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THE DESTRUCTIVE ACTION OF LOCOMOTIVE DRIVING WHEELS.

The rapid acceleration of railway speed which has taken place in the last few years has developed some new problems in the design of the locomotive; or, to speak more correctly, it has brought into prominent notice certain details of design which, in the earlier locomotives, received but little attention. A sixty-five ton locomotive at rest and a sixty-five ton locomotive running over the track at eighty miles an hour are two very different things. In their action upon the steel rail and the roadbed, there is all the difference between static and dynamic forces, and this difference will increase with the increase of speed. The builders of the early locomotives understood this, no doubt, as well as we do today, but, at the speeds at which they ran their trains, the variations of wheel pressures were not so serious as to call for special attention. The proper counterbalancing of a locomotive is, for obvious reasons, a more difficult problem than that of counterbalancing a stationary engine. The latter is bolted rigidly to a solid bed; whereas the locomotive is hung upon springs, and the whole machine is capable of violent lateral, vertical, and longitudinal oscillations. If it were possible so to arrange the weights in the driving wheels that they would exactly counterbalance all the moving parts of the locomotive, it would be possible to construct a perfectly smooth running engine. But in the ordinary two-cylindered locomotive this cannot be done. As far as the balancing of the revolving weights is concerned, there is no trouble; but to balance the reciprocating parts, such as the crosshead, piston rod, piston, etc., so that at all points of the revolution they shall be perfectly counterbalanced, is a physical impossibility. If they are fully counterbalanced when at the half stroke and traveling at their maximum speed, there will be an excess of counterbalance at the dead centers, when they are at rest. Among the earlier builders it was a common practice to counterbalance all the reciprocating parts; and, on some roads, this is still the practice, though it is more usual to counterbalance only from one-half to two-thirds of these weights. If they are all counterbalanced, there will be a hammering action set up by the excess counterbalance at the full stroke. At the downward half of the revolution, its effect on the driving wheel in which it is located will be to increase the pressure on the rail; and on the upward half it will tend to lift the wheel and so reduce the total pressure. So that instead of the wheel bearing upon the rail with an even pressure, equal at all times to the tension of the springs, it will vary with a range increasing with the velocity of rotation. As the speed increases, this action will become more dynamic in its effect, until a point is reached at which variation in pressure will be so great and so rapid as to set up a positive hammering action upon the rails.

When engineers first began to come in off their runs and complained that at high speed the driving wheels would occasionally lift entirely clear of the rails, the statement was received either with incredulity or ridicule. But when it was found that in a certain case the passage of a badly balanced engine at high speed over a piece of track left a series of regularly spaced depressions in the rail, showing that it had been bent down out of level at these points, locomotive builders began to understand how destructive was this action, and that a force which in its downward action could bend and give a permanent set to a 70 pound rail might conceivably exert an upward pressure greater than the load upon the wheel, and sufficient to lift it clear of the track.

A force that bends a cold steel rail to such an extent as to leave a permanent set in it is destructive to the bridges on a line. This is shown by the sudden snapping of tie rods at the moment when an overbalanced engine is passing at high speed. These rods are designed to be proportional in strength to the static load of the locomotive and train. The greatest concentration of load is that of the driving wheels; and there are thousands of bridges in existence which have been designed on the assumption that the static load of say from 15 to 20 tons on the drivers was the highest concentration to which they would be subjected. Yet, as a matter of fact, these same bridges are liable to be subjected to the hammering action of an engine which strikes a series of blows of not less than 40 or 50 tons weight.

The evils of overbalancing may be avoided, or reduced to a minimum, in two ways—first by reducing the weight of the reciprocating parts to the lowest practicable limit, and second by counterbalancing only a part of their total weight. There is no doubt but that the weight of pistons, crossheads, and slide valves could in many cases be greatly reduced. Weight could be saved in the case of the piston by designing it in forms which allowed a minimum amount of material to be disposed to the best possible advantage for strength, and also by making it of the highest grade of material. A great saving of weight could be made over the cast iron pistons which have been so largely employed. The same thing is true in a lesser degree of the whole of the reciprocating parts. In many cases a total saving of thirty to forty per cent could be made on the present weight. With the weight thus reduced it would not be necessary to counterbalance for more than fifty per cent of it; and in the case of heavy engines the percentage could be less than this.

