PAPER.

IMPROVEMENTS IN LOCOMOTIVE DETAILS.

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DISPOSAL OF EXHAUST STEAM FROM WESTINGHOUSE PUMP.

Up to a few years ago it was the practice to conduct all the exhaust steam from the pump duct to the funnel, and most of the locomotives were fitted up in this manner. There were two serious objections to this method—Firstly, condensation of steam in the exhaust pipe caused accumulation of water when the engine and pump cooled down; and when the pump was re-started the accumulated water was forced violently up the funnel, generally scattering a lot of soot from the funnel and from the ceiling of the engine-shed. This sooty water fell over the engine and persons standing near. The second objection was the noise made by the pump exhaust, which certainly was a nuisance during late night and early morning hours. Residents near the railway lines in suburbs complained about it, but for very many years the railway mechanical engineers could not devise any means of relief.

Eventually the author was instructed to investigate the matter with a view to improvement, and he found that in an engine which had been used for experiment the pump exhaust had been conveyed beneath the fire grate. Those responsible for this arrangement admitted they could not improve it. This was a failure, because the vapour rising from the steam had such a deleterious effect on the fire that the engine was soon non-effective on account of the fire dying down. It had been thought that the fire would be kept in good condition by the action of the blast when the engine was running under steam. When the engine was “coasting” (rolling) down hill, however, the fire was seriously affected; and also when the engine was standing at a station.

An attempt had been made to overcome this trouble by means of a “cut-out” valve, which turned the pump exhaust steam out into the atmosphere instead of into the ashpan. The driver operated this cut-out valve as soon as the engine
stopped at a station. This plan partly overcame the difficulty so far as the fire was concerned, but the locomotive engineers were still "up against" something; the new trouble being that there was so much vapour around about the engine cab and tender that the driver could not see through it to get the signal from the guard for starting the train. In the course of a few weeks, however, and after a few preliminary experimental trips, the author obtained the necessary authority and fixed up an engine.

The operation of this arrangement was as follows:—Exhaust steam from pump entered the condenser at the top; considerable condensation took place immediately the steam struck the walls of the condenser, which was simply a cast-iron box, cylindrical in form, and something less than one cubic ft. capacity. The vapour arising from the condensing steam flowed along the pipe to the funnel. The water resulting from condensation flowed to the ashpan, into the space between the ashpan bottom and the apron-plate, and trickled out near to the "front" door of the ashpan and the sliding doors in the bottom of the ashpan. Most of the water got away at these places, as, of course, such doors are not watertight. Ashes near the door were well wetted. The combined effect of this arrangement was most satisfactory. The noise of the pump exhaust was reduced to about one-twentieth part of what it had been formerly. The condenser became a "silencer." The sound was not an irritating loud blast, 100 to the minute, but a gentle "Foo—Foo." Water could not collect in the pipe leading to the funnel, because what little vapour did condense in it flowed back into the "silencer," and thence to the ashpan. Ashes did not have a tendency to fall out of the front of the ashpan, because they were thoroughly wetted within a few minutes after the pump was started, and even if any did happen to fall on to the track there was no danger of them setting fire to the sleepers, or causing grass fires or bush fires. The reason why the noise was so much reduced was that the pressure of the exhaust steam was reduced from about 30 lbs. to about 5 lbs. per square inch as soon as it entered the "silencer," and this was further reduced by the time the vapour reached the engine funnel. After many months of trial in service this scheme was adopted on all engines.

**DUMP-GRADES ON LOCOMOTIVES (Victorian Railways).**

Some years ago it became desirable to use dump-grates or tip-bars on locomotives for the purpose of minimising the labour otherwise necessary when shovelling out clinker and ash and red-hot coals at the end of a trip. This material
had to be got out through the fire-hole. The arrangement in was as shown in Fig. 1.

Fig. 1.

This arrangement was not a success, for the following reasons:

1. The dump-grate occasionally became accidentally lifted out of its supporting brackets, one at each side of the
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firebox. This would happen whilst an engine was on service, and eventually a serious delay was caused to an express train on account of the dump-grate falling down into the ashpan, and the enginemen being unable to replace it in position, another engine had to be sent for from the nearest depot. This incident led to the author receiving instructions to look into the matter with a view to improvement. As was his usual practice, he made a few trips on an engine fitted with the arrangement just described, in order to make observations and notes of the conditions of working. At the termination of a journey the fireman “tipped” the ashes and clinker and some red-hot coals into the ashpan. This red-hot mass accumulated around the rocking shaft (R), and made it so red-hot that when the fireman attempted to raise the tip bar, or dump-grate, up into “running” position the shaft twisted, and the whole arrangement thus became non-effective, and put the engine out of service. The fireman however, tried to raise the dump-grate into its “running” position by means of a bar of iron; then something else happened; without warning the dump-grate tumbled down into the ashpan. The fireman had “accidentally” unshipped it from its supporting brackets (B). In a few weeks the scheme as shown (Fig. 2) was tried. This arrangement was given a thorough trial on engines in service, and it proved effective and efficient in every desirable way, and was adopted as “standard.” The advantages resulting from adopting the improved method of disposing of the exhaust steam from the Westinghouse pump, as well as the improved dumping-grate brackets, are briefly as follow:

1. The ashes were thoroughly wetted, thus eliminating danger of setting fire to sleepers, grass or bush.
2. The Westinghouse pump steam exhaust was dealt with in such a manner as did away with most of the noise, and prevented water collecting in the exhaust pipe.
3. The rocking-shaft could not become red-hot, and therefore would not refuse to function.
4. The dump-grate was “fool-proof,” and could not be accidentally lifted out of its brackets (BB).
5. The fire was not affected, because most of the steam became condensed within the “silencer,” and most of the vapour arising from the hot water which flowed into the space between the bottom plate of the ashpan and the apron plate also condensed, the water simply flowing out near the sliding doors, or wetting the ashes which accumulated there.

