In the construction to follow, the thickness shall equal 2 6-0 tangerine.

The cross-section is made on which type of locomotive is to be modeled and

Some devices have been eliminated when necessary, as the white background is the same for all.

The selection of a locomotive to be modeled is simply where the interest lies.

Within the limits of all, the Horn Horse.

From here, the railroad's lines and branches are shown to the

The main locomotive design is to be modeled so it is

Now that the picture, some details may be added in.

Considering what measurement and graduation scale to

The design locomotive is the

Perhaps no invention of man has more impact on changing the of life than

INTRODUCTION

Engineering Notes
15. LOCOMOTIVE Hauling Power

Many people ask how much can a locomotive pull up grades of varying percentages. This can not be answered in so many pounds as there are many influencing factors such as locomotive tractive effort, rail conditions, rolling friction in the car journals and general locomotive performance. However, over a period of years railroads found average value for grades which when applied will give good results or at least some idea of what a given locomotive will do. The following table and example will illustrate why railroads keep all track as level as possible.

| Grade in % | 1% | 2% | 3% | 4% | 5% | 6% \\
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<td>10%</td>
<td>4%</td>
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To illustrate the use of the above chart we will say a given locomotive will pull a load of 4,000 pounds. If we go up a 2% grade we can only pull 1,200 of 4000 or 520 pounds.

17. SIZE OF LOCOMOTIVE SPRINGS

In order for a locomotive to operate properly and to stay on the track it is necessary to have the locomotive fitted with equalizing levers and springs. The purpose of the equalizing lever is to distribute the weight equally on the driving axles, also to reduce the effects of shocks caused by the rails, and to allow the wheels to adjust themselves readily to any unevenness in the track without throwing an undue strain on the frames and other parts of the locomotive.

The formula below will give a good approximation of springs to use to give proper riding qualities to the locomotive.

First of all several things have to be known about the spring before we can work out the details. These things are the length, width, thickness and the weight the spring has to support. The length can be scaled from the prototype or some arbitrary length chosen. The width can also be scaled or taken as the frame width or less. Thickness is a matter of choice remembering that a thick spring leaf will make the locomotive ride stiff and a thin one will cause it to bounce. I feel that on 1\textsuperscript{st} locomotives or average size a spring of from 0.035 to 0.065 will give good results. Weight is something that is hard to come by, but with a little calculations it can be approximated close enough to give good results. Now for the formula.

\[
\text{Load in tons} \times \text{length of spring in inches} \times \text{width in inches} \times (\text{thickness of one leaf in sixteenth})
\]

This gives the number of leaves needed for each spring.

Working out a typical problem we have:

- Total weight on drivers: 400 lbs
- Number of springs: 6
- Weight each spring has to support: 400/6 = 66 lbs
- Length of spring: 3.5 ft
- Width of spring: 3.5 ft
- Thickness of one leaf: 0.050

Number of leaves = \( \frac{3.5 \times 3.5 \times 0.050}{0.050} = 5 \) leaves

19. DEFLECTION OF LOCOMOTIVE SPRINGS

The amount a spring will deflect is calculated by the use of the formula below. This is understood to be only approximate but will serve as a guide as to how much to allow for in the set when in the free state.

\[
\text{Deflection} = (\text{lengths of spring in inches})^2 \times 1.5 \times \text{width in inches} \times (\text{thickness in sixteenths})^2 \times \text{number of leaves}
\]

In our example, we will fill in the known quantities.
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*Figures of Equilibrium Stream*