On a visit to the Wirral society a few days ago I was presented with an adhesion problem, and on getting back home an email requested details of ejectors for various sizes of locomotives/trains.

For a first-time driver on the Wirral railway, the trip is quite alarming. For the track slopes downwards from the station, but this is not obvious to the eye. The station seems dead level, and the regulator has to be opened for the start, but before the train is on the main line gravity takes over and the train gathers speed. Although I had been driven round the track - always a good idea for "strangers" - I did not notice this gradient and thought at first that the regulator had jammed in the partially open position. Worrying, n'est ce pas?
This gradient lasts almost unchanged to the bottom of the first loop, of course this means opening regulator again for the climb to the second loop and from this it is uphill all the way back to the station. The curves are gentle and the track well maintained, but when seen at a fast speed and the belief that the regulator has stuck open - they look rather sharp. The gradient is not steep, and the King I was driving took the full train up it with only 40 psi. on the clock!
There are a few level crossing places where whistling is required but this is no problem; visibility is good; the crossings are protected by the standard system of flashing lights. The station has a turntable, for the line is "out and back", extra run is obtained by a crossing where the loops cross.
This reminds me of a similar track in Los Angeles. The crossing is protected by signals, and if any driver passes one of these at danger a nice fat exploding rocket fires off. Exploding with a fine bang, when everybody pays attention - and no doubt speaks a few words - and the offending driver has to pay for a new rocket. That was the system in 1979 at least - probably still going strong.
Through woods for most of the line, the return loops are in a field, and the station is beside a wall parting a big field from the wood. The railway is visible from a big car park, so does quite well from passenger donations.
Altogether a very fine railway, enjoyable to a great extent.

The adhesion matter was quite simple. He had a Stirling single (4-2-2) and was concerned about its difficulty in hauling a load. Well, a single is tricky to handle anyway. As far as I know, the ultimate record on full-size was witnessed by the late Harold Holcroft when he was working in the Swindon drawing office; he described the matter in his book "An Outline of Great Western Locomotive Practice".
He witnessed a Dean Single pulling 23 bogie coaches! I am not certain of the weight of this train, but I would think about the 800 ton mark. Nothing to be sneezed at. The speed was about 45 mph, and the driver must have known his locomotive, and how he got started produces food for thought. Also the locomotive must have been in reasonably good condition, well "weighed".
I discussed the matter many years ago, and was rewarded by correspondence from someone who didn't know much about mathematics. I pointed out the obvious fact that a locomotive pulled forwards by pushing the rails backwards,

and in one of the published letters I recall the phrase "when Mr. Wilson advanced this theory" He maintained that there was no backwards thrust on the rails and the locomotive moved forwards by the pressure of the steam on the front cylinder cover.
I wonder just how a locomotive can lose its feet and skid. I wonder how a locomotive can stop if there is no longitudinal force on the rails?
Now it must surely be obvious that a locomotive is pulling forwards by trying to push the rails backwards; this raises a further very interesting matter. The backward thrust is obviously at the rail top. The backward pull of the train, or the forward pull of the locomotive - take your pick - is a few feet above rail level - about 4 feet. Now I know that the height of the standard system of coupling and buffing gear in this country is about 3ft-4", some can be a bit higher. As memory serves, the big Swindon tenders were 1" higher than the smaller tenders - I know not why.
The pulling force must exactly match the pushing force, less the friction of the bogie wheels. This is self-evident, therefore we have two equal and opposite forces, parallel, and at a distance apart of about 4 feet (the coupling from engine to tender is higher than the other coupling types). Therefore we have what is known in mathematics as a Couple. Now the important point of a couple is that it cannot be "neutralized" by any single force no matter what. It can only be nullified by an equal and opposite couple.
This couple is invisible but it cannot "not exist". Therefore it must lie within the locomotive, and there is only one possibility; the transfer of weight from the front end towards, the rear end. This means a "dig in" of the locomotive, but clearly the result of this action must depend on the wheel arrangement.
In general, engines of the 4-4-0, 4-6-0, 4-8-0, 2-6-0 this dig-in means a transfer of weight from the leading truck - be it bogie or pony - to the driving wheels. In the case of a King for example this is a gain in adhesive weight of about 6 tons - useful in starting. For 4-2-2, 4-4-2, 4-6-2, 4-8-2, 2-6-2, this transfer of weight gives much to the rear wheels, be they trailing, Bissel, or any other formation. This gives some reason for the former types being generally better at starting than the latter. In connection with this, even a Castle running backwards can slip without having a train attached - I know this from my own experience.
It therefore follows that should my Wirral friend reduce the springing on the rear wheels, his trouble in running will be greatly reduced.

Note that this weight transfer would not be obvious from watching the engine at work (except for 0-4-0 locomotives), because the tilt-back effect is not obvious by looking at the engine. Note that the location of the center of gravity does not move and the total weight does not change, it is entirely hidden from view.
In connection with this phenomenon, for an engine moving forwards, the lower guidebar is superfluous, whereas for rearward motion, the thrust is concentrated on the lower guidebar. This is one of the matters for locomotive designs with guidebars only above the crossheads, the system means that in forward running there is nearly twice the effective surface to take the load, and less than 1 guidebar in reverse. This reads a bit peculiar at first, but I am sure you will know what I mean!