficult to allow the locomotive to float on the springs as does the prototype, (Figure 1c) and apart from the satisfaction of producing a model which faithfully reproduces the riding of the prototype there is little technical advantage over the semi-sprung type.
   A fully sprung locomotive floating on the

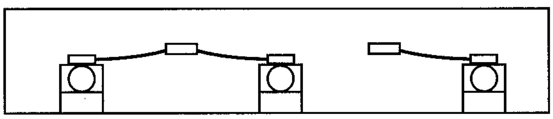


Figure. 1b - ***Semi sprung frame***

springs on level track is defined as being in the neutral position.

2. All axles follow track variations as they occur and return quickly to the stops (or neutral position) on regaining level track i.e. they do not jam.
3. If in following the track contour an axle tilts slightly it must not cause the bearings or axle boxes to bind. If the vertical location of the bearing bush is rigid it may be necessary to allow greater clearance to accommodate the maximum tilt of the axle.
4. Adequate movement is provided to cope with reasonable track imperfections (-2mm semi-sprung) and + and -1mm fully sprung).

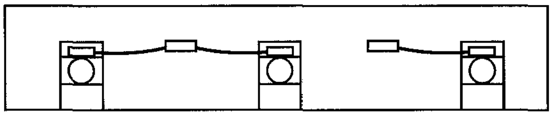


Figure. 1c - ***Fully sprung frame***

Compensated Type (Figure 1d)
The driven axle is rigidly located in the frame and the others are allowed to swing about a beam mounted centrally between the frames.

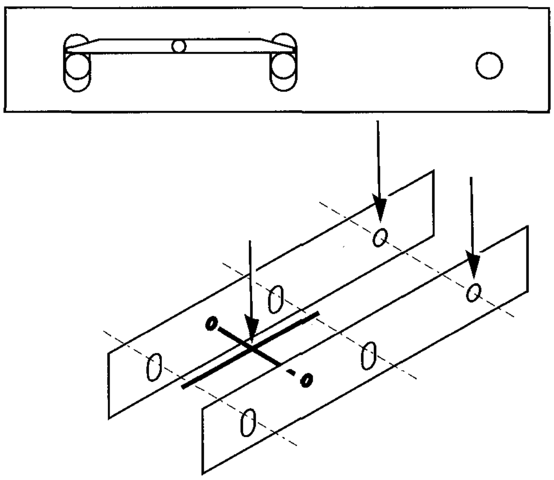


Figure. 1d - ***Compensated frame***

Equalised type
The weight of the locomotive is transferred to the axleboxes by equalising beams which ensure equal weight on every axle. This type is more suited to diesel and electric locomotive models with individual axle drive. It is more complicated than a sprung chassis and has little advantage for steam locomotive models where the driving wheels are coupled, consequently it is seldom used for them.

It follows that the design and construction of a sprung, compensated or equalised chassis is considerably more complex than are the corresponding operations for a rigid one and thus a higher level of skill is demanded if the result is to justify the additional work. However, construction of the more complex types is now made much easier by the availability of a growing range of components such as axleboxes and guides.

5.1.2 Division Between the Chassis and the Body
Having decided the type of chassis to be used the next step is to settle the dividing line between chassis and body. When most motors were purchased complete with frames and wheels it was common practice to attach the cylinders and the front and rear frame extensions to the body proper, this method being used by many r-t-r model manufacturers such as Hornby and Bassett-Lowke, but modern practice is to produce a chassis which is the full length of the model and carries all the working parts including the bogie, pony truck, cylinders, motion and motor. On steam locomotives and rigid frame diesel shunters it maybe convenient to make the dividing line at the running plate, any portions of the prototype frame which are visible above this line being made integral with the body.

Practical considerations of scale and clearance result in the "working" portion of the chassis usually having to be less than true scale width and by making the break along the running plate the frame above it can be made true width and thus appear right, a feature which is particularly important above the buffer beam. The great advantage of this later arrangement is that the "works" can be assembled and fully tested independently of the body which, however attractive in appearance, is merely a cover. It is usually more rigid than the chassis frame and it is essential that it does not distort the latter when the two parts are assembled together.

