

ON A NEW CONSTRUCTION OF RAILWAY SPRINGS.

A considerable portion of the material used in the construction of the ordinary laminated steel spring gives, in the writer's opinion, but little elastic action, and in fact acts more as the base upon which the other portions of the spring deflect; and hence he has been led to the conclusion that two important defects are inherent in that principle of construction, namely, a superfluous dead weight of material used, and an unequal strain upon the several portions of it. It then occurred to him that if the plates of a laminated steel spring could be arranged so as to act upon the principle of a series of beams directly connected with each other, and so that the number of plates in action might be determined to some extent by the load (which in all carrying vehicles such as tenders, carriages, and wagons, is well known to vary considerably), these defects would be removed, and a spring of the greatest practicable strength with the minimum quantity of material be the result. Many experiments were made to clear up these points, all of which proved conclusive as to the superior strength and elastic action of the plan of spring described in the present paper over the common construction.

Various modes of constructing this spring are shown in Plate 40. The cast iron shoes are made with a series of steps, and the ends of the plates bear independently on the several steps of the shoes; the whole spring being inverted as compared with the ordinary springs, the bottom plates being the longest. Each plate is arranged to carry its proportion of the load independently to some extent of any other plate, by the steps being made gradually deeper in succession, so that only the longest plates bear at first, and the other plates take a bearing successively as the deflection of the spring increases, giving a uniform elasticity under a variable load.

By tapering each of the plates in thickness or in breadth, from the centre to each end, a uniform deflection of the plates throughout their length is obtained. The result of this mode of construction is that a

spring about two thirds the length of an ordinary spring gives out as much elastic action; whilst if the same depth be retained its carrying power is much increased, and hence it follows that to do the same work a much lighter spring will suffice.

The facility for giving as much deflection as may be deemed necessary to each plate independently is an important improvement in this construction of spring, as it avoids any undue proportion of the work falling on such plates as from their length should not receive it. In consequence of the independent action of each plate, they are not required to be fitted to each other as in the ordinary make of springs; and hence their cost of manufacture is lessened by the expense of so much fitting.

In Plate 40 are shown the different forms of these springs that have been used.

Fig. 1 is a Wagon Spring with curved plates tapered in thickness.

Fig. 2 is a Wagon Spring with straight plates tapered in thickness.

Fig. 3 is an Engine Spring with straight plates tapered in thickness.

Fig. 4 is a Tender Spring with curved plates tapered in thickness.

Fig. 5 is a Tender Spring with straight plates tapered in breadth.

Fig. 6 is a plan of the spring shown in Fig. 5.

The following Table gives the particulars of experiments made on the comparative weight and deflection of the new springs, and of springs of the ordinary construction:—

TABLE.

Description of Spring.	Weight of Steel.	Length of Bearing.	No. of Plates.	Breadth of Plates.	Thickness of Plates.	Camber.	Load.	Deflection.		Permanent Set.
								Total.	Per Ton.	
Common Spring	98	2 7½	12	3½	⅜	2½	2·70	1·62	·60	0·12
New Curved Spring	60	1 10	9	4	$\left\{ \begin{array}{l} 1 \times \frac{3}{8} \\ 8 \times \frac{1}{4} \end{array} \right\}$	1½	2·70	1·12	·42	0·12
Common Spring	78	3 0	7	4	⅜	4½	2·05	0·75	·37	
New Straight Spring	66	2 9	6	4	⅜ to ⅜	¾	2·05	0·69	·34	
New Curved Spring	56	2 4	6	4	⅜ to ⅜	1¾	2·05	0·62	·31	

The wagons in which the new springs are working are 14 ft. 6 in. long, by 6 ft. 2 in. wide, and 1 ft. 6 in. deep inside, and intended for 6 tons load ; but they have been frequently loaded to $9\frac{1}{2}$ tons, and the straight springs were then deflected downwards about $\frac{1}{2}$ inch, but were still doing their work efficiently, no failure having occurred with them.

There are now about 350 of these springs in use on wagons and tenders upon different railways ; several have been two years in regular work, and the results are very satisfactory, none of them having failed.