LOCOMOTIVE DRAWBAR SPRINGS.

Of course, everyone is aware of the fact that there is a spring between engine and train to prevent shock when train
is started. Something of this kind was absolutely necessary in steam practice because drivers frequently start the train too hurriedly, causing a jerk which sometimes pulled a drawbar right out of a truck or car, or gave passengers an unpleasant experience, even causing bodily injury. Up to a few years ago a really efficient engine drawbar spring had not been invented or designed. The arrangement in general use was as illustrated in Fig. 3.

This arrangement permitted a movement, or compression, of the indiarubber washer of about \( \frac{1}{2} \) inch only; after that the cast-iron cups touched each other, and the pull was then against solid metal. The indiarubber very soon perished, and the arrangement was then of no use whatever. Eventually the author examined the drawgear in use, and travelled in cars next to engines in order to observe actual conditions and to get ideas about the problem. In a few days he submitted a design as shown in Fig. 4.

This design provided for a maximum movement of \( 2\frac{1}{2} \) in. before the spring would close up "solid"; so as to give reasonable time and distance for the momentum of the engine, when starting, to be absorbed by the spring whilst the train
was being got into motion. The spring was also required to resist a maximum pull, or jerk, of 20,000 pounds before closing up solid.

In fixing upon a section of steel for the spring, it was necessary to avoid the use of a mathematical formula which might result in a demand for some special section of steel which would not be readily available. Delay was not desirable. The strongest section of spring steel available immediately, and in sufficient quantity for the purpose, was one of $\frac{5}{8}$ in. by 5 in. The next move was to find out what would be the amount of deflection of a spring made of this material, and coiled in the manner proposed, when subjected to a load of 20,000 pounds.

The length of this material required to make a spring coiled as above was 84 in. Ten inches of this length was required to form a "base" at the small end, and 24 in. to form a base at the large end—that is to say, at the largest diameter. Deducting 10 in. + 24 in. from 84 in. left 50 in. of material to act as a spring. No suitable formula was available for a spring of the above shape, but it was clear that the deflection could be calculated by treating the spring as a cantilever loaded at the end. The calculated deflection was 2.66 inches. This result was close enough to the 2½ in. limit to be considered satisfactory. A test of one of these springs in a hydraulic press showed that it required 8½ tons to fully compress it. The test proving favourable, one of the springs was fitted to a suburban engine, and the motions of the spring were graphed as shown in Fig. 4. The engine so fitted was put on to run a Box Hill train (passenger). Starting from Flinders-street Station, a graph like Fig. 5 was produced.

These springs were exceedingly easy and cheap to make, as there was no forging required. The lengths of steel were cut off and heated in a furnace, and coiled so that no part of the spring touched any other part when compressed; 2½ in. being allowed for compression. The coiling only occupied a few minutes, and the hardening and tempering was also quite a simple matter.

After exhaustive trials this design was adopted as the "standard" drawbar spring for all engines and tenders. When properly made and tempered these springs are practically everlasting in their service, as there is nothing to wear out or get out of order.

**DISCUSSION.**

The President said there were three matters that stood out prominently among the problems that Mr. Ison had solved, and very great advantage had been brought about by the use of the seemingly ordinary details of construction shown. The matter of preventing the exhaust from the air-
pressure pump becoming a nuisance was a boon that could be appreciated generally throughout the world. The method Mr. Ison had used to overcome that difficulty was very ingenious and yet so simple that it was a wonder it had not been generally adopted. The next matter of very great interest was the simple device for overcoming the shock due to the sudden starting of trains. He was surprised that the rubber washer for absorbing the shock had not been superseded long ago. The spring introduced by Mr. Ison would evidently overcome the difficulty, and not only prevent the shock to passengers but have the effect of improving the working of the locomotive, in that the strain would be brought more evenly into operation. He thought the great lesson to be learned was that they all should delve into the minutiae of all matters. Nowadays, when information could be obtained so easily by the members of the profession, many were inclined to take things for granted, and did not always get down to the details that must be understood to solve the problems that confused them. The thanks of the Institute were due to Mr. Ison for having brought the matter forward.

Mr. G. F. Robert thanked the author for his lecture, and said that the principle of the rubber washers as shock absorbers was in the early days used extensively on battleships, and proved very effective. However, in the more recent ships increased efficiency had been secured by the use of springs and plungers. The method of determining deflection by means of a drum, as mentioned by Mr. Ison, was also used on battleships to determine the deflection caused by a broadside, and was very successful.

The President said that, in connection with measurement of delicate deflections, members would be interested to know of a very simple application of gas-recording gauges. When the earthquake was felt in Melbourne about four years ago the Assistant Astronomer was much interested when he was shown practically the exact track of the earth tremor from the variation of the gas-recording gauges throughout Melbourne. They had acted as small seismographs, and indicated the direction in which the shock travelled.

Mr. W. R. Pollock said the efficiency of the spring to absorb shocks had been proved in the tramway system, where considerable shock would be experienced in the case of carriages coming back with a run if there were not some such arrangement. The springs brought them to rest very gently, and were more effective.

Mr. W. Ison, in reply, said he had seen an apparently similar spring in use before designing the spring he introduced, but it was of very little value, because one end of the spring had been forged thin instead of maintaining the full thickness throughout its length.
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