On bogie type diesel and electric locomotives a similar principle can be employed by attaching the bogies to a floor plate over which the body fits.

5.1.3 Mounting of the Motor and Drive
The method of mounting the motor and drive within the available space is best done by making a full size drawing of the motor and gearbox which can be superimposed on that of the body. Allow about 2mm minimum clearance above the motor and 0.5mm on each side. Cross section drawings should be made for each position where there is a change in width of the body aperture or motor.

Inserting the motor into the body must be considered as well as its final position. Getting a wide motor into a "waisted" firebox can be a problem and there is nothing more frustrating than finding that the motor will not go into the body without major surgery on an almost completed model.

5.1.4 Drive Arrangement

The drive arrangements described will all give satisfactory performance given sound design and construction, and the one actually used can be largely a matter of the builder's preference, although the choice may be limited by the type of motor and the design of the chassis and body. The dimensions of the vast majority of Gauge O motors are such that some form of right angle drive is necessary and arrangements of this type are the only ones considered in detail. Some motors are short enough to be mounted parallel to the axles, which are driven through multi-stage spur gearing, but these are, or were, specialist units sold complete with wheels and gearing, (eg. Lima, early Bassett Lowke and all Hornby motors).

Rigidly Mounted Motor (Figure 2a)

If the drive is a single reduction worm, (or other type of right angle drive), the input gear is mounted directly on the motor shaft and engages with the driven gear on the axle. The motor is secured rigidly to the frame but the mounting method, which will depend on the motor construction, must allow initial adjustment of the shaft alignment and gear mesh. However, these should not need alteration once they have been set. It is best to arrange the mounting so that the motor can be removed and replaced without the need for readjustment.

If an intermediate stage of gearing is employed its bearings are mounted directly in the chassis frame plates. They must be accurately located on initial drilling because it is difficult to provide a means of subsequent adjustment. The gearing for this type of drive is usually left open as it is more difficult to enclose it than with a separate gearbox.

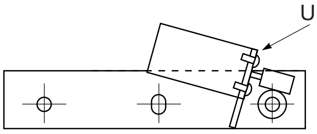


Figure 2a ***Rigidly Mounted Motor***

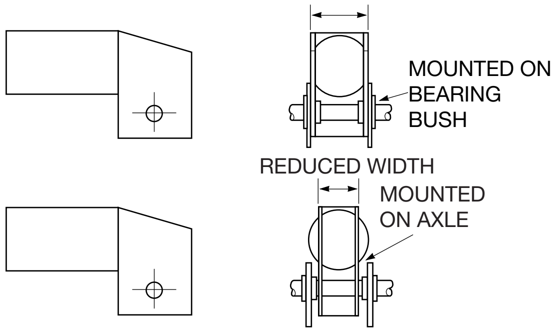
This type of drive can only be used with a rigidly located axle.

Axle Mounted Motor and Gearbox Unit (Figures 2b and 2c)

This is the simplest arrangement to use and is the equivalent of the full size axle hung motor. The gearbox and motor are a single unit which mounts on the driven axle and fits between the chassis frames, the only fixing to the latter being a means of preventing the unit rotating around the axle. It is very important that this restraint should not positively locate the motor in any plane, even if used with a rigid chassis, because this would be certain to cause binding of the axle. The method chosen will depend on the particular construction of the motor/gearbox unit, but could be, for example, a stud screwed into the end of the motor engaging with a slotted bracket on the chassis.

The gearbox can be of either the open or enclosed type, purchased as a unit with the motor or purchased or constructed separately.

This type of drive can be used with either a rigid or sprung chassis, but in the case of the latter clearance must be provided between the gearbox and the chassis frame so that the axle can tilt under the control of the springs. It is particularly important to provide sufficient freedom of movement at the restraint when this drive is used with a sprung chassis.