Mr. A. ALLAN said he had made trial of the new plan of springs for 2 years on the Scottish Central and other railways, and had applied them to a considerable number of the ordinary class of railway wagons, and found the result very satisfactory ; the action of these springs was more easy under the variable circumstances of load, and there was an important saving in weight and cost as compared with the springs in ordinary use. The plan of spring was specially intended to meet the case of the variable load to which wagons were subjected, as the ordinary springs were simply made strong enough to carry the heaviest load without undue deflection, but with light loads they had such excessive rigidity as to be in fact little better than mere props with scarcely any elastic action. With the new spring however many of the plates were entirely off the bearing when the wagon was empty or only lightly loaded, and such portion of the plates only were in action at that time as were proportionate to the load ; but when fully loaded all the plates were at work carrying the load. He had also made a trial of this plan of spring for an engine spring, but in that case the advantage in reference to a changeable load did not apply ; there was still however the advantage of the complete action of each plate independently, and the reduction in weight and cost ; the springs had been tried in an engine with a load of about 5 tons on each and were doing well, but they had not yet been long enough at work to give a definite result.

The CHAIRMAN observed the principle of the new spring was certainly best applied where there was a variable load, a case for which other springs did not provide, as they were uniformly strong whatever variation might take place in the load.

Mr. E. A. COWPER enquired how the tapering of the plates in thickness was effected, and whether it cost much, as that mode of graduating the strength of the plates would certainly make the most perfect construction if it were not too expensive.

Mr. A. ALLAN replied the tapering was done by the ordinary eccentric rolls used for spring making, only extended for the purpose of giving the length of taper required; and there was not any difficulty in getting the plates tapered, at a small cost of only 1s. or 2s. per cwt.; he considered this make was preferable to tapering the plates in width by shearing, as it kept all the bearings at the ends the full width of the plates.

Mr. J. TOMLINSON asked whether a difficulty was not found from increased variation in the level of the buffers with the new springs, the present variable height of the wagon buffers in trains being a serious defect, which he was afraid would be increased owing to the more elastic action of the new spring.

Mr. A. ALLAN replied the springs were arranged for the same total deflection as the springs in ordinary use, so that there was no more variation in the height of buffers between empty and loaded vehicles; the difference in the deflection of the new springs was that with the lighter loads the deflection per ton was greater than with the ordinary springs, making the action easier for the lighter loads, the deflection per ton being reduced as the load increased. He had also tried the new springs by running the wheels over 2 inch wedges placed upon the rails, and they were found to have considerably more elastic action than the ordinary springs, as shown by the range of vertical oscillation indicated by a pencil fixed from the wagon frame and marking upon a card fixed upon the centre of the spring or axlebox.

Mr. E. A. COWPER observed that in the ordinary laminated springs the friction between the plates caused great resistance to their action; and keeping the plates separate throughout their length as in the new

spring would certainly make the spring more lively. In reference to the saving in weight of steel required for carrying the same load, he did not see how any material saving could be effected by that construction, unless it were by the tapering of the plates in thickness; and thought the main advantage would arise from each plate being at liberty to follow its natural elastic curve in bending, not being controlled by the adjoining plates as was the case in the ordinary springs, where the plates being supported by one another each one got a leverage over the end of the one below, causing a tendency of the plate to set up in the centre; this effect was often seen in springs by the plates gaping open between the centre and the ends. The fact of the springs being proportioned to their work, as explained by Mr. Allan, was an important point, so that a spring should have as much action or play when lightly loaded as when heavily loaded.

Mr. A. ALLAN said a more lively action was plainly shown in the new springs when working. The saving of weight was effected by getting a more complete action from the steel in each plate independently, for in the ordinary springs a portion of the steel was not fully called into action. There was also a saving of the cost of fitting the plates together, which was incurred in the manufacture of the ordinary springs; this fitting also had the disadvantage of interfering with the true action of the plates, as they were fitted together so as to bear on each other only at the ends, having spaces between them at the centre before being closed up; and the shorter plates then became unduly strained by being pressed down out of shape by the longer plates, whilst the latter were not doing their proportion of duty and consequently wasted steel.

Mr. T. SPENCER had found that the greater elasticity of the spring enabled it to be shortened for performing the same duty, which effected a saving of material; and the shortening of the spring prevented its more lively action being carried to any objectionable extent.

Mr. A. ALLAN observed that the wear upon the ends of the plates was not so great as in the common springs, as each plate of the series took a separate bearing, instead of the top plate having to sustain the whole load; so that the pressure upon each plate end was much less, and the wear was distributed over them all, instead of being confined to the ends of the top plate alone.