Of course, the unbalanced weight will tend to produce a fore-and-aft oscillation; but this weight will be relatively so small that it will scarcely affect the mass of the engine as a whole.

There is one other element, the size of the driving wheel, which greatly affects the question of balancing. For high speeds it should be made as large as is consistent with a reasonable amount of starting power. The downward blow of the excess balance will vary, other things being equal, with the diameter of the driving wheel, and this is one of the causes, among others, which have led American designers to adopt larger wheels for the latest types of high speed locomotives.

Enlarging on Canvas.

Mrs. Allen gives in the St. Louis and Canadian Photographer the following method of enlarging upon canvas: Wash canvas in hot water, rinse with cold, after which stretch to remove all folds. Salting solution:

Potassium bromide	3 parts
Potassium iodide	1 part
Cadmium bromide	1 "
Water	240 parts

Thoroughly saturate the canvas with this, and hang in a warm room to dry. Then sensitize with

Nitrate of silver	4 parts
Citric acid	1 part
Water	140 parts

Sensitizing is done same way as salting. Expose in solar camera, or in a similar camera illuminated by electric light. Develop the exposed canvas in

Pyrogallic acid	10 parts
Citric acid	4 "
Water	410 "

Use slightly warm, and about ten minutes is necessary to bring out the picture, thoroughly washing after development. Tone same way as silver prints, with acetate of soda and gold. Fix in hyposulphite of soda.

Slate for Houses.

Slate is too much overlooked as a material for inside decoration. It exists in many different shades. It is easy and inexpensive to quarry, and, by far the easiest stone to shape into pleasing forms. These qualities render it the cheapest of durable materials for interior purposes, and the wonder is that so little of it is in common use. If large dealers would establish depots of standard goods made up for combination in house building in such forms as would be available to architects, its use would be indefinitely extended. Hardly a cottage of any pretensions would be built where it would not take a prominent part. If such depots were established, house builders would be enabled to see it, and appreciate its beauty and cheapness. As it is, hardly one in five hundred knows anything of either.—Stone.

British Association.

The ten presidents for the various sections of the British Association meeting in Liverpool next September have now been chosen. They are Prof. J. J. Thomson, F.R.S., Mathematical and Physical Science Section; Dr. Ludwig Mond, F.R.S., Chemistry; Mr. John E. Marr, F.R.S., Geology; Prof. E. C. Poulton, F.R.S., Zoology; Major Leonard Darwin, Geography; the Right Hon. Leonard Courtney, M.P., Economics; Sir Charles Douglas Fox, M.Inst.C.E., Mechanical Science; Mr. Arthur Evans, F.S.A., Anthropology; Dr. Walter Holbrook Gaskell, F.R.S., Physiology and Pathology; and Dr. D. H. Scott, F.R.S., Botany. Prof. Flinders Petrie, and probably Sir Andrew Noble, will deliver the evening discourses, and Prof. Fleming, F.R.S., will give the lecture to workingmen.

AT the Am Urban Hospital in Berlin 411 diphtheria patients were treated in 1894-95, 255 of whom were discharged cured. Of 245 treated with serum, 28 per cent died, while among the 146 who were treated otherwise the mortality was 42 per cent; 53·2 of the serum cases were serious, 23·7 severe, and the rest slight. No evil effects were observed to follow the use of the serum, and its effectiveness was proportionate to the earliness of its application and the strength of the first doses. The hospital authorities infer from this that it is not an infallible, but a highly valuable remedy.

THE Brooklyn Institute has purchased the Berthold-Neumoegen Collection of Lepidoptera, comprising 40,000 to 45,000 specimens. The institute will also secure the collection of Jacob Doll, of over 55,000 specimens, and will employ Mr. Doll as curator. Edward L. Graef will present his collection of about 20,000. The institution already owns the Calvarey collection, so that altogether the institution will have, says Nature, the most complete collection of lepidoptera in the world.