Figures 2b and 2c ***Axle Mounted Motor and Gearbox Unit***

Independent mounting of the Motor and Gearbox (Figure 2d)

If both the motor and gearbox. (or gearboxes), are positively located with respect to each other they could be coupled by a solid shaft, but better results will usually be obtained by employing a flexible coupling which will accept any slight misalignment without binding. With this arrangement the gearbox must be prevented from rotating around the axle by means of a torque arm. If used with a sprung chassis a flexible coupling is essential and must have slight lateral as well as angular flexibility. The ultimate development of this type of drive is the mounting of the motor in a separate vehicle to the driven wheels, (such as in the tender of a small boilered steam locomotive), but the development of powerful very small motors should eliminate the need for this in Gauge O. This arrangement requires considerably more lateral and angular flexibility in the coupling than when motor and gearbox are mounted on the same chassis.

Irrespective of whether the chassis is rigid or sprung the motor is solidly mounted and the arrangement offers a wide choice in the design of the gearing, which can be either entirely on the axle or split between the axle and the motor or it may even include a third unit on the frame. The possible arrangements are too numerous to consider in detail but the section on gearing gives the necessary information to enable the builder to design a drive to meet his particular requirements.

5.1.5 Drives for Diesel and Electric Locomotives

Most model steam locomotives have an advantage over more recent types in that only one axle need be driven, the coupling rods providing a simple means of obtaining the necessary adhesion, but where these do not exist it is necessary to use other methods of driving sufficient axles to provide the haulage capacity. In general this requires at least two axles of four motor prototypes and four axles of six motor ones to be driven in order to provide haulage capacity approaching that of their prototypes. In order to prevent the bogie tilting under load, and thus reducing the weight on the leading axles, the pivot should be as near as is practicable to the axle centre line. The simplest arrangement is to use multiple motors mounted vertically on either axle mounted gearboxes or on the bogie frame if there is no springing. (Figure 3)

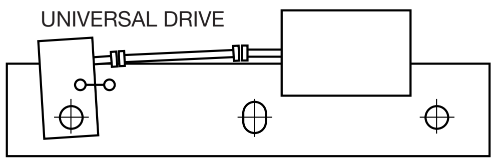


Figure 2d ***Independent mounting of the Motor and Gearbox***

Because of their small wheels and usually higher maximum speeds these types of locomotives require lower gear ratios than steam models, some motors needing only 6 to 1, and so single reduction worm drives will give a compact unit with reasonable efficiency. A disadvantage of the small wheels is that they can limit the choice of gears because of the need to give adequate clearance to the rail, a situation which is most likely to arise on stud contact and three rail systems.

An alternative is to use horizontally mounted motors, preferably with shafts at both ends, driving axle or frame mounted gearboxes, these drives being in effect double versions of those already described for steam applications and thus calling for no further comment.

If only a single ended motor is available it is necessary to either mount a gearbox on it to provide an output at each end or drive a single bogie with the motor mounted over the dummy one.

In addition to the various types of gear drives, chain and toothed belt drives suitable for coupling the axles of a bogie are available.

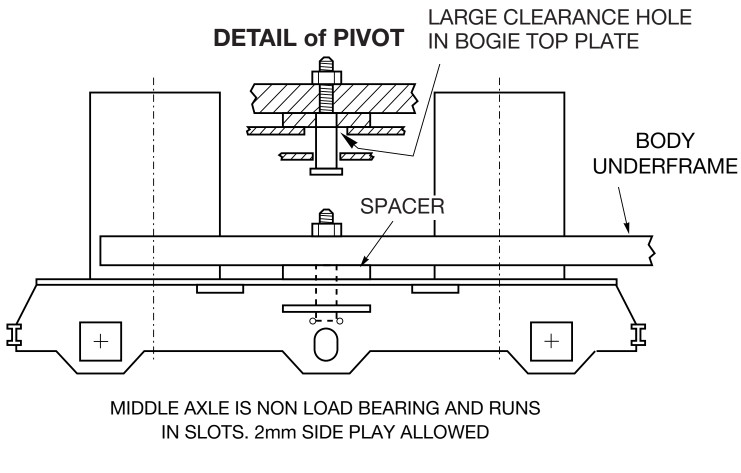


Figure 3 ***Multi - Motor Drive for a CO-CO Diesel Electric Locomotive***