Mr. T. S. PRIDEAUX asked whether the new spring had been tried on any common road carriages ; he thought the principle would be particularly applicable there, as whenever the load was light the present springs acted imperfectly from being proportioned strong enough to carry the full load ; he had thought, in noticing the action of the springs in such vehicles as omnibuses where the load was subjected to great variation, that it would be a great advantage if the springs could be varied in strength with the load, and the plan of spring now described appeared to effect this to a great extent by a self-adjusting change.

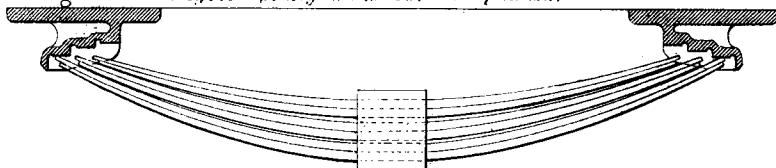
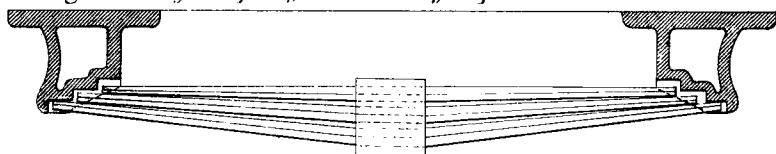
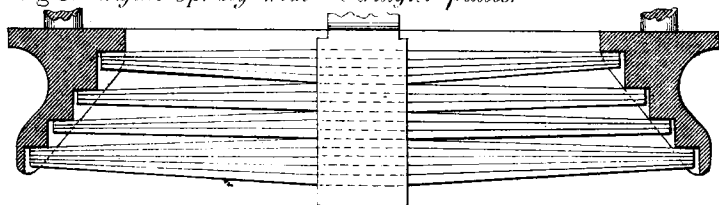
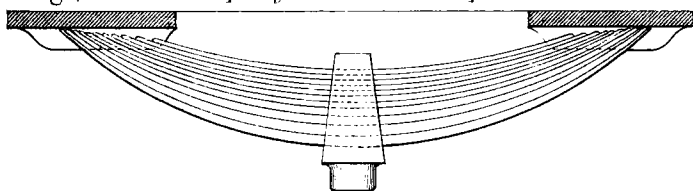
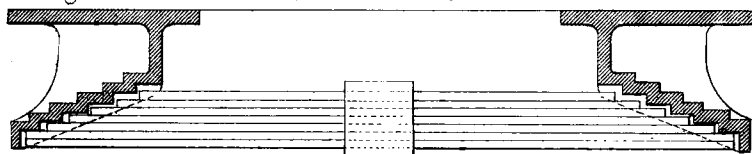
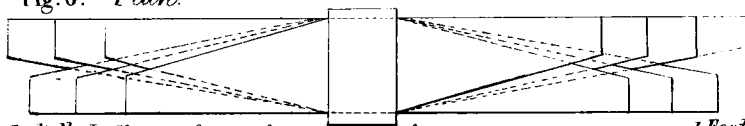
Mr. A. ALLAN replied that only one trial had been made at present on a common road, where instead of the ordinary double plates for each bow of the spring in a dog cart, the inner plates had been made free, without coming to a bearing whilst there was only a light load of one or two persons ; and taking a bearing only when there was a heavy load to be carried, the spring then having its full strength in action.

Mr. R. LAYBOURN enquired how the form of spring so different from that in ordinary use had been arrived at ; whether it was designed in that form, or obtained in the course of experiments.

Mr. A. ALLAN replied that the spring had been invented by Mr. Hunt, who was unavoidably prevented being present at the meeting ; the object that had been specially aimed at was to obtain a spring that would be equally suitable for working with light or heavy loads, and also to effect economy in the use of the steel.

The CHAIRMAN proposed a vote of thanks to Mr. Hunt for his paper, which was passed.

The following Paper, by Mr. William A. Fairbairn, of Manchester, was then read :—

Fig. 1. *Wagon Spring with Curved plates.*Fig. 2. *Wagon Spring with Straight plates.*Fig. 3. *Engine Spring with Straight plates.*Fig. 4. *Tender Spring with Curved plates.*Fig. 5. *Tender Spring with Straight plates.*Fig. 6. *Plan.*

Scale $\frac{1}{8}$ th Ins. 12 9 6 3 0 1 Foot.
 (Proceedings Inst. M.E. 1858, Page 161.)
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